SLOVENIAN ENVIRONMENT AGENCY

SLOVENIA'S NATIONAL INVENTORY REPORT 2013

Submission under the Decision 280/2004/EC

Submission under the United Nations Framework Convention on Climate Change

and under the Kyoto Protocol

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PREFACE

Slovenian Environment Agency (ARSO) is in accordance with the Slovenian legislation charged with both the overall coordinating of activities that are necessary for the development of emission inventories, as well as with implementing inventories for the purposes of reporting to the United Framework Convention on Climate Change (UNFCCC) and to the European Commission. The Republic of Slovenia is as a party to the convention obligated to make annual GHG emission inventories and to report them.

The National inventory report (NIR), as established by decision 18/COP.8, is one element of the annual greenhouse gas inventory that is required to be submitted to the UNFCCC by Annex I Parties to the Convention on 15 April each year. The other elements of this submission include the reporting of GHG emissions by sources and removals by sinks in the common reporting format (CRF) tables for the period 1986-2011 and additional information as support of this submission in the following annexes:

Annex 1: Detailed information on key category analyze including Table 7.A1 of the IPCC good practice guidance

Annex 2: Detailed methodology and data for estimating CO_2 emissions from fossil fuel combustion

Annex 3: Other detailed descriptions for agriculture and LULUCF sector

Annex 4: CO_2 reference approach and comparison with sectoral approach and relevant information on the national energy balance

Annex 5: Assessment of completeness

Annex 6: SEF Tables, SIAR, and Documentation on the Consolidated System of EU registries

Annex 7: Uncertainty analyze including Table 6.3 of the IPCC good practice guidance

Specific responsibilities for the NIR 2013 have been as follows:

Overall responsibility: Tajda Mekinda Majaron

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Industrial processes	*Martina Logar D.Sc.*
F-gases	*Tajda Mekinda Majaron*

Solvent use *Martina Logar D.Sc.*

Agriculture *Jože Verbič D.Sc., Tajda Mekinda Majaron*

LULUCF *Primož Simončič D.Sc. Milan Kobal D.Sc., Gal Kušar D.Sc., Laura Žižek Kulovec*

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Recalculations *Tajda Mekinda Majaron*

CFR Tables *Tajda Mekinda Majaron, Martina Logar D.Sc., Laura Žižek Kulovec*

Annexes *Tajda Mekinda Majaron, Martina Logar D.Sc., Irena Malešič, Gal Kušar D.Sc., Primož Simončič D.Sc.,*

PART 2 : SUPLEMENTARI INFORMATION UNDER ARTICLE 7, PARAHRAPH 1 OF THE KYOTO PROTOCOL

KP- LULUCF *Primož Simončič D.Sc., Milan Kobal D.Sc., Gal Kušar D.Sc., Laura Žižek Kulovec*

Information on accounting of Kyoto Units: *Irena Malešič*

CPR calculation *Tajda Mekinda Majaron*

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Information on minimization of adverse impacts *Andrej Kranjc M.Sc.*

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Executive Summary

An emissions inventory that identifies and quantifies a country's primary anthropogenic sources and sinks of greenhouse gases is essential for addressing climate change. This inventory adheres to both: a comprehensive and detailed set of methodologies for estimating sources and sinks of anthropogenic greenhouse gases, and a common and consistent mechanism that enables Parties to the United Nations Framework Convention on Climate Change (UNFCCC) to compare the relative contribution of different emission sources and greenhouse gases to climate change.

In 1992, the Republic of Slovenia signed and in 1995, ratified the UNFCCC. As stated in Article 2 of the UNFCCC, “The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. ”2 Parties to the Convention, by ratifying, “shall develop, periodically update, publish and make available…national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the *Montreal Protocol*, using comparable methodologies…”3 The Republic of Slovenia views this report as an opportunity to fulfil these commitments.

This chapter summarizes the latest information on Slovenian anthropogenic greenhouse gas emission trends from 1986 through 2010. To ensure that the Slovenian emissions inventory is comparable to those of other UNFCCC Parties, the estimates presented here were calculated using methodologies consistent with those recommended in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC/UNEP/OECD/IEA 1997), the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (IPCC 2000), and the IPCC *Good Practice Guidance for Land Use, Land-Use Change, and Forestry* (IPCC 2003). The structure of this report is consistent with the UNFCCC guidelines for inventory reporting.

1 INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

At the Second World Climate Conference in Geneva in October and November 1990, a clear need was expressed for standard methodology for monitoring emissions of greenhouse gases, which was to enable comparing and enhancing inventories in individual countries. Under the auspices of OECD and International Energy Agency and with the support of the United States of America, United Kingdom, and Norway, a draft methodology was set up. That document comprised six direct and indirect greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_x), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). The methodology was adopted in Paris in March 1991 at the Fifth Session of the Intergovernmental Panel on Climate Change (IPCC) and it became the starting point for individual states in creating their national inventories of greenhouse gases.

The methodology for the calculation of greenhouse gases kept developing all the time and is even today a project under development. In the IPCC inventory of greenhouse gases for Slovenia, first the 1996 version was applied (Intergovernmental Panel on Climate Change: Greenhouse Gas Inventory - Reference manual, UNEP-OECD-IEA-IPCC, Bracknell 1996), which in some parts also takes into account the emissions of direct greenhouse gases that have been encompassed by the Kyoto Protocol (CF_4, C_2F_6, PFCs, HFCs and SF_6). Later the inventory has been permanently improving with implementation of GPG (Intergovernmental Panel on Climate Change: Good practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000)

The guidelines for the implementation of the inventory of greenhouse gases contain prescribed methods for calculation of emissions, providing a unified framework for reporting and documenting sources for all inventories. One of the main aims of this method is to ensure comparability of data gathered in individual states and that calls for a definition of at least a minimum scope of equal methods, criteria, and estimating procedures.

The report presents estimates for the 6 greenhouse gases included in Annex A to the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF_6), as well as estimates for indirect GHGs, including carbon monoxide (CO), nitrogen oxides (NOx), and non-methane volatile organic compounds (NMVOC). Data are also reported for sulphur oxides (SOx).

Global warming potential

The GWP of a greenhouse gas is defined as the ratio of the time-integrated radiative forcing from the instantaneous release of 1 kg of a trace substance relative to that of 1 kg of a reference gas (IPCC 2001). Direct radiative effects occur when the gas itself is a greenhouse gas. The reference gas used is CO_2, and therefore GWP-weighted emissions are measured in Gg of CO_2 equivalents (Tg CO_2 eq.).

While any time period may be selected, this report uses the 100-year GWPs recommended by the IPCC, and adopted by the UNFCCC for reporting purposes (IPCC 1996). GWP values are listed below in Table 1.1.1.

Table 1.1.1 Global Warming Potentials (100 Year Time Horizon) Used in this Report

Gas	GWP
Carbon dioxide (CO_2)	1
Methane (CH_4)*	21
Nitrous oxide (N_2O)	310
HFC-23	11,700
HFC-32	650
HFC-125	2,800
HFC-134a	1,300
HFC-143a	3,800
HFC-152a	140
HFC-227ea	2,900
HFC-236fa	6,300
HFC-4310mee	1,300
CF_4	6,500
C_2F_6	9,200
C_4F_{10}	7,000
C_6F_{14}	7,400
SF_6	23,900

Source: IPCC (1996)

* *The methane GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapour. The indirect effect due to the production of CO_2 is*

not included. Global warming potentials are not provided for CO, NOx, NMVOCs, SO_2 or aerosols because there is no agreed upon method to estimate the contribution of gases that are short-lived in the atmosphere, spatially variable, and have only indirect effects on radiative forcing (IPCC 1996).

1.2 A description of the institutional arrangement for inventory preparation

In Slovenia, the institution responsible for GHG inventories is the Slovenian Environment Agency (ARSO). In accordance with its tasks and obligations to international institutions, the Slovenian Environmental Agency is charged with making inventories of GHG emissions, as well as emissions that are defined in the Convention on Long Range Transboundary Air Pollution within the specified time limit. In making the inventories, the Environmental Agency cooperates with numerous other institutions and administrative bodies which relay the necessary activity data and other necessary data for the inventories.

Table 1.2.1 Inventory Institutional Arrangements and Data Sources

IPCC category	IPCC sub-category	Sources of data
CRF 1 A – Energy. Fuel Combustion	CRF 1A1 - Energy Industry	• Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy Balances, annual energy statistics • Slovenian Environment Agency: ETS data
	CRF 1A2 - Manufacturing Industries and Construction	• Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy Balances, annual energy statistics • Slovenian Environment Agency: ETS data
	CRF 1A3 – Transport	• Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy balances • Ministry of Infrastructure and Spatial Planning, Directorate for National Roads (DRSC) • Ministry of the Interior (vehicle stock)
	CRF 1A4 – Other Sectors	• Statistical Office of the Republic of Slovenia:
CRF 1 B – Fugitive Emissions from Fuels		• Statistical Office of the Republic of Slovenia: • natural gas distributors
CRF 2 – Industrial Processes	CRF 2A – Mineral Products	• Statistical Office of the Republic of Slovenia: • Slovenian Environment Agency
	CRF 2B – Chemical Industry	• Statistical Office of the Republic of Slovenia: • Slovenian Environment Agency
	CRF 2C – Metal Production	• Statistical Office of the Republic of Slovenia: • Slovenian Environment Agency
	CRF 2D – Other Production	• Statistical Office of the Republic of Slovenia: • Slovenian Environment Agency
	CRF 2F – Consumption of Halocarbons and SF_6	• Slovenian Environment Agency
CRF 3 – Solvent and Other Product Use		• Statistical Office of the Republic of Slovenia • Slovenian Environment Agency
CRF 4 – Agriculture		• Statistical Office of the Republic of Slovenia • Agricultural Institute of Slovenia
CRF 5 – Land Use, Land Use Change, and Forestry		• Slovenian Forestry Institute
CRF 6 – Waste	CRF 6A – Solid Waste Disposal on Land	• Slovenian Environment Agency
	CRF 6B – Wastewater Handling	• Slovenian Environment Agency • Statistical Office of the Republic of Slovenia

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Pollution within the specified time limit. In making the inventories, the Environmental Agency cooperates with numerous other institutions and administrative bodies which relay the necessary activity data and other necessary data for the inventories.

The chief sources of data are the Statistical Office of the Republic of Slovenia (SORS) and the Ministry of Agriculture and the Environment; however, the Slovenian Environmental Agency obtains 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 (KIS), and sinks in the LULUCF sector are calculated by the Slovenian Forestry Institute (GIS).

1.3 Brief description of the process of inventory preparation

Owing to the ever-increasing obligations of Slovenia with regard to reporting, the Slovenian Environment Agency has decided to implement a unified system of data collection for the purposes of making inventories, as well as secure reliable financing in accordance with the annual program of its work. The ability to fulfil its obligations with regard to reporting was also improved by the participation of Slovenian Environmental Agency in the GEF project

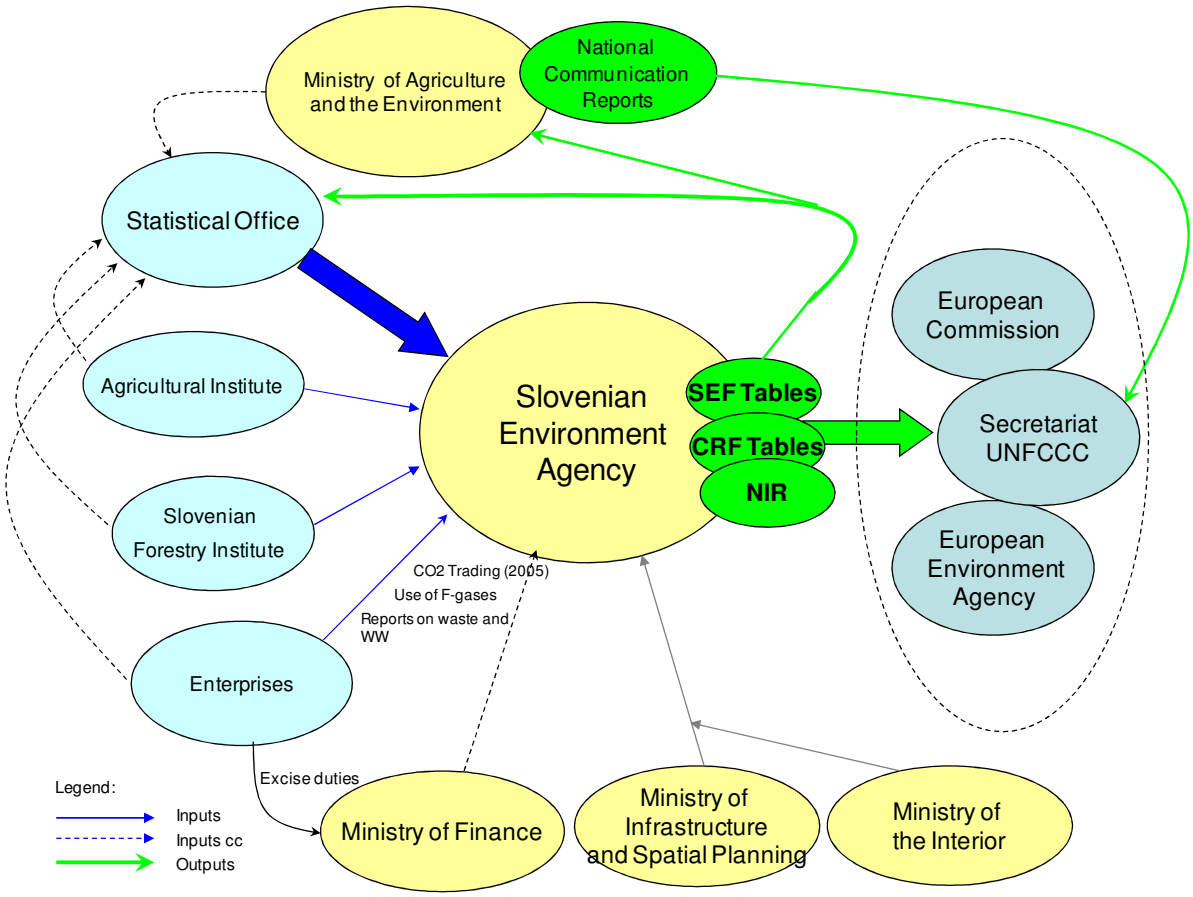

Figure 1.3.1: Data flow in the Slovenian Inventory System

"Capacity building for improving GHG inventories", which ended in June 2006, and thus Slovenia made the inventories in due time and sent them in the required form to the UNFCCC Secretariat.

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 inventories and the NIR have shortened with the entry of Slovenia into the EU, since inventories and part of the NIR for the year before last must be made by 15 January, and with corrections and final submission of the NIR by 15 March. 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.

The year 2003 saw the end of the process of harmonisation of data collection among the Directorate of Energy, Ministry of Agriculture and the Environment, 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 Environmental Agency came into force. Accordingly, all statistical data which are necessary for preparing GHG 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.

Experts from the Slovenian Forestry Institute and the Agricultural Institute of Slovenia work on GHG inventories according to the standing rules of institutes (ordinance). Financing is assured by governmental institutions according to the yearly work plan. All data from external institutions are submitted to the Slovenian Environmental Agency, where they are archived. The detailed process from gathering data to emissions calculation and reporting is described in our Manual of Procedures, which was prepared in 2005 and has been further updated when needed. The QA/QC plan as part of the Manual was developed and mostly implemented in 2009.

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 Slovenian Environment Agency 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 have started to develop a joint database for GHGs and other pollutants: ISEE – Information system for emission inventories. In broad terms the application is completed and operational since 2011, but it is still necessary to conduct regular maintenance and improvements. The database contains 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. It contains equations necessary for calculation of emissions and enables a direct bulk import into the CRF Reporter.

1.4 Brief general description of methodologies and data sources used

Inventories of GHG emissions were presented on the basis of the IPCC (IPCC 1996, GPG 2000) methodology for all gases and sectors. Due to the importance of the source and accessible data, different approaches (tiers) from within the IPCC methodology were used.

In energy sector a national/plant specific CO_2 emission factors were used for assessment of emissions from coal and natural gas (Tier 2), while for other fuels, default IPCC emission factors were mainly used. The quantities of fuels and consumed fuel energy values were taken from the Statistical Office of the Republic of Slovenia. Additional data on the energy use of some types of waste (waste tyres, 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. GHG emissions in road transport were determined with the COPERT 4 model.

Emission factors for fugitive emissions of CO_2 and CH_4 in mining activities were determined on the basis of measurements of methane concentrations in ventilation shafts in mines and estimated quantities of released methane. The emission factor that was determined in this manner was lower than the default IPCC emission factor. CO_2 emissions in post-mining activities were not assessed, as no estimation method is available. The regional default IPCC emission factor for transmission and distribution of natural gas does not correspond to the conditions in Slovenia; consequently, in calculating CH_4 emissions from the distribution of natural gas, data from the companies that manage the distribution and transportation network were used. Losses were estimated according to the length of individual types of transmission or distribution pipelines with regard to the pipe type, applying specific losses per unit of length, as presented in the German Inventory, and this appears to be a sensible solution considering the level of maintenance and low average age of the distribution network.

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. These data have also been used for preparing our National Allocation Plan for the EU-ETS. Since 2005, data from verified reports have mostly been used. In some cases (aluminium and ferroalloy production), the plant data still have to be obtained. Emissions from primary aluminium production were estimated from anode consumption and from PFC emissions, which were determined on the basis of the number and duration of anode effects. In determining actual emissions caused by the use of HFCs, data were obtained from companies that use or sell these materials, as well as data on the export and import of refrigerators. For SF_6 emissions, the release of this gas from gas-insulated switchgear in the Energy sector was assessed.

Emissions from the consumption of solvents and diluents consisted only of N_2O, which arises from evaporation during the use of N_2O, mostly for anaesthesia.

In agriculture, methane emissions from enteric fermentation and manure management in bovine animals were determined using Tier 2 approach and the Tier 1 approach was used for other animals that represent a smaller fraction in methane emissions. Input data for N_2O emissions from manure handling and from indirect emissions from fertilisation with animal fertilisers were obtained in the process of estimating methane emissions. For N_2O emissions, default IPCC factors for determining the conversion of nitrogen into N_2O were used.

Table 1.4.1: Summary report for methods and emission factors used from CRF tables

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	EF	Method applied	EF	Method applied	EF
1. Energy	**M,T1,T2,T3**	**CS,D,M,PS**	**M,T1,T3**	**CS,D,M**	**M,T1**	**D,M**						
A. Fuel Combustion	M,T1,T2	CS,D,M,PS	M,T1	D,M	M,T1	D,M						
1. Energy Industries	T1,T2	CS,D	T1	D	T1	D						
2. Manufacturing Industries and Construction	T1	CS,D,PS	T1	D	T1	D						
3. Transport	M,T1	CS,D,M	M,T1	D,M	M,T1	D,M						
4. Other Sectors	T1	CS,D	T1	D	T1	D						
5. Other	T1	D	T1	D	T1	D						
B. Fugitive Emissions from Fuels	T1,T3	CS	T1,T3	CS,D	NA	NA						
1. Solid Fuels	T3	CS	T3	CS	NA	NA						
2. Oil and Natural Gas	T1, T3	CS	T1,T3	CS,D	NA	NA						
2. Industrial Processes	**CS,D,T2**	**CS,D,PS**	**D**	**D**	**NA**	**NA**	**T1,T2**	**CS,D**	T3	PS	**T2**	**CS,D**
A. Mineral Products	CS,D,T2	CS,D	NA	NA	NA	NA						
B. Chemical Industry	D	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Metal Production	D,T2	D,PS	NA	NA	NA	NA	NA	NA	T3	PS	NA	NA
D. Other Production	NA	NA										
E. Production of Halocarbons and SF_6							NA	NA	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6							T1,T2	CS,D	NA	NA	T2	CS,D
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**NA**	**NA**			**D**	**D**						
4. Agriculture			**T1,T2**	**CS,D**	**D,T1,T1a,T1b**	**CS,D**						
A. Enteric Fermentation			T1,T2	CS,D								
B. Manure Management			T1,T2	CS,D	D	CS,D						
C. Rice Cultivation			NA	NA								
D. Agricultural Soils			NA	NA	D,T1,T1a,T1b	CS,D						
E. Prescribed Burning of Savannas			NA	NA	NA	NA						
F. Field Burning of Agricultural Residues			NA	NA	NA	NA						
G. Other			NA	NA	NA	NA						
5. Land Use, Land-Use Change and Forestry	**CS,D,T1,T2,T3**	**CS,D**	**D,T1**	**D**	**D,T1**	**D**						
A. Forest Land	CS,D,T1,T2,T3	CS,D	D,T1	D	D,T1	D						
B. Cropland	D,T1,T2	CS,D	NA	NA	NA	NA						
C. Grassland	D,T1,T2,T3	CS,D	NA	NA	NA	NA						
D. Wetlands	D,T1,T2	NA	NA	NA	NA	NA						
E. Settlements	D,T1	CS,D	NA	NA	NA	NA						
F. Other Land	D,T2	CS,D	NA	NA	NA	NA						
G. Other	NA	NA	NA	NA	NA	NA						
6. Waste	**D**	**D**	**T1,T2**	**CS,D**	**D,T1**	**D**						
A. Solid Waste Disposal on Land	NA	NA	T2	CS,D								
B. Waste-water Handling			T1	CS,D	T1	D						
C. Waste Incineration	D	D	NA	NA	D	D						
D. Other	NA	NA	NA	NA	NA	NA						
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

In 2013 emissions and removals from the LULUCF sector have been calculated for all types of land use for the first time. Reported calculations are based on the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003) completed by country-specific methodologies. The land areas from are represented by geographically explicit land-use data with a resolution of 0.25 ha. Study of land use by Slovenian Forestry institute enables to calculate spatially explicit land-use change matrices.

Methane emissions from solid waste handling were determined by the FOD method, which takes into account the time dynamics of methane release. Emissions of CH_4 and N_2O from wastewater were calculated with default method as well as emissions from waste incineration.

1.5 Brief description of key categories

The analysis of key source categories was performed on the basis of sectoral distribution and using the Tier 1 approach. This approach was used both for the base year and for the year 2011. A level assessment was undertaken for 1986 and 2011, and a trend assessment was performed for 2011. The KCA has been performed with and without LULUCF sector.

On the basis of the tier 1 KCA including LULUCF, 26 categories were selected as a key, representing 95.0% of emissions in 2011 according to the level assessment, and 2 were chosen which are key categories according to the trend assessment only. As many as 19 categories are key sources according to level and trend key source analysis.

From 26 key categories the most are from Energy sector: 8 categories are CO2 emissions from fuel combustion, and one is CH_4 emissions from Coal mining and handling, their contribution to the level is 45.0 %. The second most representative sector is LULUCF with 7 key source categories and 42.4% to the level. Six KC are in the Agriculture sector; 4 are related to methane emissions and 2 to N_2O emissions. Their contribution to the total is only 4.6%. In the industrial processes there are 3 KC and in the Waste sector are only one, together they contribute 3.1% of GHG emissions.

On the basis of the tier 1 KC analysis excluding LULUCF, 25 categories were selected as a key, representing 95.2% of emissions in 2011 according to the level assessment, and 8 were chosen which are key categories according to the trend assessment only. As many as 20 categories are key sources according to level and trend key source analysis.

From 25 key categories the most (11) are from Energy sector: 9 categories are CO_2 emissions from fuel combustion, one is CH4 emissions from fuel combustion, and one is CH_4 emissions from Coal mining and handling, their contribution to the level is 78.1%. The second most representative sector is Agriculture sector with 8 KC; 5 are related to methane emissions and 3 to N_2O emissions. Their contribution to the total is only 10.5%. In the industrial processes are 4 KC and in the Waste sector are 2, together they contribute 6.6% of GHG emissions.

On the following pages Tier 1 key categories estimates are presented with and without LULUCF. The KCs are indicated with red number (rank 2011, KC trend, Rank 1986).

Table 1.5.1: IPCC KS Categories for 2011, Tier 1 with LULUCF.

Rank 2011	CRF	Sector	Category	Gas	GHG 1986	GHG 2011	KC trend	Rank 1986
1	5	**LULUCF/ A. Forest land**	1. Forest Land remaining Forest Land	CO2	10343.796	11577.808	1	1
2	1A	**1. Energy Industries**	a. Public Electricity and Heat Production	CO2	6533.755	6223.550	3	2
3	1A	**3. Transport**	b. Road Transportation	CO2	1905.428	5592.846	2	3
4	1A	**4. Other Sectors**	b. Residential	CO2	1100.185	1020.357	5	6
5	1A	**2. Manufacturing Ind. and Constr.**	f. Other	CO2	1774.835	869.932		4
6	5	**LULUCF/ E. Settlements**	2. Land converted to Settlements	CO2	624.727	744.520	6	8
7	5	**LULUCF/ C Grassland**	2. Land converted to Grassland	CO2	197.072	633.397	4	27
8	1A	**4. Other Sectors**	a. Commercial/Institutional	CO2	612.110	569.808	9	9
9	5	**LULUCF/ A. Forest land**	2. Land converted to Forest Land	CO2	464.736	464.736	11	11
10	5	**LULUCF/ F. Other Land**	2. Land converted to Other Land	CO2	278.392	453.185	8	20
11	4	**A. Enteric Fermentation**	1. Non-Dairy Cattle	CH4	263.057	376.045	10	23
12	4	**D. Agricultural Soils**	1. Direct Soil Emissions	N2O	435.343	373.619	15	13
13	5	**LULUCF/ B. Cropland**	2. Land converted to Cropland	CO2	316.021	372.358	13	18
14	6	**A. Solid Waste Disposal on Land**	1. Managed Waste Disposal on Land	CH4	298.801	366.372	12	19
15	1A	**2. Manufacturing Ind. and Constr.**	d. Pulp, Paper and Print	CO2	649.556	348.448		7
16	2	**Industrial Processes**	1. Cement Production	CO2	514.615	316.063		10
17	4	**D. Agricultural Soils**	3. Indirect Emissions	N2O	334.663	284.738	19	17
18	1B	**Fugitive Emissions from fuels**	a. Coal Mining and Handling	CH4	358.906	253.343	22	16
19	4	**A. Enteric Fermentation**	1. Dairy Cattle	CH4	383.587	235.601		15
20	2	**Industrial Processes**	1. Refrigeration and AC Equipment	HFC		209.756	14	
21	1A	**4. Other Sectors**	c. Agriculture/Forestry/Fisheries	CO2	428.364	200.726		14
22	1A	**2. Manufacturing Ind. and Constr.**	a. Iron and Steel	CO2	1141.586	194.458	7	5
23	2	**Industrial Processes**	3. Limestone and Dolomite Use	CO2	47.390	165.300	16	45
24	4	**B. Manure Management**	1. Non-Dairy Cattle	CH4	66.046	164.190	18	38
25	5	**LULUCF/ D. Wetlands**	2. Land converted to Wetlands	CO2	137.966	157.932		29
26	4	**B. Manure Management**	1. Dairy Cattle	CH4	152.449	131.427		28
27	4	**B. Manure Management**	13. Solid Storage and Dry Lot	N2O	267.309	123.028		22
29	1A	**4. Other Sectors**	b. Residential	CH4	134.558	112.155		30
31	4	**B. Manure Management**	8. Swine	CH4	228.267	100.800		25
32	1A	**2. Manufacturing Ind. and Constr.**	e. Food Processing, Beverages and Tobacco	CO2	247.754	99.212		24
33	2	**Industrial Processes**	2. Lime Production	CO2	220.206	90.735		26
34	1A	**2. Manufacturing Ind. and Constr.**	b. Non-Ferrous Metals	CO2	440.325	86.328	17	12
45	2	**Industrial Processes**	3. Aluminium Production	PFC	276.291	28.611	20	21

Table 1.5.2: IPCC KS Categories for 2011, Tier 1 without LULUCF.

Rank 2011	CRF	Sector	Category	Gas	GHG 1986	GHG 2011	KS trend	Rank 1986
1	1A	**1. Energy Industries**	a. Public Electricity and Heat Production	CO2	6533.755	6223.550	20	1
2	1A	**3. Transport**	b. Road Transportation	CO2	1905.428	5592.846	1	2
3	1A	**4. Other Sectors**	b. Residential	CO2	1100.185	1020.357	25	5
4	1A	**2. Manufacturing Ind. and Constr.**	f. Other	CO2	1774.835	869.932	3	3
5	1A	**4. Other Sectors**	a. Commercial/Institutional	CO2	612.110	569.808		7
6	4	**A. Enteric Fermentation**	1. Non-Dairy Cattle	CH4	263.057	376.045	13	18
7	4	**D. Agricultural Soils**	1. Direct Soil Emissions	N2O	435.343	373.619	23	10
8	6	**A. Solid Waste Disposal on Land**	1. Managed Waste Disposal on Land	CH4	298.801	366.372	21	15
9	1A	**2. Manufacturing Ind. and Constr.**	d. Pulp, Paper and Print	CO2	649.556	348.448	5	6
10	2	**Industrial Processes**	1. Cement Production	CO2	514.615	316.063	9	8
11	4	**D. Agricultural Soils**	3. Indirect Emissions	N2O	334.663	284.738	26	14
12	1B	**Fugitive Emissions from fuels**	a. Coal Mining and Handling	CH4	358.906	253.343	19	13
13	4	**A. Enteric Fermentation**	1. Dairy Cattle	CH4	383.587	235.601	12	12
14	2	**Industrial Processes**	1. Refrigeration and AC Equipment	HFC		209.756	8	
15	1A	**4. Other Sectors**	c. Agriculture/Forestry/Fisheries	CO2	428.364	200.726	7	11
16	1A	**2. Manufacturing Ind. and Constr.**	a. Iron and Steel	CO2	1141.586	194.458	2	4
17	2	**Industrial Processes**	3. Limestone and Dolomite Use	CO2	47.390	165.300	16	
18	4	**B. Manure Management**	1. Non-Dairy Cattle	CH4	66.046	164.190	17	
20	4	**B. Manure Management**	1. Dairy Cattle	CH4	152.449	131.427		22
21	4	**B. Manure Management**	13. Solid Storage and Dry Lot	N2O	267.309	123.028	11	17
19	6	**B. Waste Water Handling**	2. Domestic and Commercial Waste Water	CH4	113.217	117.522		25
22	1A	**4. Other Sectors**	b. Residential	CH4	134.558	112.155		23
23	2	**Industrial Processes**	3. Aluminium Production	CO2	89.402	107.969		28
24	4	**B. Manure Management**	8. Swine	CH4	228.267	100.800	15	20
25	1A	**2. Manufacturing Ind. and Constr.**	e. Food Processing, Beverages and Tobacco	CO2	247.754	99.212	10	19
26	2	**Industrial Processes**	2. Lime Production	CO2	220.206	90.735	14	21
27	1A	**2. Manufacturing Ind. and Constr.**	b. Non-Ferrous Metals	CO2	440.325	86.328	4	9
28	1A	**2. Manufacturing Ind. and Constr.**	c. Chemicals	CO2	98.052	84.269		27
29	1B	**Fugitive Emissions from fuels**	a. Coal Mining and Handling	CO2	120.238	81.847	28	24
37	2	**Industrial Processes**	3. Aluminium Production	PFC	276.291	28.611	6	16
54	1A	**1. Energy Industries**	b. Petroleum Refining	CO2	62.225	4.239	22	
56	1A	**5. Other**	b. Mobile - Military use	CO2	41.093	3.343	27	
68	2	**Industrial Processes**	4. Carbide Production	CO2	44.985	1.178	24	
72	1A	**1. Energy Industries**	c. Manufacture of Sol. Fuels and Oth. En. Ind.	CO2	104.728	0.771	18	26

1.6 Information on the QA/QC plan, verification and treatment of confidentiality

In 2009, Slovenia developed and mostly implemented a Quality Assurance and Quality Control plan as recommended by the IPCC Good Practice Guidelines (IPCC 2000). The QA/QC plan is part of the Manual of Procedures, elaborated in 2005 and updated in 2009.

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 final 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 (CRF Reporter).

In late 2009, the first two stages of development of ISEE were finished, while the bulk importing into CRF Reporter have been finished in 2011. 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 are expected. But for QA/QC purpose all emissions are also calculated in the old way in Excel spreadsheets. Both estimates were then compared; all differences were carefully investigated, and corrected.

<u>During development of the database, the following QC was performed:</u>

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 1986–2009, GHG 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:

Uncertainty
According to the QA/QC plan checks of uncertainty were performed in 2011. The checks consist of the following:
- Check that the qualifications of individuals providing expert judgement for uncertainty estimates are appropriate.
- Check that qualifications, assumptions and expert judgements are recorded. Check that calculated uncertainties are complete and calculated correctly.
- Check that there is detailed internal documentation to support the uncertainty estimates.

While first two QC have been performed the last QC shows that detailed documentation is not available for most of the uncertainty estimates. So we decided to use expert judgements, except for categories for which uncertainty estimates are available in GPG,2000.

Preparation of NIR
- Check that all chapters from annotated NIR are included in the NIR
- Check that AD, EF and other numerical information mentioned in the text is correct
- Check all AD data presented in the tables in the NIR
- Check all EF and other parameters used in the tables in the NIR
- Check that AD, EF and other numerical information mentioned in the text is correct
- Check all graphs that are accurate and for the whole period
- Check all titles for tables and pictures
- Check that all Annexes to the NIR are updated

For 2012 the whole NIR have been cross-checked and errors, mostly in energy sector have been put off.

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 Agriculture and the

Environment 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.

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, CD-ROM, 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 in one place. In 2012 all studies have been scanned, transformed to PDF file and stored on network server, CD-ROM and computer hard disk. The studies are available in hard copies and also in electronic format.

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 all supporting documentation on QA/QC procedures are archived
- Check that results of QC analyze and uncertainty estimates are archived
- 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.
- Check that inventory improvements plan is updated ad archived

QA
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. Since then the Energy sector and Industrial processes sector is regularly checked by experts from Energy efficiency centre (CEU/IJS).

For Agriculture and LULUCF sector it is very hard to perform peer review as the main institutions (Slovenian Forestry Institute and Agricultural Institute of Slovenia) are already involved in the inventory preparation. Due to the lack of relevant independent expert for LULUCF sector in Slovenia this sector has been reviewed during the two days visit in JRC Ispra, which was in April 2012.

In 2011 the peer review for waste sector has been performed, no important errors have been found.

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 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 2013-2017 http://www.stat.si/doc/drzstat/MediumTerm_2013-2017.pdf .
The strategic directions of Quality in National Statistics are presented in detail at http://www.stat.si/eng/drz_stat_kakovost.asp .

1.6.1 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 Agriculture and the Environment. The inventory is sent to the Ministry according the following plan:

- draft CRF tables on 3 January
- final CRF tables and draft NIR on 1 March
- final report on 1 April

1.6.2 Public availability of the inventory

The inventories are public available on the web. Every submission is accompanied with a short description in Slovene language. The estimates are presented in more simple way with the table similar to Table 2.3.1 in the NIR. GHG emissions are also presented as indicator. It is very common that yearly submission of GHG inventory is followed by press conference, where our last estimates are presented in connection with our Kyoto goal.

Web page address:
http://www.arso.gov.si/podnebne%20spremembe/emisije%20toplogrednih%20plinov/

1.7 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

In 2005 the uncertainties of activity data and emission factors in sector 1.A.1.a Public Electricity and Heat Production have been reduced. In this sector, because of the introduction of CO_2 emission trading within the EU, we have re-verified the input data and the procedure of determining the consumption of fuels. In calculating emissions from this sector, the national emission factors based on coal sampling and ascertaining the carbon contents have also been applied. All analyses have been done in the accredited laboratory in accordance with the EN ISO 17025 (“General requirements for the competence of testing and calibration laboratories”). Public power plants have presented their plan of measures to ensure that fuel consumption will be measured without intermediate storage before combustion in the installation applying measuring devices resulting in a maximum permissible uncertainty of less than +/- 2.5% for the measuring process.

The combined uncertainty was derived from Tier 1 method. The uncertainties of individual activity data and emission factors are based on expert judgment or 2000 GPG. Since expert judgments of individual experts are at variance, the highest individual uncertainties

have been taken into account. The total uncertainties have been derived both for Level Uncertainty as well as for Trend Uncertainty.

For 2011 submission the uncertainty estimates in 2009 in all sectors have been carefully investigates and uncertainties of certain categories in energy and industrial processes have been reduced. But the total combined uncertainty is still rather high because of LULUCF sector which has relatively high uncertainty and very high amount of sinks comparing to emissions (~50%). The detailed results are in the table below.

In the 1986 the uncertainty of the inventory was 50,14% (8.96 w/o LULUCF).

In the 2011 the uncertainty was 33.48% (6.75 w/o LULUCF). The biggest contributions to the lower uncertainty in 2011 have the energy and LULUCF sector. Uncertainty in Industrial processes is higher than in 1986 due to the high uncertainty of HFC estimates.

Table 1.7.1: Uncertainty in 1986 and 2011 by sectors.

	1986	2011
1A Fuel combustion	6.75%	2.51%
1B Fugitive	40.18%	39.92%
2&3 Industrial Processes & Solvents	7.31%	14.67%
4 Agriculture	64.62%	63.66%
5 LULUCF	56.74%	31.59%
6 Waste	48.82%	47.20%
TOTAL COMBINED UNCERTAINTY	**50.14%**	**33.48%**

TOTAL trend uncertainty (2011/1986) = 4.83% (2.74% w/o LULUCF).

The detailed results of uncertainty analyse are in the Annex 7 to the NIR

1.8 General assessment of the completeness

An assessment of completeness for each sector may be found in the Sector Overview part of the corresponding subchapters; here some aggregated information is presented.

Sources and sinks
All sources of direct GHG gases, included in the IPCC Guidelines, are covered in inventory. There are some gaps in estimations

Gases
All direct GHGs as well as the postulated precursor gases are covered by the Slovenian inventory.

Geographic coverage
The geographic coverage is complete. No territory in Slovenia has been left uncovered by the inventory.

Notation keys

IE (included elsewhere):
There are few categories marked with IE because relevant data are not available on the reporting level but are included in other category. These sources are:
- GHG emissions from inland navigation (included in road transport)
- GHG emissions from jet kerosene used in the domestic aviation are included in Other mobile / Army
- in solvent use sector N_20 emissions from Fire Extinguishers and Other use (included in anaesthesia)
- All GHG emission from forest fires are reported under Forest land remaining Forest Land
- All CO2 emissions from agricultural lime application are reported under cropland as limestone (all other categories are reported as IE)
- All emissions from bio-diesel and bio-ethanol are reported in Road transport

NE (not estimated):

There are few categories marked with NE because methodologies for estimating GHG emissions are not available in IPCC manuals from 1996 or in GPG from 2000. These sources are:
- GHG emissions in solvent use sector
- CH_4 from enteric fermentation from poultry

There are still few missing sources in the LULUCF sector in Wetlands and emissions related to HWP.

NA (not applicable):
The increase of this number is due to improved completeness of the CRF- tables.

NO (not occurring)
The highest number of source categories marked with NO is found in agriculture and LULUCF sector, but there are some in industrial processes and energy industries.

C (confidential)
Statistical low considering confidentiality is very strict in Slovenia. All data which are gathered from three or less reporting unit are confidential. It is good practise in national statistic that this boundary is even higher (five units). As Slovenia is a small country almost all relevant categories from industrial processes sector and in less extend also in energy sector are confidential. Nevertheless no data in our report is marked with C. The confidentiality problem in activity data has been solved on individual level with each relevant plant. After 2005 verified reports from installations included in ETS, have resolved this problem generally for most cases.

2 TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Description and interpretation of emission trends for aggregated GHG

The total emissions of GHG in 2011, sinks not considered, amounted to 19,509.31 kt CO_2 eq., which represents a 3.4% decrease of emissions compared to the year 1986 and 4.0% decrease compared to the base year emissions. In the period 1986-1991, a reduction of emissions was recorded due to the economic conditions at that time and the Republic of Slovenia gaining its independence. In the period 1992-1997, a strong increase of emissions was recorded, which was a consequence of increasing economic growth and revival of industrial production. In the second half of that period, the increased emissions were a consequence of “gasoline tourism” (25% of the total sale of motor fuels in the Republic of Slovenia), since the prices of motor fuels in the Republic of Slovenia were appreciably lower than in the neighbouring countries.

In the period 1998-1999, emission decreased due to the measures undertaken by the neighbouring countries to curb the ”gasoline tourism” and due to the increased supply of electrical energy from the Krško Nuclear Power Plant. In the period 2000-2002 emission kept increasing again due to the renewal of obligatory export of electrical energy from the Krško Nuclear Power Plant to the Republic of Croatia. After joining the EU in 2004 and after acceptance of Romania and Bulgaria into EU in 2007, emissions from road transport have increased drastically and has prevailed over decrease in other sectors which have happened due to the policies and measures in manufacturing industry, agriculture and waste sector.

In 2009 emissions from fuel used and industrial processes emissions started to decrease due to the global financial crisis. In 2010 and 2011 emissions stayed almost the same as in 2009.

2.2 Description and interpretation of emission trends by gas

CO_2 emissions in 2011 represented 82.9% of overall emissions of greenhouse gases. CO_2 emissions excluding LULUCF followed the consumption of energy and with regard to their fraction exerted a major influence on total emissions. Compared to 1986 in 2011 they decreased by 1.1%. CH_4 emissions represented 10.1% of total emissions in 2011 (10.8% in 1986) and were lower than in 1986 by 9.5%. N_2O emissions represented 5.7% of total emissions and were lower than N_2O emissions in 1986 by 20.5%. F-gases represent 1.3% of total emissions and some (HFCs and SF_6) have shown significant increases since 1995 (base year for F-gases) while PFC decrease drastically in 2008 and has continued to decrease in 2009. In 2010 a slight increase was observed and in 2011 emissions have doubled comparing to the previous year.

Carbon dioxide – CO_2

CO_2 emissions in the period 1986–2011 arise mostly from Energy sector and may be split into five segments. In the first segment, 1986–1991, emissions diminished due to a reduction in industrial production and the war for independence in 1991. Emissions rose strongly in the 1991–1997 period, when emissions also increased due to gasoline tourism. Then came a short period of emission reduction as a consequence of a reduction in gasoline tourism and decreased consumption of fossil fuels for the production of electrical energy. After 1999, emissions again rose, mainly as a consequence of the production of electrical energy. CO_2 emissions in 2002 thus amounted to 16.27 Mt of CO_2, which is

nearly the same as in the 1986 base year. Although in 2003, CO_2 emissions decreased by 1.5% (mainly due to lower emissions from Energy Industries) on 2004 started a period of constant increase (in 2004 by 2.2%, in 2005 by 1.8%, in 2006 by 1.1%, in 2007 by 0.8% and in 2008 as much as 5.7%), mainly due to transport. In 2009 CO_2 emissions decreased due to global financial crisis by 10.6% while in 2010 stayed almost the same (0.2% increase). In 2011 the emissions further increased for 0,3%.

In entire period of time, the strongest increase in CO_2 emissions was in transport, by as much as 202%, from 2.0 Mt CO_2 eq. in 1986 to 6.2 Mt CO_2 eq. in 2008. In 2009 emissions from this sector have decreased for 13.6% compare to 2008 but were still above base year emissions for 161.6%. In 2010 further decrease of 1.2% was observed, and transport emissions were 158.4% higher than in 1986. In 2011 emissions continued to grow by 8.2% comparing to previous year and were 185.3% above emissions in 1986.

The Industrial Processes sector contributed 4.6% to total CO_2 emissions in 2011, while contributions of other sectors are negligible or zero. The LULUCF sector represents sink for CO2 emissions, in the 1986-2011 the level of sinks is rather constant and amounted to nearly half of CO2 emissions.

Methane – CH_4

Between 1986 and 2011, methane emissions were slightly decrease, from 2.174 Mt CO_2 eq. in 1986 to 1.966 Mt CO_2 eq. in 2011. CH_4 emissions diminished by 8.5% in spite of increased emissions from solid waste (by 22.6%, compared to 1986). The larger contribution to decrease has a reduction of methane emissions in Fugitive emissions from fuel and from Manure management.

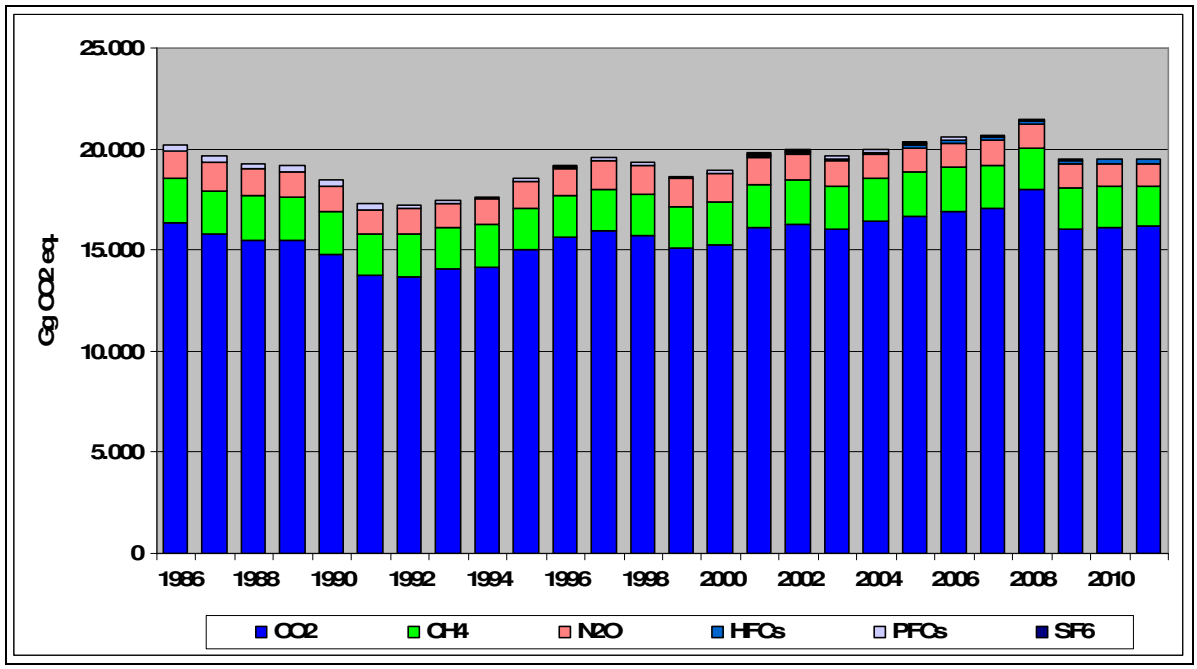

Figure 2.2.1: GHG Emissions in Slovenia by gas

Nitrous oxide – N_2O

N_2O emissions were down from 1.388 Mt CO_2 eq. in 1986 to 1.103 Mt CO_2 eq. in 2011. In Agriculture, which is the main source of N_2O emissions, emissions diminished chiefly due to fewer animals and less arable crop production, particularly legumes and N-fixing plants. This reduction was partly due to a changed manner of manure storage, since the fraction of straw-based systems is diminishing on account of the increasing use of slatted floors.

Hydro-fluorocarbons – HFC

HFC emissions have grown from year to year. In 2011, emissions increased by 4.3% compared to the previous year, which is mostly the consequence of an increasing amount of HFC in refrigeration and AC sector.

Per-fluorocarbons – PFC

The only source of PFCs in Slovenia is the primary production of aluminium. Improving the technology of aluminium production since 1992 has more than halved the then emissions, which diminished from 276 kt CO_2 eq. in 1986 to 106 kt in 1995 base year and finally to 21 kt in 2008. In 2009 emissions further decreased to 7 kt due to reduction in the aluminium production. In 2010 increase of emissions by 84.1% have been observed due to the increase in aluminium production and in 2011 emissions doubled because the aluminium production increased to the level before crises.

Sulphur-hexafluoride – SF_6

The main source of SF_6 emissions is high-voltage gas-insulated switchgear and circuit breakers. SF_6 emissions represent only 0.1% of total GHG emissions.

2.3 Description and interpretation of emission trends by source

According to the UNFCCC Reporting Guidelines, emissions estimates are grouped into six IPCC categories: Energy, Industrial Processes, Solvent Use, Agriculture, Land Use, Land-Use Change and Forestry, and Waste.

By far the most important sector is Energy, which in 2011 accounted for 81.9% of total GHG emissions. In this sector emissions have decreased by 0.7%, compared to the 1986. Within this sector, in the period 1986–2011, GHG emissions from the Energy Industry, as the biggest sub-sector, decreased by 7.0%. In the most recent period, 1999–2007, steep growth (+19.6%) has been recorded due to the increased consumption of electrical energy. Undoubtedly the greatest increase in GHG emissions has been in the transport sector, by as much as 201.6% until 2008, due to an increase in road transportation, while emissions from other kinds of traffic have slightly declined. In 2009 GHG emissions from transport decreased for 13.2% compare to 2008. The traffic emissions have further decreased by 1.2% in 2010 but increased again in 2011 for 8.2%.There was an appreciable reduction of GHGs from industry between 1986 and 2000 (-52%). After 2000, a stabilisation of emissions has been observed until 2008. Due to the global financial crisis emissions from Manufacturing industry and construction decreased in 2009 by 16.8%, in 2010 by 0.9%, and in 2011 by 10.3% compared to the previous year.

Since 1986, GHG emissions from Industrial Processes at first fell sharply to reach their lowest value in 1993, but then started to rise again. Due to the global financial crises and lower industrial production emissions in 2009 was 28.7% below the 1986 emissions; in 2010 and 2011 emissions stayed almost the same. The most important GHG of this sector was carbon dioxide, with 74.1% of emissions from this category, followed by HFCs with 21.4%, PFCs with 2.8%,and SF_6 with 1.6%. Since 2006 N_2O emissions and since 2011 CH_4 emissions in this sector have not occurred.

The main source is Mineral Production, of which the production of cement and lime alone contributed almost a half of the emissions in this sector.

The Solvent and Other Product Use sector represents 0.3% of total emissions. Emissions in this sector keep diminishing, since Slovenia has ceased all production in which GHG

emissions could arise. Thus, GHG emissions have been reduced from 82 kt CO_2 eq. to 49 kt CO_2 eq., only from N_2O emissions.

In Agriculture as the second most important sector, emissions in 2011 amounted to 1901 Gg CO_2 eq, which represents 9.7% of all emissions. Agriculture represents the main source of methane and N_2O emissions, namely 53.8% of all methane emissions and 76.4% of all N_2O emissions. In the agricultural sector, N_2O emissions account for 44.3% of emissions, and CH_4 emissions account for 55.6% of emissions.

GHG emissions from agriculture show small oscillations for individual years, but the general trend is on the decrease. In 2011, emissions were 14.0% below the base year. The most important sub-sector is emissions from agricultural soils, which contribute 37.3% of all emissions from agriculture, followed by emissions from enteric fermentation, with 34.4%; the rest is contributed by emissions of methane and N_2O from animal manure (28.3%).

In the LULUCF sector, the CO_2 sink was estimated in 2011 at 9,619 Gg CO_2 eq, which is 4.6% more than in 1986. The increase in sinks was primarily the result of an increase in timber growing stock in existing forests.

Methane emissions from the Waste sector are the second largest source of methane and represent 25.2% of all methane emissions in Slovenia in 2011. The fraction of methane emissions in this sector amounts to 88.0%, while the remaining part represents N_2O (10.7%), CO_2 emissions are nearly negligible (0.9%). Solid waste handling contributes 65.1% to the total emissions from this sector, wastewater handling 33.9% and incineration of waste 0.9.

Compared to the base year, emissions have risen by 14.6%, which is mostly due to emissions from SWDSs, which show an increase of 22.6%. The increase in emissions from this source is mainly a consequence of the increase in the amount of disposed municipal waste in the past and the application of the FOD method for calculating emissions. Emissions from wastewaters are lower than in the base year by 0.7%. In the last period a slow decreasing trend have been observed, which is mostly due to recovery of gas in wastewater treatment plants and the decrease in industrial production.

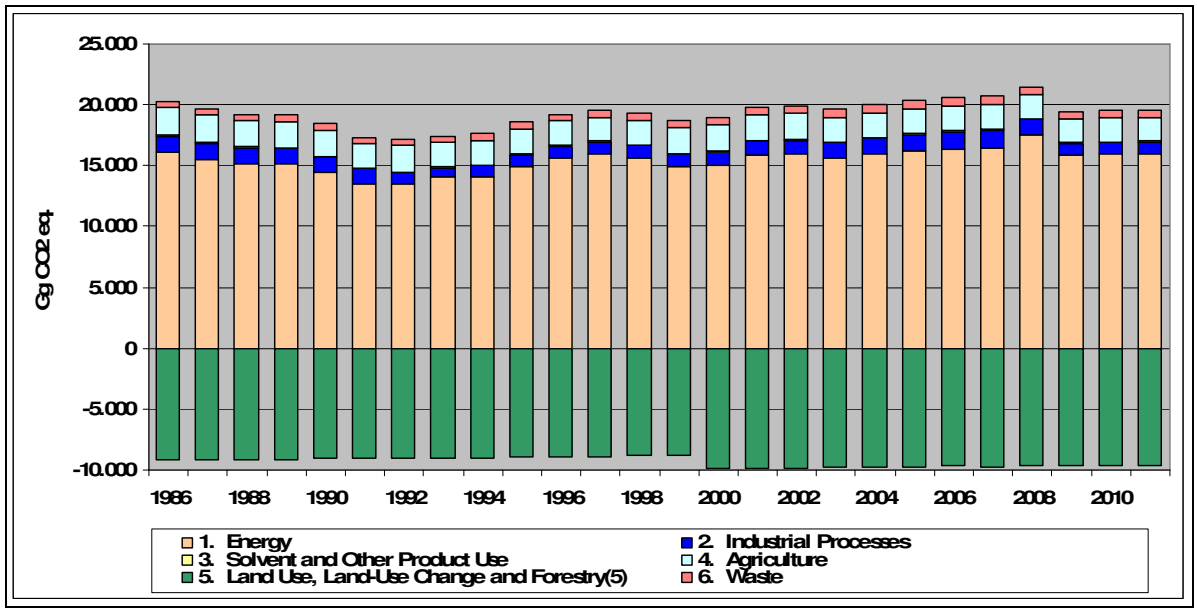

Figure 2.3.1: GHG Emissions in Slovenia by sector

Table 2.3.1: GHG emissions and removals in Slovenia by sectors and sub-sectors 1986-2011

GHG SOURCE AND SINK CATEGORIES	1986	1990	1995	2000	2005	2010	2011	Change (%)
TOTAL net emissions (with LULUCF) in Gg CO2 eq.	**11,011**	**9,387**	**9,559**	**9,019**	**10,536**	**9,830**	**9,891**	**-11.4**
1. Energy	**16,103**	**14,416**	**14,919**	**15,058**	**16,197**	**15,966**	**15,983**	**-0.7**
A. Fuel Combustion	15,567	13,957	14,506	14,684	15,827	15,607	15,619	**0.3**
1. Energy Industries	6,729	6,265	5,627	5,498	6,325	6,214	6,259	**-7.0**
2. Manufacturing Industries and Construct.	4,404	3,119	2,615	2,269	2,486	1,900	1,704	**-61.3**
3. Transport	2,025	2,730	3,824	3,862	4,428	5,265	5,699	**181.4**
4. Other Sectors	2,367	1,811	2,439	3,053	2,585	2,226	1,954	**-17.5**
5. Other	41	32	1	3	3	3	3	**-91.9**
B. Fugitive Emissions from Fuels	536	459	413	374	370	359	364	**-32.0**
1. Solid Fuels	479	401	358	331	337	330	335	**-30.0**
2. Oil and Natural Gas	57	58	55	43	33	29	29	**-49.0**
2. Industrial Processes	**1,317**	**1,318**	**1,002**	**1,063**	**1,373**	**980**	**1.014**	**-23.0**
A. Mineral Products	795	725	609	682	761	629	585	**-26.3**
B. Chemical Industry	49	40	31	33	52	5	1	**-97.6**
C. Metal Production	463	542	318	291	408	123	194	**-58.1**
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF6	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
F. Consumption of Halocarbons and SF6	10	10	44	57	152	224	234	**2,181.9**
G. Other	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**82**	**43**	**17**	**43**	**43**	30	49	**-39.8**
4. Agriculture	**2,211**	**2,134**	**2,042**	**2,133**	**2,003**	**1,955**	**1,901**	**-14.0**
A. Enteric Fermentation	676	652	644	692	660	666	653	**-3.4**
B. Manure Management	741	734	636	629	594	563	538	**-27.3**
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	**NO**
D. Agricultural Soils	794	748	762	813	749	726	709	**-10.6**
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO

GHG SOURCE AND SINK CATEGORIES	1986	1990	1995	2000	2005	2010	2011	Change (%)
5. Land Use, Land-Use Change and Forestry (LULUCF)	**-9,193**	**-9,056**	**-8,971**	**-9,901**	**-9,773**	**-9,652**	**-9,619**	**4.63**
A. Forest Land	-10,809	-10,796	-10,866	-11,952	-11,992	-12,040	-12,041	**11.4**
B. Cropland	377	386	397	407	419	431	433	**14.9**
C. Grassland	197	264	348	432	524	615	633	**221.4**
D. Wetlands	138	141	145	149	153	157	158	**14.5**
E. Settlements	625	643	666	689	714	739	745	**19.2**
F. Other Land	278	306	340	374	410	446	453	**62.8**
G. Other	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**491**	**532**	**549**	**623**	**692**	**550**	**562**	**14.6**
A. Solid Waste Disposal on Land	299	345	376	439	486	356	366	**22.6**
B. Waste-water Handling	192	186	172	182	225	223	227	**-0.7**
C. Waste Incineration	NO	1	0	2	2	5	5	**NA**
D. Other	NA	NA	NA	NA	NA	NA	NA	NA
7. Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items:								
International Bunkers	**58**	**48**	**57**	**68**	**61**	**141**	**188**	**226.0**
Aviation	58	48	57	68	61	74	70	**21.5**
Marine	NA	NA	NA	NA	77	67	118	**NA**
Multilateral Operations	**NA**	**NA**	**NA**	**1**	**0**	0	0	**NA**
CO2 Emissions from Biomass	**2,254**	**2,088**	**2,036**	**1,897**	**2,299**	2,808	2,548	**13.1**
Total CO2 Equivalent Emissions without LULUCF	**20,204**	**18,443**	**18,529**	**18,920**	**20,309**	**19,482**	**19,509**	**-3.4**

2.4 Description and interpretation of emission trends for indirect GHGs and SO_2

The highest contribution to the total emission of SO_2 is that of thermal power plants and power cogeneration plants. In 1995, SO_2 emission was reduced considerably, mostly because of the operation of the device for desulphurisation of flue gases on unit 4 of the Šoštanj Thermal Power Plant, as well as due to lower sulphur contents in liquid fuels, as set by the Directive on the Quality of Liquid Fuels with regard to the contents of sulphur, lead, and benzene. A further considerable reduction was noticeable after 2000, when the device for desulphurisation of flue gases on unit 5 of the Šoštanj Thermal Power Plant was put into operation. Considerable decrease of SO_2 happened after 2006 due to operation of wet flue gas desulphurisation in TE Trbovlje.

The biggest contribution to the overall NOx emissions is that of mobile sources (road traffic). After 1992, NOx emissions began to grow, mainly because of the ever-increasing traffic density; the growth has been extremely strong, despite of ever-greater number of vehicles with catalytic converters. After 1997, NOx emissions declined markedly, due to decreased consumption of fuels in the Road Traffic sector and increased fraction of vehicles with catalytic converters.

Road traffic accounts for nearly half of total NMVOC emissions, but overall emissions from traffic keep diminishing and have from 1986 to 2011 been reduced due to the modernization of the vehicle stock and a growing fraction of diesel-fuelled motor vehicles.

Table 2.4.1: Emissions of CO, NOx, SO_2 and NMVOC in Slovenia excluding LULUCF (kt)

	1990	2000	2005	2010	2011
NOx	59	52	53	45	45
CO	318	194	143	158	147
NMVOC	47	52	49	34	30
SO2	197	98	41	10	11

Table 2.4.2: Emissions of CO, NOx, SO_2 and NMVOC in Slovenia including LULUCF (kt)

	1990	2000	2005	2010	2011
NOx	59	52	53	45	44
CO	323	196	145	158	148
NMVOC	48	52	49	34	30
SO2	197	98	41	10	11

NMVOC and CO inventories have been in 2000 complemented with emissions of NMVOC and CO from the consumption of woody biomass in households. Since the recalculation for the previous period has not been performed yet, a direct comparison of emissions prior to and after year 2000 is not possible.

In 2008 submission emission from forest fires have been calculated and reported for the first time. In Table 2.4.2 emissions of other pollutants are presented including these emissions from forest fires. In CLRTAP reporting emissions are presented without forest fires, as in Table 2.4.1.

3 ENERGY (CRF sector 1)

3.1 Overview of sector

The energy sector is the most important sector of GHG emissions in the Republic of Slovenia, since it accounts for 81.8% of overall CO_2 eq. emissions (w/o considering LULUCF). Emissions from this sector arise from fuel combustion, accounting for 97.7% emissions from the energy sector, and as fugitive emissions from fuels, accounting for 2.3% of emissions.

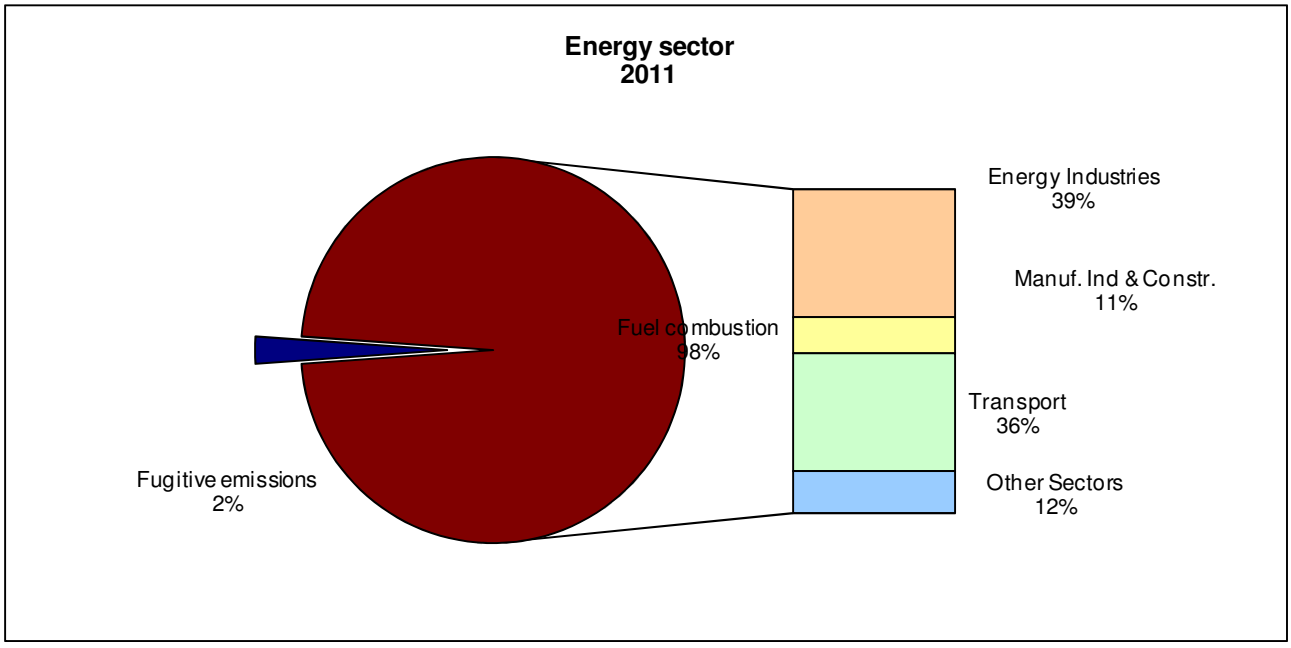

Figure 3.1.1: Emissions of GHG in Energy Sector by categories in 2011

GHG emissions from fuel combustion in 2011 have, compared to 2010, increased by less than 0.1% and were thus 0.3% higher than in the 1986 base year. The most important sub-sector is Energy Industries with 40.1% of emission of CO_2 eq., followed by Traffic with 36.5%. For traffic, virtually all emissions are accounted for by road traffic and within that category particularly noticeable is the growth of the fraction of emissions from goods transport, since the goods transport in transit through Slovenia is since 2000, annually increasing by more than 10%. Due to the recession the emissions in 2009 decreased drastically and have remained almost the same in 2010 while in 2011 the emissions increased by 8.2% compared to previous year. The strongest reduction of emissions was recorded in Manufacturing Industries and Construction, which accounted for 10.9% of emissions. Emissions in this sector have, chiefly due to substitution of coal and liquid fuels, diminished by as much as 61.3% since 1986.
In the Other sector consumption, which accounts for 12.5% of emissions, Residential sector prevails.

Very small emissions (0.02%) have been reported under “Other” and are related to fuel used for transport of natural gas.

Emissions from the production of electrical energy and heat (IPCC 1.A.1.a) vary in accordance with the production of electrical energy. It has to be taken into consideration that in the Republic of Slovenia in 2011, 3.7 TWh (i.e. 23%) of electrical energy was produced in public hydroelectric power plants, 6.2 TWh (i.e. 39%) in the Krško Nuclear Power Plant, while the remaining 6.1 TWh was produced in thermal power plants (i.e. 38%). The structure changes slightly from year to year, depending mostly on the changes in the hydrology of the Slovenian rivers.

Table 3.1.1: Emissions from Energy sector by sources in Gg CO_2 eq.

	1986	1990	1995	2000	2005	2010	2011	Change (%)
1. Energy	**16,103**	**14,416**	**14,919**	**15,058**	**16,197**	**15,966**	**15,983**	**-0.7**
A. Fuel Combustion	15,567	13,957	14,506	14,684	15,827	15,607	15,619	**0.3**
1. Energy Industries	6,729	6,265	5,627	5,498	6,325	6,214	6,259	**-7.0**
2. Manufacturing Ind. and Constr.	4,404	3,119	2,615	2,269	2,486	1,900	1,704	**-61.3**
3. Transport	2,025	2,730	3,824	3,862	4,428	5,265	5,699	**181.4**
4. Other Sectors	2,367	1,811	2,439	3,053	2,585	2,226	1,954	**-17.5**
5. Other	41	32	1	3	3	3	3	**-91.9**
B. Fugitive Emissions from Fuels	**536**	**459**	**413**	**374**	**370**	**359**	**364**	**-32.0**
1. Solid Fuels	479	401	358	331	337	330	335	**-30.0**
2. Oil and Natural Gas	57	58	55	43	33	29	29	**-49.0**

Fugitive emissions in the Republic of Slovenia are of minor importance. The biggest fraction in the structure of these emissions of carbon dioxide and methane is coal mining in underground mines. Since base year emissions constantly diminishing due to ever-smaller excavation of coal until 2000 when have been stabilized. Due to the harmonization of reporting process in EU CO_2 emissions from flue gas desulphurisation (SO2 scrubbing) are included in Industrial processes under Limestone and dolomite use and not under 1.B.1.c Other, as is recommended in the IPCC guidance. Based on the in-country review and recommendations, Slovenia has developed country-specific emission factors for fugitive emissions from transport and distribution of natural gas.

CO_2 emissions from biomass have been computed as well, but have not been included in the calculation; however, all other greenhouse gases (CH_4, N_2O) have been included in accordance with the methodology.

3.1.1 Comparison of the sectoral approach with the reference approach

The total difference of CO_2 emissions between the sectoral approach and the reference approach in 2011 amounted to less than 0.2% which is deemed satisfactory.

For liquid and gaseous fuel we have used the same data as reported in the Joint questionnaires to IEA. The main deficiency of these data is that fuel is rounded to 1000 tonnes. For this reason we had used more precise data in the previous submissions but due to the fact that data we had used was sometimes different from data in JQ we have decided to follow recommendations from the ERT and replace fuel balance data for liquid, gaseous and bio fuel with the data reported to IEA for the entire period 1990-2010. For years before 1990 this data are not available and for these years we are still using old data from LEG – Annual Energy Statistics.

Related to the solid fuel the difference in energy consumption is very low (0.1%) while the difference in CO2 emissions is much higher (1.5%). The reason for this is that in the RA the default CO2 EF has been used while in SE the plant specific EF from ETS have been used since 2005 for all domestic coal and most imported coal.

Table 2.4.2: Differences in energy consumption,% (Reference approach/National Approach)

	1986	1990	1995	2000	2005	2009	2010	2011
liquid	-2.38	2.30	1.23	-0.58	1.76	0.68	1.50	-0.32
solid	0.24	1.76	0.32	1.18	-0.49	-0.05	0.14	0.11
gaseous	4.46	-4.97	-2.65	-0.50	0.63	-0.002	-0.008	-0.05
total	**-0.16**	**0.70**	**0.30**	**-0.14**	**0.86**	**0.02**	**0.18**	**-0.69**

Table 2.4.3: Differences in CO_2 emissions, % (Reference approach/National Approach)

	1986	1990	1995	2000	2005	2009	2010	2011
liquid	-1.56	-3.32	7.43	-2.59	2.83	-1.69	-0.32	0.02
solid	0.17	1.80	0.39	1.22	-1.15	-0.14	-0.29	1.49
gaseous	-4.15	-8.37	-053	0.29	0.54	-0.06	-0.49	-0.04
total	**-0.87**	**-1.47**	**3.64**	**-0.86**	**0.73**	**-1.20**	**-0.84**	**0.17**

3.1.2 International bunker fuels

International navigation

A fuel sold for small boats and yachts has been sold on four petrol stations at Adriatic coast (Izola Pier, Lucija Pier, Marina Koper and Piran Pier). As those stations are selling fuel to road vehicle also, a division between road and marine traffic is not possible. For this reason we have reported all fuel in sub sector road traffic.

Slovenia has only one international port “Luka Koper” but in the period 1986-2004 no ships had been refuelled in that port (mostly the ships were refuelled in the international waters by Italian ships under Panama flags). Since 2005 a small amount of heavy fuel oil has been reported as fuel sold to the international marine bunkers.

Table 3.1.2: International Navigation Bunkers

	2005	2006	2007	2008	2009	2010	2011
fuel in TJ	880	1206	2030	2737	1347	768	1354
Gg CO_2 eq.	77	105	177	238	117	67	118

International aviation

In the past the entire consumption of jet kerosene had been counted as aviation bunker fuel since there were no commercial domestic flights in Slovenia. Following recommendation from ERT since 2008 data about jet kerosene used in Slovenian Army

and Police is obtained and belonging emissions have been excluded from international aviation bunkers and included under 1.A.5.b Other/Mobile. For the period 1986-2007 these data are not available. Following the recommendation from AAR 2011 the fuel used in Slovenian army and Police has been estimated using correlation with the number of aircrafts in the Slovenian army. To estimate emissions in the period 1986-1990/91 when Slovenia was still part of Yugoslavia, the fuel used for the international aviation have been estimated taking into account a correlation with the number of passenger and the remaining amount of jet-kerosene was counted as fuel used in the Yugoslavian army in Slovenian territory.

In spite of negligible quantities of emissions, the entire consumption of aviation gasoline for piston engine aircraft was counted as consumption and emission in Slovenia, since it was assumed that this was fuel for small aircraft, which fly between smaller regional airports in Slovenia.

Table 3.1.3: International Aviation Bunkers

	1986	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
fuel in TJ	799	672	786	945	852	976	1306	1452	1087	1022	967
Gg CO_2 eq.	58	48	57	68	61	70	94	105	78	74	70

Multilateral operations

The jet kerosene used in Slovenian Army and Police have been excluded from international aviation bunkers and included under 1.A.5.b Other/Mobile. An exemption was fuel consumption on international missions (Kosovo, Afghanistan…), which is included under 1.C.2 Multilateral operations. Information about Slovenian cooperation in international operations is on web page: http://www.slovenskavojska.si/en/international-cooperation/international-operations-and-missions/

In 2011 about 6 TJ of jet kerosene were used on international missions what is amounted to 0.5 Gg CO2 eq. of GHG emissions.

Emissions from Army are included also in road transportation (diesel), in Institutional sector (heating oil) and in civil aviation (aviation gasoline).

Recalculation

No recalculations have been performed for this category.

3.1.3 Feedstock and non-energy use of fuels

Natural gas

Table 3.1.4: Non-energy use of natural gas

		1986	1990	1995	2000	2005	2008	2009	2010	2011
Natural Gas	1000 m^3	67666	69524	91577	136740	164407	118091	111149	97004	6164
Fraction of C stored		1	1	1	1	1	1	1	1	1
Carbon EF	t C/TJ	15,075	15,075	15,075	15,075	15,075	15,075	15,080	15,070	15,070
Stored CO_2	Gg	125.3	131.0	172.6	257.6	292.4	222.6	209.5	190.3	3.3

Source of activity: from 1985 to 1995 Statistical office, LPI
from 1995 to1996, Statistical office, DGP
from 1997 to2003 LEG, Table Tg/6-3
since 2004 on SURS excel files and JQ

The biggest fraction of non-energy usage of fuels is the consumption of natural gas for the production of methanol, amounting to 89,475 Sm^3 of natural gas in 2010, when this production has stopped and in 2011 there was no methanol production in Slovenia.

Natural gas is entirely used as the row material for transformation into methanol. In every cycle only fifth part is transformed to the product, while the remaining natural gas is returned into the process. The schematic diagram of the process is shown on the Figure 3.1.3.

Figure 3.1.2: Methanol production in Nafta-Petrochem Lendava.

In Slovenia low-pressure Lurgi technology is used. The methanol is produced from synthesis gas obtained from natural gas and steam in reactor.

$$CH_4 + H_2O \rightarrow CO + 3\ H_2$$

This reaction, commonly called steam-methane reforming or SMR is endothermic and the heat transfer limitations place limits on the size of the catalytic reactors used. The carbon monoxide and hydrogen then react on a second catalyst to produce methanol

The exothermal methanol reactor with three main reactions:

$$CO + 2H_2 \rightarrow CH_3OH$$

$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$

$CO_2 + H_2 \rightarrow CO + H_2O$

is operated at high pressure and unconverted gas is recycled.

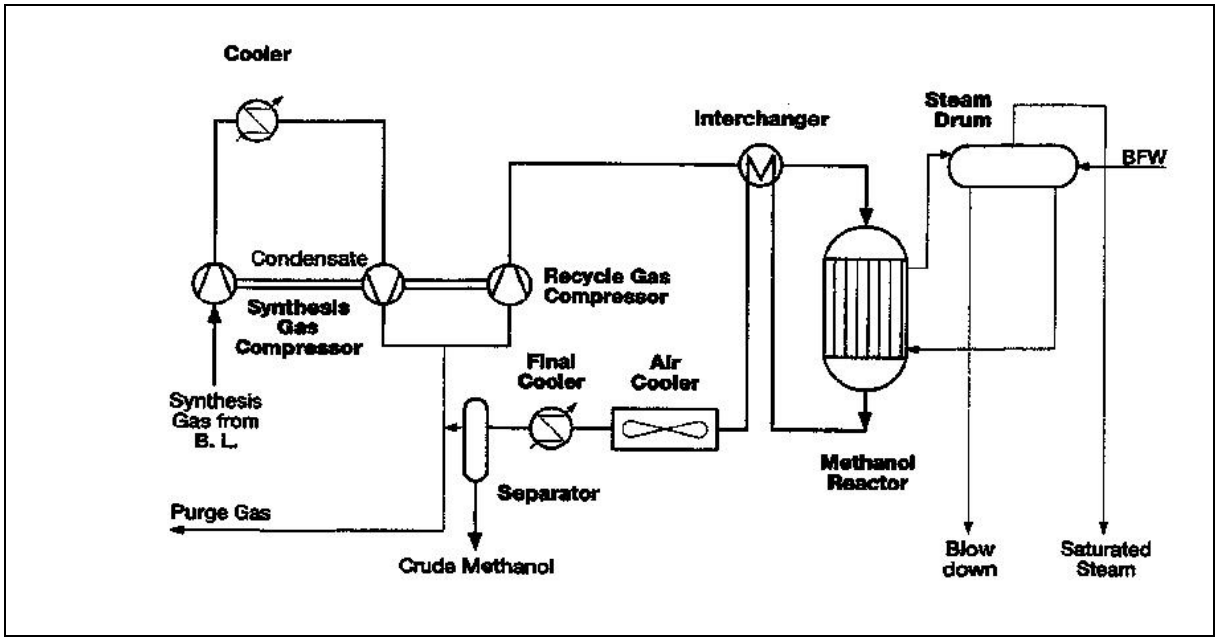

Figure 3.1.3: Schematic diagram of methanol production.

Stored CO_2 has been calculated on the basis of the formula from IPCC guidelines, p. I.28., I. 23, I.13. We have assumed that all methane used for methanol production is stored in the product or in CO in emitted gas. This fact was confirmed also by expert from the company Nafta-Petrochem.

The remaining amount of non-energy use of natural gas is used in the chemical industry also as a row material for production of organic and inorganic chemicals and plastics. The detailed data are presented in the Table 3.1.7.

Table 3.1.5: Non-energy use of natural gas for different products.

	unit	2005	2006	2007	2008	2009	2010	2011
Methanol production	1000 Sm^3	145,903	129,384	151,556	94,437	104,487	89,475	0
Other organic chem.	1000 Sm^3	410	0	0	14,976	0	0	0
Inorganic chemicals	1000 Sm^3	8,314	8,717	8,327	8,695	6,625	7,465	6,164
Rubber and Plastics	1000 Sm^3	590	819	709	38	0	64	
Total	**1000 Sm^3**	**155,217**	**138,920**	**160,592**	**118,146**	**111,112**	**97,004**	**6,164**
Total	**TJ**	**5,290**	**4,734**	**5,472**	**4,028**	**3,787**	**3,306**	**210**

Table 3.1.6: Estimate of Uncertainty of Utilized Data (in %)

Estimate of Uncertainty of Input Data	5%
Estimate of Uncertainty of Calorific Values	2.5%
Estimate of Uncertainty of Emission Factors	2.5%

Source: Author's estimate

Oil and Lubricants

According to the Statistical data all lubricants in Slovenia have been used for non-energy purpose only. Data about different types of use are not available. Likely, the largest applications for lubricants are in the form of motor oil. After the end of use the lubricants which have been used in the engines are collected and mostly used as a fuel.

Slovenia has been adhering to the basic system of collection, recovery and disposal of waste oil since 1998. The main foci and provisions regarding the programme of waste oil management are stipulated in our legislation, in particular in the Decree on the disposal of waste oils, which is harmonized with the EU directive on the disposal of waste oils. Producers of waste oil are obliged to deliver the oil to collection services. Each collector must have a collection centre and must ensure either recovery or disposal of waste oils. Recovery is the preferred choice if technically feasible and if its cost is not unreasonably higher than the cost of disposal. One of the forms of recovery is the utilisation of waste oils for energy – co-incineration in accordance with recovery procedure R1. Records by the Slovenian Environment Agency show that most waste oils have been used for this purpose. The only evidence of such a use is in the cement production. Emissions are already included in the inventory and are reported in the CRF tables under "1A2 Manufacturing industry and construction/other industries/Other fuel".

A small portion of collected waste oils has been also incinerated (procedure R9) or reform and then reuse (procedure D10). We had reported these emissions in waste sector under waste incineration in submission 2010 for the first time. No other use of lubricants as a fuel has been recorded in Slovenia until now.

Source of activity:
The data on import and export as well as data from waste oil combusted in the industry have been obtained from SORS while the data on incineration of waste oils are from the EARS

Emission factor:
Stored CO_2 has been calculated on the basis of the formula from IPCC guidelines,1996, p. I.28., I. 23, I.13.

Table 3.1.7: Oil and Lubricants

		2004	2005	2006	2007	2008	2009	2010	2011
Oil and Lubricants	t	28623	17465	30000	22000	16000	12000	12000	13848
Waste oil - combusted	t	3878	4404	4502	4281	4228	4582	6763	6109
NCV	TJ/kt	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Fuel stored	TJ	995	525	1025	712	473	298	210	310
Carbon EF	t C/TJ	20	20	20	20	20	20	20	20
Stored CO_2	Gg	73	39	75	52	35	22	15	23

Table 3.1.8: Estimate of Uncertainty of Utilized Data (in %)

Estimate of Uncertainty of Input Data	20%
Estimate of Uncertainty of Calorific Values	5%
Estimate of Uncertainty of Emission Factors	5%

Source: Author's estimate

Other fuels

Coke and petroleum coke, used in industry as reduction agent or feedstock have been subtracted from energy sector and emissions from these fuels are presented in industrial processes sector.

Before 1997, amount of coke, used for production of iron and steel, ferroalloys and carbide was reported as fuel consumption in relevant sectors. After 1997 this fuel started to be collected separately, but it takes a while that all non-energy used fuel has been reported correctly. Since 2000 in statistical data energy and non-energy use of fuel in industry are presented separately.

To avoid double counting, we have subtracted all coke used in iron and steel, ferroalloys and carbide production from energy sector except coke in iron production in the base year 1986. In that time pig iron was still produced and the disaggregated into the consumption of fuel as an additive and the consumption of fuel as an energy product was impossible. For consumption of coke, the decision was taken to attribute all coke, which is consumed in the production of iron and steel in this year, to the energy sector as fuel consumption and no emissions from coke used in iron and steel are presented in industrial processes.

3.1.4 CO_2 capture from flue gases and subsequent CO_2 storage

There are no plants for recovery and storage of CO_2 in Slovenia.

3.2 Fuel combustion (CRF 1.A)

3.2.1 Sources of activity data

The main source of data for Fuel consumption for all sectors 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 was not published early enough to enable us to calculate GHG inventory on time in 2005 we have for the first time received data directly from Statistical Office of the Republic of Slovenia in electronic format before they are published. After 2007 the LEG is not published anymore. Since 2005 the verified reports from ETS have been also used.

Besides the SORS provides us also data in Joint questionnaires which have been used mostly for QA/QC.

The following files with data for 2011 have been received from the SORS:

E1L-11-arso – fuel consumption in public power plants
E2L-11-arso – fuel consumption in auto producers
E2LP-11-arso – fuel consumption in cogeneration plants
E3L-11-arso – fuel consumption in public heat
epel_arso11_NACE2008.xls–fuel consumption in mining, manufacturing industry and construction

ZBIRNA E8-E11 ARSO 2011.xls – data on energy balance

Joint questionnaires:
ENERGY_NTGAS_A_SI_2011.xls – gaseous fuel
ENERGY_PETRO_A_SI_2011.xls- liquid fuel
ENERGY_RENEW_A_SI_2011.xls- other fuel
ENERGY_SOLID_A_SI_2011.xls – solid fuel

3.2.2 Country-specific issues

An interesting feature of inventories of greenhouse gases for Slovenia is the fact that the chosen 1986 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 1986 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.

To avoid erroneous interpretations in international comparisons of inventories, we have decided to combine the entire production of domestic coal in the CRF table 1.A(b) – Sectoral background data for Energy (Reference Approach) on the basis of net calorific value under „Lignite".

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.

3.2.3 Country-specific EFs

Lignite – CO_2 EF

Table 3.2.1: National CO_2 emission factor for domestic lignite from Velenje pit.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
t CO_2/TJ	109.95	109.25	111.89	107.76	106.98	101.84	101.06	101.48	101.69
	1995	1996	1997	1998	1999	2000	2001	2002	2003
t CO_2/TJ	100.99	101.85	101.82	99.54	100.21	102.56	106.71	105.44	104.90
	2004	2005	2006	2007	2008	2009	2010	2011	
t CO_2/TJ	105.85	107.94	106.32	106.15	105.64	104.76	104.52	104.48	

Table 3.2.2: National CO_2 EF for domestic lignite from Velenje pit including oxidation.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
t CO_2/TJ	107.76	107.07	109.65	105.61	104.83	99.76	99.07	99.44	99.78
	1995	1996	1997	1998	1999	2000	2001	2002	2003
t CO_2/TJ	98.97	99.81	99.78	97.55	98.08	100.51	104.58	103.33	102.80
	2004	2005	2006	2007	2008	2009	2010	2011	
t CO_2/TJ	103.74	105.78	104.19	104.03	103.52	102.67	102.43	102.39	

With regard to the need to upgrade GHG emissions inventories, in 2004, national CO_2 emission factors for domestic coal were developed. CO_2 emission factors were obtained on the basis of determined carbon contents in the fuel. Data on carbon contents in fuel for the entire period 1986-2004 are available only for coal from the biggest pit in Slovenia, the Šoštanj Lignite Pit. After 2005 also the CO_2 EFs of coal from Trbovlje pit have been available as well as for all imported coal used in electricity and heat production and in both cement plants. The carbon contents of lignite were verified by supplementary chemical analyses of coal samples from this pit in an accredited laboratory in accordance with EN ISO 17025. (further information: A Review of the Chemical Analysis of Coal from the Pit of Šoštanj).

Table 3.2.3: National CO_2 emission factor for domestic brown coal from Trbovlje pit.

	2005	2006	2007	2008	2009	2010	2011
t CO_2/TJ	101.94	102.89	101.66	101.81	102.71	101.33	101.18

Table 3.2.4: National CO_2 EF for domestic brown coal from Trbovlje pit including oxidation.

	2005	2006	2007	2008	2009	2010	2011
t CO_2/TJ	99.90	100.83	99.63	99.77	100.65	99.30	99.16

Natural gas – CO_2 EF

We use slightly modified EF also for natural gas. CO_2 emission factors were obtained on the basis of determined carbon contents in the fuel. A detail results are in study from year 1998, which is available only in Slovene language (Določitev emisijskega faktorja CO_2 pri energetski izrabi zemeljskega plina). Because in the study from 1998 only yearly values until 1996 are available, we have used yearly values for the period 1986-1996 and 1996 value for period 1997-2010. The value is already multiplied with default oxidation factor for gaseous fuels.

In the previous report we are planning to obtain data about chemical composition of natural gas used in Slovenia for period 1997-2010, calculate actual values of EF and recalculate emissions back to 1997. Unfortunately, data on chemical composition are not available any more. The natural gas distributor (Geoplin Plinovodi) is not interested in such data and they believe that chemical composition is not changing a lot between the years. The main importer of natural gas is Russia while approximately one third of natural gas is from Algeria. CO_2 emission factors among years differ around 0.1% and because composition data from the company are not available we believe that cost for regular sampling and analyzing in the accredited laboratory would represent unreasonable costs.

Table 3.2.5: National CO_2 emission factor for combustion of natural gas.

EF (t CO_2/TJ)	1986-1991	1992	1993	1994	1995	1996-2011
including oxidation factor	55.055	55.044	55.2	55.112	55.006	55.015
excluding oxidation factor	55.332	55.321	55.477	55.389	55.282	55.291

Liquefied petroleum gas – CH_4 EF

LPG is a flammable mixture of hydrocarbon gases (mostly propane and butane) and will evaporate at normal temperatures and pressures. It burn more 'cleanly' than heavier molecule hydrocarbons. In Reference Manual 1996 the CH_4 EF are available for natural gas and for oil, but our energy experts have considered that LPG has to have lower CH_4 EF than oil. We have used value of 2 kg/TJ in energy and manufacturing industry sectors even before 2006 GL was available and this EF was used also for determination of emissions in our base year. We do not considered that this value is more appropriate only for Slovenia but we considered that default CH_4 EF from Reference Manual 1996 for LPG is too high for all country. The 2006 GL what we believe is the most up to date source of EFs has confirmed our assumptions and set default CH_4 EF for LPG and for natural gas to 1 kg/TJ for combustion in all sectors.

3.2.4 Oxidation factors

For inventory purpose we have used default oxidation factor from IPCC Reference Manual, 1996. They are as follows:

Solid fuels:	0.980
Liquid fuels:	0.990
Gaseous fuels:	0.995

3.2.5 Energy Industries

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

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

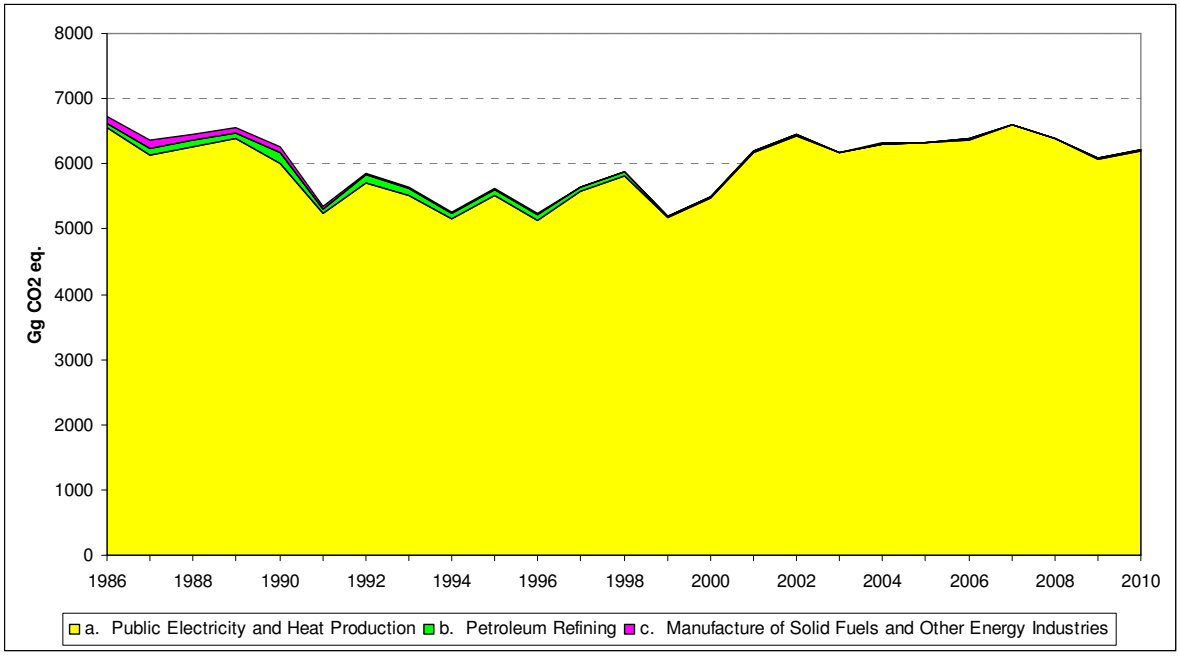

Figure 3.2.1: GHG emissions from Energy Industries

Public electricity and heat production is the most important category in this sub-sector with 97.5% share in the base year and almost 100% share in 2011. Other two categories have consisted mainly from fuel consumption in one refinery and in fuel consumption for coal mining activities.

Table 3.2.6: GHG emissions from Energy Industries in Gg CO2 eq.

in Gg CO_2 eq.	1986	1990	1995	2000	2005	2008	2009	2010	2011
1. Energy Industries	**6729**	**6265**	**5627**	**5498**	**6325**	**6388**	**6087**	**6214**	**6259**
a. Public Electricity and Heat Prod.	6562	6015	5513	5466	6321	6379	6079	6198	6253
b. Petroleum Refining	62	169	92	32	1	1	6	14	4
c. Manufacture of Solid Fuels and …	105	81	21	0	2	9	2	1	1

3.2.5.1 Public Electricity and Heat Production (CRF 1A1a)

	KS	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level
Base Year	Level	CO_2	20.03		2
2011	Level, Trend	CO_2	18.32	15.07	2

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 3.2.7: Public electricity and Combined Heat and Power Plants in Slovenia

Power plant	Location	Unit	Year	Power (MW)	Main fuel type
TEŠ	Šoštanj	A/1	1956-2010	30.0	Lignite
TEŠ	Šoštanj	A/2	1956-2008	30.0	Lignite
TEŠ	Šoštanj	A/3	1960	75.0	Lignite
TEŠ	Šoštanj	B/4	1972	275.0	Lignite
TEŠ	Šoštanj	C/5	1977	345.0	Lignite
TEŠ	Šoštanj	Gas units	2008	2 x 42.0	Natural gas
TE-TOL	Ljubljana	D/1 (1)	1966	136.0	Imported coal
TE-TOL	Ljubljana	D/2 (2)	1967	126.0	Imported coal
TE-TOL	Ljubljana	D/3 (3)	1984	202.0	Imported coal, from 2008 on also wood
TET	Trbovlje	F/4 (4)	1968	125.0	Coal, mostly domestic brown 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.

Emissions = Quantity of Fuel Combusted x NCV x EF per energy of Fuel x OF

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 was not published early enough to enable us to calculate GHG inventory on time in 2005 we have for the first time received data 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. Since 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.

Table 3.2.8: NCVs for the fuel used in energy industry.

Year	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Bituminous Coal	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1986	9.390	11.880			41.820	39.740	46.000	33.500	12.170
1987	9,650	11.820			41.870	39.800	46.000	33,500	12.170
1988	9,440	12.000			41.870	39.800	46.000	34,080	12.170
1989	9,820	12.050			41.870	39.900	46.000	34,100	12.170
1990	9.810	12.760			41.870	39.800	46.000	34.100	12.170
1991	9.980	12.879			41.880	39.800	46.000	34.100	12.170
1992	10.260	12.589			41.900	39.900	46.000	34.100	12.170
1993	10.070	13.351			41.900	39.800	46.000	34.100	12.170
1994	9.960	12.666			41.900	39.860	46.000	34.100	12.170
1995	10.220	10.000	15.546		41.900	40.000	46.000	34.100	12.170
1996	9.690	11.300	16.107		41.900	40.000	46.000	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	11.094	17.868		42.600	41.420	46.050	34.074	11.128
2010	11.097	12.815	18.050	28,271	42.600	41.420	46.050	34.080	9.871
2011	11.068	11.935	18.317	28,251	42.600	41.420	46.050	34.087	10.267

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

For the period 1986-1992, 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. 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. Since 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 1986-2003 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 1986 only data on the consumption of natural gas in 1986 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.

Following the recommendation of the expert review team data on fuel consumption by type and year are reported in the Annex 2 to the NIR, Table 1.1.

Net calorific values

Net calorific values have been taken from SORS (Table 3.2.8). 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.

Emission factors

We have used country specific CO_2 EFs for coal and natural gas. More detailed description is in chapter 3.2.2. Emission factors for all other fuels have been taken from IPCC Reference Manual 1996.

Table 3.2.9: Emission factors used for the period 1986-2005

	Unit	Lignite (Velenje)	Sub-bituminous Coal	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	Table 3.2.1	101.2	74.0	77.4	63.0	Table 3.2.5	108.5
EF*OF	t/TJ	Table 3.2.2	99.2	73.3	76.6	62.4	Table 3.2.5	107.4
CH_4 EF	t/TJ	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N_2O EF	t/TJ	0.0014	0.0014	0.0006	0.0006	0.0006	0.0001	0.004

Table 3.2.10: Emission factors used for 2006

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	104.190	102.890	99.340	77.4	74.0	63.0	55.291	108.5
EF*OF	t/TJ	102.106	100.832	97.353	76.6	73.3	62.4	55.015	107.4
CH_4 EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N_2O EF	t/TJ	0.0014	0.0014	0.0014	0.0006	0.0006	0.0006	0.0001	0.004

Table 3.2.11: Emission factors used for 2007

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	106.151	101.661	100.25	77.4	74.0	63.0	55.291	108.5
EF*OF	t/TJ	104.028	99.628	98.245	76.6	73.3	62.4	55.015	107.4
CH_4 EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N_2O EF	t/TJ	0.0014	0.0014	0.0014	0.0006	0.0006	0.0006	0.0001	0.004

Table 3.2.12: Emission factors used for 2008

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	105.636	101.807	100.873	77.4	74.0	63.0	55.291	108.5
EF*OF	t/TJ	103.525	99.770	98.855	76.6	73.3	62.4	55.015	107.4
CH_4 EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N_2O EF	t/TJ	0.0014	0.0014	0.0014	0.0006	0.0006	0.0006	0.0001	0.004

Table 3.2.13: Emission factors used for 2009

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	104.761	102.707	101.015	77.4	74.0	63.0	55.291	108.5
EF*OF	t/TJ	102.666	100.653	98.995	76.6	73.3	62.4	55.015	107.4
CH_4 EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N_2O EF	t/TJ	0.0014	0.0014	0.0014	0.0006	0.0006	0.0006	0.0001	0.004

Table 3.2.14: Emission factors used for 2010

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal	Bituminous Coal	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	104.517	101.328	100.408	92.830	77.4	74.0	63.0	55.291	108.5
EF*OF	t/TJ	102.427	99.302	98.400	90.973	76.6	73.3	62.4	55.015	107.4
CH_4 EF	t/TJ	0.001	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N_2O EF	t/TJ	0.0014	0.0014	0.0014	0.0014	0.0006	0.0006	0.0006	0.0001	0.004

Table 3.2.15: Emission factors used for 2011

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal	Bituminous Coal	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	104.478	101.180	98.833	90.881	77.4	74.0	63.0	55.291	108.5
EF*OF	t/TJ	102.389	99.157	96.856	89.062	76.6	73.3	62.4	55.015	107.4
CH_4 EF	t/TJ	0.001	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N_2O EF	t/TJ	0.0014	0.0014	0.0014	0.0014	0.0006	0.0006	0.0006	0.0001	0.004

Emission factors for biogas are the same as for natural gas.

Waste incineration

Emissions from category Other fuel have arisen from Slovenian only waste incineration thermal plant which has started to work in 2009. Data on amount of incinerated waste, NCVs and distribution between biogenic and other waste have been obtained directly from the plant. It shows up that most of the waste in non biogenic part of waste is plastics. Because plastic is made from fossil fuels, its combustion is considered an anthropogenic source of carbon emissions.

CO_2 emissions from combusting plastic depend on the carbon content of the plastic and the amount of carbon that is converted to CO_2 during the combustion process. There is no EF available in the 1996 and 2000 IPCC guidelines. After research done on scientific literature, which is available on the web, the emission factor of 20 t C/TJ has been used (73.3 t CO_2/TJ). It is the same as lower value for combustion of non-biomass fraction of Municipal waste in 2006 IPCC Guidelines on Table 2.2.

For calculation of non CO2 emissions the following values have been used: CH4 EF 0.01 t CH4 /TJ (waste, lower value) from Table 2.2 and N2O EF 170 g N2O/t waste (plastics) from Table 5.5.

Source specific QA/QC activities

Beginning in 2005, all thermal power plants in the Republic of Slovenia have carried out regular coal sampling and determine the carbon contents in accordance with the Monitoring guidelines for monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of European Parliament and of the Council is necessary for CO_2 emission trading in the period 2005-2007 on the territory of the European Union. For this reason the country specific CO_2 EF have been used also for coal from Trbovlje pit in 2006 for the first time.

The monitoring of fuel in four plants under EU-ETS is defined in the permit and accompanied monitoring plan. Each fuel is monitored with maximum uncertainty which depend on total GHG emissions from the plant and typical consumption of particular fuel. All three plants have to monitor the coal consumption on the higher level of accuracy and determine NCV and C content in the accredited laboratory for every batch of fuel. The fourth plant is using natural gas as a main fuel.

The detailed description of requirements are in the Guidelines for the monitoring and reporting: (2007/589/EC: Commission Decision of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (notified under document number C(2007) 3416))
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007D0589:EN:NOT

Table 3.2.16: Levels of pretentiousness (Tiers) for fuel used in TPP in Slovenia in 2005-2011.

	AD	NCV	CO2 EF
Natural gas	Tier 4	Tier 2a	Tier 2a
Solid fuel	Tier 3	Tier 3	Tier 3
Fuel oil	Tier 1 or 2	Tier 2a	Tier 2a

A description of the requests under particular Tier

AD
Tier 1: The fuel consumption cover the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ±7.5% taking into account the effect of stock changes where applicable.

Tier 2: The fuel consumption cover the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ±5.0% taking into account the effect of stock changes where applicable.

Tier 3: The fuel consumption cover the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ±2.5% taking into account the effect of stock changes where applicable.

Tier 4: The fuel consumption cover the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ±1.5% taking into account the effect of stock changes where applicable.

NCV
Tier 2a: The operator applies country-specific net calorific values for the respective fuel as reported by the respective Member State in its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change.

Tier 3: The net calorific value representative for the fuel in an installation is measured by the operator, a contracted laboratory or the fuel supplier in accordance with the provisions of Section 13 of Annex I to Guidelines for the monitoring and reporting.

EF
Tier 2a: The operator applies country-specific emission factors for the respective fuel as reported by the respective Member State in its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change.

Tier 3: Activity-specific emission factors for the fuel are determined by the operator, an external laboratory or the fuel supplier according to the provisions of Section 13 of Annex I to Guidelines for the monitoring and reporting.

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 GHG inventory and notification to SORS is made to correct their data.

Recalculations

For MSW incinerated in the Slovenia only incineration plant the updated values of biomass fraction have been obtained and therefore GHG emissions from this plant related to the other and biomass fuel have been recalculated for the period since 2009. This is the year when the incineration plant has started to work. Following the recommendation from EU TERT the CH4 and N2O emissions have been also calculated, they were reported as NO in the previous submissions.

Future improvements

No improvements are planned for this sector.

3.2.5.2 Petroleum Refining (CRF 1A1b)

Key sector - Base year: no
Key sector - Year 2011: no

The main representative of this category was company the Nafta Lendava Refinery – Slovenian only refinery which has stopped with oil refining in 2002. 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 following methodology has been adopted.
Quantity of Fuel Combusted x Net Calorific value x EF per energy of Fuel x (oxidation factor) = Emissions

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:
for the period 1986-1996 under „Oil Industry"
From 1997 – 2004 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.

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. Consequently, these quantities (which in the reference approach have been subtracted within the framework of the chapter Stored Carbon) have not been taken into account in sectoral because they have not been used as fuel but as feedstock for the production of methanol).

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 1997-2003 are comparable to the period 1986-1996.

Since 2004 data are available in the excel files from SORS (E_PE-M YYYY.xls).

In the period 2004 -2007 according to the old SKD classification the following SKD categories have been included in this CRF category:
CA11 Extraction of crude petroleum and natural gas including support activities
DF Production of coke, refined petroleum products and nuclear fuel

Since 2008 the new SKD_2008 classification has been used and the following categories have been included in this CRF category:

B06 Extraction of crude petroleum and natural gas
B09.1 Support activities for petroleum and natural gas mining
C19.2 Manufacturing of refined petroleum products

Data on fuel consumption by type and year are reported in the Annex 2 to the NIR, table 1.1.

Net calorific values

Table 3.2.17: NCVs for the fuel used in energy industry.

Year	Fuel Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	MJ/Sm3
1986	41.82	39.74			33.500
1987	41.87	39.80			33,500
1988	41.87	39.80			34,080
1989	41.87	39.80			34,100
1990	41.87	39.80			34.100
1991	41.88	39.80			34.100
1992	41.90	39.90			34.100
1993	41.90	39.80			34.100
1994	41.90	39.86			34.100
1995	41.90	40.00			34.100
1996		40.00			34.100
1997		40.00			34.080
1998		40.00			34.080
1999	41.90	40.00			34.080
2000	41.90	40.00			34.080
2001	41.90	40.00			34.080
2002	41.90	40.00			
2003	41.90	40.00			
2004	41.90				
2005	41.90		42.70		
2006	41.90	40.00	42.60	46.05	34.080
2007	41.90		42.61	46.05	
2008	41.90		42.60	46.05	
2009	41.90		42.60	46.05	34.074
2010	41.90		42.60	46.05	34.080
2011	41.90		42.60	46.05	34.087

Emission factors

We have used country specific CO_2 EF for natural gas. More detailed description is in chapter 3.2.2. Emission factors for all other fuels have been taken from IPCC Reference Manual, 1996.

Table 3.2.18: Emission factors used for all years.

Year	Unit	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
CO_2 EF	**t/TJ**	74.0	77.4	74.0	63.0	Table 3.2.5
EF*OF	**t/TJ**	73.3	76.6	73.3	62.4	Table 3.2.5
CH_4 EF	**t/TJ**	0.002	0.002	0.004	0.002	0.005
N_2O EF	**t/TJ**	0.0006	0.0006	0.03	0.0006	0.0001

Recalculations
No recalculations have been performed in this category.

Future improvements
No improvement is planned for this category.

3.2.5.3 Manufacture of solid fuels and Other energy Industries (CRF 1A1c)

Key sector - Base year: no
Key sector - Year 2011: no

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

Methodology

To estimate emissions from Manufacturing of solid fuels and Other energy Industries the following methodology has been adopted.

Quantity of Fuel Combusted x Net Calorific value x EF per energy of Fuel x (oxidation factor) = Emissions

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

Since 2004 data are available in the excel files from SORS (E_PE-M YYYY.xls).

In the period 2004 -2007 according to the old SKD classification the following SKD categories have been included in this CRF category:
CA10 Mining of coal and lignite

Since 2008 the new SKD_2008 classification has been used and the following categories have been included in this CRF category:
B05 Mining of coal and lignite
C19.1 Manufacturing of coke oven products - do not exist in Slovenia.

Data on fuel consumption by type and year are reported in the Annex 2 to the NIR, table 1.1.

Net calorific values

Net calorific values have been taken from SORS, and are presented in the table 3.2.19.

Table 3.2.19: NCVs for the fuel used in energy industry.

Year	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Fuel Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3
1986	11.880		41.82			46.00	33.50
1987	11.820		41.87			46.00	34.10
1988	12.000		41.87			46.00	34.10
1989	12.050		41.87			46.00	34.10
1990	12.760		41.87			46.00	34.10
1991	12.879		41.88			46.00	
1992	12.589		41.90	39.90		46.00	34.10
1993	13.351		41.90			46.00	34.10
1994	12.666		41.90			46.00	
1995		17.404	41.90			46.00	34.10
1996		16.353	41.90			46.00	
1997		17.712	41.90				
1998		20.664	41.90				
1999		20.806	41.90				
2000		20.782	41.90				
2001		20.947	41.90				
2002			41.90				
2003			41.90				
2004			41.90			46.05	
2005			42.60	41.42	42.70	46.05	
2006			41.90	40.00	42.60	46.05	
2007				41.42	42.61	46.05	
2008				41.12	42.60	46.05	34.096
2009					42.60		34.074
2010					42.60		
2011					42.60		

Emission factors

We have used country specific CO_2 EF for natural gas. More detailed description is in chapter 3.2.2..Emission factors for all other fuels have been taken from IPCC Reference Manual, 1996.

Table 3.2.20: Emission factors used for all period

Year	Unit	Sub-bituminous Coal	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
CO_2 EF	**t/TJ**	101.2	74.0	77.4	74.0	63.0	Table 3.2.5
EF*OF	**t/TJ**	99.2	73.3	76.6	73.3	62.4	Table 3.2.5
CH_4 EF	**t/TJ**	0.010	0.002	0.002	0.002	0.004	0.005
N_2O EF	**t/TJ**	0.0014	0.0006	0.0006	0.0006	0.03	0.0001

Recalculations
No recalculations were performed in this sector.

Future improvements
No improvement are planned for this sector

3.2.6 Manufacturing Industries and Construction (IPCC: I A 2)

Iron and Steel	KC	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	3.50		5
2011	Level, Trend	CO_2	0.57	2.02	22

Non-ferrous Metals	KC	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	1.35		12
2011	Trend	CO_2	0.25	0.72	34

Pulp, Paper and Print	KC	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	1.99		7
2011	Level	CO_2	1.02	0.09	15

Food, Bev. and Tob.	KC	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	0.76		24
2011	no	CO_2	0.29	0.14	32

Other	KC	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	5.44		4
2011	Level	CO_2	2.56	0.19	5

This chapter presents the consumption of fuels and emissions of greenhouse gases in five specific types of industry, all other are hidden under other industry where also fuel for construction industry is included. For this reason, that in “other” a big number of enterprises are included this is the most important for GHG emissions The most important industry under other is non-metal production which including cement and lime production as two of the most important fuel consumers. There was an appreciable reduction of GHG from industry in 1986-1997 then stabilisation of emission has been observed with the slight increase in the period 2004-2006.

Table 3.2.21: GHG emissions from Manufacturing Industries and Construction in Gg CO_2 eq.

in Gg CO_2 eq.	1986	1990	1995	2000	2005	2008	2009	2010	2011
2. Manufacturing Ind. and Constr.	**4404**	**3119**	**2615**	**2269**	**2486**	**2305**	**1918**	**1900**	**1704**
a. Iron and Steel	1147	419	232	281	208	209	155	198	195
b. Non-Ferrous Metals	442	435	177	63	62	97	111	89	87
c. Chemicals	98	208	153	169	166	165	173	116	86
d. Pulp, Paper and Print	652	376	688	509	571	424	410	383	351
e. Food Processing, Bev. and Tob.	249	219	201	181	174	126	115	112	100
f. Other	1816	1460	1166	1066	1305	1283	953	1002	886

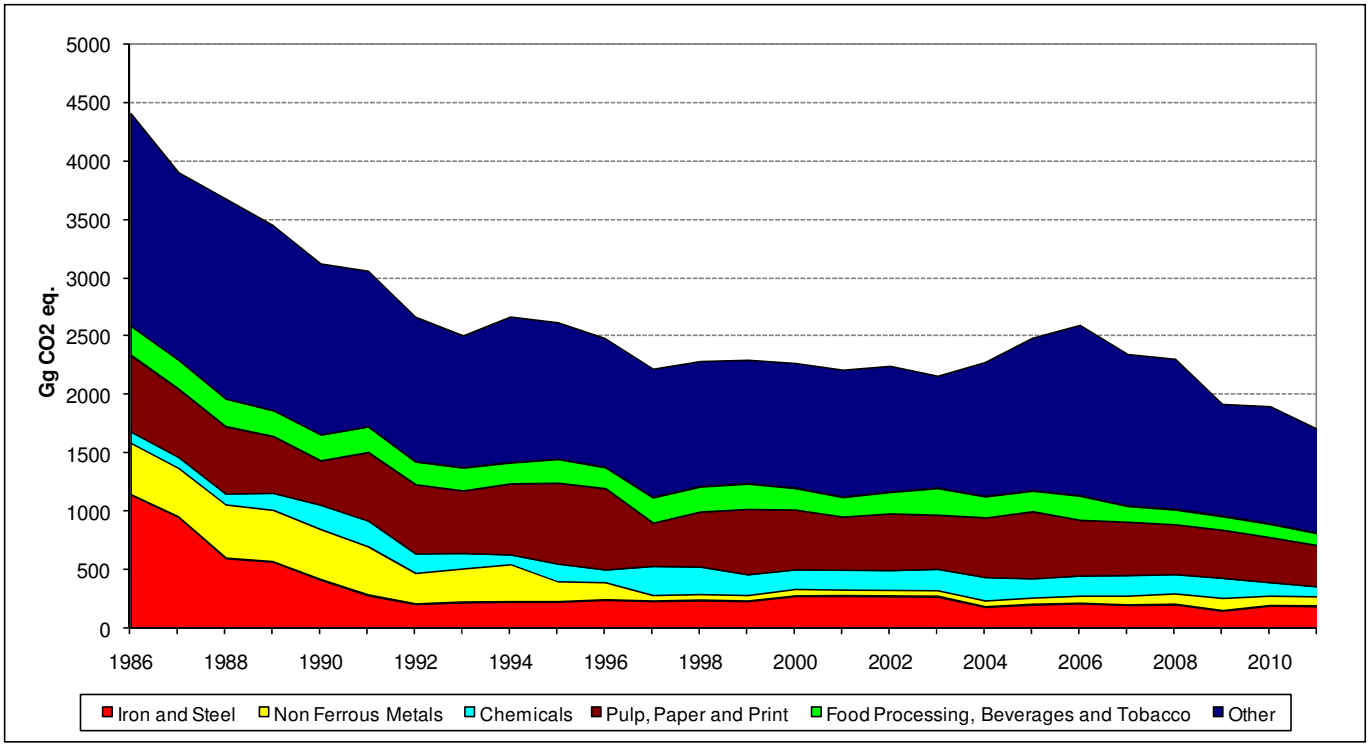

Figure 3.2.2: GHG emissions from Manufacturing Industries and Construction

Methodology

Emissions from combustion in manufacturing industries and construction were estimated using the Tier 1 methodology described in IPCC 96. The following basic formula was used: Quantity of Fuel Combusted x Net Calorific value x EF per energy of Fuel x (oxidation factor) = Emissions
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 3.2.22: Conversion table between national energy statistics (LEG) and CRF

CRF category	LEG Classification (1986-1996)
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
Food Processing. Beverages and Tobacco	Food Processing Industry Tobacco Industry
Other	Other

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

Table 3.2.23: Conversion table between national energy statistics (LEG) and CRF

CRF category	LEG Classification (1986-1996)
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 3.2.24: Conversion table between national energy statistics (LEG) and CRF

CRF 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 3.2.25: Conversion table between national energy statistics (LEG) and CRF

CRF category	LEG Classification
Other	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
	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.

YEARS 2004 - 2011

For the year 2004 we have obtained very detailed data about fuel consumption in industry in electronic format (E_PE_M YYYY.xls). 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 Table 3.2.25 is valid until 2007 and Tables 3.2.26 and 3.2.27 since 2008 as new version of SCA classification have been used by SORS.

Table 3.2.26: Table for disaggregation of fuel in DJ sector (manufacture of basic metals and fabricated metal products)

SCA category	CRF 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 machin equipment

Table 3.2.27: Table for disaggregation of fuel in manufacture of basic metals and fabricated metal products since 2008

SCA 2008, V2	CRF 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 fi
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 3.2.28: Conversion table between national energy statistics and CRF

CRF 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, exc manufacture of articles of straw and plaiting materials C 21 – Manufacture of basic pharmaceutical products and pharmac 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 1986 -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 data on auto producers at the level of industrial branches for the period 1986-2000, 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 2000-2011

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.

Following the recommendation of the expert review team data on fuel consumption by industry type, fuel type and year are reported in the Annex 2 to the NIR, table 1.2. Following the recommendation from 2011 review also data on bio fuels and other fuels have been included.

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

Year	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Other Bituminous Coal	Anthracite	Coke	Petroleum coke
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt
1986	9.390	11.880		27.57	29.25	29.30	31.000
1987	9,650	11,820		27.57	29.25	29.30	31.000
1988	9,440	12,000		27.57	29.25	29.30	31.000
1989	9,820	12,050		27.57	29.25	29.30	31.000
1990	9.810	12.760		27.57	29.25	29.30	31.000
1991	9.980	12.879		25.00	29.25	29.30	31.000
1992	10.260	12.589		25.00	29.25	29.30	31.000
1993	10.070	13.351		25.00	29.25	29.30	31.000
1994	9.960	12.666		25.00	29.25	29.30	31.000
1995	10.220		17.404	25.00	29.31	29.31	31.000
1996	9.690		16.353	25.00	29.31	29.31	31.000
1997	9.610		17.712	25.00	29.31	29.31	31.000
1998	10.010		20.664	25.00	29.31	29.31	31.000
1999	9.690		20.806	25.00	29.31	29.31	31.000
2000	10.170		20.782	25.00	29.31	29.31	31.000
2001	10.660		20.947	25.00	29.31	29.31	31.000
2002	10.350		21.000	25.00	29.31	29.31	31.000
2003	10.138		21.570	25.00	29.31	29.31	31.000
2004	10.301		19.908		29.40	28.49	29.927
2005			20.381	25.15		27.90	29.927
2006			20.108	25.77		29.44	32.223
2007			20.387	24.46		29.37	31.949
2008			18.623	24.31		29.87	31.949
2009			17.972	23.896		29.67	32.498
2010			16.325	25.290		29.42	30.644
2011			15.138	25.422		29.619	31.684

Year	Gas Oil	Residual Fuel Oil	Diesel	Gasoline	LPG	Natural Gas	Wood and other
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1986	41.82	39.74	42.70	43.18	46.00	33.50	12.17
1987	41,78	39,80	42.70	43.10	46.00	33,50	12.17
1988	41,71	39,80	42.70	43.10	46.00	34,08	12.17
1989	41,85	39,80	42.70	43.10	46.00	34,10	12.17
1990	41.87	39.80	42.70	43.07	46.00	34.10	12.17
1991	41.88	39.80	42.70	43.17	46.00	34.10	12.17
1992	41.90	39.90	42.70	43.10	46.00	34.10	12.17
1993	41.90	39.80	42.70	43.08	46.00	34.10	12.17
1994	41.90	39.86	42.70	43.08	46.00	34.10	12.17
1995	41.90	40.00	42.70	43.08	46.00	34.10	12.17
1996	41.90	40.00	42.70	43.08	46.00	34.10	12.17
1997	41.90	40.00	42.70	43.08	46.05	34.08	12.17
1998	41.90	40.00	42.70	43.08	46.05	34.08	12.17
1999	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2000	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2001	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2002	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2003	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2004	41.90	40.00	42.70		46.05	34.08	12.17
2005	42.60	41,42	42.70		46.05	34.08	12.17
2006	42.60	41,42	42.70	43.08	46.05	34.072	12.17
2007	42.60	41,42	42.70	43.08	46.05	34.08	12.17
2008	42.60	41,42	42.70	43.85	46.05	34.096	12.17
2009	42.60	41,42	42.70	43.85	46.05	34.08	12.17
2010	42.60	41,42	42.70	43.85	46.05	34.08	10.77
2011	42.60	41,42	42.60	43.85	46.05	34.087	10.79

Table 3.2.30: NCVs for the solid fuel used in manufacturing industry and construction in 2011.

Industry - 2011	Unit	Lignite	Sub-bituminous Coal - imported	Other Bituminous Coal	Coke
Iron and steel	TJ/kt				30.318
Non-Ferrous metals	TJ/kt			25.000	
Pulp. Paper and Print	TJ/kt	10.717	18.834	23.867	
Other	TJ/kt		13.004	25.494	29.300

Emission factors

We have used country specific CO_2 EF for domestic lignite and natural gas. More detailed description is in chapter 3.2.2.. Emission factors for all other fuels have been taken from IPCC Reference Manual, 1996.

Table 3.2.31: EFs for the fuel used in manufacturing industry and construction.

Year	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Other Bituminous Coal	Anthracite	Coke
CO_2 EF	**t/TJ**	Table 3.2.1	101.2	101.2	94.6	98.3	108.2
EF*OF	**t/TJ**	Table 3.2.2	99.2	99.2	92.7	96.3	106.0
CH_4 EF	**t/TJ**	0.010	0.010	0.010	0.010	0.010	0.010
N_2O EF	**t/TJ**	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014

Year	Unit	Petroleum coke	Gas Oil	Residual Fuel Oil	Diesel	Gasoline	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	t/TJ	100.8	74.0	77.4	74.0	71.7	63.0	Table 3.2.5	108.5
EF*OF	t/TJ	99.80	73.3	76.6	73.3	71.0	62.4	Table 3.2.5	107.4
CH_4 EF	t/TJ	0.0100	0.002	0.002	0.004	0.05	0.002	0.005	0.030
N_2O EF	t/TJ	0.0014	0.0006	0.0006	0.03	0.002	0.0006	0.0001	0.0040

Table 3.2.32: Country specific CO_2 EF (EF*OX) for the solid fuel used in manufacturing industry and construction in 2011.

Industry - 2011	Unit	Lignite	Sub-bituminous Coal - imported	Other Bituminous Coal	Petroleum Coke
Pulp. Paper and Print	t/TJ	104.347	97.247		
Other	t/TJ			94.350	96.535

Waste incineration

In industry, particularly in cement industry, beside common used fuel also same wastes are incinerated because very high temperature in own.

We have very detailed data about amount and composition of waste from one cement plant where the main process of waste incineration in Slovenia was occurring. This data are available since 1996.

From 2004 to 2006 we have obtained data from pulp and paper industry about consumption of black liquor. NCV was between 6.1 and 6,4 TJ/kt. For GHG calculation we have used the same EF as we used for wood. From 2007 there was no consumption of the black liquor any more.

Table 3.2.33: Amount of waste incinerated in cement plant.

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	t	t	t	t	t
1996	1058	0	0	1649	725
1997	1629	0	0	1390	760
1998	1526	0	0	2695	800
1999	3459	0	0	2744	835
2000	1854	0	0	4551	619
2001	2382	2124	0	2014	957
2002	1626	2214	0	3138	230
2003	2229	3319	0	4346	110
2004	3598	5225	12	6051	0
2005	4193	4496	0	10258	0
2006	4294	2177	0	10978	0
2007	4277	2535	0	8645	0
2008	4204	3074	0	12163	0
2009	4570	2280	0	11436	0
2010	4709	2071	0	18801	16509
2011	3531	1950	0	15776	17373

Table 3.2.34: NCVs for waste incinerated in the cement plant.

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt
1996	37.00			27.21	11.00
1997	37.00			27.21	11.00
1998	37.00			27.21	11.00
1999	37.00			27.21	11.00
2000	37.00			27.21	11.00
2001	37.00	39.20		27.21	11.00
2002	37.00	39.20		27.21	11.00
2003	37.00	39.20		27.21	11.00
2004	41.90	40.41	40.00	27.21	
2005	40.00	39.20		27.21	
2006	34.53	39.20		27.21	
2007	38.00	39.95		27.00	
2008	38.06	39.81		27.20	
2009	38.24	39.81		27.10	
2010	36.69	39.20		27.21	22.29
2011	36.54	39.20		27.21	19.52

Table 3.2.35: EFs for waste incinerated in the cement plant in the period 1986-2009

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	t/TJ	t/TJ	t/TJ	t/TJ	t/TJ
CO_2 EF	72.60	70.01	70.01	70.01	70.01
CH_4 EF	0.0020	0.0300	0.0300	0.0300	0.0300
N_2O EF	0.0006	0.0040	0.0040	0.0040	0.0040

Table 3.2.36: CO2 EFs for waste incinerated in the cement plant since 2010

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	t/TJ	t/TJ	t/TJ	t/TJ	t/TJ
2010	70.27	70.01	-	54.854	60.472
2011	70.27	70.01	-	52.631	49.473

Recalculations

No recalculations have been performed for this sector.

Future improvements

No improvements are planned for this sector.

3.2.7 Transport (IPCC: I A 3)

Traffic is an important source of emissions of greenhouse gases, mostly carbon dioxide and nitrous oxide, and also an important source of emissions which cause problems in terms of air quality, such as sulphur oxides (SOx), nitrous oxides (NOx), carbon monoxide (CO), non volatile organic compounds (NMVOC), and consequently are indirectly responsible for the formation of ozone (O_3) in lower troposphere.

Table 3.2.37: GHG emissions from Transport in Gg CO_2 eq.

in Gg CO_2 eq.	1986	1990	1995	2000	2005	2008	2009	2010	2011
3. Transport	**2025**	**2730**	**3824**	**3862**	**4428**	**6158**	**5325**	**5265**	**5699**
a. Civil Aviation	1	1	2	3	2	1	2	2	2
b. Road Transportation	1948	2656	3774	3816	4384	6108	5278	5217	5654
c. Railways	77	73	49	43	42	46	42	42	42
e. NG transmission	NO	NO	NO	NO	IE	2	3	4	1

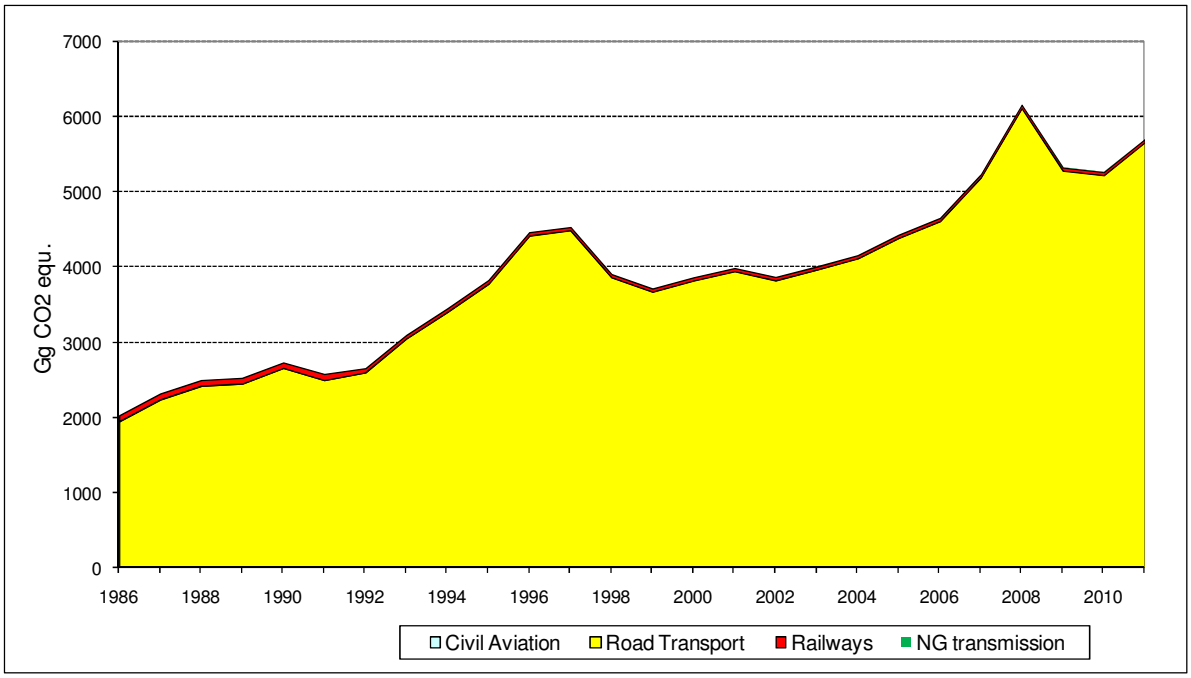

Figure 3.2.3: GHG emissions from Transport.

3.2.7.1 Road transport

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	5.84		3
2011	Level, Trend	CO_2	16.46	24.09	3

Clearly, the most important source is road traffic, which accounts for 99% of all traffic emissions. GHG emissions have more than doubled compared to the base year.

Methodology

COPERT 4 (version 9.0) methodology has been used for calculation of national greenhouse gas emissions from road transport for the entire 1986-2011 period. The methodology is fully incorporated in the computer software programme COPERT 4 (version 9.0) which facilitates its application. The actual calculations have been therefore performed by using this computer software. Upgraded version of COPERT 4, this is version 9.0, has been used for the first time for this year's submission. For previous submissions version 6.1 had been used.

COPERT 4 model 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, NH_3, SO_x, 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 dioxins and furanes. 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 EMEP/EEA air pollutant emission inventory guidebook 2009. 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 3.2.38 provides a summary of all vehicle categories and technologies covered by the applied methodology.

Table 3.2.38: 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 2010 those data have been collected by Ministry of Infrastructure and

Spatial Planning of the Republic of Slovenia. Since no database exists on licensed motor and trailer vehicles in the Republic of Slovenia for the years 1986–1991, 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 1986–2011 are shown in Annex 1 (Table 1.4 : Road transport : Fleet data (number of vehicles) 1986–2011).

The vehicle fleet structure is presented in Figure 3.2.4. 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 1986 to 1991. Both vehicle classes are considered together as heavy duty trucks. The number of buses has been almost constant between 1986 and 2011. 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.

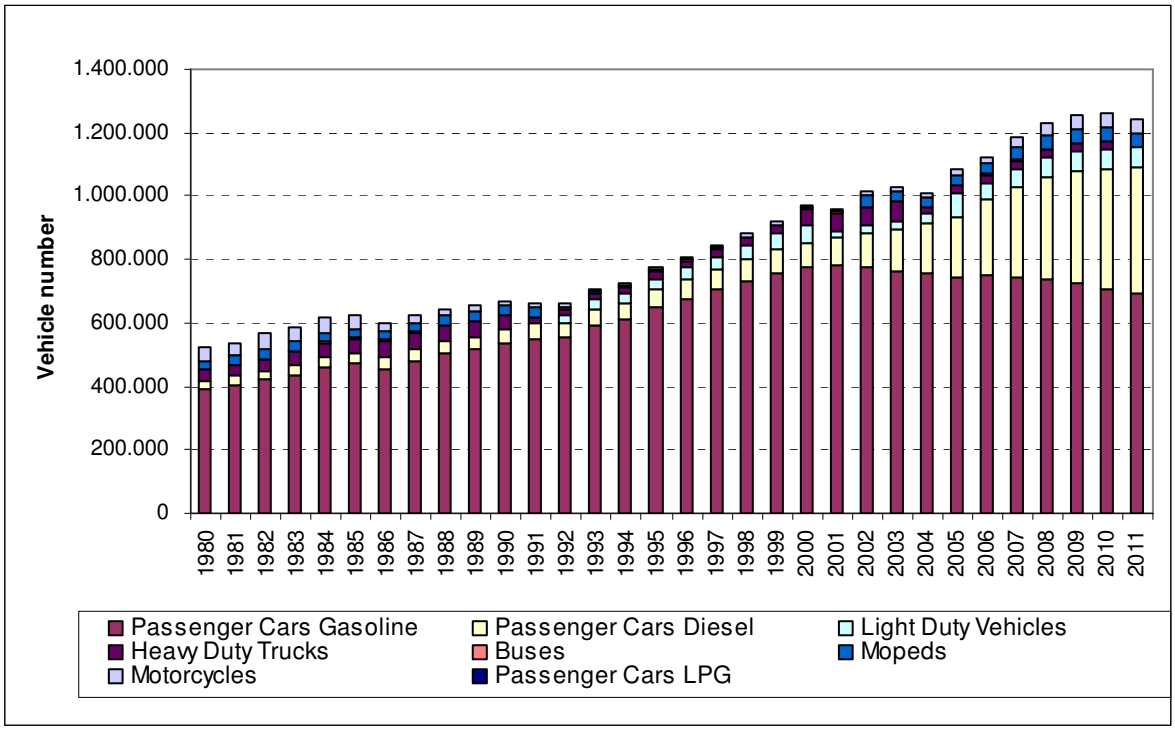

Figure 3.2.4: **Vehicle fleet 1986–2011**.

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 Infrastructure and Spatial Planning, 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 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 1986 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 1986–1987 the same values were taken as for the year 1998.

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 1986–1991. 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 2 (Table 1.5: Road transport: Mileage data 1986–2011).

Passenger cars

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 1986 to 2009. For the years 2010 and 2011 data from survey conducted by Statistical Office of the Republic of Slovenia in 2010 was applied. (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 1986 to 1991, light duty vehicles, mid-size duty vehicles as well as heavy duty vehicles have been considered together as one category. The light duty and mid-size duty vehicles were numbered among heavy duty vehicles.

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 1986 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 1986 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:

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

Buses

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 $\qquad m_R^{Cbus} = \frac{M_R^{Cbus}}{M_R^{Cbus} + M_H^{Cbus}} \qquad m_H^{Cbus} = \frac{M_H^{Cbus}}{M_R^{Cbus} + M_H^{Cbus}}$

Motorcycles and mopeds
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 1986 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 2 (Table 1.6: *Road transport: Speed data 1986–2011*).

Fuel Consumption

Statistical data on the total volume of fuel consumed in the Republic of Slovenia has been obtained from 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 3.2.5 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%. In 2010 consumption of diesel was increased compared to previous year, whereas consumption of gasoline has been still on the decline. In 2011 consumption of both, diesel and gasoline were increased compared to 2010. Lower consumption of fuel in period 2009-2010 was due to the world economical crisis. In the year 2005 sale of diesel fuel exceeded the sale of gasoline. In 2011 the fuel use shares for diesel and gasoline were about 69% and 31%, respectively. The share of liquefied petroleum gas (LPG) was below 0.4%.

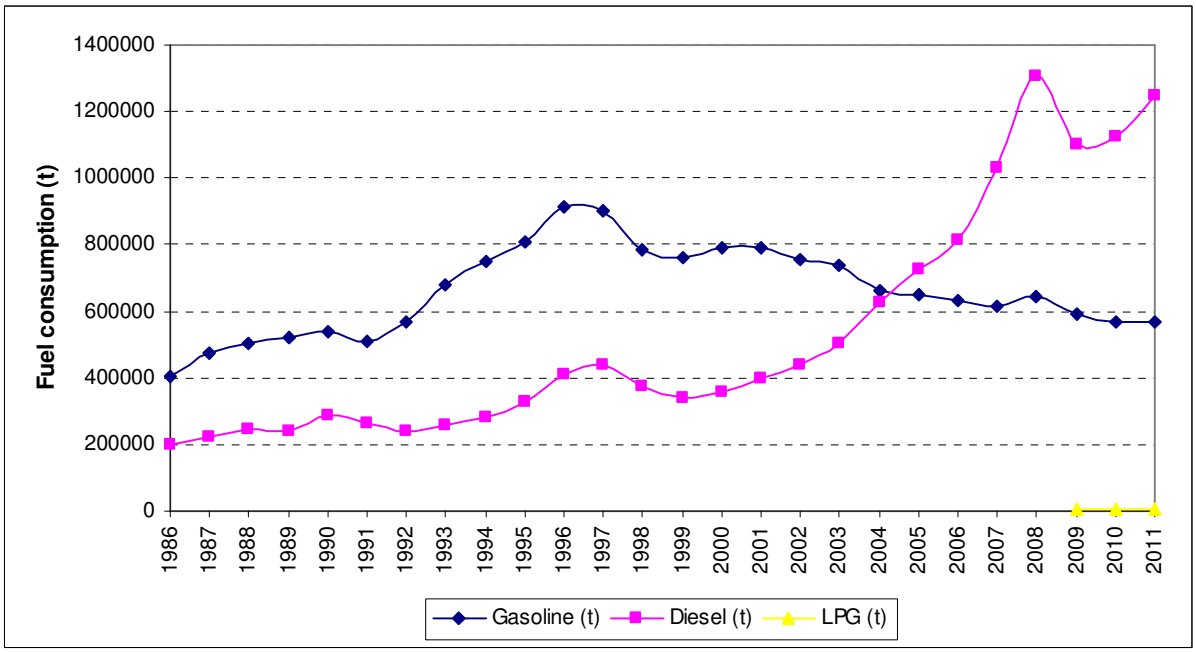

Figure 3.2.5: Fuel consumption in road transport for 1986–2011.

As shown in Figures 3.2.6 and 3.2.7, 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 1986 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 2 *(Table 1.7: Road transport: Fuel Consumption by types of vehicles 1986–2011).*

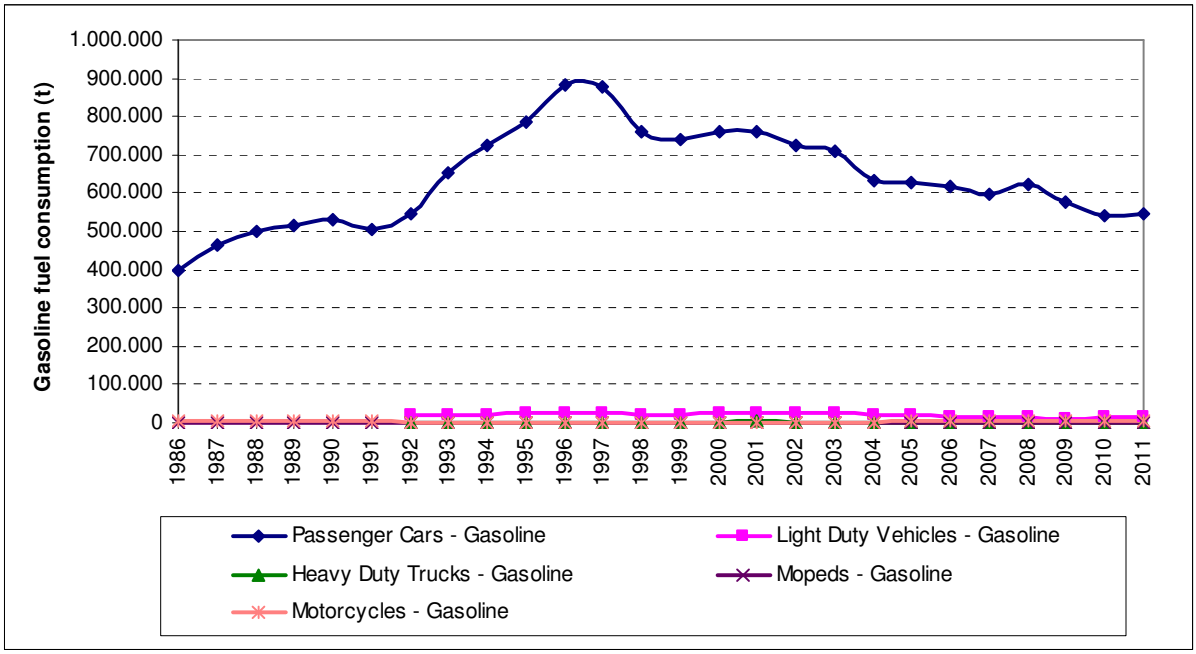

Figure 3.2.6: Gasoline fuel consumption per vehicle type for road transport 1986–2011.

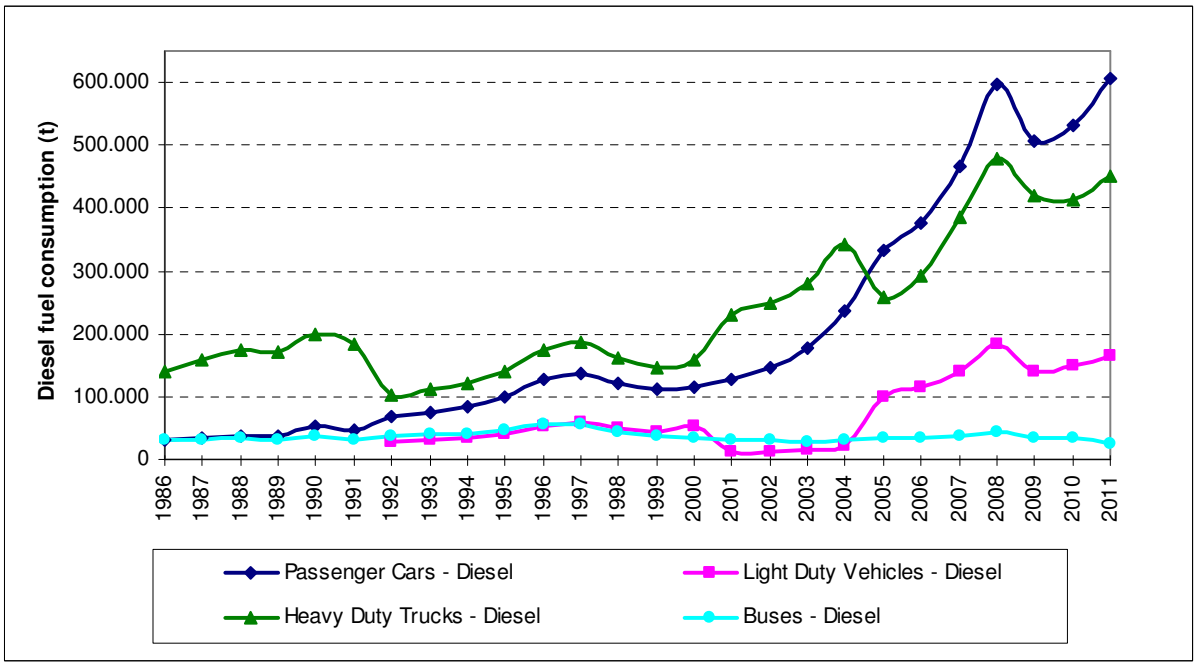

Figure 3.2.7: Diesel fuel consumption per vehicle type for road transport 1986–2011.

In 2011, fuel consumption shares for gasoline passenger cars, diesel passenger cars diesel heavy duty trucks were about 33, 30, 25 %, respectively (Figure 3.2.8).

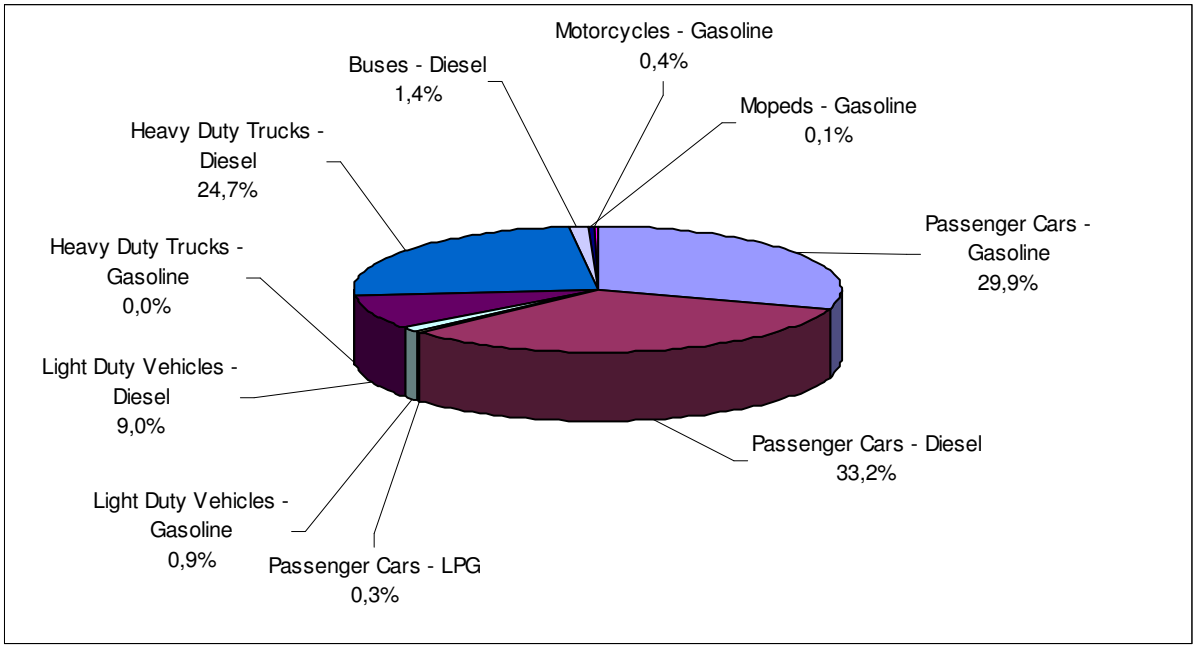

Figure 3.2.8: Fuel consumption share per vehicle type for road transport in 2011.

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.

Table 3.2.39: 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
	2009-2011	0.001
Diesel	1980-1994	1
	1995	0.25
	1996-2001	0.20
	2002-2004	0.035
	2005-2008	0.005
	2009-2011	0.001

Table 3.2.40: 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
	2002-2011	0.005

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 Tables 3.2.39 and 3.2.40.

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 Slovenian Environment Agency. 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 Slovenian Environment 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 CO_2, N_2O and CH_4

From 1986 to 2011 the road transport emissions of CO_2 and N_2O have increased by 194 % and 122 %, respectively. The emissions of CH_4 have decreased by 57 %. Due to the world economical crises and consecutively smaller fuel consumption emissions of all GHG considerably decreased in 2009. In view of difficult economical situation even slightly lower

emissions of all GHG were observed in the year 2010. In the year 2011 emissions of GHG were on the rise again and slowly approaching pre-crisis values. Referring to the third IPCC assessment report, 1 g CH_4 and 1 g N_2O have the greenhouse effect of 21 and 310 g CO_2, respectively. In spite of the relatively large CH_4 and N_2O global warming potentials, the largest contribution to the total CO_2 emission equivalents for road transport comes from CO_2 (Figure 3.2.9).

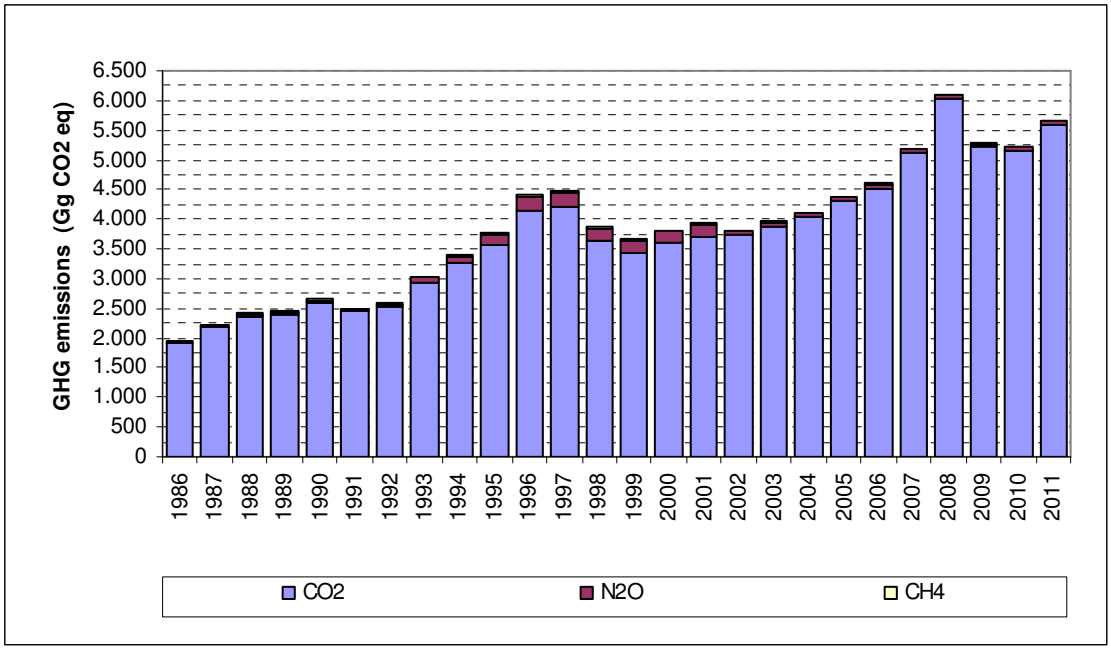

Figure 3.2.9: CO_2, N_2O and CH_4 emissions for road transport 1986–2011.

Due to the direct dependency of CO_2 emissions on fuel consumption, the total growth in CO_2 emissions reflects the trend of increased fuel consumption till 2008. In 2009 significant drop of CO2 emissions was occurred due to smaller fuel consumption. The same trend is shown for 2010, but in 2011 the trend was changed. As shown in Figures 3.2.10 and 3.2.11, the most important emission source for road transport is passenger cars, followed by heavy duty trucks, light-duty vehicles, buses and 2-wheelers in decreasing order. In 2011, the respective emission shares were about 64, 25, 10, 1.4 and 0.5%, respectively.

CO_2 emissions of passenger cars were gradually increasing from 1991 to 1996 mainly due to fuel being sold to foreigners as a consequence of lower fuel prices in Slovenia. During the period 2000–2008 an extensive switch from petrol powered to diesel powered cars could be observed. Better energy efficiency of diesel cars and a general improvement in fuel efficiency for all new vehicles diminished a considerable increase in fuel consumption which led to slower increase of CO_2 emissions in this period.

The fall of CO_2 emissions in heavy duty trucks occurring in 1992 was due to a change in methodology. In the category of light duty vehicles and heavy duty trucks, fuel consumption was considered jointly from the year 1986 to 1991. Since 1992 onwards, each vehicle category is treated separately. The economical crisis which began in 2008 and intensified in 2009 also led to reduced emissions from diesel powered heavy duty vehicles.

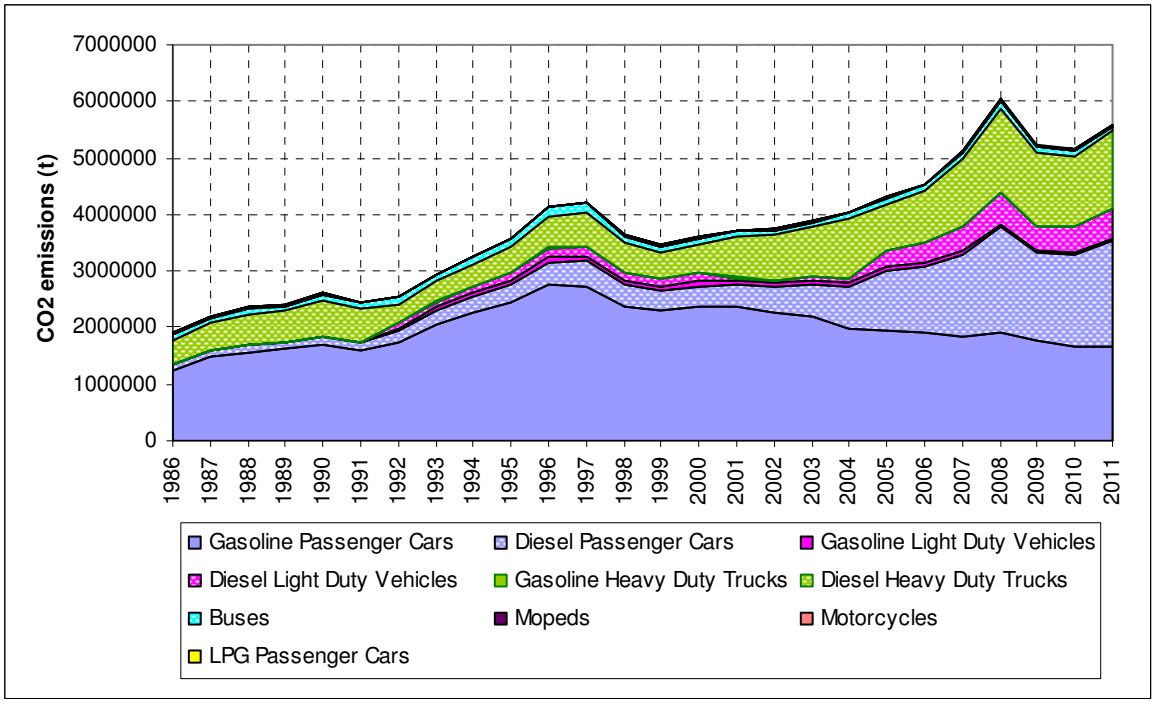

Figure 3.2.10: CO_2 emissions (t) per vehicle type for road transport 1986–2011.

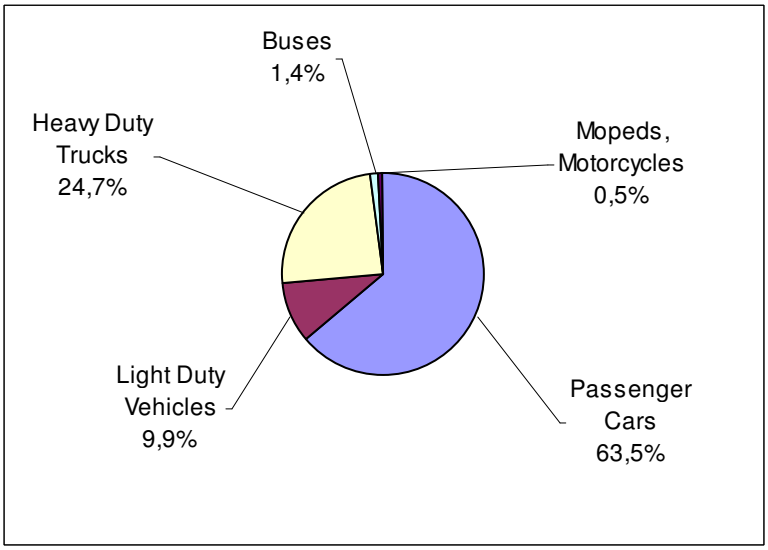

Figure 3.2.11: CO_2 emission share per vehicle type for road transport for 2011.

An undesirable environmental side effect of the introduction of catalyst cars is the increase in the emissions of N_2O. N_2O emissions have increased significantly from 1991 onwards, mostly due to the growing number of passenger cars with catalysts. In 2002 a huge drop of N_2O emissions occurred due to switching to lower sulphur fuel. Sulphur content in fuel has an important impact on N_2O emissions. Sulphur content dropped between 2001 and 2002 from 0,05 % to 0,015% for gasoline and 0,2% to 0,035% for diesel.

In 2011, emission shares for passenger cars, heavy duty trucks and light duty vehicles were about 70, 19 and 10 %, of the total road transport N_2O, respectively (Figures 3.2.12 and 3.2.13).

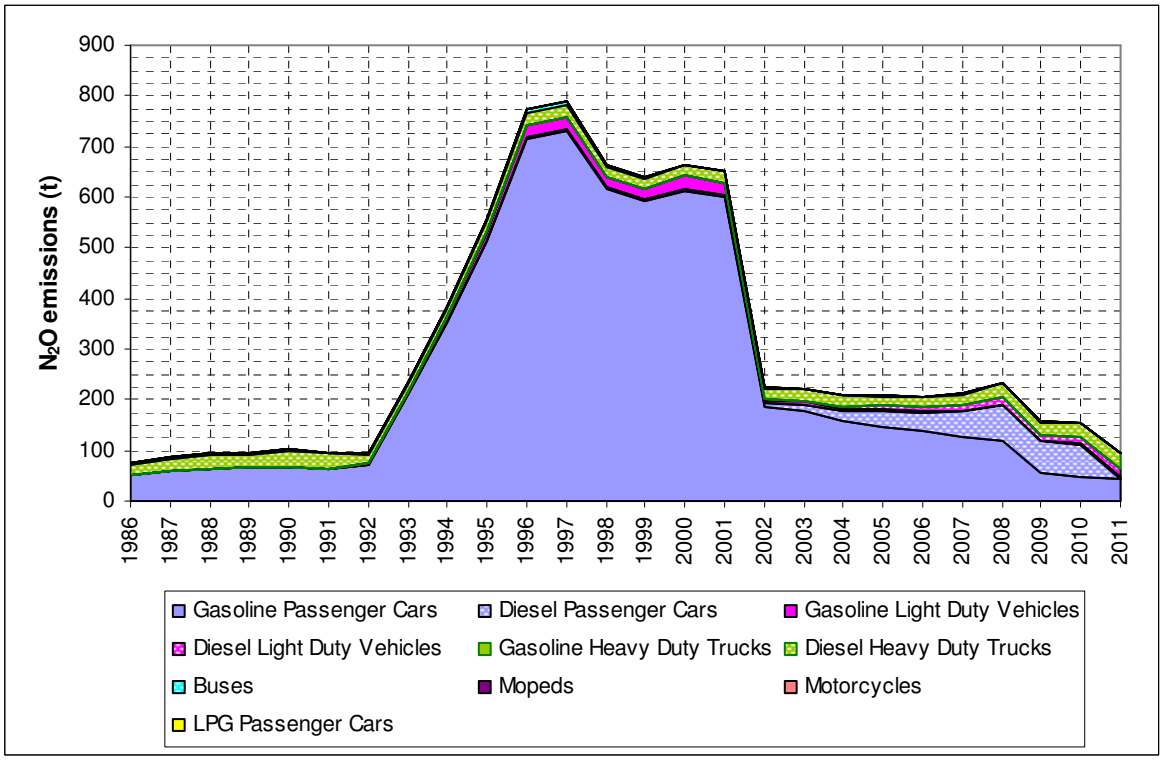

Figure 3.2.12: N_2O emissions (t) per vehicle type for road transport 1986–2011.

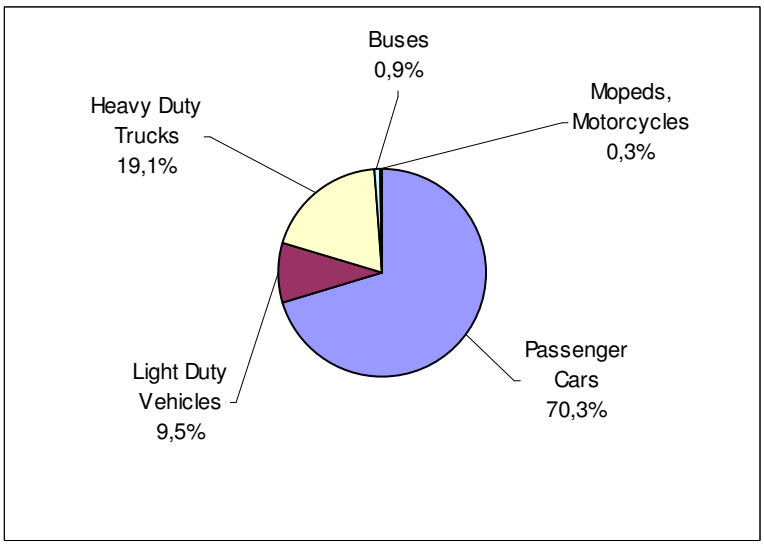

Figure 3.2.13: N_2O emission share per vehicle type for road transport for 2011.

The majority of CH_4 emissions from road transport come from gasoline passenger cars. The emission increase from 1992–1996 for this vehicle category is a result of introduction EURO 1 gasoline cars, which have a higher emissions factor than the older conventional

gasoline cars. The emission drop from 1997 onwards is explained by the penetration of EURO 2 and EURO 3 catalyst cars into the Slovene fleet. The newer technology stages have lower CH_4 emission factors than conventional gasoline vehicles. The 2011 emission shares for CH_4 were about 72, 14 and 10 % for passenger cars, heavy duty trucks and 2-wheelers respectively (Figures 3.2.14 and 3.2.15).

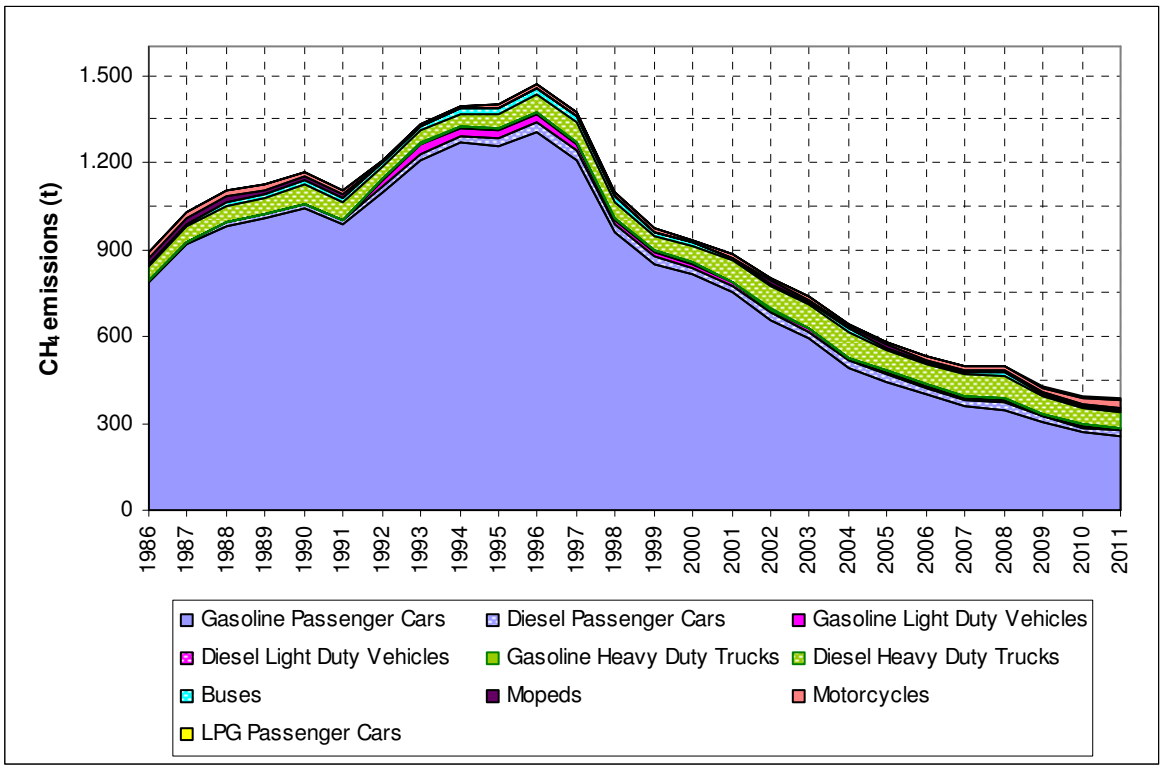

Figure 3.2.14: CH_4 emissions (t) per vehicle type for road transport 1986–2011.

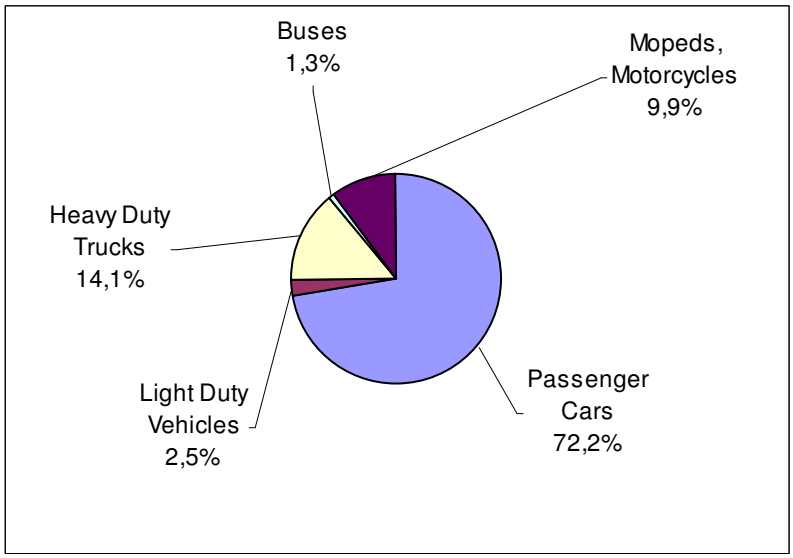

Figure 3.2.15: CH_4 emission share per vehicle type for road transport for 2011.

3.2.7.1.1 Source-Specific QA/QC and verification

Thorough examination of all input data, the model calculation and the data reported in CRF tables as part of AC/QC procedure was performed, especially due to use of new version of COPERT 4 for this year's submission.

One of the required model input data is annual amount (in tonnes) of consumed gasoline and consumed diesel fuel. Output of the model are calculated CO_2 emissions distributed according to fuel type, vehicle category and type of roads. CRF Tables require separate reporting of emissions arising from consumption of gasoline and diesel fuel. CO_2 emissions have to be reported in Gg. In CRF Tables fuel consumption has to be presented as energy (in TJ), not in mass (in tonnes). Implied CO_2 emission factors, expressed in t CO_2/ TJ fuel, are calculated automatically by CRF Reporter and used for reporting requirements only.

Thorough examination showed that all input data and calculated CO_2 emissions reported in CRF Tables are accurate. CO_2 emission factors (g CO_2/ kg fuel) used for emission calculation are comparable with the Revised 1996 IPCC Guidelines. Differences between CO_2 emissions factors (t CO_2/ TJ) presented in CRF Tables and those stated in the Revised 1996 IPCC Guidelines arise from differences in applied net calorific values. In period 2006-2011 additional slight deviations are due to use of bio fuel. Information on CO_2 implied emission factors (IEFs) for gasoline and diesel is presented in Annex 2 *(Table 1.8: Road transport: CO_2 implied emission factors 1986–2011).*

CH_4 and N_2O emissions were thoroughly examined as well. New version of COPERT 4 (version 9.0) delivers some improvements in emission calculations and also corrects some bugs in software performance. CH_4 and N_2O emissions reported in CRF Tables are accurate.

3.2.7.1.2 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.

3.2.7.1.3 Recalculations

Recalculations of CO_2, CH_4 and N_2O emissions were performed for entire period 1986-2010 due to a new version of model COPERT 4 used. COPERT 4, version 9.0 has been used for emissions recalculations. Version 9.0 replaced version 6.1.

3.2.7.1.4 Planned improvements

No improvement is planned for this category.

3.2.7.2 Railways

Key sector - Base year: no
Key sector - Year 2011: no

Table 3.2.1: GHG Emissions in the period 1986-2011.

	1986	1990	1995	2000	2005	2010	2011
fuel in TJ	930	879	588	514	512	511	511
Gg CO_2 eq.	77	73	49	43	42	42	42

Methodology

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

Quantity of Fuel used x Net Calorific value x EF per energy of Fuel = Emissions

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) and since 2006 from JQ.

The consumption of brown coal in railway transportation was small (from 0 to 646 t). This coal was 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. Since 2005 no consumption of coal has been reported in this category.

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

Emission factors
In calculating emissions of individual gases, emission factors from IPCC guidelines 1996 have been applied. They are shown in the following table.

Table 3.2.2: EFs for fuel used in railways.

EF	Unit	Gas Oil	Brown coal
CO_2 EF	**t/TJ**	74.0	101.2
EF*OF	**t/TJ**	73.3	99.2
CH_4 EF	**t/TJ**	0.004	0.01
N_2O EF	**t/TJ**	0.030	0.014

Recalculations
No recalculations have been performed since last submission.

Future Improvements
No improvement is planned for this category.

3.2.7.3 Aviation

Key sector - Base year: no
Key sector - Year 2011: no

Table 3.2.3: GHG Emissions in the period 1986-2011.

	1986	1990	1995	2000	2005	2010	2011
fuel in TJ	9	15	28	40	24	23	27
Gg CO_2 eq.	1	1	2	3	2	2	2

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.

Quantity of Fuel used x Net Calorific value x EF per energy of Fuel = Emissions

Activity data
As consumption in Slovenia, the category Aviation Gasoline for Piston Engine Aircraft is taken into account.

Net calorific values
We have used value 43.54 TJ/1000 t for aviation gasoline.

Emission factors
For the calculation of emissions and individual gases, the emission factors from IPCC guidelines from 1996 have been applied: 71.5 t CO_2/TJ, 0.001 t CH_4/TJ and 0.002 t N_2O/TJ for aviation gasoline and for jet kerosene as well.

Recalculations
No recalculations have been performed since last submission.

Future Improvements
No improvement is planned for this category.

3.2.7.4 Other Transportation

Key sector - Base year: NO
Key sector - Year 2011: no

This category includes emissions from natural gas combusted on compressor station.

Methodology
To estimate emissions the following methodology has been adopted.

Quantity of Fuel used x Net Calorific value x EF per energy of Fuel = Emissions

Activity data
Statistical office has not collected data from this source and in Joint questionnaires amount of fuel under this category was reported as zero. This amount has been included under Commercial/institutional as correction to energy balance.
We have obtained the data on natural gas used on compressor station since 2008 from the company Plinovodi which is the owner of this compressor station while for the period 2005-2007 notation key IE has been used. There was no compression station in Slovenia before 2005.

Net calorific values
We have used the same NCV as presented in chapter on Commercial sector.

Emission factors
We have used the same EF as presented in chapter on Commercial sector.

Recalculations
Following the recommendation from 2012 UNFCCC review the emissions from natural gas transmission (combustion on compressor station) have been reallocated from 1.A.4.a Other sectors / Institutional and commercial sector to the 1.A.3.e Transport sector / Other transportation.

Data are available since 2008, therefore the CO2, CH4, and N2O emissions have been recalculated for the period 2008-2010, while for the period 2005-2007 the notation key IE has been used. There were no compressor stations in Slovenia before 2005.

Future Improvements
No improvement is planned for this category.

3.2.8 Other sector (IPCC: I A 4)

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

- Commercial / Institutional sector (IPCC: I A 4 a)
- Residential sector (IPCC: I A 4 b)
- Agriculture and forestry (IPCC: I A 4 c)

Table 3.2.4: GWP of GHG emissions from Other Sector.

in Gg CO_2 eq.	1986	1990	1995	2000	2005	2008	2009	2010	2011
4. Other Sectors	**2367**	**1811**	**2439**	**3053**	**2585**	**2277**	**2186**	**2226**	**1954**
a. Commercial/Institutional	632	515	712	922	714	697	678	646	573
b. Residential	1256	924	1444	1871	1613	1314	1279	1345	1156
c. Agriculture/Forestry/Fisheries	479	371	283	261	258	265	229	234	225

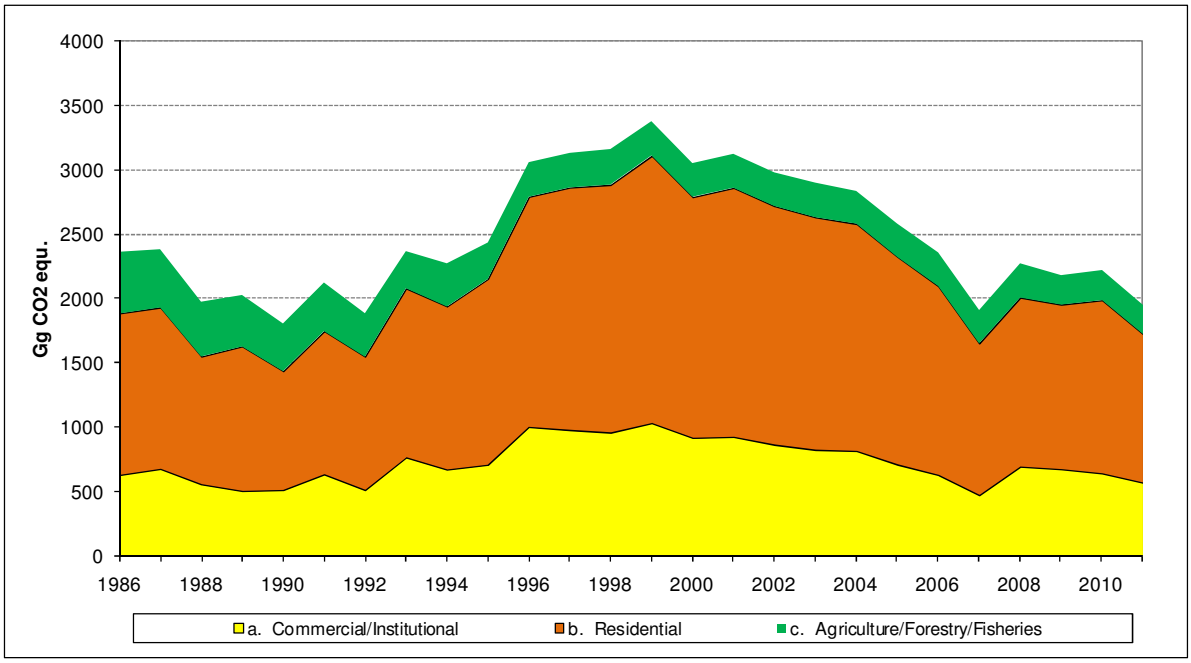

Figure 3.2.1: GHG emissions from Other Sector.

3.2.8.1 Commercial/Institutional Sector (IPCC: I A 4 a) and

3.2.8.2 Residential Sector (IPCC: I A 4 b)

Commercial/ Institutional	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level	KS
Base Year	Level	CO_2	1.88		9
2011	Level, Trend	CO_2	1.68	2.34	8

Residential	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level	KS
Base Year	Level	CO_2	3.37		6
2011	Level, Trend	CO_2	3.00	2.39	4
Base Year	Level	CH_4	0.41		30
2011	no	CH_4	0.33	0.23	29

Methodology

Emissions were estimated using Tier 1 methodology described in IPCC 1996. The following basic formula was used:

$$\text{Emissions} = \sum (EF_{abc} * \text{Activity}_{abc})$$

Where:

EF = Emission Factor (kg/TJ);
Activity = Energy Input (TJ);
a = Fuel type;
b = Sector-activity; and
c = Technology type.

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 (Gasperič, Dornik 1998). Data from that research project have been corrected in the following points:

Table 3.2.5: 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 (NIR)	Split of "Inappropriate" Use of Fuel Oil		Actual Consumption of Res. Fuel Oil in Other Consumption	
				Resid.	Comm./ Institution	Resid. (NIR)	Comm./Inst (NIR)
	A	B	C=A-B	D=0.8 x B	E=0.2 x B	F+G=C	
	(tonnes)	(tonnes)	(tonnes)	80%	20%	(tonnes)	(tonnes)
1986	157835	36121	121714	28897	7224	72117	49597
1990	310342	96020	214322	76816	19204	121803	92519
1991	327577	80733	246844	64586	16147	145063	101781
1992	300726	59608	241118	47686	11922	144779	96339
1993	411782	744	411038	595	149	262945	148093
1994	432591	1141	431450	913	228	275945	155505
1995	512171	-23212	535383	-	-	342645	192738
1996	625621	-79731	705352	-	-	451425	253927
1997	697066	0	697066	-	-	446084	250982
1998	718587	0	718587	-	-	459896	258691
1999	755417	0	755417	-	-	483467	271950
2000	674464	0	674464	-	-	431657	242807
2001	684636	0	684636	-	-	438167	246469
2002	658761	0	658761	-	-	421607	237154
2003	633476	0	633476	-	-	405425	228051
2004	620586	0	620586	-	-	397175	223411
2005	553409	0	553409	-	-	345255	208154

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

Year	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Fuel 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
1986	9.390	11.880		41.82	39.74	46.00	33.500	12.17
1987	9,650	11,820		41,78	39.80	46.00	33.500	12.17
1988	9,440	12,000		41,71	39.80	46.00	34.080	12.17
1989	9,820	12,050		41,85	39.90	46.00	34.100	12.17
1990	9.810	12.760		41.87	39.80	46.00	34.100	12.17
1991	9.980	12.879		41.88	39.80	46.00	34.100	12.17
1992	10.260	12.589		41.90	39.90	46.00	34.100	12.17
1993	10.070	13.351		41.90	39.80	46.00	34.100	12.17
1994	9.960	12.666		41.90	39.86	46.00	34.100	12.17
1995	10.220		17.404	41.90	40.00	46.00	34.100	12.17
1996	9.690		16.353	41.90	40.00	46.00	34.100	12.17
1997	9.610		18.203	41.90	40.00	46.05	34.080	12.17
1998	10.010		18.531	41.90	40.00	46.05	34.080	12.17
1999	9.690		18.563	41.90	40.00	46.05	34.080	12.17
2000	10.170		17.983	41.90	40.00	46.05	34.080	12.26
2001	10.660		18.834	41.90	40.00	46.05	34.080	12.51
2002	10.350		19.000	41.90	40.00	46.05	34.080	12.77
2003	10.138		19.000	41.90		46.05	34.080	13.03
2004	10.301		19.000	41.90		46.05	34.080	13.29
2005	10.803	11.724		42.60		46.05	34.080	13.56
2006				41.90		46.05	34.072	13.84
2007				42.60		46.05	34.076	14.12
2008				42.60		46.05	34.096	14.41
2009			16.264	42.60		46.05	34.080	14.71
2010			16.120	42.60		46.05	34.080	14,71
2011			16.000	42.60		46.05	34.087	14,71

Emission factors

We have used country specific CO_2 EF for domestic lignite and natural gas. More detailed description is in chapter 3.2.2. Emission factors for all other fuels have been taken from IPCC Reference Manual, 1996.

Table 3.2.7: EFs for the fuel used in Commercial Sector.

Year	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Fuel Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	**t/TJ**	Table 3.2.1	101.2	74.0	77.4	63.0	Table 3.2.5	108.5
EF*OF	**t/TJ**	Table 3.2.2	99.2	73.3	76.6	62.4	Table 3.2.5	107.4
CH_4 EF	**t/TJ**	0.010	0.010	0.01	0.01	0.005	0.005	0.30
N_2O EF	**t/TJ**	0.0014	0.0014	0.0006	0.0006	0.0001	0.0001	0.0040

Table 3.2.8: EFs for the fuel used in Households.

Year	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
CO_2 EF	**t/TJ**	Table 3.2.1	101.2	74.0	63.0	Table 3.2.5	108.5
EF*OF	**t/TJ**	Table 3.2.2	99.2	73.3	62.4	Table 3.2.5	107.4
CH_4 EF	**t/TJ**	0.3	0.3	0.01	0.005	0.005	0.30
N_2O EF	**t/TJ**	0.0014	0.0014	0.0006	0.0001	0.0001	0.0040

Recalculations

Following the recommendation from 2012 UNFCCC review the emissions from natural gas transmission (combustion on compressor station) have been reallocated from 1.A.4.a Other sectors / Institutional and commercial sector to the 1.A.3.e Transport sector / Other transportation.

Data are available since 2008, therefore the CO2, CH4, and N2O emissions have been recalculated for the period 2008-2010.

Future Improvements
No improvement is planned for this sector.

3.2.8.3 Agriculture and Forestry (IPCC: I A 4 c)

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	1.31		14
2011	Level	CO_2	0.59	0.09	21

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 formula:
$Emission_{(p.y)} = EF_{(p)} * Cons_{Fuel(y)}$
Where

$Emission_{(p.y)}$ - Emission of pollutant p in year y (ton/yr);

$EF_{(p)}$ - Quantity of pollutant p emitted (ton/TJ);

$Cons_{Fuel(y)}$ - consumption of gas oil in agriculture machines and off-road vehicles during in year y (ton/yr).

Activity data

The consumption of fuels till year 2000 has been calculated from data on fuel consumption in state owned agriculture enterprises and corresponding agriculture land. The same energy intensity have been used to calculate fuel used on total agricultural land. 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 3.2.9: Estimate of Consumption of Gasoline in Agriculture.

	1986	1990	1995	2000	2005	2010	2011
Cultivated Land in State owned Agriculture ent. (1000 ha)	70	77	62	31	-	-	-
Total Cultivated Land (1000 ha)	647	653	634	509	485	483	458
Consumption of Gasoline in State owned Agriculture ent. (1000 t)	1.3	1.1	0.7	0.4	-	-	-
Consumption of Gasoline per Hectare of Cultivated Land (t/1000 ha)	18.6	14.1	10.5	7.1	7.1	7.1	7.1
Estimated Consumption of Gasoline in Total Agriculture (1000 t)	12.016	9.227	6.647	3.626	3.458	3.440	3.264

Table 3.2.10: Estimate of Consumption of Diesel in Agriculture.

	1986	1990	1995	2000	2005	2010	2011
Consumption of Diesel in State owned Agriculture ent. (1000 t)	11.7	10.1	6.4	3.5	-	-	-
Consumption of Diesel per Hectare of Cultivated Land in State owned Agriculture ent. (t/1000 ha)	167.4	130.6	103.1	123	123	123	123
Estimated consumption of Diesel Fuels in Total Agriculture (1000 t)	108.326	85.255	65.353	62.596	59.702	59.379	56.355

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 m^3 of cut in state owned logging enterprises (4.8 tonnes /1000 m^3) 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 m^3 of felled wood in private forestry as in state forestry.

Table 3.2.11: The Calculation of the Consumption of Fuels in State Owned Forest

	1986	1990	1995	2000	2005	2010	2011
Consumption of Fuel in State owned Forest (1000 t)	6.902	5.922	3.680	2.808			
Cut in State owned Forest (1000 m^3)	1438	1230	862	907	919	1138	1297
Consumption of Fuel per Cut Quantities (tons per 1000 m^3)	4.8	4.8	4.3	3.1	3.23	1.21	1.20
Consumption of gasoline per Cut Quantities (tons per 1000 m^3)					0.28	0.18	0.16
Consumption of diesel per Cut Quantities (tons per 1000 m^3)					2.95	1.03	1.03
Total Cut (1000 m^3)	3501	2435	2092	2609	3236	3374	3897
Total Consumption of Fuel in Forestry (1000 t)	16.804	11.720	8.931	8.077			
Gasoline (1000 tonnes)	1.680	1,172	0.893	0.808	0.917	0.616	0.637
Diesel (1000 tonnes)	15.124	10,548	8.038	7.272	9.536	3.486	4.037

Source of activity data:

Data needed for estimation of consumption of fuels in Agriculture and Forestry is available for years from 1986 to 2010 (Statistical Office of the Republic of Slovenia: Statistical Yearbook RS, Statistical Office of the Republic of Slovenia, Ljubljana).

Net calorific values

We have used value 43.850 TJ/1000t for gasoline and 42.6 TJ/1000t for gas diesel oil.

Source of calorific values: Ministry of Energy: Statistični letopis energetskega gospodarstva republike Slovenije 1986-2003. Ljubljana: Ministry of Energy, Table Zb/3, Table Zb/1
Since 2004 these data are from JQ.

Emission factors

In calculating emissions, the emission factors, recommended in IPCC Reference manual, on page 191 have been used, category: Agriculture and Forestry (for diesel, category: Diesel Engines, for gasoline, category: Gasoline 4-stroke engines).

Table 3.2.12: EFs of the Consumption of Fuels in Agriculture and Forestry.

Year	Unit	gasoline	Gas/Diesel Oil
CO_2 EF	**t/TJ**	71.7	74.0
EF *OF	**t/TJ**	71.0	73.3
CH_4 EF	**t/TJ**	0.08	0.004
N_2O EF	**t/TJ**	0.002	0.03

Recalculations
During UNFCCC review process in 2012 it has been found out that wrong CO2 EF for diesel (72.6 Gg CO_2/TJ) have been used for fuel used in agriculture and forestry. In the present submission the IPCC EF 73.3 Gg CO2/TJ has been used instead of 72.6 Gg CO2/TJ and CO2 emissions have been recalculated for the entire period 1986-2010.

Future Improvements
No improvement is planned for this sector.

3.2.9 Other (IPCC: 1 A 5)

3.2.9.1 Other mobile (IPCC: 2 A 5 b)

Key sector - Base year: no
Key sector - Year 2011: no

Table 3.2.13: GHG Emissions in the period 1986-2011.

	1986	1990	1995	2000	2005	2010	2011
fuel in TJ	577	444	19	43	46	40	47
Gg CO_2 eq.	41	32	1	3	3	3	3

Methodology

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

Quantity of Fuel used x Net Calorific value x EF per energy of Fuel = Emissions

Activity data

Since 2008 the consumption of jet kerosene in Slovenian army and police has been obtained.

For the period 1986-2007 these data are not available. Following the recommendation from AAR 2011 the fuel used in Slovenian army and Police has been estimated using correlation with the number of aircrafts in the Slovenian army. To estimate emissions in the period 1986-1990/91 when Slovenia was still part of Yugoslavia, the fuel used for the international aviation have been estimated taking into account a correlation with the number of passenger and the remaining amount of jet-kerosene was counted as fuel used in the Yugoslavian army in Slovenian territory.

Net calorific values
We have used value 43.54 TJ/1000t for jet kerosene.

Emission factors
For the calculation of emissions and individual gases, the emission factors from IPCC guidelines from 1996 have been applied: 71.5 t CO_2/TJ, 0.001 t CH_4/TJ and 0.002 t N_2O/TJ for jet kerosene as well.

Recalculations
No recalculation has been performed for this category.

Future Improvements
No improvement is planned for this category.

3.2.10 Uncertainty and time series consistency

Uncertainty estimates for energy sector are mostly based on the judgement. To determine uncertainties of AD the consultations with experts from SORS have been performed while for uncertainties of EF also values from the IPCC GPG have been taken into account. The combined uncertainty for category fuel combustion was 6.76 in 1986 and 2.63 in 2010. The uncertainty was lowered because of use of EU-ETS data.

Table 3.2.14: Uncertainties of activity data as used in the 2013 submission.

		IPCC GPG	1986	2011
Electricity and heat production	Liquid Solid Gaseous Biomass	Less than 1%	5 10 5 10	3 3 2 10
Industrial combustion	Liquid Solid Gaseous Biomass Other	2-5%	5 10 5 10 10	3 3 2 10 10
Road Transport	Liquid Biomass		5	2 2
Commercial, institutional and residential	Liquid Solid Gaseous Biomass	3-5%	5 10 3 20	5 10 3 20

The uncertainty of activity data is a combination of systematic and random errors. Statistic data which are obtained from obligatory reporting are usually within 3% (IPCC GPG). In addition the activity data are subject to the random errors in the data collection. Countries with the good data collection systems may keep the random error to about 2-3%. Experts believe that for most developed countries the total uncertainties of activity data are in the range of 5%. After consultation with SORS and taking into account levels of uncertainties associated with stationary combustion recommended in the IPCC GPG we have used different uncertainties for different types of fuel as presented in the table 3.2.53.

In calculating emissions from this sector, the national emission factors based on coal sampling and ascertaining the carbon contents have also been applied. All analyses have been done in the accredited laboratory in accordance with the EN ISO 17025 (“General requirements for the competence of testing and calibration laboratories”). Public power plants have presented their plan of measures to ensure that fuel consumption will be measured without intermediate storage before combustion in the installation applying measuring devices resulting in a maximum permissible uncertainty of less than +/- 2.5% for the measuring process.

3.2.11 Source specific QA/QC and verification

The source category QA/QC is covered with general QC procedures described in the chapter 1.6. 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 500 units or less. If it is bigger the reasons for this is trying to find out.

During 2011 review the data from CRF tables have been compared with the data from Statistical Yearbook in kilotons of oil equivalent and some differences have been found. We are aware of these differences because data presented in the Statistical Yearbook are not appropriate to be used for GHG inventory. The reason is that fuel consumption is rounded on kilotons of oil equivalent what is not appropriate for small countries as Slovenia. We are using much more precise data about fuel used in manufacturing industry where fuel consumption is presented in tonnes in Standard Classification of Activities (SKD – 2008).

3.3 Fugitive emissions from solid fuels and oil and natural gas (CRF 1.B)

This chapter presents the fugitive emissions of greenhouse gases from:

- Solid fuels (IPCC 1.B.1) *Coal Mining. Coal Handling*
- Oil (IPCC 1.B.2) *Production. Processing. Storage*
- Natural Gas (IPCC 1.B.2) *Production. Transmission. Distribution and Leakages*
-

Table 3.3.1: Fugitive emissions of GHGs.

in Gg CO2 eq..	1986	1990	1995	2000	2005	2010	2011
Total	**536**	**459**	**413**	**374**	**370**	**359**	**364**
Coal Mining and Hand.	479	401	358	331	337	330	335
Fug. Emiss. from oil	0.4	0.4	0.4	0.1	0	0	0
Fug. Emiss. from nat. gas	56	58	54	43	33	29	29

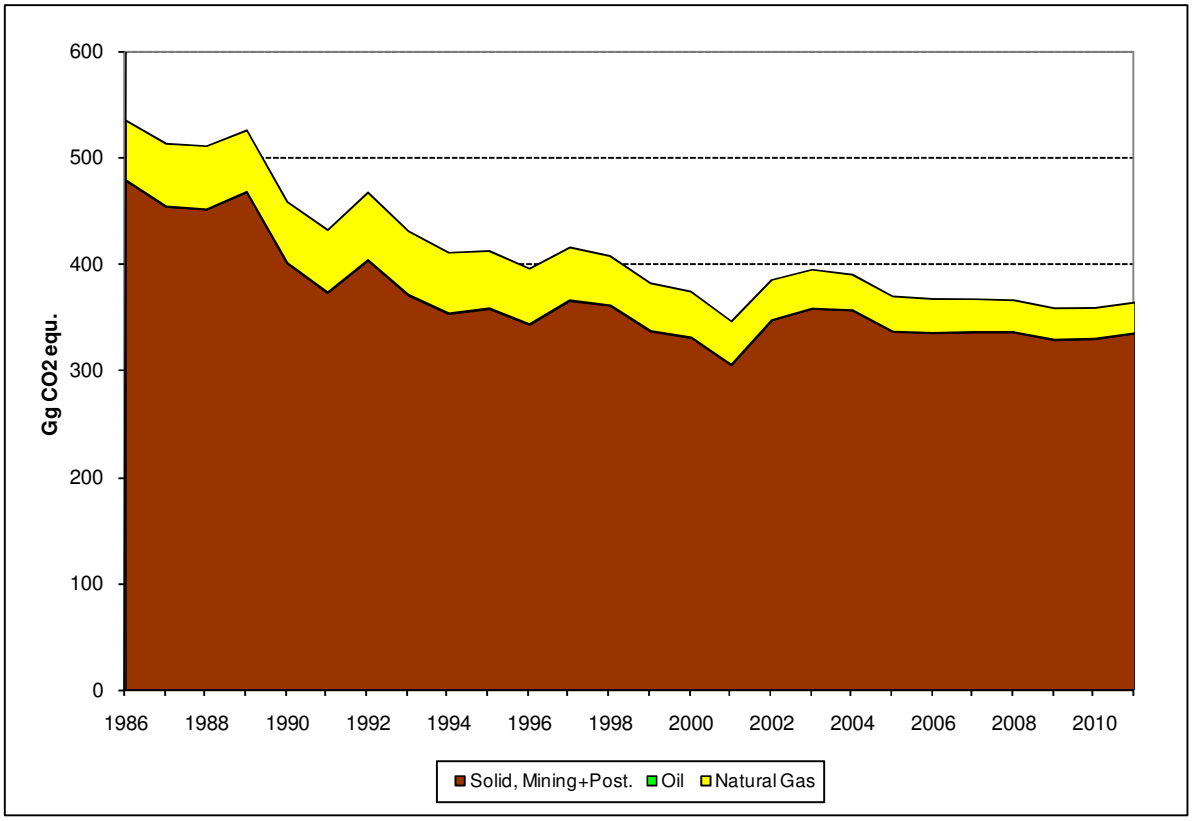

Figure 3.3.1: Fugitive emissions in Gg CO2 eq..

3.3.1 Solid Fuels (IPCC: I B I)

Coal Mining (IPCC: I B I a) + Coal Handling (IPCC: I B I b)

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH_4	1.10		16
2011	Level, Trend	CH_4	0.75	0.37	18

This chapter encompasses emissions arising from the production, processing, and storage of coal. The most important component of those emissions is CH_4 emissions that arise in mining and post-mining activities although CO2 emissions occur as well.

Methodology

Methane emission (t) = (EF1(m^3 CH_4/t)+ EF2(m^3 CH_4/t)) excavated coal (t/year)* 0.67*
CO2 emission (t) = EF3(m^3 $C0_2$/t)) excavated coal (t/year)* 1.8*

EF1 = Methane emission factor in coal excavation (m^3 CH_4/t)
EF2 = Methane emission factors in post-mining activities for coal (m^3 CH_4/t)
EF3 = CO2 emission factor in coal excavation (m^3 CO_2/t)

Activity data

Data on excavated quantities of coal according to individual coalmines are taken from LEG Table Pr/2 and LEG Table Pr/3. Since 2004 the data are available in the excel files obtained directly from the SORS.

Table 3.3.2: Excavation of Coal in Slovenia 1986 – 2011

Pit	1986	1990	2000	2005	2010	2011
Velenje	5,000.5	4,210.0	3,743.1	3945.1	4,010.9	4,066,3
Trbovlje - Hrastnik	1,241.6	904.6	736.6	594.5	419.5	435,2
Zagorje	314.6	244.1	(closed)	(closed)	(closed)	(closed)
Senovo	120.0	108.0	(closed)	(closed)	(closed)	(closed)
Kanižarica	126.2	94.4	(closed)	(closed)	(closed)	(closed)
Laško	25.0	(closed)	(closed)	(closed)	(closed)	(closed)
Total Coal Excavation (Gg)	**6,827.9**	**5,561.1**	**4,479.7**	**4,539.6**	**4,430.4**	**4,501.5**

Emission factors

Estimates of emission factors for individual coalmines in Slovenia were done at the Ecological Research Institute (Zapušek A., Orešnik K., Avberšek F: Assessment of methane emission factors in coal excavation in 1986 and in the period 1990-1996, Velenje: ERICO - Ecological Research Institute, 1999).

Due to rather small emissions from this sector for the period 1996-2004, no special research project has been done so that for that period an average emission factor from the past period has been assumed.

Table 3.3.3: Emission Factors for CH_4 in Coal Excavation 1986 – 2011 (m3 CH_4/t coal)

Pit	1986	1990	2000-2011
Velenje	0.95	0.33	3.00
Trbovlje - Hrastnik	0.62	0.88	1.00
Zagorje	1.39	3.59	(closed)
Senovo	0.57	0.63	(closed)
Kanižarica	0.33	0.45	(closed)
Laško	3.82	(closed)	(closed)

Table 3.3.4: Emission Factors for CH_4 in Post Mining Activities 1986 – 2011 (m^3 CH_4/t coal)

Pit	1986	1990	2000-2011
Velenje	3.05	3.67	1.00
Trbovlje - Hrastnik	2.38	2.12	3.00
Zagorje	1.61	2.00	(closed)
Senovo	2.43	2.37	(closed)
Kanižarica	2.67	2.52	(closed)
Laško	0.18	(closed)	(closed)

Table 3.3.5: Emission Factors for CO_2 in Coal Excavation 1986 – 2011 (m^3 $C0_2$/t coal)

Pit	1986-2007
Velenje	10.54
Trbovlje - Hrastnik	6.03
Zagorje	9.51
Senovo	16.16
Kanižarica	8.21
Laško	30.80

Table 3.3.6: Emission of CH_4 from Mining & Post Mining Activities 1986 – 2011 (Gg CH_4)

(1000 ton)	1986	1990	2000	2005	2010	2011
Mining Activities	4.13	2.12	8.02	8.33	8.34	8.46
Post-Mining Activities	12.96	12.30	3.99	3.84	3.53	3.60
Total	**17.09**	**14.42**	**12.01**	**12.17**	**11.87**	**12.06**

Table 3.3.7: Emission of CO_2 from Mining Activities 1986 – 2011 (Gg CO_2)

(1000 ton)	1986	1990	2000	2005	2010	2011
Mining Activities	120.2	98.4	79.0	81.3	80.6	81.8

Recalculations
No recalculations have been performed for this category.

Future Improvements
No improvements are planned for this source.

3.3.2 Oil and natural gas (IPCC: I B II)

3.3.2.1 Oil (IPCC: I B 2)

Key sector - Base year: no
Key sector - Year 2011: no

Owing to negligible quantities of produced crude oil (963 tons in 2002, and no production since then), methane emissions from the production of crude oil and refined petroleum products were insignificant in 2002 and did not occur in period 2003-2007.

Methodology

CH_4 emissions = CH_4 emission1 + CH_4 emission2 + CH_4 emission3

CH_4 emission1:
Emission in the production of crude oil = production of crude oil (ton) x calorific value x emission factor (kgCH_4/TJ)

CH_4 emission2:
Emission in the processing of crude oil = quantities processed in Slovenia (ton) x calorific value x emission factor (kgCH_4/TJ)

CH_4 emission3:
Emission in storage of crude oil = quantities processed in Slovenia (ton) x calorific value x emission factor (kgCH_4/TJ)

Activity data

Data on production. processing (processing and internal consumption). and calorific values of oil have been taken from LEG (Table Zb/1. Statistical Yearbook of the Energy Sector in the Republic of Slovenia 1985-2003. Ljubljana: Ministry of the Economy). No data are available on stored quantities. In this section. it is assumed that all quantities of processed oil are also stored in Slovenia.

In distribution of gasoline (at refinery dispatch stations. in transport. at depots. and at service stations) NMVOCs emissions arise. Calculations take into account the quantities of gasoline that are sold in Slovenia (Statistical Yearbook of Energy Sector in the Republic of Slovenia 1985-2003. Ljubljana: Ministry of the Economy. Tables Zb/1).

Emission factors

Emission factors for the emission of methane arising in the production. Processing, and storage of oil have been calculated on the basis of the arithmetic mean from IPCC guidelines (Intergovernmental Panel on Climate Change: Greenhouse Gas Inventory - Workbook. UNEP-OECD-IEA-IPCC. Bracknell 1995. p. I.21) from the data for former Soviet Union. Central and Eastern Europe. Emission factors are given in a relatively wide interval (for production from 300 to 5000 kg CH_4/PJ. and for processing from 90 to 1400 kg CH_4/PJ).

For oil production:

$$\text{Emiss. Factor} = \frac{300 + 5000}{2} = 2650 \text{ kg } CH_4/\text{PJ}$$

For oil processing:

$$\text{Emiss. Factor} = \frac{90 + 1400}{2} = 745 \text{ kg } CH_4/PJ$$

For oil storage:

$$\text{Emiss. Factor} = \frac{20 + 250}{2} = 135 \text{ kg } CH_4/PJ$$

Table 3.3.8: Fugitive emissions from Oil

	1986	1990	1995	2000	2001	2002	Since 2003
Production (Gg)	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000
Processing (Gg)	0.0170	0.0170	0.0165	0.0046	0.0000	0.0000	0.0000
Storage (Gg)	0.0028	0.0031	0.0030	0.0008	0.0000	0.0000	0.0000
Total (Gg)	**0.0201**	**0.0204**	**0.0197**	**0.0056**	**0.0001**	**0.0001**	**0.0000**

3.3.2.2 Natural Gas (IPCC: I B 2)

Key sector - Base year: no
Key sector - Year 2011: no

CH4 emissions

CH_4 emissions = Production + Transport + Distribution + Leakages at consumers

Table 3.3.9: Fugitive emissions from Natural gas in Gg CH_4

	1986	1990	1995	2000	2005	2010	2011
production	0.010	0.033	0.024	0.008	0.006	0.009	0.003
transport	0.854	0.886	0.823	0.489	0.273	0.195	0.195
distribution	1.632	1.615	1.441	1.207	0.952	0.769	0.749
gas use	0.181	0.205	0.289	0.349	0.339	0.413	0.430
total	**2.676**	**2.739**	**2.577**	**2.052**	**1.571**	**1.386**	**1.376**

Production

Table 3.3.10: Fugitive emissions from production of Natural gas in 1000 Sm^3 of CH_4.

	unit	1986	1990	1995	2000	2005	2010	2011
production	1000 m^3	7371	24800	18200	6000	4335	6673	2323
emissions	1000 m^3	15	50	36	12	9	13	5

Activity data

Quantity of natural gas in Slovenia is very small, in 2011 it was 1,323 km3.

Data on the production and calorific value of natural gas have been taken from LEG (Table Zb/1, Statistical Yearbook of Energy Sector in the Republic of Slovenia 1985-2004, Ljubljana: Ministry of the Economy). From 2005 on the data are from JQ reports to the Eurostat.

Emission factors

Emission factor for the emission of methane from the Production of natural gas have been taken from GPG, Table 2.18. We have used medium value 0.2% from net gas production.

Transport, distribution and use of natural gas

Gasification of Slovenia started in the early 1970s. The newly discovered fields of natural gas in the former Soviet Union and Algeria and increasing demand for energy following the economic growth in Europe, actualized natural gas as an economic and practical source of energy. A possibility to connect to the newly constructed pipelines in Austria and Italy, enabled realization of natural gas delivery to Slovenia, as the country has no natural gas reserves of its own.

In 1974, the company Petrol-Zemeljski plin was established with the purpose to realize the »gasification program in Slovenia«. After three years of intensive preparations, construction of the backbone of the main pipeline system started, divided into the following three phases:
Ceršak – Rogatec – Vodice – Ljubljana,
Vodice – Jesenice,
Ljubljana – Nova Gorica – Anhovo.

In 1978, the newly constructed pipeline system enabled transportation of Russian natural gas for Croatia and delivered gas to the first two consumers in Slovenia, namely, Tovarna lesovine in lepenke Ceršak and Sladkogorska Sladki vrh. Till 1980, 630 km of mostly main pipelines were constructed and the Dispatching Centre in Ljubljana as well as Maintenance Centres in Ljubljana and Maribor was built. The pipeline system has been expanded later and by the end of 1980s, the main lines to Novo mesto and Radeče were finished as well. Now, the total length of the pipeline system, owned by Geoplin Plinovodi, comes to almost 1.000 km and is still being extended.

From the very beginning, during the pipeline construction all environmental requirements have been taken into consideration. Alongside the whole pipeline route, the original state of the ground has been reinstated after concluded construction works, so that only the characteristic markings and meter-regulating stations show that under the surface there are kilometres and kilometres of pipes.

In 1992, natural gas deliveries from the second source, namely, from Algeria, started, what essentially increased reliability of supply and enabled growth of natural gas consumption also in households and commercial use. Since 2001, natural gas from the third source, that is Austria, has been delivered as well.

Social, political and economic changes in the past influenced several status transformations of the company. Since 1995, the company has been operating under the name of Geoplin d.o.o. Ljubljana. In 2004, in line with the terms of Energy Act, Geoplin established a daughter company Geoplin Plinovodi and transferred complete energy infrastructure to it. The company Geoplin Plinovodi started to perform its activity of natural gas transmission system operator on 1 January 2005.

Legislation

Before 1974 companies have used different standards. The material for pipelines has been made according to the JUS (Yugoslav standard), which has been transferred from DIN (West Germany standard) to a high degree. On same domain also east German standard TGL (Technische Gute und Lieferbedinungen) has been used.

In 1974 all companies together with body of inspectors made an agreement to use west German standards (DVGW, DIN, VDI) because more than 90% gas devices have been made according to these standards, particularly DVGW standard (Deutsche Vereinigung des Gas und Wasserfaches e.V.). Until 2002 when new regulation has been passed, DVGW was the main directive for planning, construction, operation and maintenance of pipeline system. Now standard SIST EN 12007 is used in Slovenia which is completely in line with CEN (standard of European Committee for Standardization).

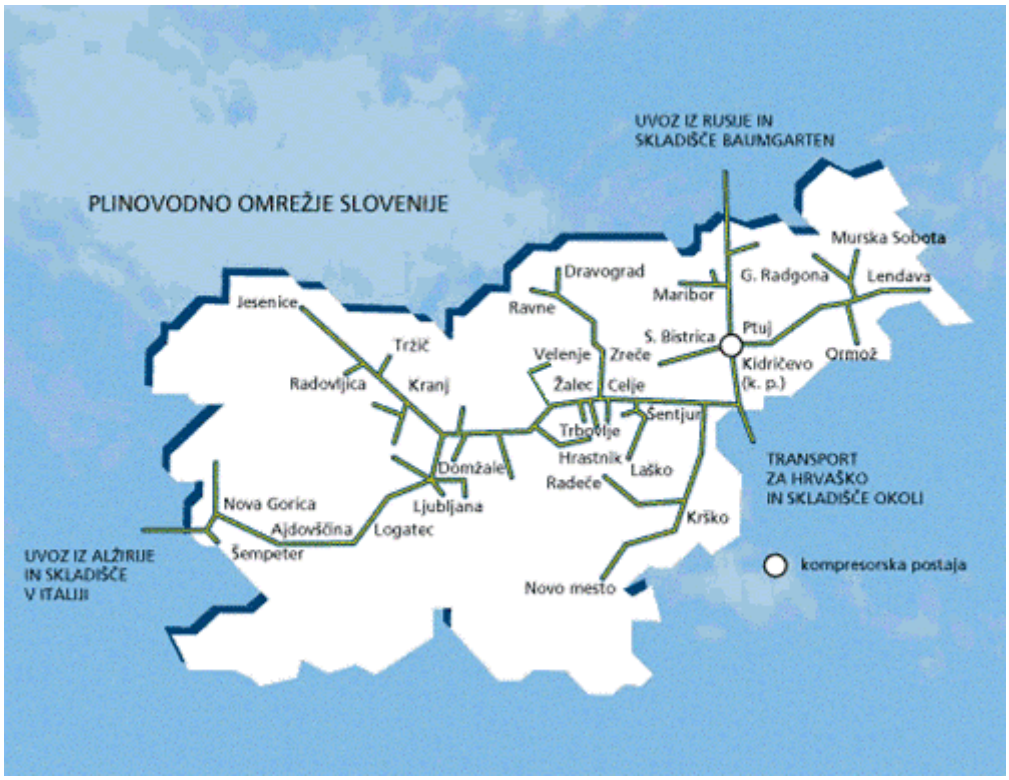

Figure 3.3.2: Network of pipes for transportation of natural gas.

The in-country review concluded that current emissions were far too low and needed to be further analysed and investigated for possible errors. After many consultations with expert from gas distribution companies we decided to use EF for transport and distribution which are presented in the paper from J. Reichert and M. Schoen: Methanemisionene durch den Einsatz von Gas in Deutchland von 1990 bis 1997 mit einem Ausblick auf 2010, Karlsruhe, Mai 2000. After uniting W and E part in one country, Germany was confronted with problem of reporting fugitive emissions from natural gas because two different types of standards were used in the history. Although Slovenia has never used east European standard and was in this and in many other fields more west oriented, we decided to use EF for E Germany for the base year and gradually lower this EF until present. Although standards were west European from beginning of our pipeline network we believe that emissions were higher in the base year as they are now. In former Yugoslavia system of control wasn't as rigorous as it is nowadays. Also the conscious of people involved in the building and maintenance of pipelines is on more high level in independent Slovenia as it was in the

past. For this, mainly human and not legislation reason our emissions in the past were higher than now, but even in the worst case they were never as huge as GPG suggests. In GPG for former Yugoslavia the same EF are suggested as for former USSR, which had very different legislation and also different geographic and economic circumstances than Yugoslavia and particularly than Slovenia.

Justification of trends for EF

In the submissions 2004 and 2005 the EF 298 kg/km have been used for fugitive emissions from high pressure transport pipelines for the base year 1986. This EF has been determined in the study from 1999 made by IE (Energy institute from Ljubljana). In the in-country review report 2004 and in the centralised review report 2005 is stated that emission factor is too low for east European country. To make emissions more believable the E Germany EFs have been used in the later submissions, what was accepted by ERT during in-country review of initial report in April 2007.

However EFs used for 1986 emissions is not appropriate for present situation. While in transport pipelines decrease in EF is a consequence of more rigorous control and higher level of maintenance the situation considering distribution pipelines is different. From picture bellow where the length of distribution and service pipelines are presented it is evident that Slovenian natural gas distribution network have been expanded after 1995. More than a half of old steel distribution pipelines have been replaced and the cast iron pipelines have been replaced even before 1990. All new pipelines were built according to EU legislation and standards. There was no moment when the old situation had changed to the new one, as the implementation of EU regulations and adaptation to the new legislation is a long term and continuous process.

Transport

For estimation of fugitive emissions from transport of natural gas we were taking in account the following leakages:

- from transport pipelines
- from metering and regulation stations
- from damaged pipelines
- from shifting of pipelines because of highway building
- from compressor station

Table 3.3.11: Fugitive emissions from transport of Natural gas in 1000 Sm^3 of CH_4.

	1986	1990	1995	2000	2005	2010	2011
pipelines	950	1007	864	515	309	214	214
pneumatic stations	124	124	165	120	66	66	66
M&R stations	198	187	132	0	0	0	0
Routine mending	8	10	11	7	2	2	2
AC building / damage	2	3	62	90	32	10	10
compressor station					0.136	0.136	0.136
TOTAL	**1282**	**1320**	**1233**	**732**	**409**	**292**	**292**

Activity data

Data on the length of pipeline and some leakages from 1986 to 1996 have been taken from the research project of the Institute of Energy Industries (Gasperič M., Dornik M.: Determining the CO_2 Emission Factor in Energy Use and CH_4 Emission Factor in Transport

and Distribution of Natural Gas, Ljubljana: Institute of Energy Industries, 1998). From 1997 to 2004 data have been obtained directly from company Geoplin Plinovodi.

Figure 3.3.3: Compressor station in Kidričevo.

Table 3.3.12: Length of transport pipelines in km.

	1986	1990	1995	2000	2004-2010
pipelines	740	784	927	948	960

Since 2010 Company Geoplin Plinovodi has had 960 km of pipelines. They are built from longitudinally welded steel pipes, which are protected with anticorrosive isolative material and dug in the soil approximately 1.5 m deep. Main three branches are working under pressure of 50 bar thus one branch has pressure 67 bars.

As demand from natural gas is increasing, the compressor station in Kidričevo was starting to work in 2002. Its maximum amount of compressed natural gas is 260.000 Sm^3/h with 50 bars. In station there are two compressors both with 3.2 MW, but only one is operating in the time while the second is only for backup.

Emission factors

Emission factors for the emission of methane from the pipelines have been taken from German article. For emissions from pipeline for period 1986 to 1992 EF 1284 m^3/km for east Germany had been used. From 1993 the 10% reduction of emissions annually had been taken in account. Since 2009 on the EF 223 m^3/km for west Germany is used.

Table 3.3.13: EFs for fugitive emissions from transport pipelines.

	1986	1990	1995	2000	2005	2010	2011
EF in 1000 Sm^3/km	1,284	1,284	932	544	322	223	223

All data on other losses from transport of natural gas have been obtained from company Geoplin Plinovodi. Losses from metering and regulation station are zero from 2000 on, because there is no mechanical metering stations any more. There were some losses because of landslides and building of highways. According to company measurements methane emissions from compressor station are negligible.

Distribution

For estimation of fugitive emissions from distribution of natural gas we were taking in account the following leakages:

- from distribution pipelines
- from metering and regulation stations
- during construction of new pipelines and maintenance of existing
- from inspection of gas meters
- from service pipelines (pipelines between main distribution network and households)

Table 3.3.14: Fugitive emissions from distribution of Natural gas in 1000 Sm^3 of CH_4.

	1986	1990	1995	2000	2005	2010	2011
distribution pipelines	1162.5	1055.0	913.1	698.1	522.5	389.1	372.4
M&R stations	7.5	9.7	12.7	24.6	31.3	36.4	37.4
construction…	0.4	0.5	1.3	2.7	3.8	3.8	3.8
gas meters	0.02	0.02	0.03	0.05	0.04	0.04	0.04
service pipelines	1278.5	1358.5	1233.2	1083.7	870.2	724.1	708.1
total	**2448.9**	**2423.7**	**2160.4**	**1809.2**	**1427.7**	**1153.3**	**1122.3**

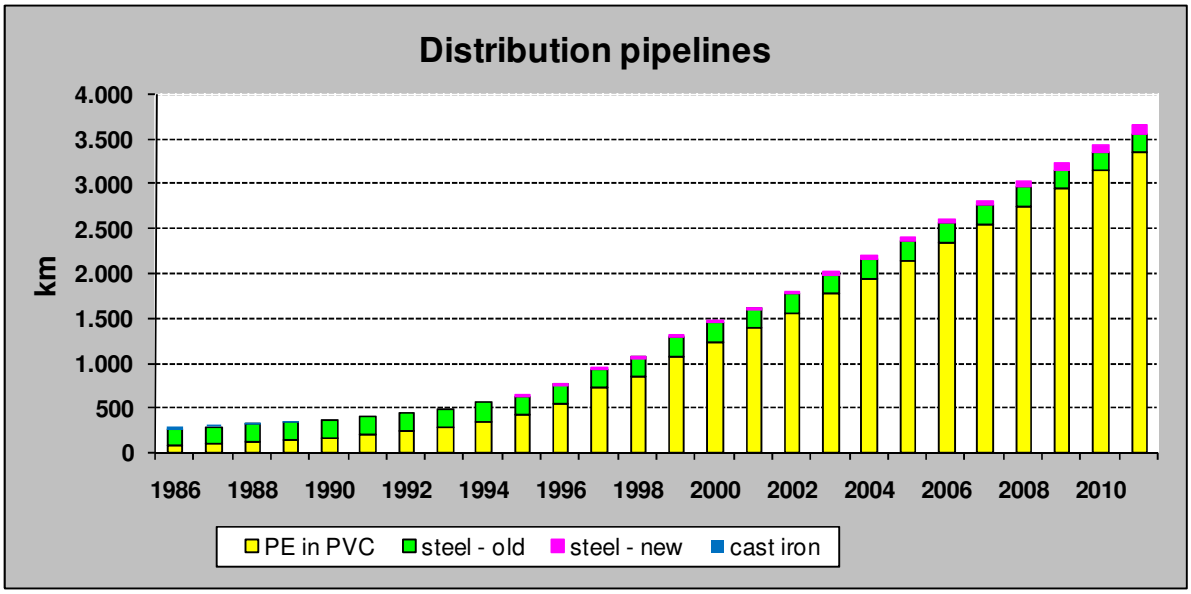

Figure 3.3.4: **Length of distribution pipelines by material.**

Activity data

Activity data for distribution of natural gas have been taken from the research project, made by the Economic Interest Association of Natural Gas Distributors. Data are including the following:

- type and length of distribution pipelines,
- number of M&R stations,
- number and type of inspected gas meters
- typical volume of gas meters
- leakages during construction and maintenance work
- type and length of service pipelines

Table 3.3.15: Length of distribution pipelines in km.

	1986	1990	1995	2000	2005	2010	2011
PE+PVC	78	161	409	1,223	2,134	3.134	3.334
steel(old)	166	199	216	216	216	216	216
steel new	0	0	7	16	39	79	87
cast iron	36	0	0	0	0	0	0
Total (km)	**281**	**360**	**632**	**1,455**	**2,389**	**3,429**	**3,637**

Table 3.3.16: Number of meter-regulation stations

	1986	1990	1995	2000	2005	2010	2011
M&R stations	37	48	63	122	155	180	185

Table 3.3.17: Number of inspected gas meters

gas meter	1986	1990	1995	2000	2005	2010	2011
G4	9062	8414	12228	19992	17261	17261	17261
G6 DO G10	56	71	80	101	89	89	89
over G10	110	135	231	381	349	349	349
total	**9228**	**8620**	**12539**	**20474**	**17699**	**17699**	**17699**

A volume of gas meters are: type G4 has 0.002 m3, from G6 to G10 we have taken average of 0.006 m3 and for bigger meters 0.016 m3.

Table 3.3.18: Length of service pipelines in km.

	1986	1990	1995	2000	2005	2010	2010
PE and PVC	46	95	251	756	1328	1917	2035
steel (old)	98	117	117	92	57	57	57
steel (new)	0	0	4	9	23	46	51
cast iron	21	0	0	0	0	0	0
total	**166**	**212**	**373**	**858**	**1408**	**2021**	**2144**

Emission factors

Emission factors for the emission of methane from the distribution pipelines have been taken from German article. For emissions from pipeline for period 1986 to 1992 EF for east Germany has been used. From 1993 the 10% reduction of emissions annually has been taken in account.

Table 3.3.19: EFs for fugitive emissions from distribution (low pressure) pipelines in 1000 Sm^3/km.

	1986	1990	1995	2000	2005	2010	2011
PE and PVC	445	445	324	192	113	67	62
steel (old)	4945	4945	3605	2129	1257	742	668
steel (new)	-	-	247	247	247	247	247
cast iron	8396	-	-	-	-	-	-

For emission from M&R stations EF 202 m3/station has been applied for all years.

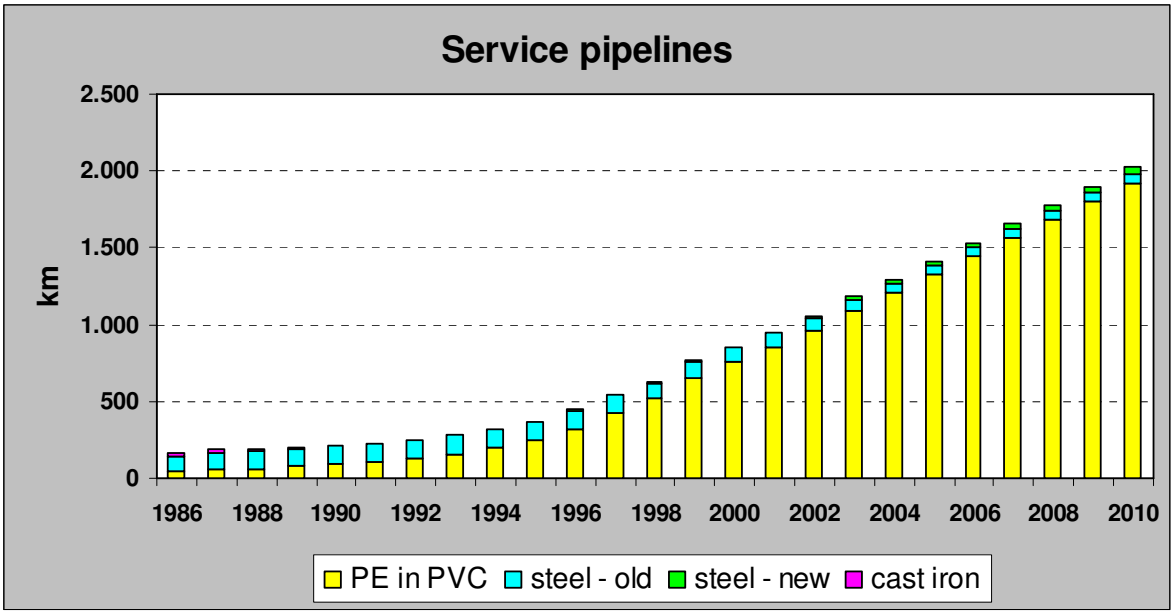

Figure 3.3.5: Length of distribution pipelines by material.

Considering emissions from gas meters we have assumed that during inspection all methane in the meter escapes. Emissions were therefore calculated as product between number of inspected gas meters and volume depending on gas meter type.
We have also obtained data about leakages during construction and maintenance.

Table 3.3.20: EFs for fugitive emissions from service pipelines in 1000 Sm^3/km..

	1986	1990	1995	2000	2005	2010	2011
PE and PVC	2101	2101	1532	904	534	315	292
steel (old)	9890	9890	7210	4257	2514	1484	1336
steel (new)	-	-	742	742	742	742	742
cast iron	9890	-	-	-	-	-	-

Emission factors for the emission of methane from the service pipelines have been taken from German article. For emissions from pipeline for period 1986 to 1992 EF for east Germany has been used. From 1993 the 10% reduction of emissions annually has been taken in account.

Leakages from households

These are CH_4 emissions which arise in the households sector during lighting of gas ranges.

Table 3.3.21: Methane emissions from gas used in households in 1000 Sm^3 CH_4.

	1986	1990	1995	2000	2005	2010	2011
households	271	308	433	523	509	619	643

Activity data

Activity data for emissions from this source are number of households using natural gas. This data have been obtained from research project, made by the Economic Interest Association of Natural Gas Distributors.
We have assumed that in the beginning only one appliance has been used in each household while in the 2006 there are approximately 1.8 appliances in household. This is very rough estimate but having no better data we taking in account this presumption.

Table 3.3.22: Number of households and appliances using natural gas.

	1986	1990	1995	2000	2005	2010	2011
households	54,282	61,570	78,368	112,431	141,353	171,978	178,857
appliances	54,282	61,570	101,878	174,268	254,435	309,560	321,942

Emission factor

Emission factor for the emission of methane from gas appliances has been taken from GPG, Table 2.18. We have used medium value 5 m3/appliance/yr for period 1986-1992 and low value 2 m3/ appliance/yr for 2004 and later. Values between 1992 and 2004 were interpolated.

Table 3.3.23: Methane emission factors for fugitive emissions from gas used (households).

	1986	1990	1995	2000	2005-2011
Emission factor	5	5	4.25	3	2

Leakages from industry

Leakages in the industry in Slovenia do not occur and notation key NO have been used for this category instead of NE.

In the GHG inventory fugitive emissions from transport, distribution and even service pipelines have been included. We have also reported on leakages from households because we believe that fugitive emissions occurred during process of switching on household appliances. Since the ignitions systems in the gas fired industrial boilers are technically completely different and that kind of fugitive emissions shall not occur. Furthermore working regime of households appliances (many switch on/off and relatively low operating hours) is completely different form industrial installations (less switch on/off more operating hours – in some sectors such as lime production, paper production there is only few switch on/off-s per year).

Following the recommendation by the ERT to estimate fugitive emissions from industry sector, Slovenia conducted a telephone survey of 10 plants which are the biggest consumers of natural gas in Slovenia and combusted almost 1/3 of all natural gas combusted in the energy and industry sector. All relevant experts from these plants confirmed that there are absolutely no leakages in the industry. All pipelines in the plant are regularly checked and all plants are using also gas detectors for detection even the

smallest traces of natural gas. They also confirmed that they did not have any accidental leakages or malfunction of installations. The experts also agree that in the boilers during combustion process there is no possibility for any leakages of natural gas. Due to the common practice that installations are usually working 24 hours a day all year any leakages from this source are extremely unlikely and it's also unlikely that potential leakages would not be detected. Therefore for the leakages in the industry we as many other EU member states are now assuming that they are not occurring (NO).

CO2 emissions from transmission of natural gas

According to the recommendations in the "Saturday e-mail" during 2009 review process fugitive CO2 emission from transmission of natural gas has been calculated for entire period.

There is no methodology available for calculation CO_2 emission from transmission of natural gas in the IPCC 1996 guidance. In the IPCC 2000 GPG a list of emission factors based on North American data is presented which we assume are not appropriate to use in our inventory.

Therefore we have estimated CO_2 emissions using the same methodology as for calculation fugitive emissions of CH4 from natural gas and using country specific data for fraction of CO_2 in the natural gas.

For the period 1986-1997 this fraction is available for every year and for the period 1998-2010 the average fraction 0.077% v/v has been used. Density of CO2 is 1,828 kg/m^3.

Recalculations
No recalculations have been performed for this category.

Future Improvements
No improvements are planned for this source.

4 INDUSTRIAL PROCESSES (CRF sector 2)

Industrial activities not related to energy, produce various GHGs emissions. Emission sources are industrial production processes in which raw materials are chemically or physically transformed. In this transformation, many different GHGs can be released, such as CO_2, CH_4, N_2O, and PFCs. Some industrial sources also produce NO_x, NMVOCs, CO, and SO_2.

Some fluorinated compounds (Hydro-fluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur Hexafluoride (SF6)) are consumed in industrial processes or used in different applications as substitutes for ozone depleting substances (ODS). They have also been considered in the inventory.

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.

Emissions from industrial processes in Slovenia account for 5.2% of total national GHG emissions, excluding LULUCF. They amounted to 1,317 Gg CO_2 equivalents in the base year and to 1014 Gg CO_2 equivalents in 2011. The main source of emissions is mineral industry with about 58% of emissions, followed by consumption of F-gases with 23% and metal production with 19% of emissions. Significantly lower are contributions from chemical industry (0.1%). The main source of emissions from this sector is cement industry, which is responsible for 31% of GHG emissions from industrial processes. Due to the world economical crises total emissions of GHG from industrial processes considerably decreased in 2009 and remained at approximately the same level also in 2010. In the year 2011 an increase of total emissions was observed, mainly due to increase of emissions from metal production, Process emissions of all GHG (in Gg CO_2 eq.) for 1986-2011 are shown in figure 4.0.1.

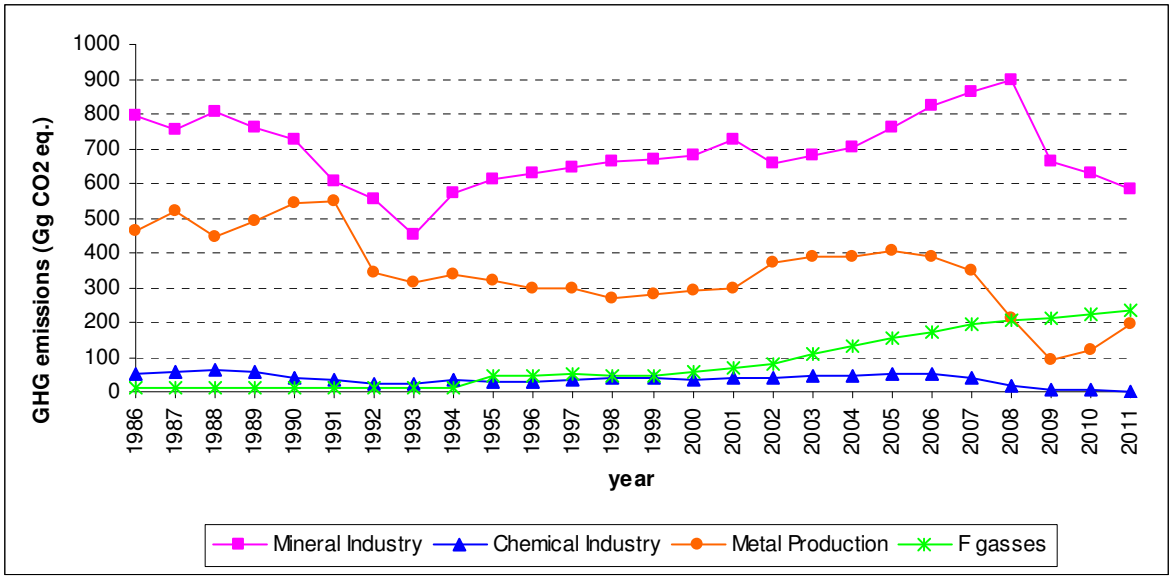

Figure 4.0.1: Process emissions of GHG from different types of industries.

MINERAL INDUSTRY

4.1 Cement Production

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	1.58		10
2011	Level	CO_2	0.93	0.28	16

4.1.1 Source category

Carbon dioxide emissions arising in the production of cement are a major industrial-process source of emissions of greenhouse gases. There are two producers of cement in Slovenia, producing mostly Portland cement.

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.

Carbon dioxide emissions from cement production result from the conversion of $CaCO_3$, the main constituent of limestone, to lime (CaO), while CO_2 as a by-product is let out into atmosphere.

Sulphur oxides emissions result from sulphur, which is present both in fuel and in some constituent materials such as clay. Contrary to what occurs with CO_2, most of the SO_2 that is formed during calcination will usually be absorbed and long-term immobilized in clinker and later in cement.

4.1.2 Methodological issues

CARBON DIOXIDE EMISSIONS

Separate emissions are estimated from carbon originally present in fuel and carbon present in raw materials, although they are in fact emitted at same place and are inseparable in concept.

CO_2 from carbon in fuel has been estimated from the fuel consumption for each fuel type. Emissions of this kind have already been included under source sector 1A2 - Energy Combustion in Industry. Since cement production is a key source category, according to the IPCC GPG, the Tier 2 method must be applied in calculating emissions.

Activity data are data on the annual production of clinker. Clinker production data were obtained from the Statistical Office of the Republic of Slovenia for the period 1986–1998, and directly from the two plants that produce cement for the years 1999–2011.

For national allocation plan purposes linked to emissions trading system more detailed data were obtained from 1999 onwards. Data on fraction of CaO and MgO in clinker from both cement works for the period 1999–2004 enabled us to determine our own emission factor. The average EF for the period 1999–2004 is 541 kg CO_2/t of clinker. As the location of quarries is the same as in the base year, we have applied this emission factor for calculating emissions from the base year 1986 to

1998. For calculating emissions for the years 1999–2004 we have used year-specific EFs. For the period 2005–2011, the EFs reported by the cement plants to the Ministry of Environment and Spatial Planning, as a competent authority in the European Union Greenhouse Gas Emission Trading System (EU ETS), are used to calculate CO_2 emissions.

EFs from both before and after 2005 based on plant specific production conditions. There are two producers of cement in Slovenia and the data for both periods were obtained from these two cement works. The same sources of raw material and methodology were used for calculation both before and after 2005 EFs. Detailed data on EFs is presented in Table 4.1.1. Inter-annual variations of EFs are due to different annual ratio of CaO and MgO in clinker.

Table 4.1.1: Emission factors used for calculation emissions from cement production.

Year	Emission factor (t CO2/t of clinker)		
	Plant 1	Plant 2	TOTAL
1986 -1998			0,5410
1999	0.5407	0.5438	0.5410
2000	0.5387	0.5438	0.5407
2001	0.5386	0.5438	0.5405
2002	0.5387	0.5438	0.5405
2003	0.5392	0.5438	0.5410
2004	0.5377	0.5410	0.5391
2005	0.5383	0.5422	0.5399
2006	0.5374	0.5386	0.5379
2007	0.5375	0.5451	0.5405
2008	0.5383	0.5449	0.5406
2009	0.5374	0.5487	0.5406
2010	0.5365	0.5487	0.5404
2011	0.5372	0.5313	0.5363

Cement kiln dust (CKD) is not accounted in emission calculation as in both cement factories CKD is returned into the process. Group of experts had visited both cement plants in the process of acquisition of the permits for greenhouse gas emissions and accompanied monitoring plans. Together with experts from the plants they defined a method for calculation of CO_2 emissions. It is in accordance with methods from Guidelines for the monitoring and reporting. For both plants it was confirmed that CKD is 100% returned to the process. This is also evident from plant specific monitoring plan which has been issued by competent authority.

To calculate emissions from cement production after 2005 we have been using data obtained by EU ETS. Data on clinker production and plant specific emission factors for both cement factories have been annually verified by independent verifiers. ETR recommended to show that the estimated CO_2 process emissions from cement production are comparable and consistent with the emissions reported under the EU ETS. EU ETS reports can not be publicly revealed due to sensitivity of information. All documentation is available for internal communication with ETR only. However, the total emissions from cement production, that is sum of process emissions and emissions from fuel combustion, reported under the EU ETS are publicly available on web site of Agency of the Republic of Slovenia.
http://www.arso.gov.si/podnebne%20spremembe/Register%20emisijskih%20kuponov/Javno%20dostopna%20poro%C4%8Dila/Poro%C4%8Dilo%20o%20izpolnitvi%20obveznosti%20za%20leto%202011_%20sprememba.pdf

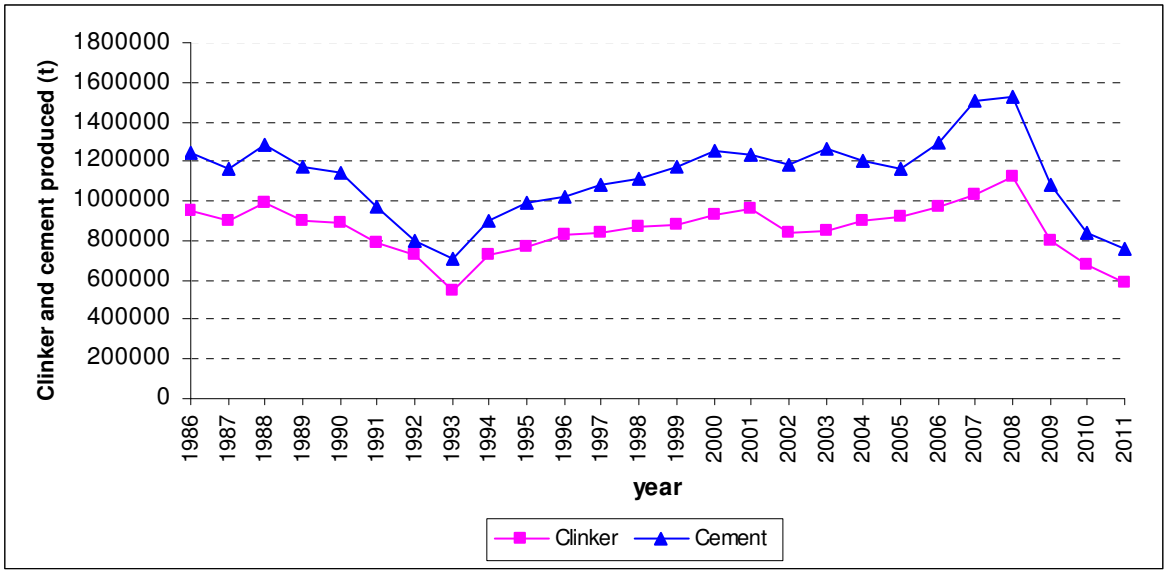

Figure 4.1.1: Cement and clinker production in ton/year.

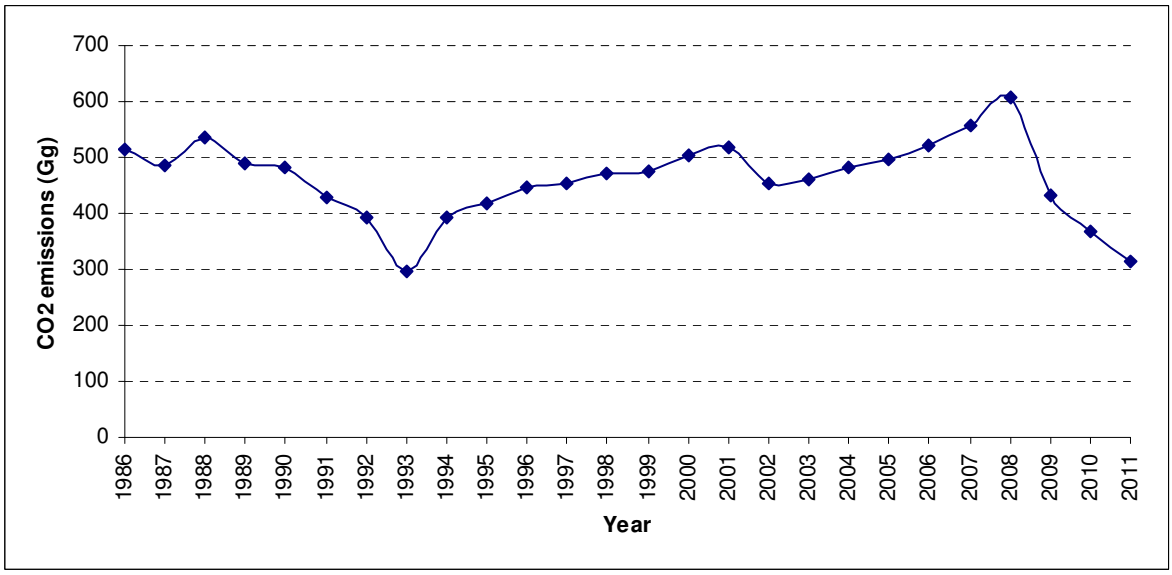

Figure 4.1.2: CO_2 emissions from cement production.

4.1.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 2%.
Uncertainty of emission factor amounts to 2%.

4.1.4 Source specific recalculations

No recalculations have been performed since last submission.

4.1.5 Source-specific planned improvements

No improvements are planned for this category.

4.2 Lime Production

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	0.68		25
2011	no	CO_2	0.27	0.11	33

4.2.1 Source category description

CO_2 emissions from the production of lime are the third most important process-source of greenhouse gas emissions and they belong to the key source categories (level in base year and trend in 2011). In Slovenia, there are three lime producers.

Lime is generated by heating the input raw material (limestone and dolomite) to high temperature (900-1200°C). During this process, limestone is converted into CaO and emits CO_2.

4.2.2 Methodological issues

CARBON DIOXIDE EMISSIONS

CO_2 emission was calculated according to IPCC methodology. Similar to cement production, more detailed data were obtained directly from lime producers for the period 1999-2004. Data on fraction of CaO and MgO in lime for the period 1999-2004 enabled us to determine our own emission factor. We have estimated country specific EF to be 749 kg CO_2/ton of lime and applied this emission factor to calculate CO_2 emissions for the period 1986–1998. Emissions for the period 1999-2004 have been calculated using the year-specific EFs. The EFs for the period 2005-2011 are based on EU ETS data. They were derived from emissions and activity data on annual production of quicklime reported under EU ETS scheme. Data on EFs is presented in Table 4.2.1.

Table 4.2.1: Emission factors used for calculation emissions from lime production.

Year	Emission factor (t CO2/t of lime)
1986-1998	0.749
1999	0.744
2000	0.749
2001	0.751
2002	0.749
2003	0.752
2004	0.750
2005	0.735
2006	0.726
2007	0.724
2008	0.723
2009	0.725
2010	0.721
2011	0.730

Detailed information on how the plant-specific data was determined and how time series consistency between the EU ETS data (after 2005) and earlier plant specific data was ensured is presented in the following paragraph. EFs from both, before the year 2005 and for EU ETS data (after 2005) based on plant specific production conditions. There are three producers of lime in Slovenia and the data for both periods were obtained from these three lime works. The same sources of raw material and methodology were used for calculation both, before and after 2005 EFs. Before the year 2005 the 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. The EFs for lime production is calculated annually on data (amount of CaO and MgO or amount of $CaCO_3$ and amount of lime produced) obtained from these three producers.

The monitoring and reporting guidelines for EU ETS installations for the period 2005-2010 were adopted in the Commission decision 2004/156/EC. Activity-specific guidelines for installations for the production of lime are in Annex VIII.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:059:0001:0074:EN:PDF

On installation level, calcination CO_2 can be calculated in two ways:
(1) based on the amount of carbonates from the raw material (mainly limestone, dolomite) converted in the process (calculation method A),
(2) based on the amount of alkali oxides in the lime produced (calculation method B). The two approaches are considered to be equivalent.

Producer 1 and producer 2 have chosen the calculation method B, while producer 3 has chosen calculation method A. Data are shown in Tables 4.2.2-4.2.5.
Annual emission factor is then calculated from total CO_2 emissions for all three plants, and total amount of lime produced in these three plants.

Table 4.2.2: Lime production emissions from producer 1.

Year	CaO (t)	MgO (t)	EF (tCO_2/t) CaO	EF (tCO_2/t) MgO	Emissions CO_2 (t)
2005	87142	1597	0.785	1.092	70150
2006	105200	1885	0.785	1.092	84641
2007	94178	1291	0.785	1.092	75340
2008	90633	1393	0.785	1.092	72668
2009	65411	1257	0.785	1.092	52721
2010	87423	1463	0.785	1.092	70225
2011	80298	6471	0.785	1.092	70101

Table 4.2.3: Lime production emissions from producer 2.

Year	CaO (t)	MgO (t)	EF (tCO_2/t) CaO	EF (tCO_2/t) MgO	Emissions CO_2 (t)
2005	13869	249	0.785	1.092	11159
2006	13788	228	0.785	1.092	11072
2007	17222	332	0.785	1.092	13882
2008	9256	215	0.785	1.092	7500
2009	8733	213	0.785	1.092	7089
2010	11504	333	0.785	1.092	9394
2011	12230	291	0.785	1.092	9918

Table 4.2.4: Lime production emissions from producer 3.

Year	$CaCO_3$ (t)	EF (tCO_2/t)	Emissions CO_2 (t)
2005	90993	0.44	40037
2006	88068	0.44	38750
2007	77738	0.44	34205
2008	67816	0.44	29839
2009	25432	0.44	11190
2010	24156	0.44	10629
2011	24355	0.44	10716

Table 4.2.5: Total CO_2 emissions of all three producers, total lime production and calculated IEF.

Year	2005	2006	2007	2008	2009	2010	2011
Lime Produced (t)	165125	185240	170464	152227	97970	125117	124219
Total emissions CO_2 (t)	121346	134462	123426	110007	71000	90248	90735
IEF (kg CO_2/t)	735	726	724	723	725	721	730

The limestone used for lime production contains mostly $CaCO_3$. The limestone has also small amount of dolomite, which next to $CaCO_3$ consists also of $MgCO_3$. High-calcium lime is the main type of lime. Quicklime and hydrated lime are the main types of lime produced in Slovenia.

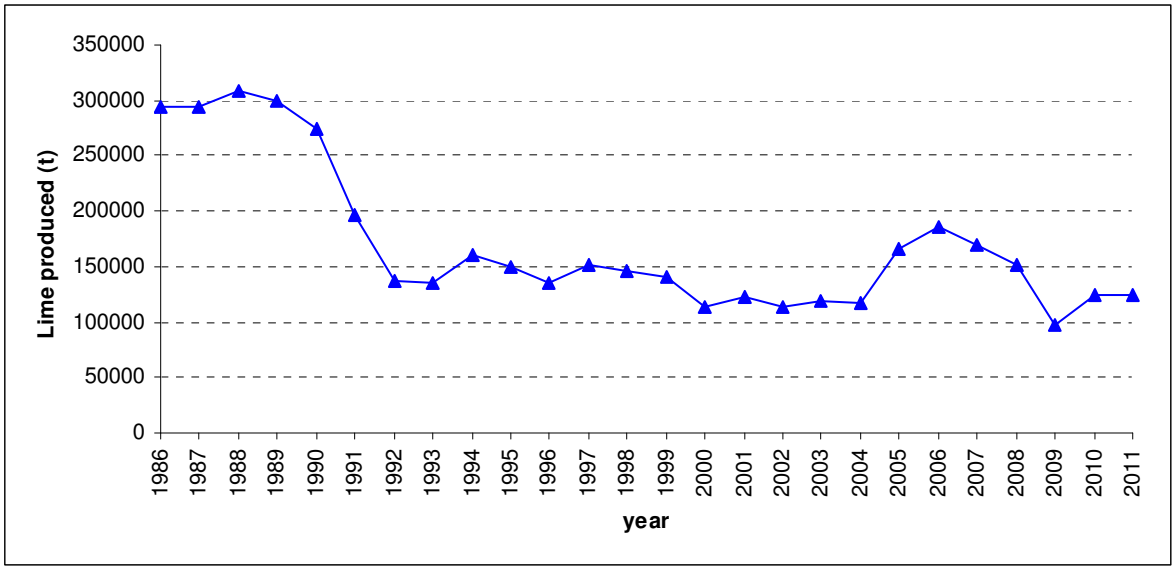

Figure 4.2.1: Lime production in ton/year.

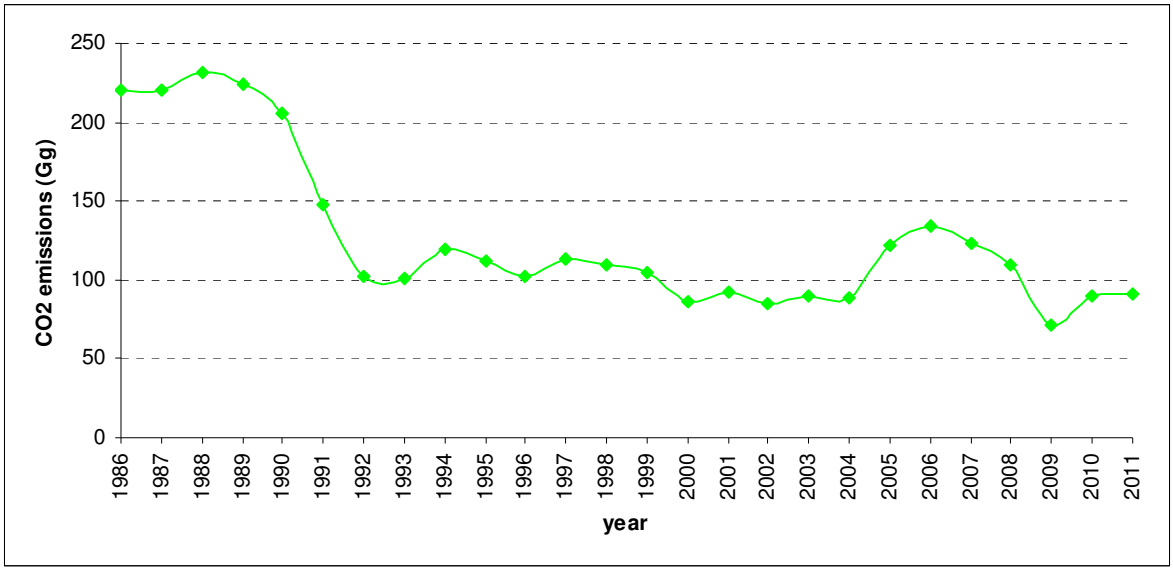

Figure 4.2.2: CO_2 emissions from lime production.

4.2.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 10%.
Uncertainty of emission factor amounts to 5%.

4.2.4 Source specific recalculations

No recalculations have been performed since last submission.

4.2.5 Source-specific planned improvements

No improvements are planned for this source.

4.3 Limestone and Dolomite Use

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CO_2	0.15		45
2011	Level, Trend	CO_2	0.49	0,74	23

4.3.1 Source category description

Limestone and dolomite are used in many industries. During heating to high temperature, carbonates convert to oxides, emitting CO_2. Most limestone and dolomite are thus consumed in the production of cement and lime, as described above. Along with other carbonates, they are also used in the production of metals and mineral products.

This sector comprises use of limestone and dolomite in production of iron and steel, in technology for the reduction of SO_2 emissions in the process of consumption of coal, in ceramics production, mineral wool production and production of TiO_2. Total CO_2 emissions from sector limestone and dolomite use are shown in Table 4.3.1.

4.3.2 Methodological issues

CARBON DIOXIDE EMISSIONS

Production of iron and steel

Consumption of limestone and dolomite in production of iron and steel produces CO_2 emissions. Primary production from ore existed only in the 1986 and 1987, after 1990 steel production is based on utilization of scrap iron and steel. Activity data on $CaCO_3$ consumption were obtained directly from iron and steel producers. CO_2 emissions have been calculated according to IPCC methodology. Default emission factor, 440 kg CO_2/ton limestone, has been applied for the whole period.

SO_2 Scrubbing

Using the technology for the reduction of SO_2 emissions in the process of consumption of coal is causing emissions of CO_2. CO_2 emissions from scrubbing have been calculated from consumption of additive $CaCO_3$ and appropriate emission factor.

Activity data on $CaCO_3$ consumption for the period 1995-2004 have been taken from the documents of Milan Vidmar Electroinstitute. Prior to 1995, there were no wet flue gas desulphurisation units installed for reducing emission of SO_2 in Slovenia. Data on $CaCO_3$ and $MgCO_3$ for the period 2005–2011 have been obtained from verified ETS reports. Default emission factor, 440 kg CO_2/ton limestone and 522 kg CO_2/ton magnesium carbonate, were applied for the whole period.

Ceramics production

Limestone and dolomite use in bricks and ceramics production was also taken into account. Activity data on $CaCO_3$ and $MgCO_3$ due to limestone and dolomite use in ceramics production for the period 2005–2011 have been obtained from verified ETS reports. Default emission factor, 440 kg CO_2/ton limestone and 522 kg CO_2/ton magnesium carbonate, were applied for the whole period.

Mineral wool production

Dolomite is used as raw material in mineral wool production. Activity data have been obtained from the producer of mineral wool used for insulation purposes. Default emission factor 477 kg CO_2/ton dolomite was applied for the whole period 1986-2011.

Manufacture of dyes and pigments

Limestone has been used in manufacturing of TiO_2 pigment for neutralization processes. Activity data on $CaCO_3$ use for the period 1986–2011 have been obtained from the producer. Default emission factor 440 kg CO_2/ton calcium carbonate has applied for the whole period.

Table 4.3.1: CO_2 emissions from limestone and dolomite use.

	Units	1986	1990	2005	2009	2010	2011
$CaCO_3$ consumption in iron and steel production	**t**	43297	1896	1928	2038	2156	3267
EF $CaCO_3$	**t CO2/t**	0.44	0.44	0.44	0.44	0.44	0.44
CO_2 emission from iron and steel production	**Gg**	19.1	0.83	0.85	0.90	0.95	1.43
Consumption of additive $CaCO_3$	**t**	0.0	0.0	187221	206482	206975	232738
EF $CaCO_3$	**t CO2/t**	0.44	0.44	0.44	0.44	0.44	0.44
Consumption of additive $MgCO_3$	**t**	0.0	0.0	0.0	633	547	794
EF $MgCO_3$	**t CO2/t**	0.522	0.522	0.522	0.522	0.522	0.522
CO_2 emissions from SO_2 scrubbing	**Gg**	0.0	0.0	82.4	91.2	91.4	102.8
$CaCO_3$ consumption in ceramics production	**t**	0.0	0.0	1998	1537	1791	1744
EF $CaCO_3$	**t CO2/t**	0.44	0.44	0.44	0.44	0.44	0.44
$MgCO_3$ consumption in ceramics production	**t**	0.0	0.0	1	15.5	18.4	35.2
EF $MgCO_3$	**t CO2/t**	0.522	0.522	0.522	0.522	0.522	0.522
CO_2 emissions from ceramics production	**Gg**	0.0	0.0	0.88	0.68	0.80	0.79
$CaCO_3$ consumption in production of dyes and pigments	**t**	39579	36089	78381	99519	110479	110256
EF $CaCO_3$	**t CO2/t**	0.44	0.44	0.44	0.44	0.44	0.44
CO_2 emissions from production of dyes and pigments	**Gg**	17.4	15.9	34.5	43.8	48.6	48.5
Dolomite consumption in production of mineral wool	**t**	22901	20624	24844	21873	22042	24624
EF dolomite	**t CO2/t**	0.477	0.477	0.477	0.477	0.477	0.477
CO_2 emissions from production of mineral wool	**Gg**	10.9	9.83	11.9	10,4	10.5	11.7
Total CO_2 emissions	**Gg**	**47.4**	**26.5**	**130.4**	**147.0**	**152.2**	**165.3**

4.3.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 20%.
Uncertainty of emission factor amounts to 10%.

4.3.4 Recalculations

No recalculations have been performed since last submission.

4.3.5 Source-specific planned improvements

No improvements are planned for this category.

4.4 Soda ash production and use

Key sector - Base year: no
Key sector - Year 2011: no

4.4.1 Source category description

Soda ash (Na_2CO_3) is used as a raw material in numerous industrial processes: production of glass, soap and detergent, production of paper. CO_2 emissions arise both in production as well as in consumption of soda ash.

4.4.2 Methodological issues

There is no production of soda ash in Slovenia. Consequently, this chapter comprises only estimation of emissions arising in soda ash consumption.

Data on consumption was obtained from the Statistical Office of the Republic of Slovenia (SORS) until 1997. Later on these data were not available anymore. Consumption of soda ash was for the period 1998-2011 calculated from the data on import and export published by SORS as well. Stock changes were disregarded. Use of soda ash in glass production is reported in sector 2.A.7.1 Glass production. CO_2 emissions from consumption have been calculated according to IPCC methodology, applying an emission factor of 415 kg CO_2/ton of Na_2CO_3.

4.4.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 10%.
Uncertainty of emission factor amounts to 5%.

4.4.4 Recalculations

No recalculation has been performed since last submission.

4.4.5 Future improvements

No improvements are planned for this category.

4.5 Production and use of Miscellaneous Mineral Products (IPCC: 2 A 7)

Key sector - Base year: no
Key sector - Year 2011: no

4.5.1 Source category description

This chapter comprises CO_2 emissions from glass manufacturing. They are reported in sector 2.A.7.1 Glass Production.

4.5.2 Methodological issues

CO_2 emissions from glass production for the period 1999-2011 have been calculated taking into account the consumption of all carbonates in glass production. Data on carbonate use in glass production were obtained from glass producers. Amount of all carbonates used in glass production is included in this sector. Those carbonates are: limestone ($CaCO_3$), magnesium carbonate ($MgCO_3$), soda ash (Na_2CO_3), potash (K_2CO_3) and barium carbonate ($BaCO_3$). Default IPCC emission factors have been used for calculation of CO_2

emissions. Those are 440 kg CO_2/ton limestone, 522 kg CO_2/ton magnesium carbonate, 318 kg CO_2/ton potassium carbonate, 223 kg CO_2/t barium carbonate, 415 kg CO_2/t sodium carbonate.

Calculation of CO_2 emissions from glass production for the period 1986-1998 has been performed in another way due to lack of data on carbonate consumption. Average implied emission factor for the years 1999-2007 has been multiplied with the annual glass production data. Data on glass production were obtained from glass producers.

4.5.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 5%.
Uncertainty of emission factor amounts to 2%.

4.5.4 Recalculations

No recalculation has been performed since last submission

4.5.5 Future improvements

No improvements are planned for this category.

CHEMICAL INDUSTRY

4.6 Nitric acid Production

Key sector - Base year: no
Key sector - Year 2011: no

4.6.1 Source category description

The production of nitric acid (HNO_3) generates nitrous oxide (N_2O) as a by-product of the high temperature catalytic oxidation of ammonia (NH_3). In Slovenia, there is no production of nitric acid since 2006.

4.6.2 Methodological issues

NITROUS OXIDE EMISSIONS

Emissions for the period 1997-2005 have been estimated according to IPCC methodology, applying an emission factor of 5.5 kg N_2O/ton nitric acid. Data on amount of nitric acid produced have been obtained from the Statistical Office of the Republic of Slovenia. Since 2006 there is no production of nitric acid in Slovenia. No emissions of N_2O have been originated from that sector since 2006.

4.6.3 Recalculations

No recalculations have been performed in this category.

4.6.4 Future improvements

No improvement is planned for this category.

4.7 Carbide Production

Key sector - Base year: no
Key sector - Year 2011: no

4.7.1 Source category description

There was only one carbide producer in Slovenia. This factory was closed down in the first quarter of 2008. Production of calcium carbide was discontinued in 2008, while the production of silicon carbide was discontinued as early as in 1995.

CO_2 emissions arise both in the production of calcium carbide as well as in its consumption. Calcium carbide (CaC_2) is produced by heating calcium carbonate and subsequently reducing CaO with carbon. Both steps lead to emissions of CO_2. In Slovenia, calcium carbide was not produced from limestone but from lime, hence CO_2 emissions arise only in the reduction with carbon. CO_2 emissions have been arising also in the consumption of calcium carbide.

In the production of silicon carbide (SiC), CO_2 is released as a by-product. Petrol coke is used as a source of carbon. Data on the consumption of petrol coke in the production of silicon carbide were provided by the producer. The CO_2 emissions had been estimated on the basis of IPCC methodology using input data on petrol coke used and carbon content in coke and product. From 1995 onwards there was no production of silicon carbide in Slovenia. The petrol coke used in the process may contain volatile compounds which will form methane. Methane emissions had been calculated using suggested IPCC emission factor 10.2 kg/t petrol coke.

4.7.2 Methodological issues

CARBON DIOXIDE EMISSIONS

Data on annual production of CaC_2 is the input data for calculation of CO_2 emissions arising from production of calcium carbide. Until 1997, those data were obtained from Statistical Office of the Republic of Slovenia (SORS), but afterwards SORS changed its methodology of gathering and presenting carbides. SORS data became inapplicable. We found alternative source of data of CaC_2 produced. We have obtained data directly from the producer and applied them for emissions calculation for the entire period. In the year 2011 there was no production of calcium carbide, since the only one carbide factory was closed down in the first quarter of 2008. CO_2 emissions from production had been calculated using suggested IPCC emission factor 1090 kg CO_2/ton of calcium carbide.

Emission arises also in consumption. Until 1997 data on consumption of CaC_2 was obtained from Statistical Office of the Republic of Slovenia. Afterwards those data were not available anymore. We tried to estimate consumption from SORS data on import and export and data on production received from producer, but considerable fluctuations in consumption of calcium carbide in individual years were observed. To obtain smoother time series, we decided to estimate consumption of CaC_2 using moving averages. As a result we have been used estimated data on CaC_2 consumption for the period 1998-2011. CO_2 emissions from calcium carbide consumption have been calculated using recommended IPCC emission factor 1100 kg CO_2/ton of calcium carbide.

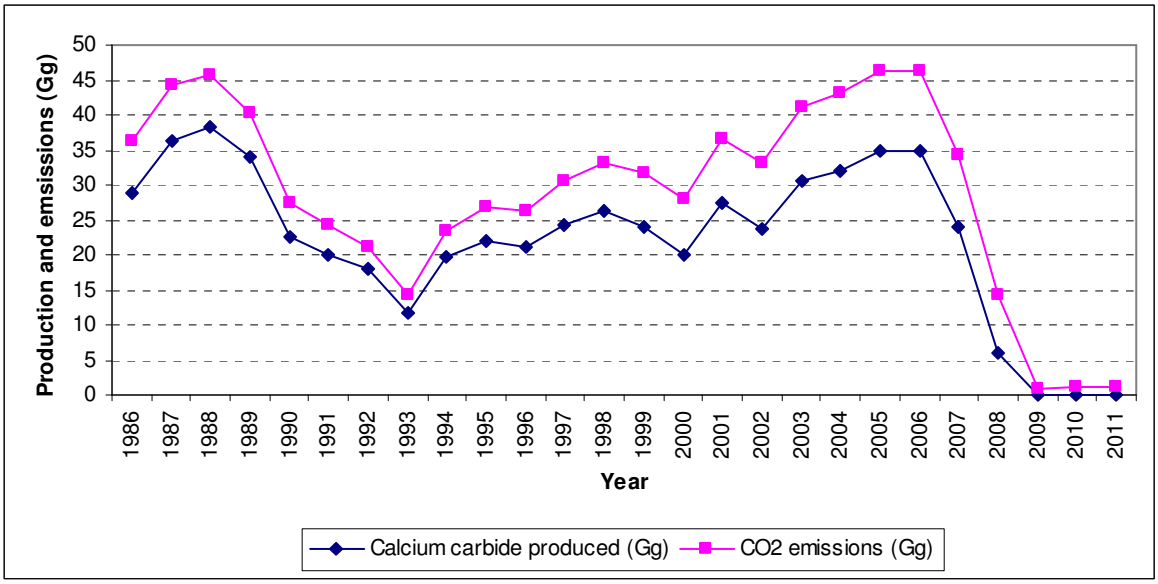

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Figure 4.7.1: Production of calcium carbide and CO_2 emissions arising from production and consumption of calcium carbide.

4.7.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 20%.
Uncertainty of emission factor amounts to 5%.

4.7.4 Recalculations

No recalculations have been performed in this category.

4.7.5 Future improvements

No improvements are planned for this category.

4.8 Production of Other Chemicals

Key sector - Base year: no
Key sector - Year 2011: no

4.8.1 Source category description

This chapter describes sources of other greenhouse gases. In Slovenia, there are no other industrial sources of N_2O besides those described above, while methane arises in the production of methanol.

4.8.2 Methodological issues

METHANE EMISSIONS

The source of emissions is the production of methanol. In calculating emissions, the default IPCC emission factor of 2 kg CH_4/t methanol was applied.
Production data of methanol have been obtained from Statistical Office of the Republic of Slovenia for the period 1986-2010. In 2011 there was no production of methanol in Slovenia.

4.8.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 30%.
Uncertainty of emission factor for CH_4 amounts to 80%

4.8.4 Recalculations

No recalculations have been performed in this category.

4.8.5 Future improvements

No improvements are planned for this category.

METAL PRODUCTION

4.9 Iron and Steel Production

Key sector - Base year: no
Key sector - Year 2011: no

4.9.1 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 emissions of CO_2. 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.

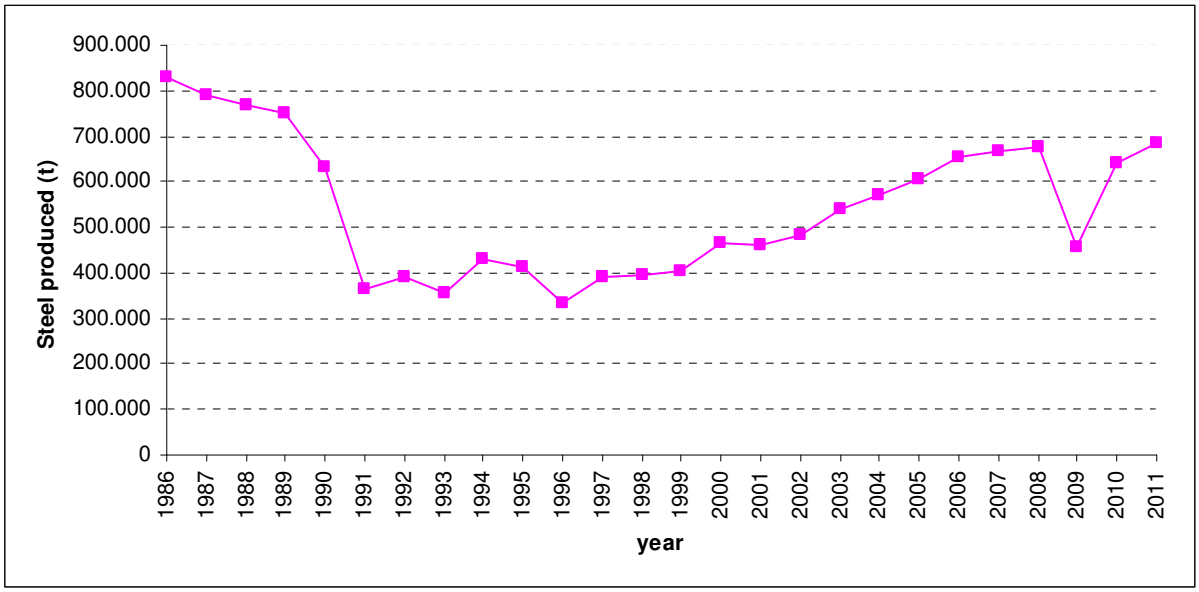


Figure 4.9.1: Production of steel in ton/year.

4.9.2 Methodological issues

CARBON DIOXIDE EMISSIONS

Process emissions of carbon dioxide in an iron and steel plant take place as a result of coke oxidation. During steel production, CO_2 emissions also take place as a result of graphite electrode consumption in the EAF. CO_2 emissions originating in the consumption of limestone and dolomite as well, but they have been dealt with in chapter Mineral Industry, as laid down by the IPCC Guidelines.

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. Consequently, 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 1988–2011 all coke consumption is 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. For allocation plan purposes more detailed data were available from 1999 onwards, which enabled us to determine our own emission factor. Average EF for the period 1999–2004 has been 47 kg CO_2/t of steel. This emission factor has been applied for calculating emissions from 1988 onwards. This EF is not appropriate for the base year because of the different type of production of steel (from ore). For the period 2005-2011 we have used precise and verified data obtained from EU ETS. Figure 4.9.2 shows CO_2 emissions contributed by different input material and steel produced for 2005-2011.

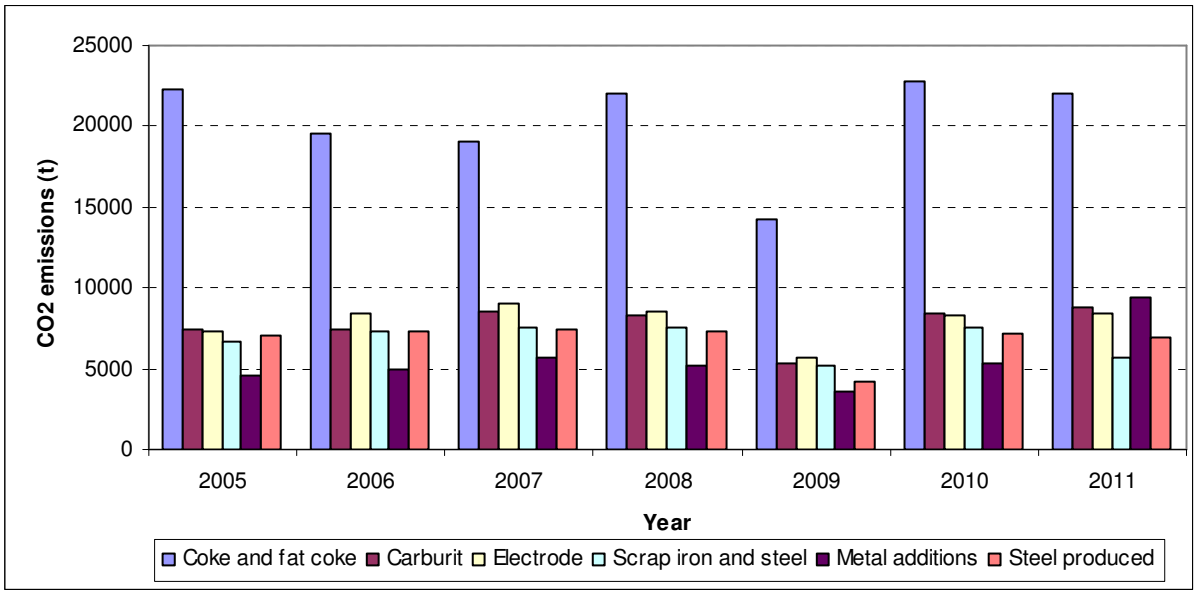


Figure 4.9.2: CO_2 emissions contributed by different input material and steel produced for 2005-2011.

4.9.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 5%.
Uncertainty of emission factor amounts to 5%

4.9.4 Recalculations

No recalculations have been performed since last submission.

4.9.5 Future improvements

No improvements are planned for this category.

4.10 Ferroalloys Production

Key sector - Base year: no
Key sector - Year 2011: no

4.10.1 Source category description

Ferroalloys 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.

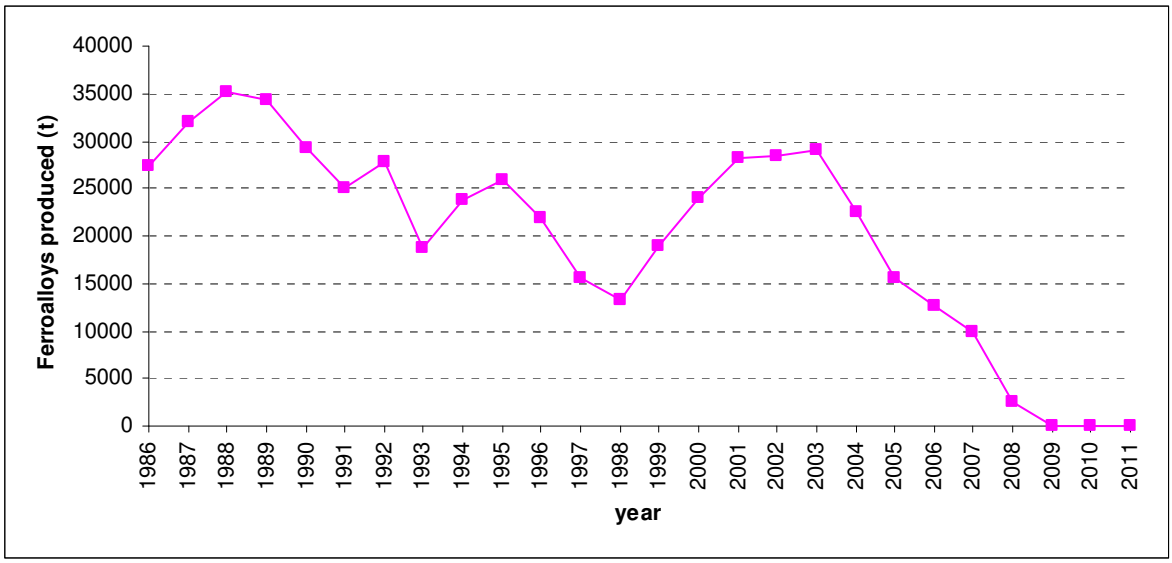


Figure 4.10.1: Ferroalloys production in ton/year.

4.10.2 Methodological issues

CARBON DIOXIDE EMISSIONS

CO_2 emissions have been calculated from the consumption of fuels, while data on ferroalloys produced were used only for the QC activity. Like in the production of steel, the presentation of fuels was split. Emissions from consumption of coal and natural gas have been reported in the Energy Sector/Manufacturing industry and Construction/Iron and Steel (CRF sector 1A2a), and emissions from coke and graphite electrodes have been reported in the process emission sector. CO_2 emissions from the consumption of wood chips, which are biomass, have not been added to total emissions. Emissions have been calculated according to IPCC methodology by applying the defined emission factors. EFs used have been constant over the whole reported period.

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. No ferroalloys were produced in 2011. Input data on fuel consumption for the entire period had been obtained from that producer. The producer had 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.

The trend in the CO_2 IEF had not been stable due to different annual shares of fuels split between energy sector (coal and natural gas) and process emission sector (coke and graphite electrodes). Changing level in annual consumption of coke and electrodes over time and different amount and type of annual ferroalloys produced was also the reason for variation in the IEF. Different ferroalloys have different CO_2 emissions factors (Revised 1996 IPCC Guidelines, Table 2.15, pg 2.31)

4.10.3 Uncertainties and time-series consistency

Estimates based on expert judgement.
Uncertainty of activity data amounts to 10%.
Uncertainty of emission factor amounts to 10%

4.10.4 Recalculations

No recalculations have been performed since last submission.

4.10.5 Future improvements

No improvements are planned for this category.

4.11 Aluminium Production

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
1986	Level	PFC	0.85		21
2011	Trend	PFC	0.08	0.59	45

4.11.1 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.

Beside CO_2, also perfluorocarbons (PFCs) arise in the production of aluminium. This occurs during anode effect when the alumina content of the electrolyte falls below 1-2% and a gas film is formed at the anode. This stops the production of the metal and increases the cell voltage. Factors that influence the generation of PFCs are the frequency and duration of anode effects and the operating current of the cell.

In Slovenia, there is one aluminium producer. Since the base year, the production of aluminium has undergone numerous modernisations, resulting in reduced GHG emissions from this source in spite of increased production.

Precise information on technological changes and improved operating conditions in the aluminium production process is presented.

Table 4.11.1: Technology used in the aluminium production and corresponding CF_4 and C_2F_6 emission factors.

Technology	Unit	Emission factors
Electrolysis unit A, Soderberg, HSS	kg CF4/t	0.61
	kg C2F6/t	0.061
Electrolysis unit B, Soderberg, HSS, until 1987	kg CF4/t	0.61
	kg C2F6/t	0.061
Electrolysis unit B, reconstruction to PB, 1988	kg CF4/t	0.40
	kg C2F6/t	0.04
Electrolysis unit C, Pechiney, PFPB, until 2004	kg CF4/t	0.035
	kg C2F6/t	0.0035

PF - Point Feeding,
PB - PreBaked anode,
HSS - Horizontal Stud Soderberg

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,
- 2010 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 40000 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 40000 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. Since 2008 only doubled electrolysis unit C with technological improved point feeding prebaked anode Pechiney has been in operation. Annual production of aluminium in 2009 and 2010 were halved compared to 2008. Significant drop in aluminium production occurred due to world economical crisis. In 2011 production of aluminium has been considerably increased and almost reached pre-crises values. It amounted to 75071 t.

4.11.2 Methodological issues

CARBON DIOXIDE EMISSIONS

Data on amount of primary aluminium produced, consumption of anodes and emissions of GHG are on a regular basis submitted to the Agency of the Republic of Slovenia by the producer expert service. Data gathered by the Statistical Office of the Republic of Slovenia are unusable for our purposes since they include the entire Slovenian production of aluminium and not only the primary production.

CO_2 emissions from primary aluminium production are most precisely estimated from the consumption of anodes. Their consumption in 2011 amounted to 397 kg/ton Al. The emission factor is 3.6 t CO_2/ton anodes. The significant decline of CO_2 emissions in 2009 is due to smaller aluminium production. Slightly higher emissions of CO_2 are observed in 2010, but they are still far from pre-crises values. In 2011 production of aluminium has been considerably increased.

To improve transparency of CO_2 emission from aluminium production this chapter comprises only emissions arising from consumption of anodes. CO_2 emissions from anode burn-off were excluded from this chapter and they are now reported under sector Other 2.C.5.

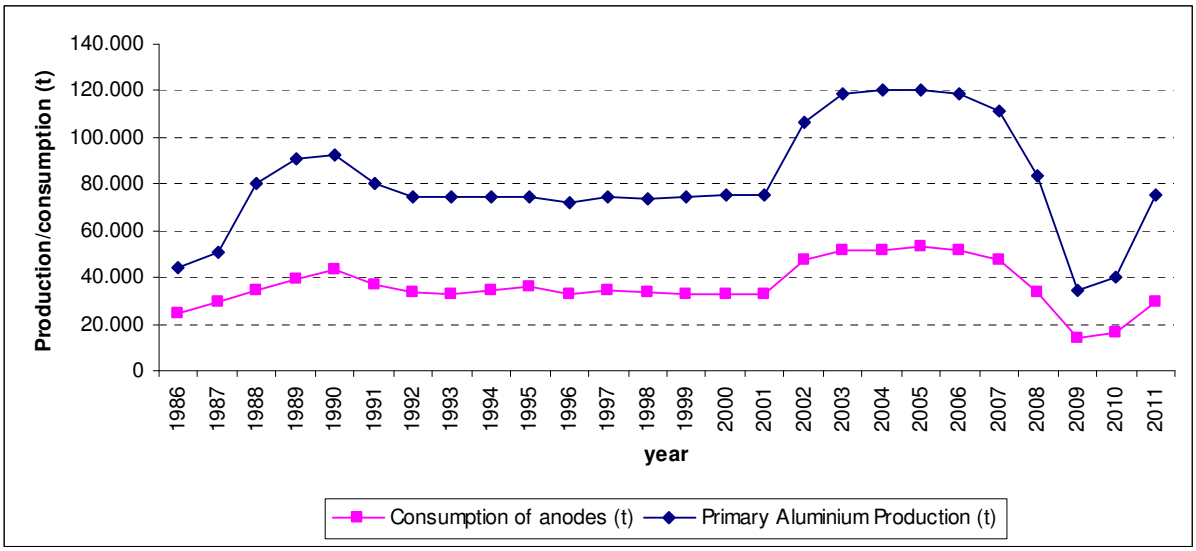


Figure 4.11.1: Primary aluminium production in ton/year and a consumption of anodes in ton/year.

PFC EMISSIONS

Data on emission calculations of tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) have been obtained directly from aluminium producer. Technological changes and improved operating conditions in the aluminium production process are the reason for the decrease of CF_4 and C_2F_6 emission factors from 1995 to 2011. The CF_4 emission factor has fallen from the base year 1995 till now from 0.191 kg CF_4/ton Al to 0.049 kg CF_4/ton Al and C_2F_6 emission factor from 0.021 kg C_2F_6/ton Al in the base year to 0.0064 kg C_2F_6/ton Al in 2011.

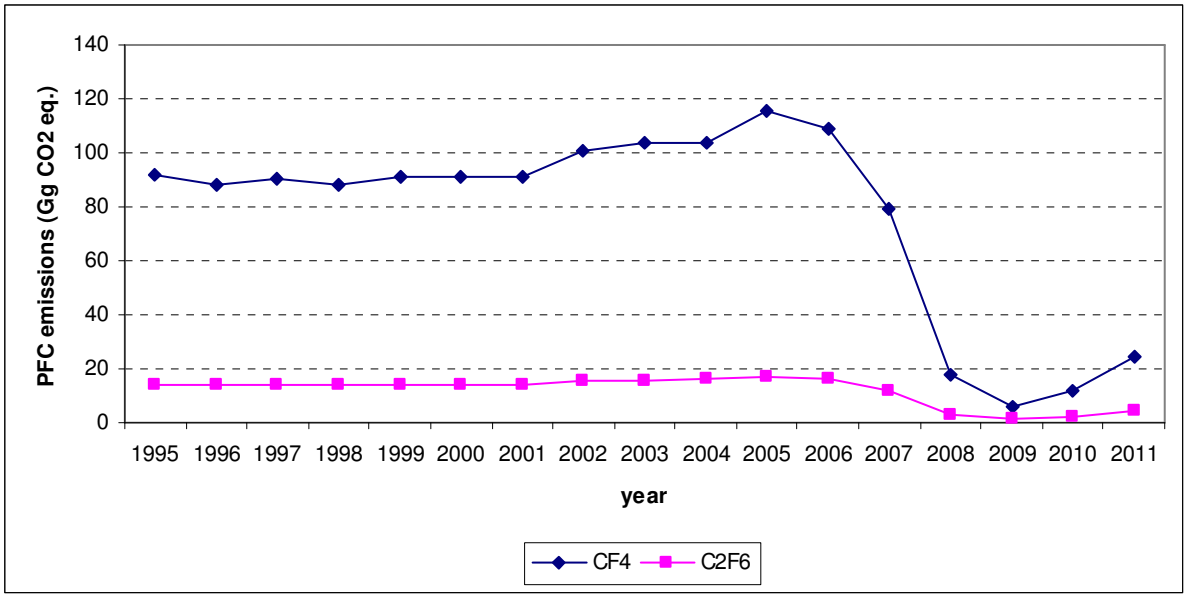


Figure 4.11.2: Emissions of CF_4 and C_2F_6 emitted during anode effect in aluminium production.

In the scope of establishing a scheme for greenhouse gas emission allowance trading for the third trading period after 2012 thorough examination of data was performed. Higher method (Tier 2) was used for calculating of PFC emissions in electrolysis unit C for the period 2005 -2011. Annually determined emission factors have been used for emission calculation. Pechiney overvoltage method was used for emissions calculation for both gases. All data were obtained from producer's electronically recorded anode-effect inventory.

4.11.3 Uncertainties and time-series consistency

Due to the improved data about Al production the quality of activity data have largely improved and it is expert judgement that the relevant uncertainty amounts to 2%. The same value is also suggested as upper limit for baked anode consumption in 2006 IPCC Guidelines.

According to the same guidance we have used uncertainty of the CO2 EF as 5% and PFC EF as 6%.

4.11.4 Recalculations

No recalculations have been performed since last submission.

4.11.5 Future improvements

No improvements are planned for this category.

4.12 Other Metal Production (IPCC: 2 C 5)

Key sector - Base year: no
Key sector - Year 2011: no

4.12.1 Source category description

This chapter comprises CO_2 emissions arising from anode burn-off in the process of anode production. Emissions are reported in sector Other 2.C.5 - Aluminium anode burn-off.

4.12.2 Methodological issues

CO_2 emissions from anode burn-off in anode baking process were excluded from the sector on aluminium production. They are reported separately in this chapter. Anodes are used in potline cells - pots for the production of aluminium. CO_2 emissions generated in the process of green anodes baking arise from oxidation of volatile substances from a tar pitch and from the burning-off the covering material (petroleum coke). EF for anode burn-off is a plant specific. Data on amount of anode burn-off and emissions of CO_2 are provided by the producer expert service. CO_2 EF for 2011 is 3.49 t CO_2/ t anode burn-off.

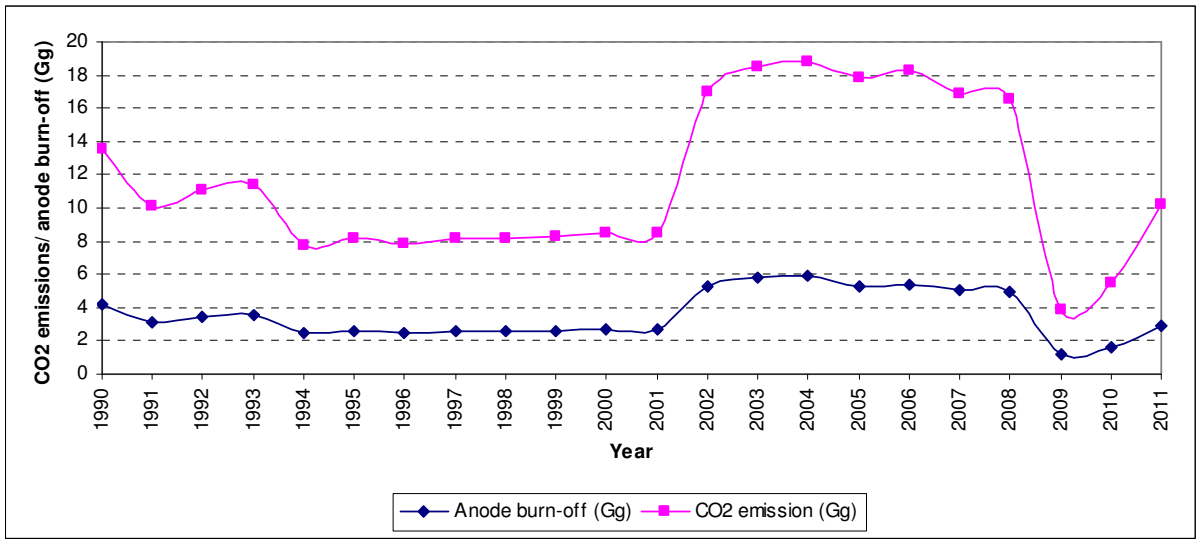


Figure 4.12.3: CO_2 emissions from anode burn-off in the process of anode production.

4.12.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 10%.
Uncertainty of emission factors amounts to 10%

4.12.4 Recalculations

No recalculations have been performed since last submission.

4.12.5 Future improvements

No improvements are planned for this category.

4.13 Source-Specific QA/QC and verification

QC procedures for the plant data included in the inventory that are collected under the European Union Emissions Trading Scheme (EU ETS) have been performed. ETS emissions data from verified printed reports have been compared with data obtained in electronic form. ETS emissions data are collected by EU ETS experts from Slovenian Environment Agency. As national inventory team and EU ETS experts work together in the same institution, even in the same unit, it is very easy to access these hard copy reports for each company. Besides the data, reports include also the description of monitoring of this data, eventual stops and changes of production. As Slovenia is small country only 15 installations from EU ETS report process emissions (2 cement, 3 lime, 3 steel, 4 glass producers, 3 ceramics producer), this QC can be performed manually. After entering this data to the calculation spreadsheet the QC is performed.

Considering calculation of emission factors time series consistency has been checked. Emission factors have been calculated according to non-energy use of fuel in particular type of industry (metal production) or according of composition data for clinker or lime production. Sources of data for calculation of emissions factors have stayed the same over the whole period. There are no difficulties of time series consistency.

4.14 Emissions Related to Consumption of Halocarbons and SF_6

Refrigeration and AC Equipment	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
1986	no	HFC	NO		NO
2011	Level, Trend	HFC	0.61	1.09	20

Other categories: Key sector - Base year: no
Key sector - Year 2011: no

4.14.1 Source category description

This category includes HFC and SF6 emissions. The emission sources, the time period and the gases used are presented in the table 4.14.1. The gases are presented in the pure form and most often in the following blends: R-402a, R-404a, R-407a, R-407c, R-410a, R-417a and R-507a.

Table 4.14.1: Emission sources of F-gases with the time period.

	period	gases
Refrigeration and AC equipment		
- domestic refrigeration	1995-2010	HFC-134a
- commercial refrigeration	1995-2010	HFC-32, HFC-125, HFC-134, HFC-143a
- industrial refrigeration	1997-2010	HFC-32, HFC-125, HFC-134, HFC-143a
- stationary air conditioning	2000-2010	HFC-32, HFC-125, HFC-134, HFC-143a
- mobile air conditioning	1995-2010	HFC-134a
Foam blowing		
- hard foam	1995-2010	HFC-134a
- soft foam	1995-2010	HFC-134a
Fire extinguishers	1997-2010	HFC-227ea
Aerosols and meter dose inhalers	2003-2010	HFC-134a
Electrical equipment	1986-2010	SF6
Noise insulation windows	1995-1997	SF6

The year 1995 was chosen as base year for HFC, PFC and SF6 emissions. Actual as well as potential emissions have been calculated.

HFCs

HFCs began to be used in Slovenia in 1993 as a substitute for CFCs, which are ozone-depleting substances. They asserted themselves in particular in those fields where no other, more appropriate alternatives (e.g. hydrocarbons, CO_2 etc.) were available.

The Slovenian chemical industry does not produce HFCs and therefore these substances are imported. Major users generally import them on their own, lesser users buy them from distributors.

In the 1995 base year only HFC-134a have been used while since 1998 also the other F-gases like R-125 and R-143a and HFC mixtures like R R-402a, R-404a, R-407a, R-407c, R-410a, R-417a and R-507a have been used. In fire extinguishers R-227ea have been used since 1995.

The sources of HFC emissions are presented on the figure below. Mobile Air-Conditioning is the most important source. In 2010 as much as 57% of all HFC emissions arose from MAC. The production and sales of cars with air conditioning has risen sharply in recent years.

The research project done by the Chamber of Commerce and Industry of Slovenia, 1999, that covered the use of HFC for the period 1995-1997 has calculated potential emissions according to Tier 1a and 1b methods, as well as actual emissions according to Tier 2 method. After this no new research has been done and except from MAC all other emissions have been calculated with extrapolation and assuming that the only HFC used was R-134a. During UNFCCC review in 2011 Slovenian emissions had been found underestimated and in response to the Saturday paper the new estimates had been calculated and resubmitted in October 2011. These estimates have been further improved in this year submission.

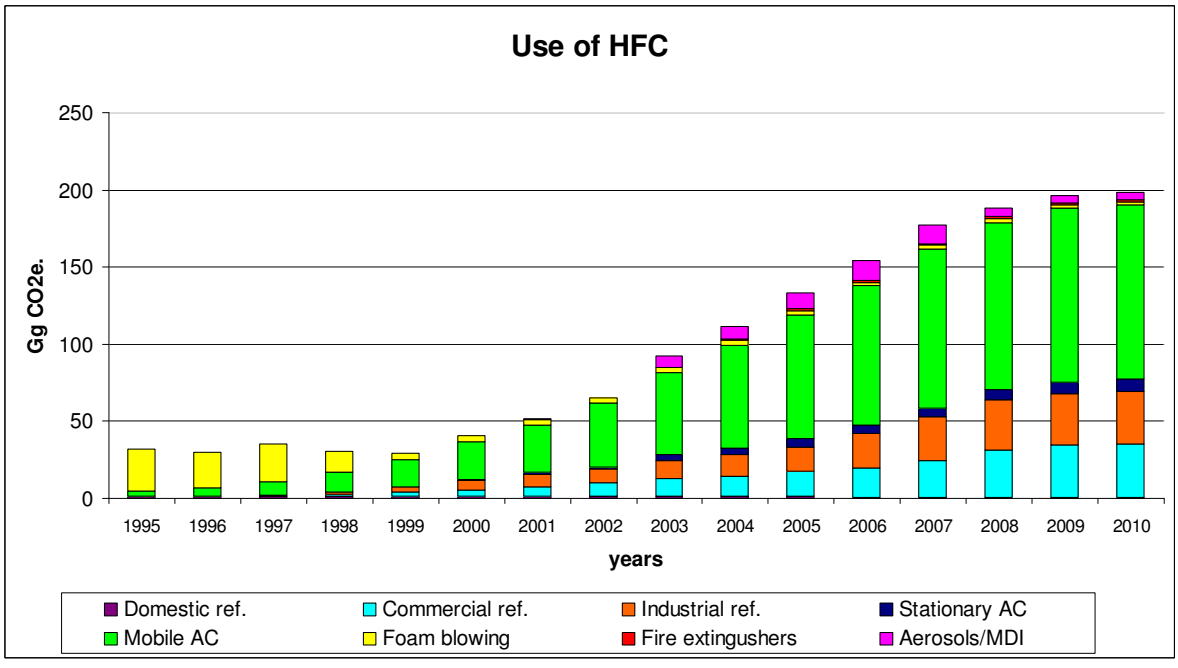


Figure 4.14.1: HFC and SF_6 emissions from different sources.

Following the recommendation from ERT in addition to HFC-134a the other F-gases and blends have been included in the inventory and AD have been updated according to the data from industry and from the new database which has been established in 2011. The database contains data on all devices with 3 kg of F-gases or more. Information includes amount and type of F-gases, year of installation and purpose of device (AC, industrial refrigeration…). We have used these data to estimate amount of F-gases for stationary conditioning, industrial refrigeration and partly also for commercial refrigeration.

The second source of data are reports from service companies which are authorized to perform 1st filling and to maintain the equipment which is filled with ODS and F-gases in commercial sector and in the industry. From these reports the total amount of each F-gas or blend which has been used for maintenance in one year is available, but no disaggregation according to the type of maintained equipment is available. We have already changed the instruction and reporting form in the way that 2012 data will be collected and reported separately for four types of use (commercial, industrial, AC and fire protection).

There is one more source of data on F-gases in Slovenia. In 2008 Slovenia adopted a regulation on an environmental tax on the use of fluorinated greenhouse gases, which entered into force on 1 January 2009. The tax is calculated on the basis of pollution units, which refer to CO_2 equivalents. When it introduced the tax on the use of F-gases, the Slovenian government anticipated a transition period during which the tax burden would gradually increase until 2013 when the full price per pollution unit will be reached.

The level of the tax depends on the purpose of the use of F-gases: The first fill of pre-charged equipment and stationary equipment is taxed 5% while F-gas quantities used for servicing and maintenance of equipment are taxed 100%.

First data on F-gas quantities used and tax revenues show high increase of the use of F-gases. Current problems of the scheme relate to the fact that taxes do not apply in neighbour countries within the EU and outside of the EU and that it is possible for companies to buy F-gases there at lower prices. Furthermore, tax rebates for recovered F-gases for reclamation and destruction are not part of the scheme. Amendments of the existing regulation are being discussed in order to improve effectiveness of the tax scheme.

SF_6

SF_6 is mostly used as an insulating agent and fire-extinguishing agent in electrical installations, in middle voltage and high voltage (110 kV and 400 kV) gas insulated switchgear and circuit breakers (HV equipment). SF_6 insulated switchgear and circuit breakers were first used in Slovenia in 1976. The trend is on the increase, and particularly after 1993, the use of equipment with SF_6 as insulating gas has increased strongly. This type of equipment is not produced in Slovenia and there is no export of SF_6 in equipment.

In 2006 a research covering all high-voltage equipment in Slovenia has been done by The Milan Vidmar Electric Power Institute, Ljubljana. Estimation of SF_6 emissions for the period 1986-2005 has been performed. Since then data from F-gases data base have been used.

For 1995-1997 the emissions from production of soundproofed windows have been included.

4.14.2 Methodological issues

Actual emissions of HFC and SF6 have been calculated using the following equation:

$$E_t = E_{assembly.\ t} + E_{operation.\ t} + E_{disposal.\ t}$$

where:

$E_{assembly,\ t} = E_{charge,\ t} * (k/100)$

$E_{assembly,\ t}$ = Emissions during system manufacture/assembly in year t
$E_{charge,\ t}$ = The amount of F-gas charged into new systems in year t
k = Production/assembly losses (%)

$E_{operation.\ t} = E_{stock.\ t} * (x/100)$

$E_{operation.\ t}$ = Amount of F-gas emitted during system operation in year t
$E_{stock.\ t}$ = Amount of F-gas stocked in existing systems in year t
x = Annual leakage rate (in per cent of total F-gas charge in the stock)

$E_{disposal,\ t} = E_{consumption\ (t-n)} * (y/100)$

$E_{disposal,\ t}$ = Amount of F-gas emitted at disposal in year t
$E_{consumption\ (t-n)}$ = Amount of F-gas used for production in year (t-n)
n = product lifetime (in years)
y = Share of F-gas in products to be disposed of in % of the amount used for their production

For the period 1995-1997 the potential emissions have been calculated according to the IPCC Tier 1b method. For the years 1998-2008 estimation was carried out according to recommended methodology of European Commission. Due to lack of data on production, imports, exports and destroyed amounts of HFC estimation of potential emissions for this period are based on the amounts filled into new manufactured products. Since 2009 the data on bulk import and destroyed amount of F-gases have been used, while the data on export are still not available. We have estimated also the import and export data on HFC-134a in product (MAC only) for the whole period 1995-2011.

2.F.1 Refrigeration and AIR Conditioning Equipment

The following chapters describe what kind of refrigeration and air-conditioning equipment has been considered in which sub-category, which refrigerants have been used in the respective applications and what method was used for the calculation of emissions in Slovenia.

Domestic refrigeration:

The use of HFC-134a as a refrigerant started towards the end of 1993 only to become partly replaced by isobuthane already in 1995. Appliances with R-134a have been produced exclusively for export to the USA and to other non European countries.

Since 1996 all household refrigerators which were produced and sold in Slovenia was filled in with R-600 (isobuthane) The amount of HFC-134a in imported refrigerators have been estimated with the study in 1999. Since then the amount in new appliances had decreased until 2006, when according to the information from experts there are no imported household refrigerators with HFC-134a. No other F-gases have been used.
Emission factors are presented in the Table 4.14.2. Product lifetime is considered to be 15 years and emissions from disposal have not been calculated, yet.

Commercial and industrial refrigeration:

Only one plant had produced commercial and industrial refrigerators with HFC-134a until 2009 when the plant was closed.
The amount of refrigerant used has been estimated with the study in 1999 and we have used projections from this study to determine amount for Stand alone commercial appliances while the amount in Medium and large commercial and Industrial refrigerators have been taken from the database. In addition to HFC-134a the following blends have been used: R-402a, R-404a, R-407a, R-407c, and R-410a.
Emission factors are presented in the Table 4.14.2. Product lifetime is considered to be 15 years and emissions from disposal have not been calculated, yet.

Residential and commercial A/C and heat pump:

There is no production of air conditioners in Slovenia; their sale on the Slovenian market may be equalled to their import. For a long time, only HCFC-22 was used and import of air conditioners with HFC began in the year 2000.

The amount in A/C and heat pumps has been taken from the F-gases database. Although some AC equipment is already filled with refrigerants when imported the many of them are filled during installation. For this reason we have assume that all amount of F-gases have been filled in Slovenia. We have also included estimates on amount of F-gases in small home AC appliances. In addition to HFC-134a the following blends have been used: R-404a, R-407a, R-407c, R-410a, R-417a, and R-507a.
Emission factors are presented in the Table 4.14.2. Product lifetime is considered to be 20 years and emissions from disposal have not been calculated, yet.

Mobile AC

Air conditioning systems in motor vehicles are filled with refrigerant at the moment of their installation into a vehicle. Car air conditioners are usually installed during vehicle assembly, although retrofitting is possible. HFC-134a began to be used in Slovenia in 1994, but some imported vehicles have been equipped with such air conditioners already since 1991. In the production of buses, HFC-134a began to be used in 1996.

There is one car producer in Slovenia and data on amount filled in new cars have been obtained from the personal contact with the producer.
Activity data for HFC stocks in MAC was annually estimated from amount of HFC in new cars equipped with air-conditioning, amount of HFC in operating systems and amount of HFC in disposed cars. The data were obtained from official database of registered vehicles. Product lifetime is considered to be 12 years

Product life factor (EF) was estimated in accordance with directive 2006/40/EC of the European parliament and of the council relating to emissions from air-conditioning systems in motor vehicles. The directive states that MAC value of 20% is appropriate for countries with no recovery and recycling program, and 10% for the countries with such a program. Slovenia started to implement that directive in 2006. 20% for MAC system emission rate

was applied until 2006 due to absence of such program. After implementation of the directive, gradual recovery and recycling program have been introduced. We assumed 1 per cent lower emissions in 2006 and the same decrease for every year after. The 15% for the year 2010 has been chosen according to that assumption. We assumed that for total implementation of recycling program a certain adaptation period is needed. Annual decrease of 1 per cent in the EF is our conservative assumption, since we have been informed that mechanical workshops intensively carry out that recycling program. The directive is available on the link:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:161:0012:0018:EN:PDF

Upon ERT recommendation to clarify which are country-specific emission factors and which are IPCC default EF values Table 4.14.2 was prepared. Comparison of EFs used by Slovenia (upper line) with the range from GPG Guidelines (lower line) is presented. Where EFs from 2006 Guidelines differ to EFs from GPG, the value (range) from 2006 Guidelines is included in the table as well. Emission factors for all categories except mobile AC have been taken from research made by Chamber of commerce and industry of Slovenia in 1999. The experts have chosen the emission factors according to their own experiences and according to some suggestions from IPCC Guidelines.

Table 4.14.2: **HFC emissions and emission factors used in refrigeration and air conditioning appliances for 2010 and comparison with EF from IPCC GPG and 2006 Guideline (if different).**

	EF Production (%)	EF Use (%)	EF Disposal (%)	HFC emissions (Gg CO_2 eq)
Domestic refrigeration	1	0.5		0.63
Range from GPG 2000	0.2 - 1	0.1 – 0.5		
Commercial refrigeration				
Stand alone	3	5		
Range from GPG 2000	0.5 – 3	1 – 10		
Range from 2006 Guidelines		1 – 15		34.73
Medium and large	3	20		
Range from GPG 2000	0.5 – 3	10-30		
Range from 2006 Guidelines		10-35		
Industrial refrigeration	3	16		34.00
Range from GPG 2000	0.5 – 3	7 - 25		
Stationary Air Conditioning	0.6	1-10		8.03
Range from GPG 2000	0.2 - 1	1 – 5		
Range from 2006 Guidelines		1 -10		
Mobile Air Conditioning	0.5	15	0.75	112.98
Range from GPG 2000	0.5	10 - 20		

2.F.2 Foam Blowing

Hard Foam

There is very few information about use of F-gases in the past. For production of insulating foams for refrigerators only one plant had used HFC-134a until 1996 when it was replaced by cyclopentane. Emissions of HFC in the manufacturing of insulating foam for household refrigerating/freezing appliances amount to 3 to 5 %, for calculations we have used average value 4%. Data about HFC in hard foam from the period 1993-1995 are available but it was assumed that no emissions have occurred during the use and that all emissions occurred after disposal (product life factor 0%). For the resubmission in October 2011 the product life factor of 4.5% has been used from IPCC GPG instead of zero.

Many plants have produced one component PU foam but all products with HFC have been exported. Emissions during the production of polyurethane assembly foams amount to 1% . HFC performs the function of propellant and blowing agent. Part of HFC is emitted during application of the product, for instance during installation of windows or doors, within the time of a year, but a part of HFC remains in the foam and is probably slowly released during the following 20-25 years. Considering the fact that this product is entirely destined for export, there are no emissions from application of the product on the domestic market and emissions arise in the importing countries.

Since 2007 the use of F-gases for PU OCF has been prohibited by EU legislation. There is no other evidence that F-gases have been used for hard foam blowing in Slovenia. For production of PU, XPS and EPS hard foams CO2 and pentane have been used as blowing agent while for PU OCF the flammable hydrocarbons (propane, butane…) have been used.

Soft Foam

In the production of soft foam all amount of HFC is emitted during the production (EF is 100%) and therefore no emissions occurred during their use and disposal. The only production of soft foam with HFC in Slovenia was production of polyurethane (PU) shoe soles until 1998 and had used HFC-134a for this purpose.

2.F.3 Fire extinguishers

The evidence of F-gases used in the fire extinguishers in our database is incomplete because not all of the enterprises are aware of this reporting obligation. Fire extinguishing agents, that are used generally, include dust, $CO_{2,}$ or water. Halon systems have been replaced by HFC.

Data about HFC used as replacement for CFC have been collected for the research made in 1999. In this research it was assume that 400 kg of HFC will be used per year. According to The operation plan of the republic of Slovenia for management of Halon, 5800 kg of CFC still existed in fire extinguishers in 2002. According to the plan all amount had been replaced with the substitutes until end of 2005. Due to the lack of detailed data we have assumed that all CFC have been replaced with HFC what is probably the overestimation. Since 2005 100 kg of HFC is assumed to be used every year for the new installations. In Slovenia only use of HFC-227ea has been detected.

In calculating emissions of HFC, IPCC methodology and the therein-stated assumption that emissions amount to 35% of the quantities used in new stationary systems were applied. This assumption is derived from experience with the use of Halon systems and is supposed to be appropriate also for estimating HFC emissions. The EF from 1st filling has decreased from 35% as it was estimated for 1997 to 2% in 2009 due to the rigorous legislation and high prices of F-gases and settled on 2% since then. We have used product life factor of 5% from IPCC GPG.

2.F.4 Aerosols/Metered Dose inhalers

Slovenia started to use HFC-134a in the MDI in 2003 as replacement to the CFC. Due to the lack on country specific data we have used the Austrian data about amount of HFC-134a in MDI divided by 4 what is a ratio between Austrian and Slovenian population (8 Mi and 2 Mi respectively). The Austrian data have been chosen instead of average value from cluster of countries because the high quality of Austrian inventory which is complete and very transparent.

For the year 2011 the national data on medicine with HFC-134a sold in Slovenia have been obtained for the first time and the relevant emissions have been reported. A comparison of emissions obtained from the national data and calculated from Austrian emissions inventory for 2011 are very similar (3.212 t and 3.527 t respectively).

2.F.8 Electrical equipment

Activity data for 1996-2005 has been taken from the research in 2006 (The Milan Vidmar Electric Power Institute, Ljubljana) while emissions since 2009 are taken from the F-gases database. Data for the period 2006-2008 have been interpolated..

Emissions have been calculated according to Tier 3a method where

$$E_t = E_{manufacturing,\,t} + E_{installation,\,t} + E_{use,\,t} + E_{disposal,\,t}$$

Table 4.14.3: HFC emissions: SF_6 emissions in high-voltage equipment.

	Units	1986	1990	1995	2000	2005	2008	2009	2010
Emissions from manufacturing	kg	0.1	0.0	0.9	1.4	2.6	1.4	2.0	2.1
Emissions from stock	kg	428.4	431.1	481.2	657.1	786.7	696.4	664.0	590.1
Total SF_6 emissions	kg	428.5	431.1	482.1	658.5	789.3	697.8	666.1	692.2
Total SF6 emissions	Gg CO2 eq	10.2	10.3	11.5	15.7	18.9	16.7	15.9	16.5

As production of SF_6 in Slovenia doesn't exist and until now no equipment including SF_6 has been disposed, emissions occurred only during installation and use.

Equipment installation emissions have been estimated by subtracting the nameplate capacity of all new equipment filled from the actual amount of SF_6 used to fill new equipment.

Equipment use emissions are determined by the amount of SF_6 used to service equipment. SF_6 which has been recovered from equipment before servicing and returned after servicing is not included in the estimate.

Upon ERT recommendation the SF_6 emissions from electrical equipment are reported in CRF table 2(II)F under emissions from stocks, with the exception of installation emissions which are reported under manufacturing emissions.

2.F.8 Other

Upon ERT recommendation emissions of SF_6 from the filling of soundproof windows for the period 1995 -1997 have been estimated using production EF of 10%. All windows had been exported thus no emissions from stock have occurred. Since 1997 there is no use of SF_6 for soundproof windows in Slovenia. According to the Regulation on certain fluorinated greenhouse gasses the placing on the market of double glazed windows filled with SF6 is also prohibited in EU countries since 4 July 2007. (Regulation (EC) No 842/2006, Article 9 and Annex II.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:161:0001:0011:EN:PDF

4.14.3 Uncertainties and time-series consistency

Estimates based on expert judgement and are presented in the table below.

Table 4.14.4: Uncertainties in %.

Category	AD	EF	Combined uncertainty
1. Refrigeration and Air Conditioning Equipment	50	50	70.7
2. Foam Blowing	10	50	51.0
3. Fire Extinguishers	50	50	70.7
4. Aerosols/MDI	100	0	100
8. Electrical Equipment	10	20	22.4

4.14.4 Source-specific planned improvements

The Slovenian F-gases database is not completed yet. Every year the new devices are included and amount of F-gases in stock is increasing. For this reason the data on stock will be updated regularly and if needed the recalculation of emissions will be performed. This can be regarded as an ongoing process, and will probably lead to an improvement of the inventory.

4.14.5 Recalculations

Due to updated data on 1st filling obtained from our database, the HFC emissions from Refrigeration and AC have been recalculated for 2010. A small correction has been also done to HFC emissions from aerosols and MDI for the period 2007-2010 due to the harmonization with the Austrian estimates.

4.14.6 Source-Specific QA/QC and verification

After applying the standard QC procedure data, EFs and emissions have been undergoing the following QA/QC procedures:

- all EFs have been compared with the EFs from IPCC GPG and from 2006 Guidance;
- values of stock have been compared with the data from neighbouring countries;
- emissions from every CRF category have been compared with the emissions from neighbouring countries

The comparison of EFs is included in the chapter on methodological issues.

For emissions of HFC from fire extinguishers it was determined that HFC emission in tons of HFC are very similar to emissions in Austria although population in Slovenia is four times smaller. But when comparing HFC emissions in Gg CO2 eq. the difference is almost as high as factor 10. The reason is that besides HFC-227ea, HFC-32 has been used in Austria with very high GWP (11,700) what is not the case in Slovenia.

Emissions from hard foam in Slovenia are comparable to the emissions from hard foam from Austria, taking into account the difference in the population and the fact that no HFC have been used for foam blowing in Slovenia since 1996.

The results of comparison for Refrigeration and AC equipment are in the table 4.14.6. In the first column HFC emissions from neighbour country in tons in 2009 from submission 2011 are presented while in the second column the HFC emissions in 2009 from Slovenian recent inventory are included. The third column named “population” represents emissions calculated from neighbouring country data and taking into account population ratio while in the last column, named “GDP” the same is done taking into account GDP ratio. In most cases emissions in Slovenia are very similar to the emissions calculated from population ratio. When GDP is taken into account emissions in Slovenia are higher for counties with higher GDP then Slovenian and lower for other.

Table 4.14.5: Slovenian HFC emissions from Refrigeration and AC equipment in 2009 in comparison with emission from Austria, Italy, Croatia, and Hungary and taking into account population and GDP.

	Austria	Slovenia	population	GDP
	ton	ton	ton	ton
HFC-32	12.70	1.71	3.11	1.60
HFC-125	79.60	9.84	19.48	10.00
HFC-134a	350.30	95.24	85.74	44.02
HFC-143a	73.30	9.35	17.94	9.21
TOTAL	515.90	116.14	126.28	64.83

	Italy	Slovenia	population	GDP
	ton	ton	ton	ton
HFC-32	602.80	1.71	20.45	13.66
HFC-125	983.10	9.84	33.35	22.28
HFC-134a	1878.00	95.24	63.71	42.56
HFC-143a	403.60	9.35	13.69	9.15
TOTAL	1989.5	116.14	131.2	87.65

	Croatia	Slovenia	population	GDP
	ton	ton	ton	ton
HFC-32	8.60	1.71	3.97	6.16
HFC-125	19.50	9.84	9.01	13.97
HFC-134a	239.60	95.24	110.74	171.65
HFC-143a	12.60	9.35	5.82	9.03
TOTAL	280.30	116.14	129.55	200.81

	Hungary	Slovenia	population	GDP
	ton	ton	ton	ton
HFC-32	15.90	1.71	3.24	5.92
HFC-125	82.70	9.84	16.88	30.77
HFC-134a	198.50	95.24	40.51	73.86
HFC-143a	72.50	9.35	14.79	26.98
TOTAL	369.60	116.14	75.42	137.53

5 SOLVENT AND OTHER PRODUCT USE (CRF sector 3)

5.1 Overview

Solvents and related compounds are important for air pollutants inventory as well as for greenhouse gas inventory because they are a significant source of emissions of non-methane volatile organic compounds (NMVOCs). NMVOC is regarded as an indirect greenhouse gas. The NMVOC emissions over a period of time in the atmosphere oxidise to CO_2. No other greenhouse gases are emitted in significant amounts from the use of solvents and related compounds. Solvents and related compounds include chemical cleaning substances used in dry cleaning, printing, metal degreasing, and a variety of industrial applications as well as household use. In this category are also included paints, lacquers, thinners and related materials used in coatings in a variety of industrial, commercial and household applications. This category also includes evaporative emissions of greenhouse gases arising from other types of product use, for example, N_2O emissions from medical use. For other sources, there is no suggested relevant methodology and data to calculate this type of emissions; consequently, this report includes only emissions from the consumption of N_2O.

5.2 Other products use

Key category - Base year: no
Key category - Year 2011: no

N_2O EMISSIONS

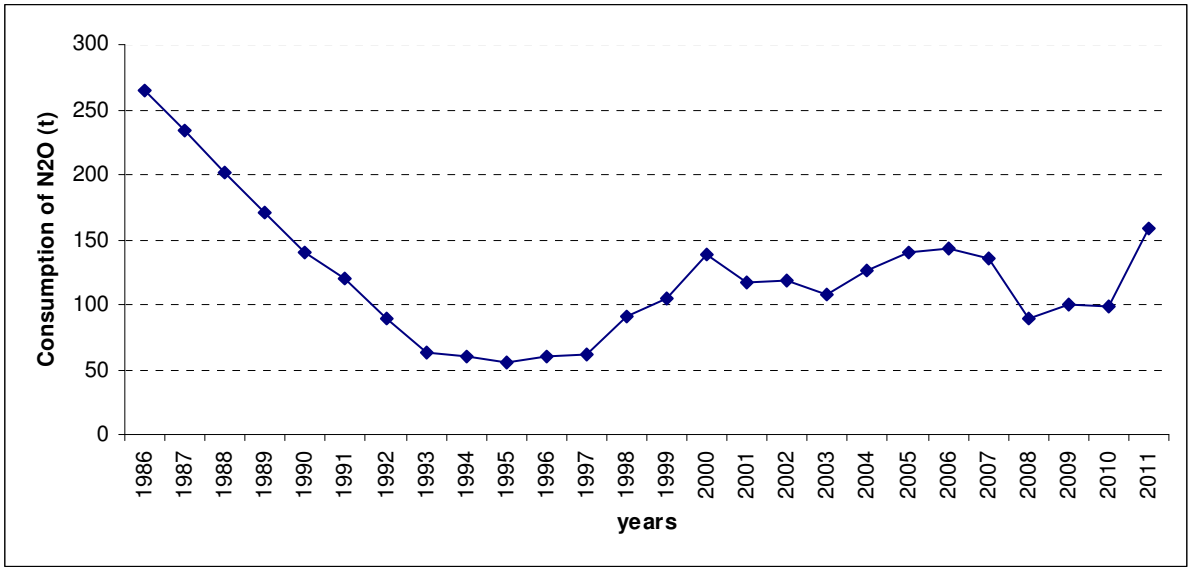


Figure 5.2.1: Consumption of N_2O.

This chapter presents N_2O emissions arising from the use of N_2O in the health service, and to a lesser extent also in food industry. Emissions of N_2O for the year 1986 and the period 1993 - 1998 have been estimated in the scope of research project done by the Chamber of Commerce and Industry of Slovenia. Data for the period 1987 – 1992 was estimated by nearest-neighbor interpolation method. Data required for emission calculation from 1999 onwards have been obtained

from the Statistical Office of the Republic of Slovenia. Consumption of N_2O has been calculated from data on import, export and production. There is no N_2O production in Slovenia since 1999. N_2O emissions are reported under 3.D.1.Use of N_2O for Anaesthesia.

5.2.1 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 50%.
Uncertainty of emission factor amounts to 20%

5.2.2 Recalculations

No recalculations have been performed for this category.

5.2.3 Source-specific planned improvements

No improvements are planned for this category.

6 AGRICULTURE (CRF sector 4)

In agricultural activities, emissions of GHGs are generated from a variety of different sources. This section includes the quantification of CH_4 emissions from enteric fermentation and manure management as well as N_2O emissions from manure management and emissions from agricultural soils (direct and indirect emissions and emissions from grazing animals).

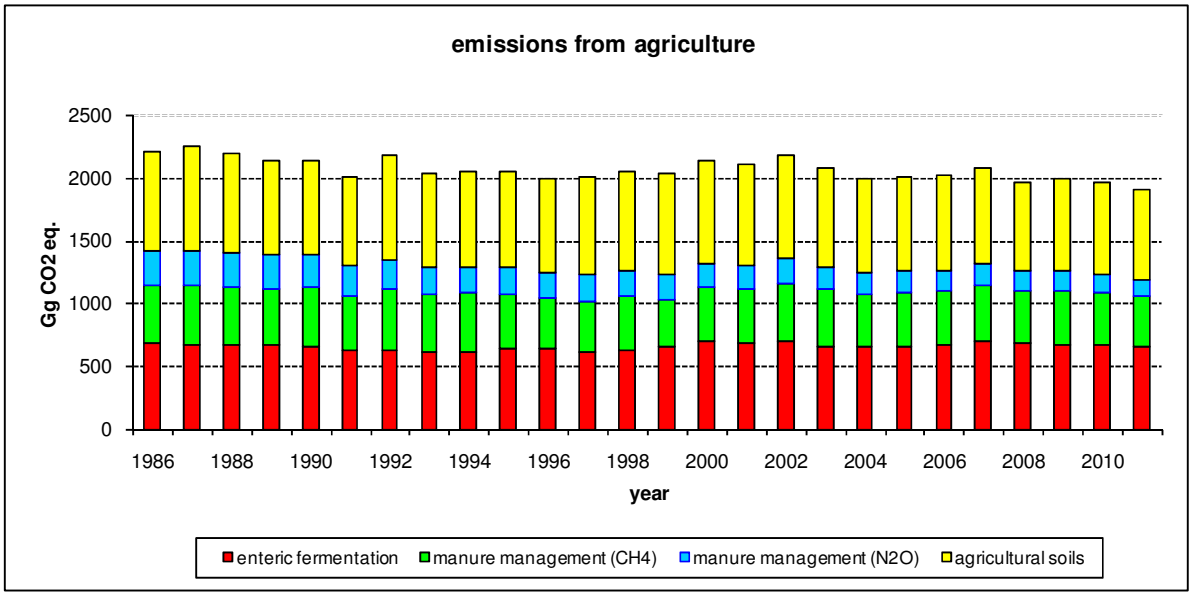


Figure 6.0.1: CH_4 and N_2O emissions from agriculture activities in Gg CO_2 eq.

Burning crop residues is not practiced in Slovenia, therefore emissions of greenhouse gases from this source have not been considered in this report (Verbič, Sušin, Podgoršek 1999, p. 9).There are no ecosystems in Slovenia that could be considered natural savannas or rice fields; consequently, no greenhouse gas emissions therefore exist for these sub-categories.

6.1 CH_4 Emissions from Enteric Fermentation

dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH_4	1.18		15
2011	Level	CH_4	0.69	0.21	19

non-dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH_4	0.81		23
2011	Level, Trend	CH_4	1.11	1.26	11

Swine, goats, horses, sheep Key category - Base year: no
Key category - Year 2011: no

6.1.1 Source category description

CH_4 emissions from enteric fermentation in animals result from methane being produced as a by-product of microbial fermentation in the digestive system. This process occurs especially in the rumen of ruminant animals, but also in smaller quantities in monogastric animals (swine, horses, birds and rabbits) where feedstuffs ferment in the large intestine. The estimates in this inventory include only emissions in farm animals. Emissions from wild animals and semi-domesticated game are not quantified and neither are emissions from humans or pet animals.

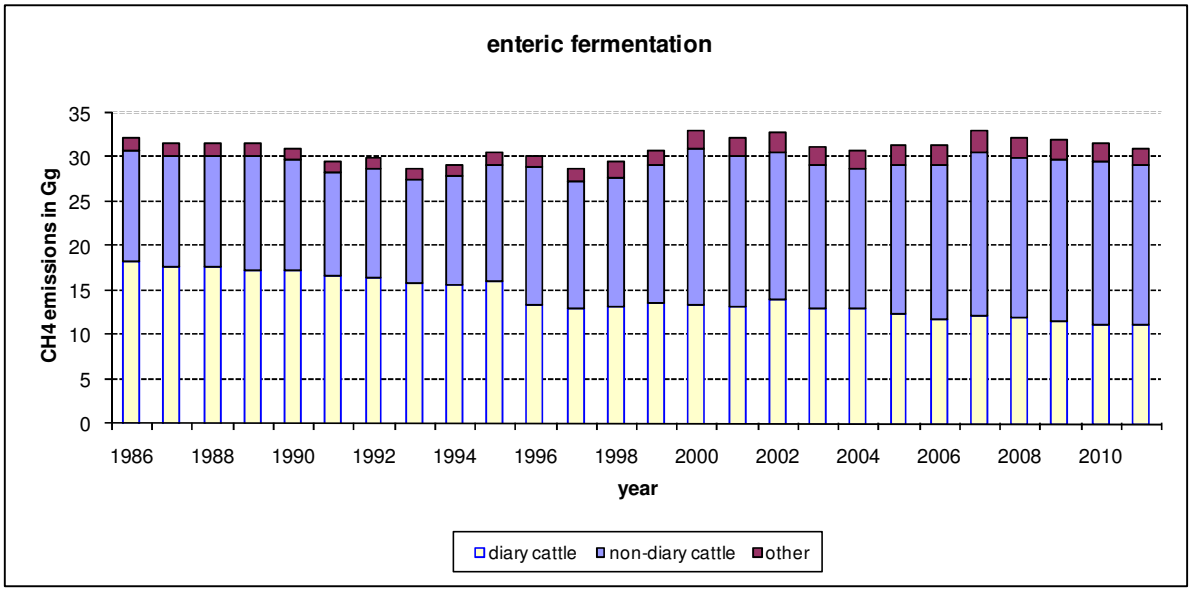


Figure 6.1.1: CH_4 emissions from enteric fermentation in Gg.

CH_4 emission from enteric fermentation is a key source, both by level and trend. Dairy cows and non-dairy cattle are significant sources: dairy cows represent 34% of total CH_4 emissions from enteric fermentation while non-dairy cattle represent about 53% of total CH_4 from enteric fermentation. Jointly, cattle are responsible for almost 87% of total CH_4 emissions from enteric fermentation. (Figure 6.1.1)

The contribution of all other animals to methane emissions from enteric fermentation, e.g. swine, sheep, horses, and goats, listed here according to the importance of their contribution, is a little more than 13%. No methodology for calculating CH_4 emission from poultry is available in IPCC guidelines.

6.1.2 Activity data and methodological issues

The majority of activity data were obtained from the Statistical Office of the Republic of Slovenia (SORS). They are also available on the web page:
http://www.stat.si/eng/index.asp
The agriculture statistics is on the SI-STAT data portal, under Environment and natural resources:
http://www.stat.si/pxweb/Database/Environment/Environment.asp

Some pieces of information, such as the number of calves per cow and year, the concentration of fat in milk for the period before the year 2000 and average daily gains in

fattening cattle, were obtained from Central database CATTLE that is managed by Agricultural Institute of Slovenia (reported by Božič et al., 2009 or calculated on request).

The detailed data about cattle are available in the Annex 3 to the NIR. In the category dairy cattle only dairy cows over 2 years have been included while non-dairy cattle consists of all other cattle groups. In the IPCC category non-dairy cattle the suckler-cows (named also other cows over 2 years) are treated differently due to the production of milk for calf. The correspondence between statistical and IPCC categories are evident from the table below:

IPCC	**SORS**
Dairy cattle	**dairy cows over 2 years**
Non-dairy cattle	**all other cattle**
other cows (suckler-cows)	other cows over 2 years
other non-dairy cattle	**YOUNG CATTLE – under 1 year** calves for slaughter- young bulls calves for slaughter - young heifers calves for fattening - young bulls calves for fattening - young heifers **YOUNG CATTLE – 1 -2 years** breeding heifers in calf other breeding heifers heifers for fattening bulls, oxen **CATTLE – over 2 years** breeding heifers in calf other breeding heifers heifers for fattening bulls for breeding bulls and oxen for fattening

Before 1997, SORS collected data on the number of livestock by ownership and as of December 31. Data on livestock in agricultural enterprises were collected and reported in the Annual Report on Livestock Production while data on livestock on family farms were collected in the Sample Survey on the Number of Livestock. Data on the number of livestock on family farms as of December 31, 1991 were estimated on the basis of the 1991 Census of Population, Households, Housing, and Agricultural Holdings. Some data on the number of livestock were taken from other administrative sources (Secretariat for Agriculture, Forestry and Food).

In 1997, SORS started collecting data on the number of livestock several times a year: data on the number of pigs were collected three times a year (April 1, August 1, and December 1), data on cattle twice a year (June 1 and December 1) and data on sheep and goats once a year (December 1). Data on family farms and agricultural enterprises were collected by mail, separately for cattle, pigs, sheep, and goats. All agricultural enterprises were covered, but only those family farms that were selected in the sample. In 1997, the date of monitoring the number of animals changed: because of the harmonisation with EU standards, we no longer collect these data as of December 31, but as of December 1. Data on animal output up to 1997 are therefore not entirely comparable with data since 1997.

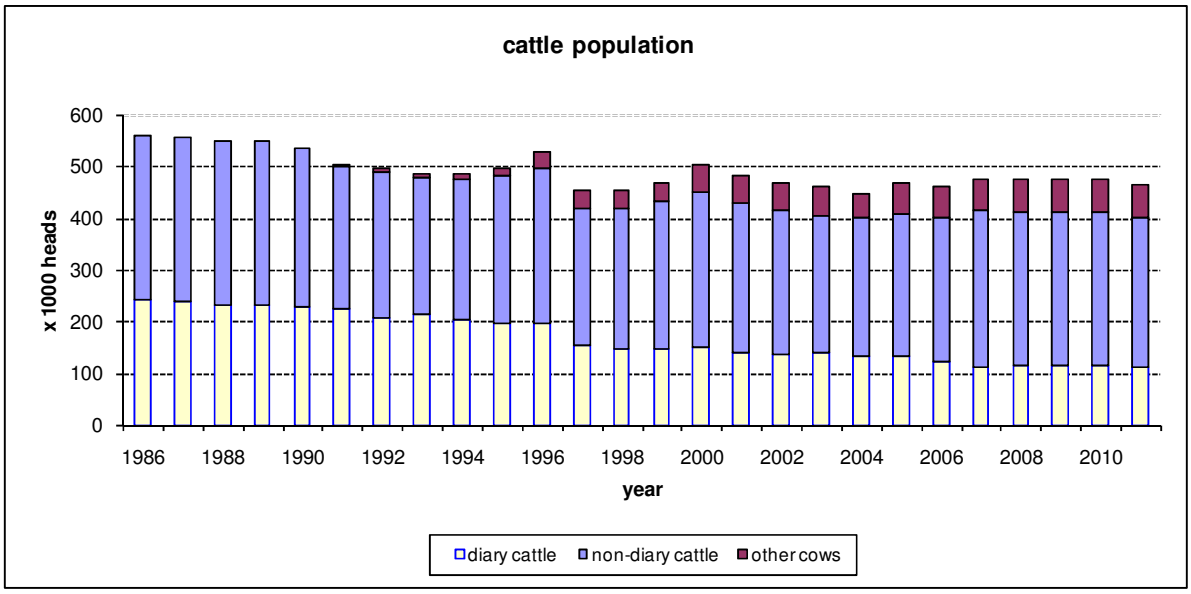


Figure 6.1.2: Number of cattle, diary and non-diary in thousands.

Since 2000, SORS has been collecting data on the number of livestock twice a year (June 1 and December 1) for cattle and pigs, and once a year (December 1) for sheep and goats, and poultry. To facilitate presentation of data on the structure of agricultural holdings, the number of animals is shown by where they are stabled and not by ownership as was the case until 2000. In the December 2002 survey, the data on the number of animals were collected with fieldwork and not by mail; this accounts for some differences between the individual periods.

In 2003, SORS has published revised data on livestock numbers and production for the period 1991-2002. These data have been published in Rapid Reports No. 256. The main purpose of that revision was the methodological harmonisation of data and methods of estimating data for the mentioned period. This methodology is harmonised with recommendations of the Statistical Office of the European Communities.

Corrections refer to livestock number and production, while the data on total number of animals did not change. Not all published data have been revised. Some remained the same. Explanations of corrections are therefore valid only for the revised data. Data were revised on the basis of the 2000 Census of Agriculture.

Explanations of corrections were divided into two parts: number of livestock and livestock production. Data on cattle, pigs, poultry and sheep and goats were mostly revised in the same way. Differences appear because of particularities of individual species, the previous method of data collection for individual species of domestic animals and the quality of collected data.

In all monitored years, data on the total number of animals were obtained with statistical surveys and have not been corrected, but changes have been made to the year that data refer to. Before 1997, each year data about animal population were collected on December 31 and in the past have been applied to the next year, but now SORS considers these data to be valid for the current year. Because SORS did this only for data from 1991 (the year Slovenia became an independent state), we have to change all data prior to 1991 in the same way by ourselves.

But discrepancies with FAO data still exist. In the FAO database, livestock numbers have been grouped in 12-month periods, ending on September 30 of the year stated in the tables. Our Statistical Office collects data on animal population in December and reports them in the current year. In the FAO database, these data are applied to the next year. Considering this explanation, all data on animals in the FAO database and in our statistical database are the same. The only difference is in the number of poultry, where our entire poultry population is shown in the FAO database as chicken population.

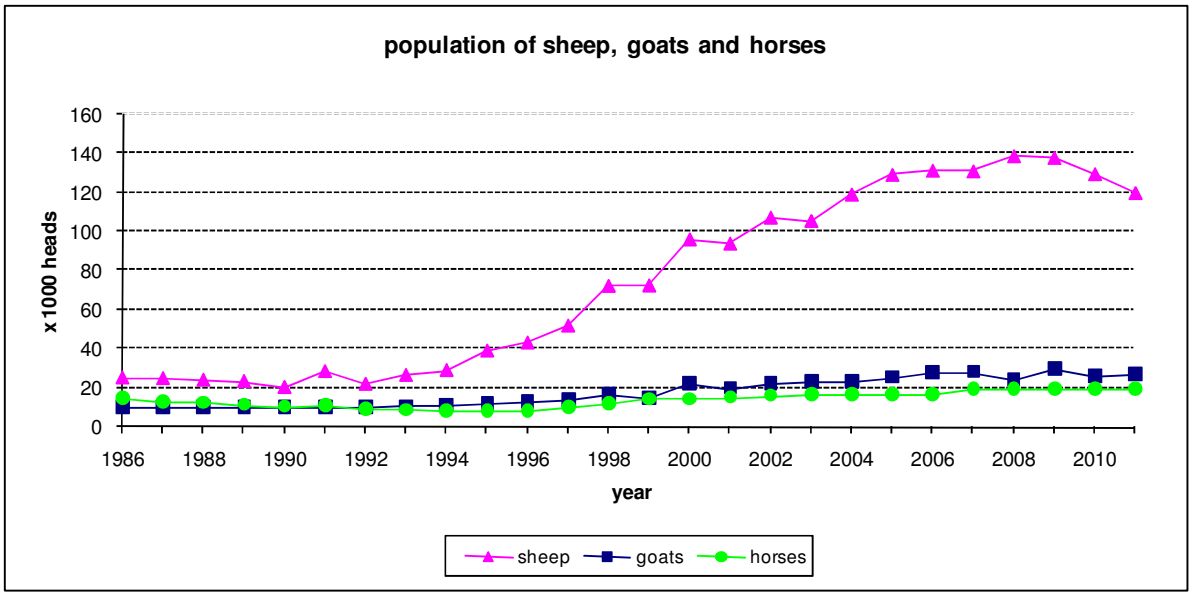


Figure 6.1.3: Number of sheep, goats and horses in thousands.

IPCC methodology provides two different methods for estimating the quantity of methane from enteric fermentation. A more detailed method (Tier 2) for calculating emissions is used for cattle because of the comparatively large population and considerable emission per head and the default methodology (Tier 1) is used for other animals.

6.1.2.1 Dairy Cattle

The method for estimation of emissions due to enteric fermentation is based on data on dairy cow population (Figure 6.1.2) and their productivity expressed in terms of milk production per year (Figure 6.1.4). IPCC (1996) methodology was used taking into account the local production practices.

In the first step, net energy requirements for the maintenance, milk production and pregnancy were estimated. Maintenance requirements were calculated on the basis of animal weight. It was supposed that animals producing more milk were heavier than those producing less milk. The relation W = 418.8 + 0.0313 × M was used for the estimation of body weight (W, in kg). M in the equation is milk production in standard lactation (kg in 305 days). In case of grazing, additional energy required for animals to obtain their food was added up (17 % of maintenance requirements). Requirements for milk production were estimated on the basis of milk production and milk fat content. Requirements for pregnancy were calculated according to IPCC (1996). Calf birth weight was estimated on the basis of cow weight. In order to express the requirements for pregnancy on a yearly basis (365 days) the obtained values were multiplied by the number of calves per cow and year.
In the second step the gross energy intake was estimated on the basis of net energy requirements that were estimated during the first step. To do this, the information on the

concentration of net energy for lactation in diets is needed. It is the most critical point of the whole procedure. Overestimation of the net energy concentration in the diet would result in underestimation of gross energy intake and vice versa. It may considerably affect the final result. The concentration of the net energy for lactation depends mainly on its concentration in the basal diet and on the proportion of concentrates in the diet. The latter depends largely on daily milk production and intake capacity of a dairy cow. Therefore, it was decided to use country specific data at this stage. Based on data from milk recording (the monitoring service performs monthly measurements of the milk yield of every individual cow) a total of 705.860 lactation curves were calculated for the period between 01.01.2000 and 01.06.2009. On the basis of the results, typical lactation curves for the range between 3500 and 12000 kg of milk in standard lactation were calculated for the intervals of 500 kg. Expected daily milk yields (for each individual day in lactation) were calculated for all these classes.

Based on daily milk yields and assumed concentrations of net energy for lactation in basal diet, the required proportions of concentrates in diets were estimated roughly. The equation for total mixed ratios presented by Spiekers (2004) was used. The rough estimates of the amount of concentrates in the diets enabled the use of more precise equation for prediction of dry matter intake (Gruber et al., 2006). Various parameters, such as breed, day of lactation, body weight, daily milk production in dependence on day of lactation, amount of concentrates, and the concentration of net energy for lactation in the basal diet were used to predict dry matter intake for each individual day within each individual production class.

On the basis of forage quality in Slovenia it was estimated that with the increasing milk yield from 3500 to 8000 kg per standard lactation the concentration of net energy for lactation in the basal diet increased from 5.4 to 6.4 MJ per kg dry matter and remained on the same level at higher milk yields. It was also assumed that with increasing milk yields the concentrations of net energy for lactation in concentrates increased from 7.6 to 8.2 MJ per kg of dry matter. The concentration of net energy for lactation in the diet was calculated as a quotient between the animal requirements for maintenance, milk production and pregnancy on the one hand and potential dry matter intake on another. National feeding standards (Verbič and Babnik, 1999) were used to assess the requirements. The average concentration of net energy for lactation in the diet was obtained by averaging the daily values over the whole lactation and dry period. Information on the concentration of net energy for lactation was then transformed to organic matter digestibility (dOM) by the use of equation

$$\text{dOM} = 24.12 + \text{net energy for lactation} \times 7.9.$$

The equation was derived on the basis of wide range of forages, cereals and oil seed meals presented in DLG Feeding Tables (DLG, 1997). Energy digestibility (DE%) was estimated as

$$\text{DE\%} = \text{dOM} - 3.1.$$

The relation was obtained on the basis of equations presented by INRA (1989) taken into account that diets are composed from grassland forages, maize silage and cereals. Finally, the gross energy intake (GE) was calculated as:

$$GE = \frac{sum\ of\ \ net\ energy\ requirements \div (NE / DE)}{DE\%}.$$

The ratio NE/DE was calculated as suggested by IPCC (1996).
Emission factor was calculated from data on gross energy intake (GE) and methane conversion rate (Y_m) according to IPCC (1996):

Emissions (kg/animal/year) = GE (MJ/year) × Y_m ÷ 55.65 MJ/ kg of methane

For methane conversion rate (Y_m) the value of 0.06 was used, as recommended by IPCC.

Table 6.1.1: Milk yield and EFs for dairy cattle.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Milk yield kg/head/year	2817	2763	2772	2795	2775	3252	2835	2800	3014
EF kg/head/year	76.9	76.4	76.5	76.7	76.6	81,0	77.5	77.4	79.5
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Milk yield kg/head/year	3831	3975	4091	4252	4625	4807	5198	5062	3831
EF kg/head/year	87.2	88.6	89.8	91.4	95.1	96.8	100.2	99.1	87.2
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Milk yield kg/head/year	4853	5479	5708	5726	5764	5531	5517	5517	
EF kg/head/year	97.4	102.6	104.0	104.4	104.8	102.8	102.8	102.9	

Emission factor for methane released from enteric fermentation depends mainly on the level of milk production. By the increase of annual milk production from 3000 to 5000 kg of milk per cow the emissions increase from about 80 to 98 kg of methane per year. Average milk production per cow was doubled during the period 1986 – 2010. The increase was mainly due to transition to open market economy and was accompanied by specialization of dairy sector. The proportion of concentrates in the diets for dairy cows increased and dual purpose Simmental and Brown Swiss cows were in part replaced by cows of specialized Holstein-Frisian breed.

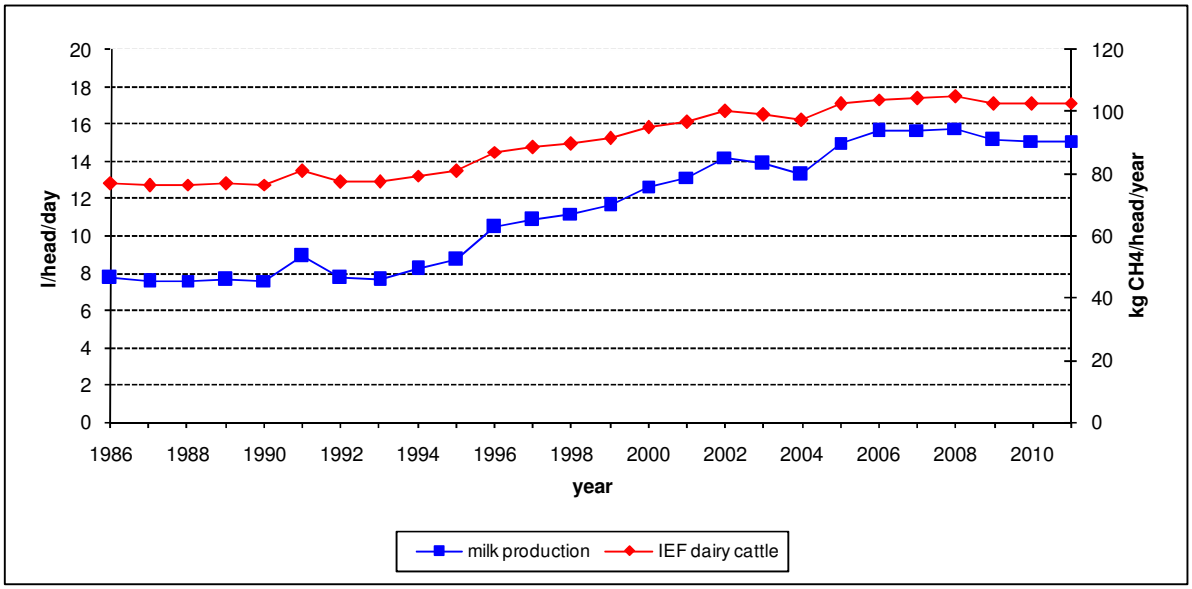


Figure 6.1.4: Milk production per cow in l milk/head/day and IEF in kg CH4/head/year.

The increase in IEF for dairy cattle is due to the increase in the milk yield. In 2010 the CS EF was slightly higher than IPCC EF for dairy cattle for Western Europe (100 kg/head/year) and considerably higher than EF for Eastern Europe (81 kg/head/year). While agriculture sector in Slovenia is more similar to the systems in the countries from West Europe the CS EF of 102.9 kg/head/year seams very reasonable.

6.1.2.2 Non-dairy cattle

This group comprises young cattle (cattle for fattening, breeding heifers), suckler-cows and sires (breeding bulls). This group is much more homogeneous as to the intensity of production than the dairy-cattle group. Data on the number of head of non-dairy cattle according to different categories are reported by the Statistical Office (Figure 6.1.2).

Methane emissions of growing cattle depend on their weight and daily weight gain. For 1986 it was assumed that the weight gain of growing heifers from their sixth month of age to first mating period was 600 g per day, and that of pregnant heifers 500 g per day. The remaining total weight gain of cattle in Slovenia (according to the Statistical Office) was been equally distributed across other growing categories of cattle and thus the average daily weight gain for young bovine animals for fattening was determined. Net energy requirements were calculated according to equations laid down by IPCC (1996). They were calculated for individual categories and then converted into gross energy intake. For breeding heifers, the energy that is needed for pregnancy was also taken into account.

To transform net energy requirements into gross energy the estimated energy digestibilities were needed. Equations to predict the energy digestibilities for individual categories were estimated on the basis national feeding standards (Verbič and Babnik, 1999) and the expected feed intake was estimated according to Kirchgeßner et al. (2008). In the first step the required concentrations of the metabolisable energy were assessed. In the second step they were converted into organic matter digestibility (dOM) by the use of equation

$$dOM = 13.95 + \text{concentration of metabolisable energy} \times 5.74.$$

The equation was derived on the basis of wide range of forages, cereals and oil seed meals presented in DLG Feeding Tables (DLG, 1997). Then it was converted into energy digestibility (DE%) using the same conversion factor as described for dairy cattle. The following equations for predicting average energy digestibility (DE%) were derived on the basis of the above mentioned procedure:

Cattle for fattening $DE\% = 57.2 + 13.72 \times \text{daily weight gain (g)}$

Breeding heifers $DE\% = 54.9 + 16.28 \times \text{daily weight gain (g)}$

For breeding bulls it was estimated that energy digestibility of the diet was 60.6%. The value was derived on the basis of requirements and expected dry matter intake as summarized by Kirchgeßner et al. (2008) using the same procedure as for fattening cattle and heifers.

Since 2005, more precise average daily gains for young bovine animals for fattening have been obtained. They were calculated on the basis of data on slaughtering date and carcass weight from slaughter houses and on the basis of birth dates of individual animals which were recorded in the Central database CATTLE (Verbič and Jeretina, 2009, unpublished). It was found that the average daily gain in fattening animals increased from 714 g in 1986 to 840 g in 2005. Average daily gains between 1986 and 2005 were estimated by

interpolation. For the period 2006-2010, average daily gains on a yearly basis were used for calculations. For breeding heifers the same daily gains as for 1986 were taken into account. Due to higher daily gains the required energy digestibility for fattening animals was also increased from 67.0 % in 1986 to 68.6 % in 2010.

Emissions were estimated on the basis of IPCC methodology as described for dairy cows (methane conversion factor 0.06).

Since in younger animals the rumen does not function normally yet, calves up to the age of 3 months were not considered. Until 2000, in calculating methane emissions, only ½ of the category of calves of up to 6 months and after 2000, only ¾ of young bovine animals up to 1 year were considered. The modification of calculation is due to slight change in the manner of official presentation as to the age structure; previously, calves under the age of 6 months were presented separately while now they are all presented in the up to 1 year group.

Table 6.1.2: EFs for non-dairy cattle.

EF kg/head/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Other cows	NA	NA	NA	NA	NA	80.5	80.5	80.5	80.5
Other cattle	39.3	39.6	40.0	40.3	40.7	41.0	41.4	41.7	42.1
Non-dairy c.	**39.3**	**39.6**	**40.0**	**40.3**	**40.7**	**41.8**	**42.2**	**42.9**	**43.5**
EF kg/head/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Other cows	80.5	80.5	80.5	80.5	80.5	80.5	80.5	80.5	80.5
Other cattle	42.4	42.8	43.1	43.5	43.8	44.2	44.6	43.9	44.3
Non-dairy c.	**44.4**	**46.4**	**47.5**	**47.7**	**48.0**	**49.7**	**50.2**	**50.0**	**50.6**
EF kg/head/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Other cows	80.5	80.5	80.5	80.5	80.5	80.5	80.5	80.5	
Other cattle	43.9	44.4	44.8	44.9	44.6	44.4	44.5	44.4	
Non-dairy c.	**49.4**	**50.6**	**51.1**	**50.9**	**50.9**	**50.5**	**50.8**	**50.7**	

After 1990, the non dairy cattle category also includes suckler-cows. Statistical Office of the Republic of Slovenia differentiates between dairy cows and suckler-cows from the year 1996; the figure for the year 1995 is based on the number of premiums paid for suckler-cows and for the years 1991-1994 the numbers were estimated by an expert (Volk, personal communication). For suckler-cows it was considered that the amount of emitted methane was equal to the amount attributed to dairy cows with 3000 kg of milk per lactation, i.e. 80.5 kg per cow per year. Based on the report by Božič et al. (2009) it was taken into account that suckler-cows gave birth to 0.91 calf per year on average.

6.1.2.3 Sheep and Goats

The Statistical Office of the Republic of Slovenia has recently changed its methodology of estimating the population of sheep, and started to publish data on the number of goats (Statistical Information, No. 197, 1998), data that so far have not been published in the Statistical Yearbook. For breeding sheep, re-established data from 1992 to 1997 are available. The total number of sheep (Figure 1.6.3) has been estimated on the basis of data on breeding sheep for the period 1992 to 1997 by applying the interacting ratio between breeding sheep and all sheep in 1997. For the time prior to 1992, the numbers

from old statistical yearbook have been taken. The number of goats (Figure 1.6.3) has been estimated in the same way as the number of sheep. As goats have not been count before 1992 we consider the number of 10.000 heads as an estimate.

Considering the rather small number of sheep and goats, coefficients from the IPCC method have been used for estimating methane emissions; 8 kg of methane annually per head for sheep, 5 kg of methane for goats (Verbič, Sušin, Podgoršek 1999, p. 6)

6.1.2.4 Horses

The number of horses (Figure 6.1.3) has been taken from the Statistical Yearbook, methane emissions have been estimated by applying generic emission factors according to IPCC methodology 18 kg per year (Verbič, Sušin, Podgoršek 1999, p. 6).

6.1.2.5 Swine

The number of swine (Figure 6.1.5) has been taken from the Statistical Yearbook, methane emissions have been estimated by applying default emission factors according to IPCC methodology 1.5 kg per year.

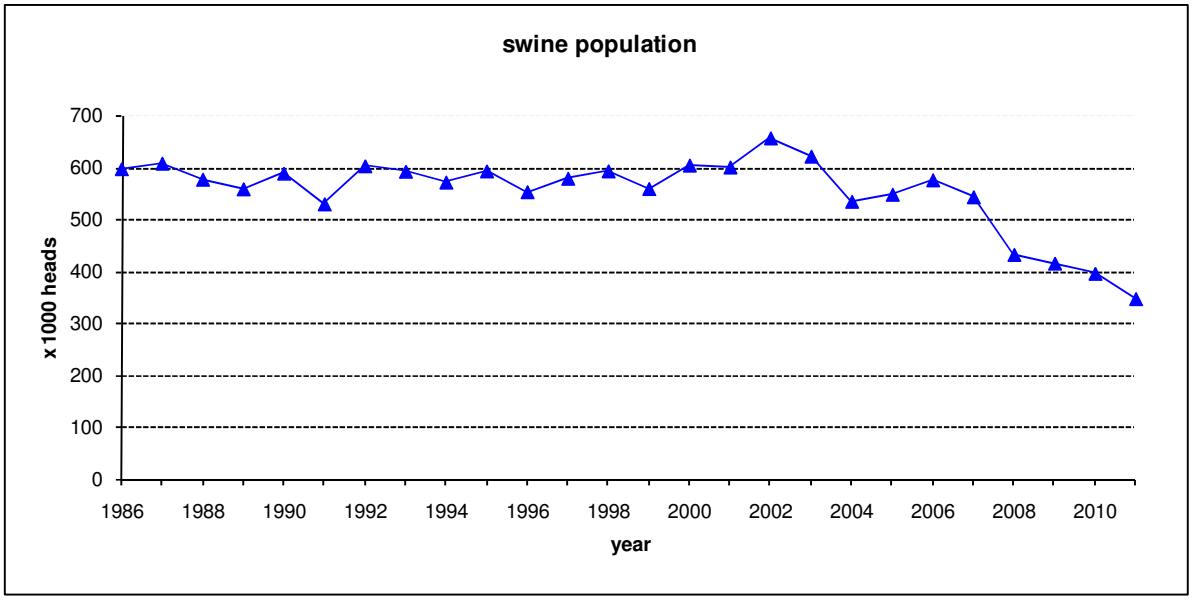


Figure 6.1.5: Number of swine in thousands.

6.1.3 Uncertainties and time-series consistency

Data on the number of livestock are not collected by ownership of the livestock but by who manages the livestock. The sample for the statistical survey on the number of livestock is selected according to the sampling methodology. Data collected with the sample are representative for the entire country. The sample is divided into four strata; each of them is determined regarding the size class of agricultural holding. The sample thus covers all large agricultural holdings, while other agricultural holdings are selected proportional to size

class and in their size class represent a specific weight. Based on information from SORS the uncertainty of activity data is 10%.

According to the IPCC GPG the uncertainty of the EFs when using default methodology is at least 30% but could be as high as 50%. When Tier 2 methodology is used the uncertainty is likely to be in order of 20%. As most emissions in this category are estimated using Tier 2 methodology uncertainty estimate of 20% have been used based on expert judgement.

The combined uncertainty, calculated according to IPCC GPG Tier 1 methodology amounts to 22.36%.

6.1.4 Source-specific recalculations

Following recommendations from 2012 technical review of the greenhouse gas emission inventory conducted by EU emissions have been recalculated in category 4.A.8 Swine for the entire period 1986-2010.

In the previous submissions Slovenia was using a modified tier 1 default method for CH4 emission from enteric fermentation from pigs on commercial farms and an increased value for private farms assuming that pigs on private farms are larger than those on commercial farms giving an approximate EF of 2.3 kg CH_4/head/yr compared to the default value of 1.5 kg CH_4/head/yr. The TERT noted that the tier 1 default CH4 parameters assume a conservative estimate covering an average of all slaughter weights in a country and that Slovenia cannot apply the default to a subset (the commercial farms only) without justification that these represent a similar average of slaughter weights.

For this reason the CH4 emissions from enteric fermentation of swine have been recalculated for the period 1986-2010 using IPCC default EF of 1.5 kg CH_4/head/yr.

Very minor recalculations have been performed also for category non-dairy cattle in 2010 due to the updated value on slaughter weight.

6.1.5 Future improvements

No improvement is planned for the future.

6.2 CH_4 Emissions from Manure Management

dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH_4	0.47		28
2011	Level	CH_4	0.39	0.28	26

non-dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CH_4	0.20		38
2011	Level, Trend	CH_4	0.48	0.68	24

swine	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH_4	0.70		25
2011	no	CH_4	0.30	0.08	31

goats, horses, sheep, poultry Key sector - Base year: no
Key sector - Year 2011: no

6.2.1 Source category description

In storing solid and/or liquid manure, both methane and N_2O are emitted. Emissions depend largely on the type of manure storage. Methane arises in significantly larger amounts when manure is managed as slurry, while N_2O prevails in storage of solid manure.

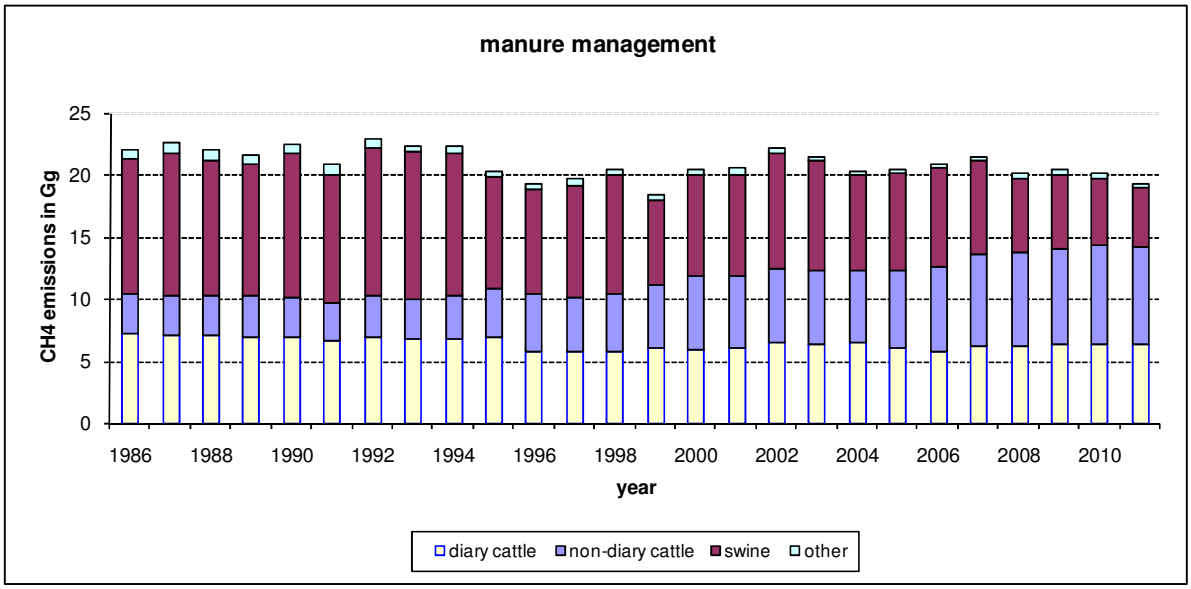


Figure 6.2.1: CH_4 emissions from manure management in Gg.

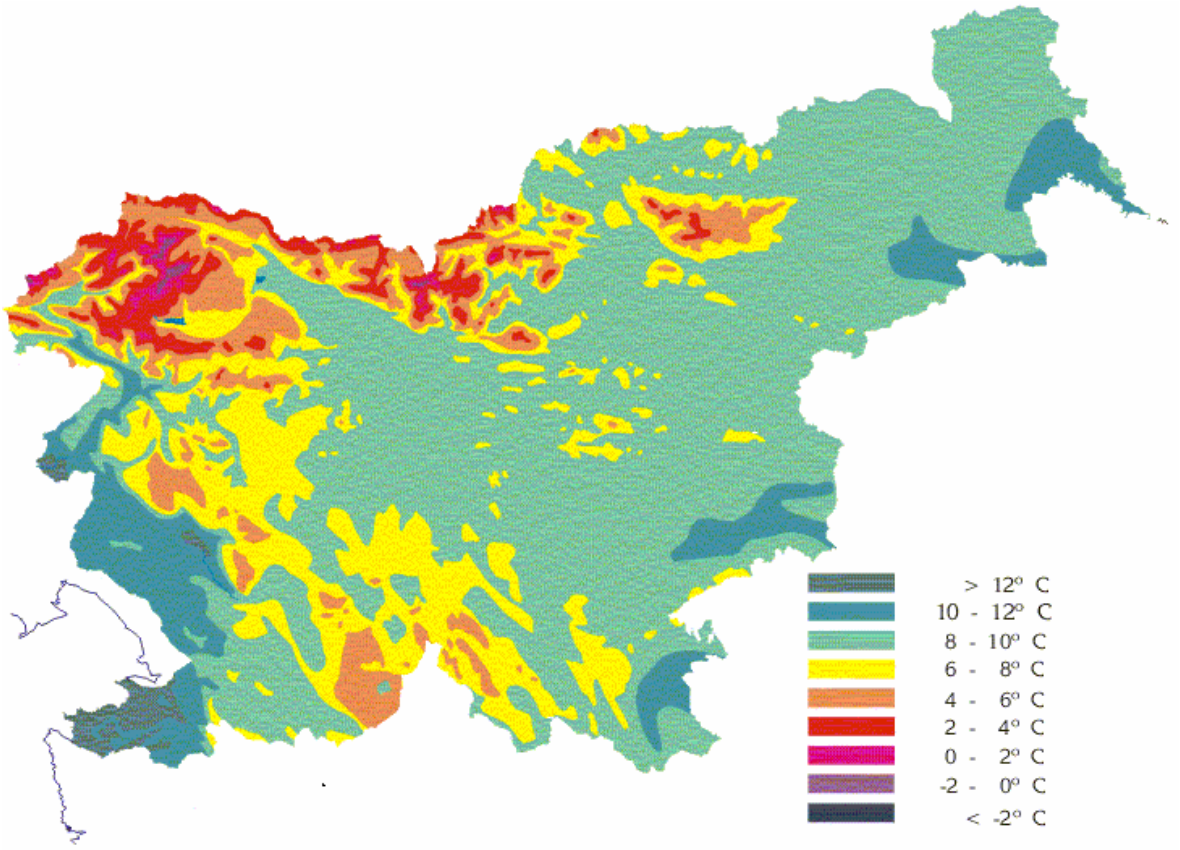


Figure 6.2.2: The average yearly temperature in Slovenia.
(http://www.arso.gov.si/podro~cja/vreme_in_podnebje/napovedi_in_podatki/temperaturna_karta.html)

Significant quantities of methane are emitted during the decomposition of animal excreta. Under anaerobic conditions, methane-producing bacteria convert organic matter into methane. The quantities of produced methane are largely dependent on the type of manure management system and environment temperature. Storing manure in lagoons or as slurry produces significantly greater quantities of methane compared to grazing on pasture or solid manure storage.

To estimate the amount of methane produced during manure management (Figure 6.2.1), it is necessary to know the quantities of excreted volatile solids (VS), methane-producing capacity of manure (B_0, in m^3 per kg of VS), and the manner of manure management (Verbič, Sušin, Podgoršek 1999, p. 7). The climate in Slovenia is cool (average yearly temperature is bellow 15°C for the whole area, Figure 6.2.2).

6.2.2 Methodological issues

6.2.2.1 Cattle

The annual quantities of volatile solids excreted via faeces were estimated by means of data gathered while estimating the extent of enteric fermentation. The equation that was laid down by IPCC (1996) was applied. Through intake of gross energy, the amount of volatile solids is directly linked to the production intensity (to milk production or daily weight gain).

VS (kg/day) = gross energy intake (MJ/day) x (1 kg/18.45 MJ) x (1 - DE%/100) x (1-ash%/100)

For dairy cows the amount of VS increased from 3.69 kg per day and animal in 1986 to 4.30 kg in 2009. For non-dairy cattle the corresponding values increased from 1.68 to 2.34 kg per day and animal.

The annual emitted amount of methane ($E_{M\ MANURE}$) was estimated according to the equation:

$$E_{M\ MANURE} = VS\ (kg/day) \times 365\ days/year \times B_0\ (m^3/kg\ VS) \times 0.67\ kg/m^3 \times MCF$$

As for the methane producing capacity of manure B_0 for dairy cows, the value of 0.24 m^3/kg VS was considered, for other bovine animals it was 0.17 m^3/kg VS (IPCC, 1996). The methane conversion factor MCF, which tells us what fraction of methane producing capacity of manure is actually used, was calculated on the basis of fractions of individual types of manure storage and partial manure conversion factors for cool climate, which were found in appropriate tables (IPCC, 2000). Methane conversion factors 0.39, 0.01 and 0.01 were used for liquid manure storage, solid manure storage and grazing, respectively.

The fraction of individual manure management systems was estimated on the basis of the results of farm census data from 1991 and 2000. Since manure management systems were not reported in the census, data on size and structure of cattle-breeding farms were used for rough estimates. It was considered that all farms with less than 10 head of bovine animals had solid manure storage systems, that 30% of farms with 10-19 head of animals practiced liquid manure storage and 70% of them solid manure storage, and that all farms with 20 cows or more had liquid manure storage systems. Linear regression was used to estimate the changes in manure management systems in the period 1990-2000. After 2000, data on farm size and structure were reported by the Statistical Office for the years 2003, 2005 and 2007. For the years with missing values the proportions of various manure storage systems were obtained by interpolation. In 2005, the estimates that were based on farm structure were tested using the information on manure management that was collected in the frame of milk recording service on a large number of dairy farms (Babnik and Verbič, 2007; about 70% of total dairy cows were covered). Based on farm structure it was estimated that 55.6% of dairy cows were kept on liquid systems (if grazing is not taken into account). The corresponding value based on farm questionnaires was only slightly lower (53.2%). It proves that the estimates based on farm structure can be considered as reliable. 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 2000-2010. 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.

Data on the number of livestock were the same as those used for calculating methane emissions from enteric fermentation.

After performing the Tier 2 QA/QC procedures we have found out that the CH4 IEF for dairy cattle is the highest of reporting parties. After performing standard checks no mistakes have been found in the calculation. When comparing all parameters used we come to the conclusion that the reason for high value is combination of use 39% for MCF and nearly 50% for allocation of manure in the liquid system. Other countries which use the same MCF do not have as large percentage of liquid system (e.g.: Austria 24%) and countries with similar allocation of slurry do not use MCF 39%. (e.g.: Germany uses MCF 10%). As default MCFs for cool climate and liquid systems are much lower in 2006 Guidelines maybe the use of 39%, what is suggested in GPG is not appropriate any more. Especially, because we have found only 4 more countries having cool climate and reported use of MCF as 39% in the CRF tables.

Table 6.2.1: EFs for cattle.

EF kg/head/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Dairy cattle	30.6	30.5	30.5	30.5	30.5	32.2	32.2	32.9	34.1
Non-dairy c.	9.9	10.0	10.2	10.3	10.4	11.1	11.5	12.0	12.5
EF kg/head/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Dairy cattle	35.3	37.3	38.4	39.5	40.6	42.3	44.3	46.6	48.0
Non-dairy c.	13.1	14.1	14.8	15.2	15.6	16.6	17.3	17.9	18.8
EF kg/head/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**1012**
Dairy cattle	48.1	49.7	51.4	53.2	54.9	55.9	57.5	57.5	
Non-dairy c.	18.5	19.0	19.8	20.3	21.0	21.5	22.2	22.2	

Based on “encouragement” from AAR 2010 we have investigated which MCF from IPCC 2006 guidelines is the most appropriate. Since liquid-base systems has the biggest influence on EF and is also very sensitive to temperature effects, we have decided taking into account only MCF for liquid systems. The average temperature of Slovenian lowlands is approximately 12 degrees Celsius and MCF for Liquid manure without natural crust cover is 20% (IPCC 2006). The MCF for liquid manure with natural crust cover is even lover (13%). The IEFs for dairy cattle calculated with both MCF of 39% and 20% are presented in the table 6.2.2.

Table 6.2.2: EFs for dairy cattle (MCF 39%) and (MCF 20%)

EF kg/head/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
MCF 39%	30.6	30.5	30.5	30.5	30.5	32.2	32.2	32.9	34.1
MCF 20%	16.4	16.3	16.3	16.3	16.3	17.2	17.2	17.5	16.4
EF kg/head/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
MCF 39%	35.3	37.3	38.4	39.5	40.6	42.3	44.3	46.6	48.0
MCF 20%	18.2	18.7	19.8	20.4	20.9	21.5	22.4	23.4	24.5
EF kg/head/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**1012**
MCF 39%	48.1	49.7	51.4	53.2	54.9	55.9	57.5	57.5	
MCF 20%	25.3	26.1	27.0	27.9	28.7	29.2	30.0	30.0	

Although the EFs when using MCF from IPCC 2006 seems more appropriate for cool climate we decided to not use it for the GHG inventory until IPCC 2006 guidelines would be accepted as official manual for GHG inventories. We also believe that because our base year emissions have been calculated with MCF 39% it is more appropriate that we continue using this value until the end of the Kyoto period.

6.2.2.2 Swine

Activity data
The population of swine (Figure 6.2.3) is divided into three segments:
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. Thereafter, 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 farms. 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 kept 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. From the year 1986 to year 2000, the fraction of pigs in small scale family farm production has kept diminishing. 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 years 2008 and 2009 the estimate was done by extrapolation of values for 2006 and 2007. Further decrease of pigs on farms that kept less than 10 pigs was observed during the period 2000-2011.

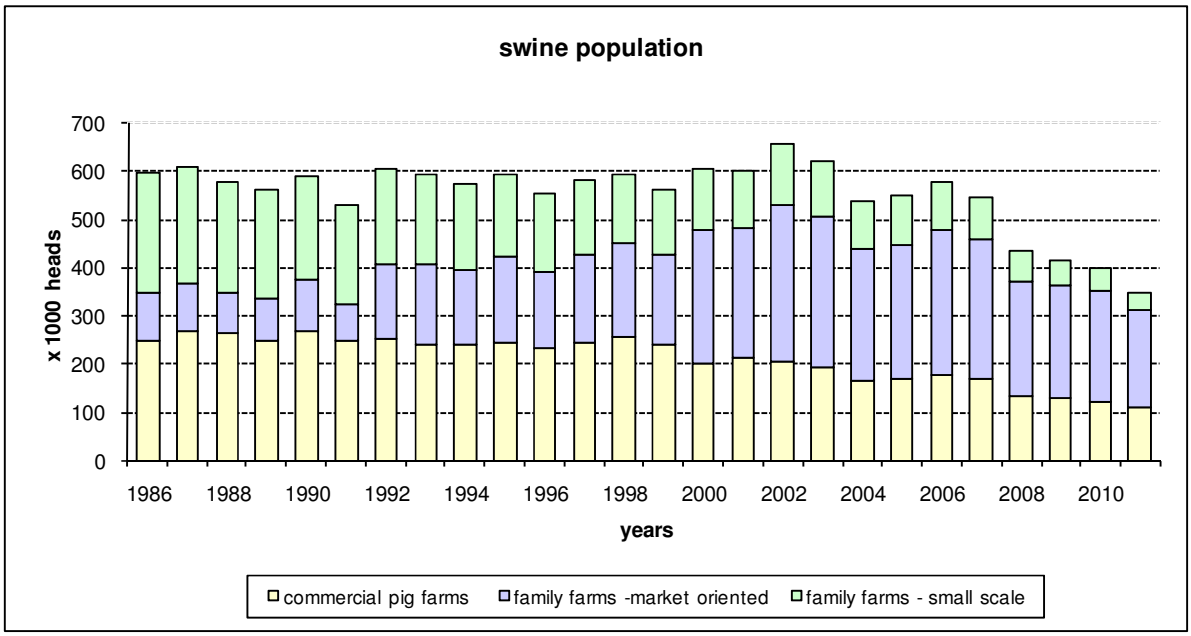


Figure 6.2.3: Number of swine in thousands.

Emission factor

Annual emissions of methane ($E_{M\ MANURE}$) have been estimated according to the IPCC method. Quantities of excreted volatile solids (VS) have been calculated using default value of 0.5 kg of VS/day (IPCC, 1996). For the methane-producing capacity of manure B_0, the value for swine (0.45 m^3/kg VS; IPCC, 1996) has been applied. The average manure conversion factor (MCF) has been estimated with regard to the type of manure management system and partial manure conversion factors that had been laid down for various systems by IPCC (2000). In doing so, the following has been taken into account.

Commercial Pig Farms
From 1985 to 1994 – using old-style separators on commercial farms, app. 20% of organic matter was separated from liquid manure. For this portion, the partial MCF for solid manure (0.01) has been taken into account. The remainder (80%) has been disaggregated into lagoons (75%) and liquid manure (25%), taking into account a MCF as suggested by IPCC (2000). The division into lagoons and liquid manure is founded on actual estimates of the extent of production on commercial farms, where the liquid portion of manure after separation is applied to fields and grassland. Considering the ratio between solid phase and liquid manure, which was either led into lagoons or used for fertilization, the average MCF = 0.62 has been calculated.

The time from 1995 to 1999 was a period of introducing new separators and the beginning of operation of an anaerobic digester in the Farm Ihan. Introducing new separators on commercial farms increased the estimated portion of separated solid phase to 40%. Since the construction of a new wastewater treatment plant in Farm Ihan, it has been considered that on that commercial farm the mechanic separation separated 80% of VS while the remainder (20%) was captured as biogas. For large commercial farms, it is generally considered that the ratio between the liquid part, which flows off to lagoons, and the liquid part, which is used as fertilizer, is the same as prior to 1995 (3:1). The estimated average manure conversion factor $K_{F\ MANURE}$ for that period was 0.378. Due to new farm reconstructions which led to improved slurry separation and introduction of additional capacity of anaerobic digesters, the methane conversion factor MCF on big farms after 1999 had decreased to 0.213 until 2005 and further to 0.112 in 2011.

Market oriented family farm production
For market oriented family farm production, it is considered that 95% of animal excreta are collected in the form of liquid manure and 5% in the form of solid manure. Based on the ratio between liquid manure and solid manure, the average manure conversion factor MCF = 0.371 (IPCC, 2000) has been used for calculations until 2006. Since then farm reconstructions occurred also on family farms and average MCF has decreased to 0.363 in 2011.

Small scale family farm production
For small scale family farm production, it is estimated that 95% of pigs is reared in solid manure storage systems and 5% in liquid manure systems. For this type of production the average manure conversion factor MCF = 0.029 was calculated on the basis of IPCC (2000) guidelines.

On the table 6.2.3 country specific IEFs for swine are presented. The decrease in IEF for swine is due to improved slurry separation and introduction of additional capacity of anaerobic digesters.

Table 6.2.3: EFs for swine.

EF kg/head/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
swine	18.2	19.0	19.1	19.0	19.8	19.5	20.0	20.0	20.3
EF kg/head/year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
swine	15.2	15.1	15.6	16.0	12.2	13.6	13.6	14.1	14.2
EF kg/head/year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
swine	14.2	14.3	13.8	13.9	13.8	14.2	13.6	13.8	

6.2.2.3 Sheep, Goats, Horses, and Poultry

Excreta of these animals contribute only a comparatively small portion of total emission of methane in Slovenia. In the estimating process, average values as suggested by IPCC (1996): 0.19 kg/sheep, 0.12 kg/goat, 1.4 kg/horse and 0.078 kg per layer or broiler (Verbič, Sušin, Podgoršek 1999, p. 8) have been considered.

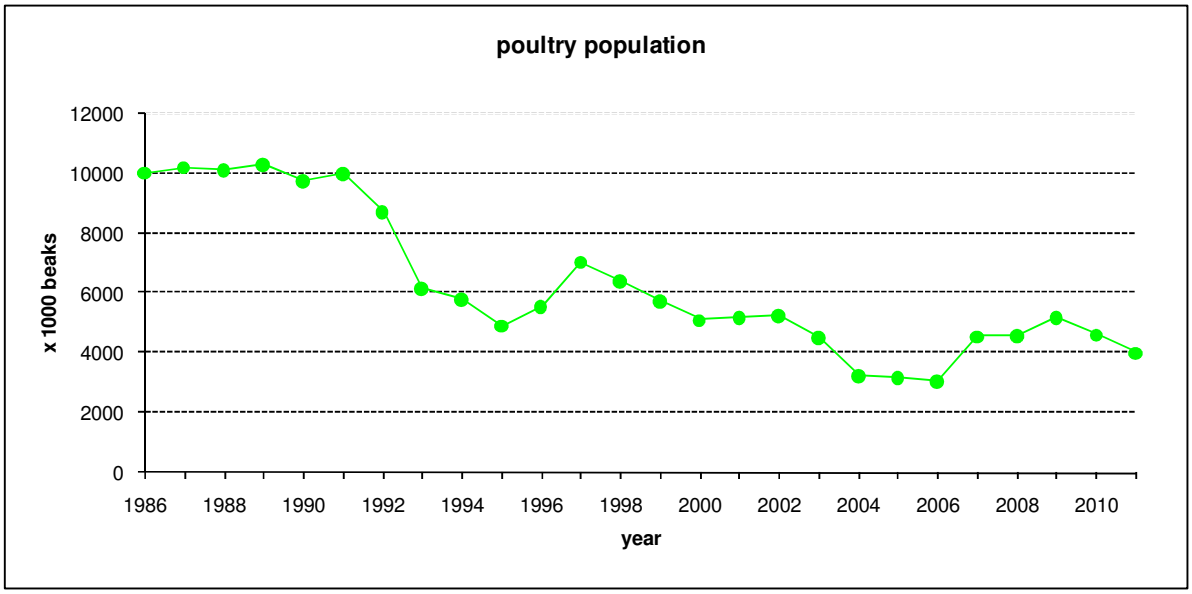


Figure 6.2.4: Number of poultry in thousands.

6.2.3 Uncertainties and time-series consistency

Uncertainty of activity data amounts to 10% (Source :SORS, KIS)
There is no suggestion for uncertainty in the IPCC GPG. It is our experts' judgement that EFs for manure management are less accurate than these for enteric fermentation. According to their judgement we are using uncertainty of 30%.
Combined uncertainty amounts to 31.62%.

6.2.4 Source-specific recalculations

Following recommendations from 2012 technical review of the greenhouse gas emission inventory conducted by EU CH4 emissions have been recalculated also in category 4.B.8 Swine for the entire period 1986-2010.

In the previous submissions Slovenia was using default quantities of excreted volatile solids (VS) for commercial farms and market oriented family farms while for small scale family farm production, considering the higher body weight, 0.775 kg VS/day has been taken into account. The TERT noted that the default VS assume a conservative estimate covering an average of all slaughter weights in a country.

For this reason the CH4 emissions from manure management of swine have been recalculated for the period 1986-2010 using IPCC default value of VS (0.5 kg VS/head/day.

6.2.5 Future improvements

No improvement is planned for this sector.

6.3 N_2O Emissions from Manure Management

Solid storage and dry lot	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	N_2O	0.82		22
2011	no	N_2O	0.36	0.07	27

Liquid systems, Anaerobic lagoons, other systems: Key sector - Base year: no
2011: no

6.3.1 Source category description

Farm animals emit directly very little nitrous oxide and have not been considered in estimating emissions of greenhouse gases. A considerable amount of nitrous oxide evolves during storage of animal waste – and is attributed to livestock production. Nitrous oxide emitted from urine and excreta of grazing animals in the pasture is attributed to emissions from agricultural soils.

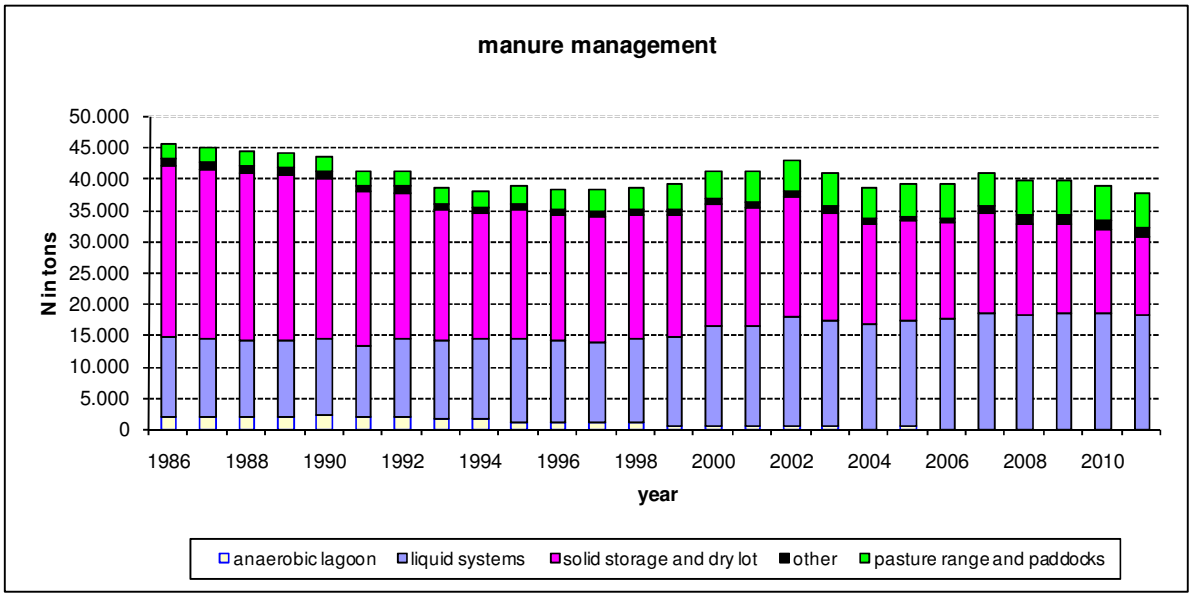


Figure 6.3.1: Nitrogen excretion per different AWMS in tons.

6.3.2 Methodological issues

Emissions of nitrous oxide (Figure 6.3.1), arising during manure storage, have been estimated on the basis of the data on the number of farm animals in Slovenia and nitrogen excretion rates of individual animal species and categories.

The nitrogen excretion rates for cattle and pigs were harmonized with the methodology for ammonia emissions (Verbič, 2004). 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:

$$\text{N excretion (kg/year)} = 52.5 + 0.0105 \times \text{M (kg/year)}$$

It has been considered that suckling cows excrete annually 78 kg of nitrogen, which corresponds to productivity of 2400 kg of milk per year. For other bovine animals 35 kg of N per year was considered (Menzi et al., 1997).

Table 6.3.1: Nitrogen excretion rates for dairy cows.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Nex kg/head/year	82.1	81.5	81.6	81.8	81.6	86.6	82.3	81.9	84.1
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Nex kg/head/year	85.8	92.7	94.2	95.5	97.1	101.1	103.0	107.1	105.7
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Nex kg/head/year	103.5	110.0	112.4	112.6	113.0	110.6	110.4	110.4	

Table 6.3.2: Nitrogen excretion rates for non-dairy cows.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Nex kg/head/year	35.0	35.0	35.0	35.0	35.0	35.8	35.9	36.3	36.5
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Nex kg/head/year	37.2	39.1	40.0	39.9	39.9	41.6	41.6	42.1	42.4
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Nex kg/head/year	41.5	42.4	42.6	42.3	42.5	42.3	42.6	42.5	

For sows and pregnant gilts 36 kg of N per year was used by taking into account consideration that this category also covers the N excreted by un-pregnant gilts, boars and piglets which were therefore not taken into account separately (EMEP/CORINAIR, 1996). For fattening pigs the excretion of 14 kg per animal was used (EMEP/CORINAIR, 1996).

It has been considered that sheep, goats, horses and poultry excrete 20, 25, 25 and 0.6 kg of N per year respectively (IPCC, 1996).

Verification of Nex value for cattle and swine

There are more reasons why Slovenia did not use IPCC default value for N excretion rates.

The first is that Manure management is a key category and in the review of our 2005 inventory submission we have got a strong recommendation to improve our estimates from this category at least for cattle and swine. In 2005 submission we have used West European excretion rates for all animal groups. After consultation with experts from Slovenian agricultural institute we agree to use N excretion rates from Menzi, 1997 for cattle and EMEP/CORINER for swine. With this choice we have harmonised our reporting of NH_3 emissions for CLRTAP with GHG reporting. This was important also because at that time we have started to build our common database with an aim that emissions for both conventions are calculated on the base of the same data and same methodological approaches, where possible.

The second reason is that in the 1996 Reference Guidelines is written that default nitrogen excretion rates from Table 4-20 need further attention and that they are maybe too high for cattle and swine. There is also suggestion to use data from Ammonia Expert Panel of the UN-ECE when available. For swine we have used results from AEP (EMEP/CORINER) while for cattle due to the big similarity in cattle production the Swiss data have been taken. According to the IPCC GPG the use of default value for Nex is the last option if country specific data are not available and if appropriate data are not available from another country.

To verify Nex used for non-dairy cattle we have calculate Nex from IPCC default value 70 kg/head/year using adjustment factors for young animals from Table 4-14 from IPCC GPG. The result of the verification for 2009 is in the table 6.3.3. For non-dairy cattle the Nex value is 40.4 kg/head/year in 2009 and 40.6 kg/head/year in 2010 what is a little lower than Nex value we have used for 2009 and 2010 in 2012 submission (42.3 kg/head/year and 42.6 kg/head/year, respectively).

Table 6.3.3: Nex for non-dairy cattle, calculated according to the IPCC methodology.

2009	population	default Nex	adj. factor	Nex
young cattle (under 1 year)	147,338	70	0.3	21
young cattle (1-2 years)	122,996	70	0.6	42
non-dairy cattle over 2 years	89,441	70	1	70
non-dairy cattle (total)	**359,775**			**40.4**

2010	population	default Nex	adj. factor	Nex
young cattle (under 1 year)	146,77	70	0,3	21
young cattle (1-2 years)	122,428	70	0,6	42
non-dairy cattle over 2 years	91,486	70	1	70
non-dairy cattle (total)	**360,684**			**40.6**

We are not able to perform the same verification procedure also for swine due to the different classification. In statistics swine are disaggregated according to the weight and not according to the age. If we take into account that majority of fattening pigs are younger than 6 months and apply the adjusted Nex of 10 kg N/animal/year (0.5 * 20 kg N/animal/year) to this category and default value of 20 kg N/animal/year we get value 10.89 kg N/animal/year what is probably too low, because not all fattening pigs are younger than 6 months.

Table 6.3.4: Nex for swine in various countries in 2009.

2009	Nex
Croatia	20
Germany	12.14
Slovenia	**11.92**
Italy	11.78
Austria	9.57
Hungary	8.07
Slovenia (IPCC, 2006)	**11.15**

Following recommendation from 2011 review Nex used in Slovenia has been compared to the value used in neighbouring countries and other European countries with similar

management practice. The comparison has been made with 2009 data. The N excretion rate of swine as reported by Slovenia is the second highest in a range of neighbouring countries. The highest value is the IPCC default value which is noticeably higher than the corresponding level prevailing in Slovenia and in the central Europe. A considerably better fit is seen if the excretion value is calculated pursuant to IPCC (2006) default values, with mean animal weights for the subcategories (sows, gilts, boars, piglets and fattening pigs).

Emission factors, which tell us how much of N from animal excreta is lost to the atmosphere in the form of N_2O, have been taken from IPCC GPG (2000). For anaerobic lagoons, anaerobic digesters, and liquid systems, the emission factors applied amounted to 0.001, for solid manure storage systems to 0.02 and for poultry manure without bedding 0.005.

IEF for other systems which comprise of anaerobic digesters and poultry manure without bedding has changed from 0.005 to 0.0035 kg N_20-N /kg N? IPCC default value is equal to 0.005 kg N_20-N /kg N. The biggest decrease in IEF in the years 1995 and 1999 can be explained by introducing anaerobic digesters on pig farms for which EF of 0.001 kg N2O-N/kg N have been used while before 1995 only poultry manure without bedding (EF 0.005 kg N_2O-N/kg N) was included under Other AWMS.

The fraction of manure nitrogen produced in different animal waste management systems for bovine animals and swine has been estimated on the basis of the methodology for methane calculation.

For goats, sheep, and horses the proportions of grazing animals were estimated by the expert (Verbič, 2004). It was estimated that during the grazing season all sheep, 80% of goats and 50% of horses are grazed. 215 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 in straw based systems.

For poultry, floor system on bedding was assumed for broilers, and combined floor system (1/4) and battery-cage systems (3/4) were assumed for layers and allocated to the other systems.

6.3.3 Uncertainties and time-series consistency

Activity data comprise of data on livestock populations, nitrogen excretion rates and MMS usage. The Nex have the larger contribution to the uncertainty of activity data. In the IPCC GPG is suggested that uncertainty range for default Nex is +/-50% but may be as low as 25% if the country specific data about N intake and retention are available. In GHG inventory we are using other sources of Nex for cattle and swine which we believe better reflects the circumstances in Slovenia. It is expert judgment that overall uncertainty of AD in this category is 50%

Due to the use of IPCC default EF we have taken uncertainty estimates of 100% as suggested in the IPCC GPG.

Combined uncertainty amounts to 111.80%.

6.3.4 Source-specific recalculations

Following recommendations from 2012 technical review of the greenhouse gas emission inventory conducted by EU N2O emissions from poultry have been recalculated in category 4.B.11 Liquid systems and 4.B.13 Other systems for the entire period 1986-2010.

In the previous submissions it was 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). This assumption is not correct because manure which is from the caged hens is removed using, among other techniques conveyor belts. This indicate that manure is not liquid (Liquid manure is normally considered fluid, can be pumped and is stored in slurry tanks with a maximum dry matter content of 10–12 %). The TERT has recommended that Slovenia reclassify this amount of manure to a correct classification 'Other poultry manure' according to 2000 IPCC GPG Table 4.11.. For this reason poultry manure has been reallocated from liquid to other system for entire period 1986-2010. Due to the different EF used for both systems, N2O emissions from poultry manure have been also recalculated, and not only reallocated.

Due to updated data on allocation of swine manure it become evident that the last pig farm which had stored the manure in the anaerobic lagoons was closed in 2009. Therefore swine manure which was allocated to anaerobic lagoon in 2010 was reallocated to liquid and corresponding N2O emissions have been recalculated.

6.3.5 Future improvements

No improvement is planned for this sector.

6.4 Emissions from Agricultural Soils

Three sources of N_2O are distinguished in the IPCC methodology: direct emissions from agricultural soil, direct soil emissions from animal production (grazing animals) and N_2O emissions indirectly induced by agricultural activities.

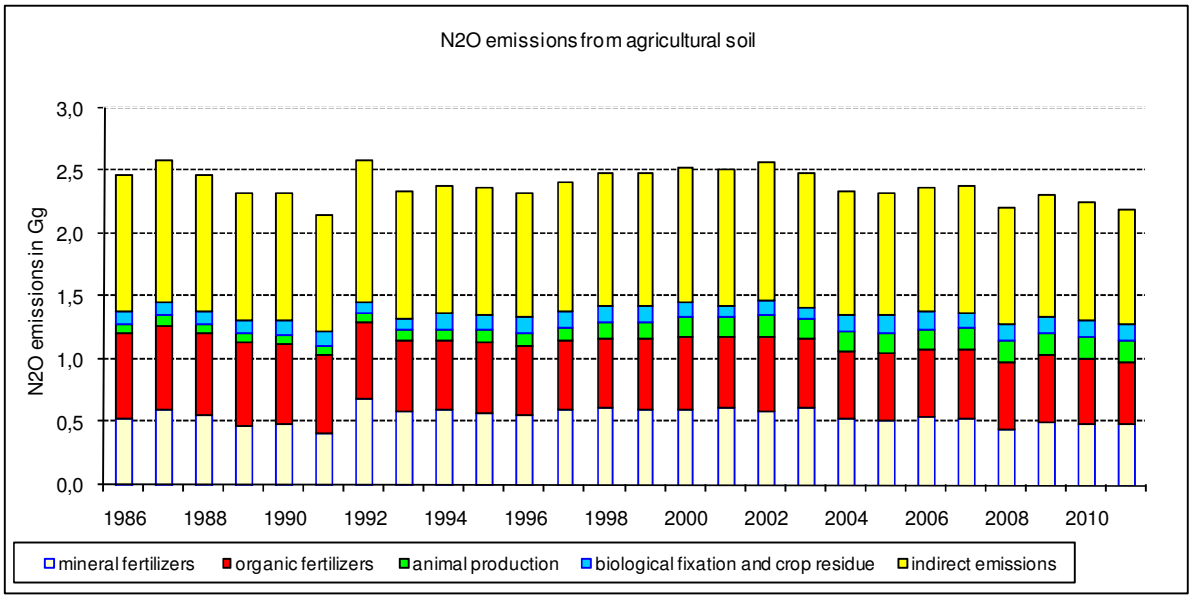


Figure 6.4.0: N_2O emissions from agricultural soil in Gg.

6.4.1 Direct N_2O Emissions from Agricultural Soil

direct soil emissions	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	N_2O	1.33		13
2011	Level, Trend	N_2O	1.10	0.79	12

6.4.1.1 Source category description

Sources of nitrogen, causing direct emissions of nitrous oxide into the atmosphere, are the following (Figure 6.4.1):

- Mineral fertilizers
- Organic fertilizers (solid and liquid manure) from animal husbandry
- Biological fixation of nitrogen
- Crop residue
- Cultivation of high-organic content (peat) soil
- Sewage sludge

6.4.1.2 Methodological issues

Nitrous oxide from mineral fertilizers

This estimate is based on the amount of N in mineral fertilizers that are annually consumed in Slovenia. The consumption of nitrogen from mineral fertilizers on agricultural soil in Slovenia has been obtained from the Statistical Yearbook.
SORS collect data on fertilisers used in enterprises, companies and co-operatives involved in crop production. Likewise, they are taking into account the data on import, export, and production. The difference between all fertilizers sold in this country and the amount that is used by enterprises, is the consumption of mineral fertilizers on family farms. Fertilizers that are not appropriate for agricultural production (mineral fertilizers for balcony flowers, lawns and similar) are not included.

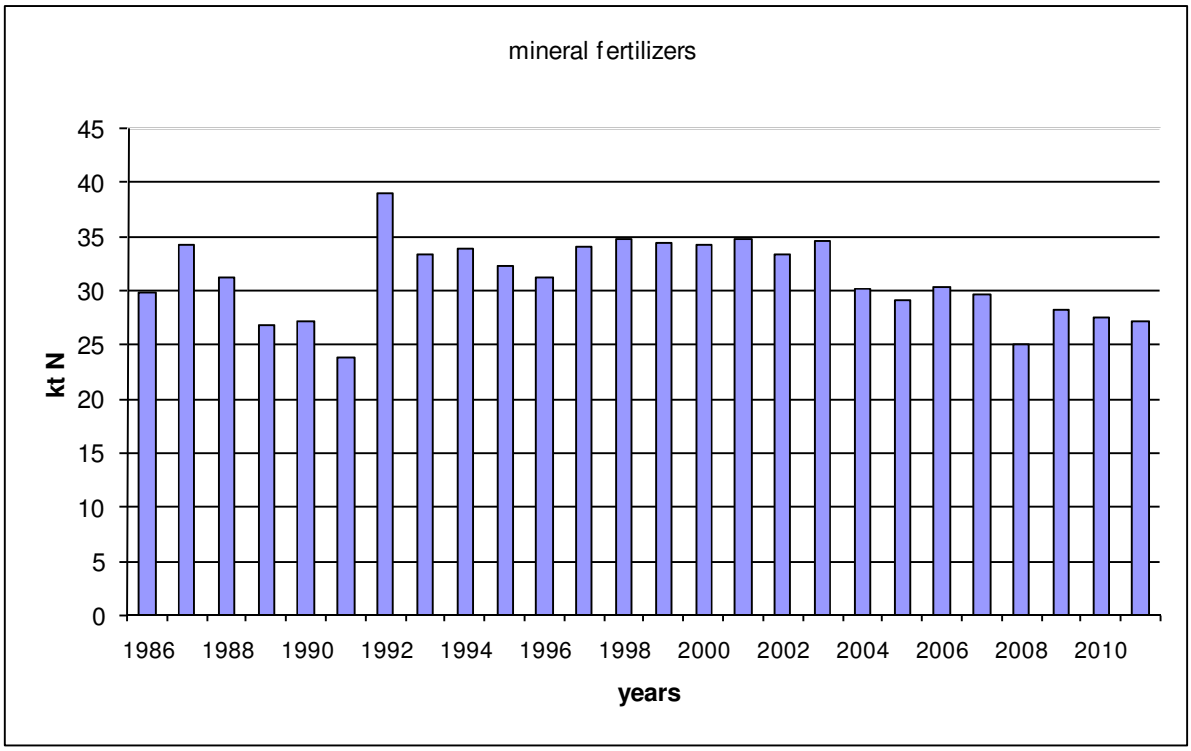


Figure 6.4.1: Amount of mineral fertilizers in kt N.

From 1987-1991 the use of fertilizers shows constant decrease and in 1992 a sharp increase – the amount of fertilizers in 1992 is the highest in the whole reporting period. The one of the reason is reduction in industrial production, poor economic situation and war for independence in 1991. In 1992 Slovenia become independent and economic situation started to improve. It is very likely that farmers did not use all fertilizers in the year 1992 but had just renewed their stocks. The consumption of N fertilizers per hectare of utilised agricultural area in Slovene agriculture has been decreasing from 2001 to 2008. The decrease is attributable to measures of Rural Development Programme which stimulate the expert based use of fertilizers. Consumption of N fertilizers decreased drastically in 2004 and in 2008. The main reasons for 2008 decrease was a considerable increase in mineral fertilizer price and consequently much lower use of fertilizers in agriculture.

Of the total estimated quantity of emitted N, the N, which is dispersed into the atmosphere in the form of ammonia and NO_X (10%; IPCC, 1996), was subtracted. The emission of nitrous oxide was then calculated according to the default method from IPCC GPG Equation 4.22 by multiplying the quantity of the remaining N with emission factor 0.0125 kg N_2O-N/kg N (IPCC, 1996).

Nitrous oxide from animal manure and liquid/slurry

The estimate is based on the amount of N in solid manure and liquid manure/slurry, which is annually used for fertilizing crops. The amount of N in the manure applied to soil has been calculated on the basis of methodology described in chapter 6.3 (N_2O Emissions from Manure Management).

We estimated emissions according to the default method from IPCC GPG Equation 4.23. Of the total estimated quantity of emitted N, we subtracted the N that is emitted on the pasture, and N that is dispersed into the atmosphere in the form of ammonia and NO_X. The emission of nitrous oxide has been calculated by multiplying the quantity of N from animal manure with the emission factor of 0.0125 kg N_2O-N/kg N (IPCC, 1996).

Nitrous oxide from biological fixation of N

Table 6.4.1: Dry matter fraction, residue/crop product ratio and N fraction for legumes.

	Dry Matter Fraction	Residue/Crop Ratio	N Fraction
Fodder peas	0.85	1.5	0.0142
Dry beans	0.895	2.1	0.03
Soya	0.86	1.4	0.023
Clover and Lucerne	0.85	0	0.03
Grass-clover mixtures	0.85	0	0.03
Peas	0.15	1.2	0.0142
French beans	0.15	1.2	0.03

The amount of nitrogen assimilated by legumes has been estimated on the basis of the production data (Statistical Office of the Republic of Slovenia) while taking into account the ratio between crop residue and edible (usable) part of the crop, dry matter fraction and N fraction (Table 6.4.1). We have used default values from GPG if available; for other crops we obtained data from our Agriculture Institute.

To calculate emissions of nitrous oxide we used Tier 1b method and Equation 4.26 from IPCC GPG. The same emission factor as for N from mineral and organic fertilizers (0.0125 kg N_2O-N/kg N; IPCC, 1996) has been applied.

Emissions of nitrous oxide from crop residue mineralization

An important source of emissions of nitrous oxide into atmosphere is nitrogen from crop residue mineralization that remains or is returned to soil (kg N/year).

We have decided to estimate crop residue on the basis of data on the production of individual arable crops, vegetables, fodder plants and industrial plants while considering the ratio between the edible (usable) part and that part which remains on the fields, dry matter fraction and N fraction (Table 6.4.2). We have used default values from GPG if available; for other crops we obtained data from our Agriculture Institute.

For calculations we have used Tier 1b method and Equation 4.29 from GPG. IPCC methodology envisages that burned crop residue has to be subtracted from the amount of crop residue. Since emissions from burning crop residue have been ignored, burning has not been taken into account here. We also do not use crop residue as a fuel, construction or fodder. To calculate emissions of nitrous oxide, the same emission factor as for N from

mineral and organic fertilizers as well as biological N-fixation (0.0125 kg N_2O-N/kg N, IPCC, 1996) has been applied.

Table 6.4.2: Dry matter fraction, residue/crop product ratio and N fraction.

	dry matter fraction	Residue/Crop Ratio	N fraction
Wheat and spelt	0.86	1.3	0.0028
Rye	0.86	1.6	0.0048
Barley	0.86	1.2	0.0043
Oats	0.86	1.3	0.007
Maize for grains	0.86	1	0.0081
Triticale	0.86	1.6	0.015
Millet	0.86	1.4	0.007
Buckwheat	0.86	1.4	0.015
Other cereals	0.86	1.3	0.015
Fodder peas	0.85	1.5	0.0142
Dry beans	0.895	2.1	0.03
Potatoes	0.19	0.4	0.011
Sugar beet	0.25	1.4	0.015
Fodder beet	0.15	0.3	0.0228
Fodder carrot	0.16	0.3	0.015
Fodder turnip	0.12	0.3	0.015
Fodder pumpkins	0.1	0.4	0.015
Oil turnip/rape	0.92	1.7	0.015
Sunflowers	0.86	1.3	0.015
Soya	0.86	1.4	0.023
Pumpkins for oil	0.9	5	0.015
Hops	0.89	0.3	0.015
Other industrial plants	0.89	0.3	0.015
Tomatoes	0.063	1	0.015
Cucumbers	0.037	1	0.015
Sweet	0.1	1	0.015
Carrots	0.1	1.5	0.015
Garlic	0.354	1	0.015
Onion	0.142	1	0.015
Beetroot	0.1	0.3	0.015
Peas	0.15	1.2	0.0142
French beans	0.15	1.2	0.03
Other vegetables	0.0854	1.2	0.015

Emissions of nitrous oxide due to cultivation of organic soils

Cultivation of soils with high contents of organic material (histosols) causes a release of a long-term bound N. The data about cultivation of organic in Slovenia have been obtained from two sources:

Pedology map of Slovenia 1:25000
The surface of organic soil in Slovenia has been obtained from the pedology map of the Centre for Pedology and Environmental Protection at the Department of Agronomy of the Biotechnical Faculty in Ljubljana, but only the surface of the peat soil of the low moor has been considered. This surface, according to data from year 2002, amounts to 13,116 ha.

Use of utilized agricultural area 1:5000
Data about land use have been obtained from the database on Ministry for Agriculture, Forestry and Food. Resolution of this database is 0.5 m and is momentary the most accurate and detailed base of agricultural land use in Slovenia.

With comparing and covering of data from both maps we determined that in 2002 9,902 ha of organic soil was agriculture land and that 6,665 ha was arable land.

To determine area of cultivated organic soil before 1997 we have used statistical data about area of arable land for the period 1991 – 1997. According to these data the area of arable land in Slovenia was diminishing from 1991 until 1997 and was in the year 2002 6 per cent lower than in 1991.

Table 6.4.3: Area of cultivated organic soil and N_2O emissions in CO_2 eq.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Area (ha)	7405	7338	7270	7203	7136	7069	7001	6934	6867
CO_2 in Gg eq.	**28.86**	**28.60**	**28.33**	**28.07**	**27.81**	**27.55**	**27.28**	**27.02**	**26.76**
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Area (ha)	6800	6732	6665	6695	6725	6755	6786	6816	6846
CO2 in Gg eq.	**26.50**	**26.24**	**26.24**	**26.09**	**26.21**	**26.33**	**26.44**	**26.56**	**26.68**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Area (ha)	6876	6906	6885	6864	6868	6884	6891	6854	
CO2 in Gg eq.	**26.80**	**26.91**	**26.83**	**26.75**	**26.77**	**26.83**	**26.86**	**26.71**	

Table 6.4.4: Utilized area of organic soil according national class ID

Code	Utilized area (ha)	2005	2010	2011
1100	Arable land	3232	2259	2320
1180	Other permanent crops on arable land	0	1	1
1190	Greenhouses	0	0	0
1211	Vineyards	0	0	0
1221	Intensive orchards	0	18	23
1222	Extensive orchard	7	10	13
1240	Other permanent crop	16	0	0
1300	Meadows and pastures	763	279	225
1321	Swampy meadows and pastures	2294	3717	3677
1410	Overgrown areas	112	217	279
1420	Forest plantation	127	10	10
1500	Mixed land use area	354	306	262
1600	Uncultivated agriculture land	0	71	38
1800	Forest trees on agricultural land	0	2	3
2000	Forest	788	920	924
3000	Built-up areas and related surfaces	364	398	438
4100	Swamps	58	45	33
4210	Reeds	11	13	13
4220	Other marshy areas	55	26	24
7000	Waters	110	90	98
Total	**Use of histosols (all uses)**	**8291**	**8383**	**8383**
Total	**Agricultural use of hist. (1100-1800)**	**6906**	**6891**	**6854**
Total	**Cultivated histosols (1100 - 1240)**	**3255**	**2289**	**2358**

Detailed data about use of agricultural area for 2005, 2010, and 2011 are in the table 6.4.4. The data for 2006 have been interpolated. For N2O emission we have taking into account all agricultural use of histosols, not only the cultivation.

Emissions of nitrous oxide due to application of sewage sludge

Following the question raised in the 2010 review the N_2O emissions from the sewage sludge have been included in Slovenian GHG inventory for the period 2000-2008 in resubmission on 16 October 2010. In this year submission the data before 2000 have been included. In Slovenia fertilisation by sewage sludge is extremely small due to the very rigorous restrictions listed in the environmental permit. In 2010 N_2O emissions from sewage sludge was 0.09 Gg CO2 eq.

Activity data
Since 2000, data about sewage sludge applied to the agricultural soils have been obtained from the Slovenian reports prepared under the Sewage sludge directive. The data provider is the Environment Agency of the Republic of Slovenia.

Following the recommendation from 2011 review the amount of sewage sludge deposited on the agricultural land before 2000 have been estimated as well. From environmental reports the values for 1998 and 1995 have been taken. We have assumed that the same percent (30%) of sewage sludge have been deposited on agriculture land even before 1995 and since the amount of sewage sludge from waste water treatment plants were constant in this period we have assumed that the amount of sewage sludge used in agriculture is constant as well. Values for 1996,1997, and 1999 have been interpolated.

As data about N content in sewage sludge are not available in Slovenia the value of 3.9 per cent N in dry matter has been taken from Austrian GHG inventory submission 2010 as recommended by the ERT.

Methodology for estimating direct emissions

Emissions are calculated according to the methodology described in IPCC GPG 2000.
First, sewage sludge nitrogen applied to the soils is adjusted for amount that volatilises as NH_3 and NO_X according to the equation below:

$$F_{SS} = N_{SS} * (1 – Frac_{SS})$$

Where:

F_{SS} = annual amount of sewage sludge nitrogen applies to soils adjusted to account for the amount that volatilises as NH_3 and NO_X
N_{SS} = annual amount of sewage sludge nitrogen
$Frac_{SS}$ = fraction of sewage sludge nitrogen that volatilises as NH_3 and NO_X

For the calculation of NH_3 volatilisation the CORINAIR default emission factor for slurry spreading (0.15 kg NH_3-N per kg sewage sludge N) was applied (EEA 2007) while for NO_X-N losses the conservative emission factor of 1% of sewage sludge nitrogen (Freibauer and Kaltschmitt, 2001) has been used. $Frac_{SS}$ used is therefore 0.16. All these values have been taken from Austrian GHG inventory submission 2010.
The direct N_2O emissions are calculated according equation:

$$N_2O = F_{SS} * EF_{DIR} * 44/28$$

For EF_{DIR} IPCC default value of 0.0125 kg N_2O-N/kg N has been used. The results are

presented in the table below.

Table 6.4.5: Data used for calculation of direct soil emissions.

Year	Sewage sludge applied kg dm	Sewage sludge kg N	$Frac_{SS}$	Sewage sludge applied kg N	EF kg N_2O - N/kg N	Emissions kg N_2O	Emissions Gg CO_2 eq.
1986-1995	2,000,000	78,000	0.16	65,520	0.0125	1287	0.399
1996	1.800,000	70,200	0.16	58,968	0.0125	1158	0.395
1997	1.600,000	62,400	0.16	52,416	0.0125	1030	0.319
1998	1,400,000	54,600	0.16	45,864	0.0125	901	0.279
1999	850,000	33,150	0.16	27,846	0.0125	547	0.170
2000	300,000	11,700	0.16	9,828	0.0125	193	0.060
2001	500,000	19,500	0.16	16,380	0.0125	322	0.100
2002	1,100,000	42,900	0.16	36,036	0.0125	708	0.219
2003	455,000	17,745	0.16	14,906	0.0125	293	0.091
2004	126,000	4,914	0.16	4,128	0.0125	81	0.025
2005	71,160	2,775	0.16	2,331	0.0125	46	0.014
2006	27,300	1,065	0.16	894	0.0125	18	0.005
2007	18,200	710	0.16	596	0.0125	12	0.004
2008	10,200	398	0.16	334	0.0125	6	0.002
2009	10,515	410	0.16	344	0.0125	7	0.002
2010	455,000	17,745	0.16	14,906	0.0125	293	0.091
2011	1,000	39	0.16	33	0.0125	1	0.000

6.4.1.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 10%.
Uncertainty of emission factor amounts to 250%.
Combined uncertainty amounts to 250.20%.

6.4.1.4 Recalculations

The amounts of sewage sludge applied to the agricultural soils have been updated for 2003, 2004 and direct and indirect N2O emissions from the sewage sludge application have been recalculated accordingly. The recalculations were extremely small.

6.4.1.5 Future improvements

No improvements are planned for this category.

6.4.2 Nitrous oxide emissions from grazing animals

Key sector - Base year: no
Key sector - Year 2011: no

Methodological issues
The estimate is based on the amount of N in manure, which is annually applied to soil during grazing. This amount has been calculated on the basis of methodology described in chapter 6.3 (N_2O Emissions from Manure Management). IPCC methodology (1996) suggests using the same emission factor (0.02 kg N_2O-N/kg of emitted N) for all grazing animals, regardless of their species and the climatic conditions.

Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 50%.
Uncertainty of emission factor amounts to 100%.
Combined uncertainty amounts to 111.80%.

Recalculations
No recalculations have been performed for this category.

Future improvements
No improvements are planned for this category.

6.4.3 Indirect N_2O emissions from Agricultural Soil

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	N_2O	1.03		17
2011	Level, Trend	N_2O	0.84	0.59	17

6.4.3.1 Source category description

The most important indirect sources of nitrous oxide are (Figure 6.4.1):
- Volatilisation of ammonia and nitrogen oxides (NO_x)
- Nitrogen leaching and runoff
- Municipal sewage (quantities have been estimated, but included in the chapter on waste treatment)

6.4.3.2 Methodological issues

Nitrous oxide arising due to volatilization of ammonia (NH_3) and nitrogen oxides (NO_X)

In fertilizing agricultural soils with nitrogen fertilizers, some N volatilises in form of ammonia and nitrogen oxides (NO_x). This N has not been considered in determining emissions from fertilizing with mineral fertilizers (4.D.1.1), organic (4.D.1.2) fertilizers and sewage sludge

(4.D.1.6). This nitrogen is deposited by precipitation and particulate matter on agricultural soil, in forests and waters and thus indirectly contributes to emissions of N_2O. Emissions are attributed to the place of origin of ammonia and NO_x, not to the place where N is re-deposited, causing N_2O emissions.

Emissions from mineral fertilizers
Indirect emissions of nitrous oxide from mineral fertilizers depend to a large extent on the fraction of N that volatilises during fertilizing. The amount of volatilised N depends very strongly on the type of fertilizer as well as on weather conditions and the manner of application. In Slovenia, data on the consumption of various nitrogen fertilizers are not available, and also IPCC methodology (1996) does not lay down different emission factors. It has been considered that 10% of N from mineral fertilizers volatilises (IPCC, 1996). For calculating indirect emissions of nitrous oxide, the emission factor of 0.01 kg N_2O-N/kg NH_3 and NO_X-N (IPCC, 1996) has been considered.

Emissions from animal manure:
Numerous factors influence the fraction of volatilised N in form of ammonia and nitrogen oxides, such as: the ratio between N excreted in dung and N excreted in urine, the manner of slurry storage, the manner of slurry application etc. In spite of differences, IPCC (1996), for the time being, suggests a generic emission factor; 20% of the excreted N are supposed to volatilise in form of ammonia and nitrogen oxides. Emissions of nitrous oxide have been calculated by multiplying the estimated quantities of volatilised N with emission factor of 0.01 kg N_2O-N/kg NH_3-N and NO_X-N (IPCC, 1996).

Emissions from sewage sludge:
Emissions have been calculated according to the methodology described in IPCC GPG 2000.

N_2O emissions from atmospheric deposition of NO_X and NH_3 are calculated according the equation bellow:

$$N_2O = N_{SS} * Frac_{SS} * EF_{AD} * 44/28$$

Where EF_{AD} is IPCC default 0.01 kg N_2O -N/kg N.

Nitrous oxide from leaching and runoff of nitrogen compounds into surface waters, groundwater, and watercourses

The nitrogen that enters groundwater and watercourses, mainly in the form of nitrates, is there subjected to nitrification and denitrification. This gives rise to some nitrous oxide, which is diffused into the atmosphere. Denitrification takes place mostly in groundwater, riverine sediments, and estuarine sediments. This nitrogen, which enters watercourses, contributes to emissions of nitrous oxide also during the course of nitrification. Algae and aquatic plants assimilate nitrates into organic matter, which in decomposing release ammonia that is quickly nitrified in rivers, giving rise to some nitrous oxide in the process.

Surface runoff or leaching of N into groundwater, surface waters, and watercourses due to mineral fertilizers:
It has been considered that 30% of N from mineral fertilizers are leached and run off into the groundwater and watercourses. In calculating emissions of nitrous oxide, it has been considered that for every kg of leached/run-off nitrogen, 0.025 kg of N_2O-N is emitted (IPCC, 1996). The applied emission factor is a sum of partial factors (denitrification in soil or in groundwater 15 g N_2O-N/kg N, denitrification in river sediments 2.5 g N_2O-N/kg N, nitrification in rivers 5 g N_2O-N/kg N, nitrification in estuaries 2.5 g N_2O-N/kg N).

Nitrogen leaching and runoff into groundwater, surface waters, and watercourses due to animal manure:
It has been considered that for every kg of N, which is excreted by farm animals, 0.3 kg of N run off to watercourses and groundwater (IPCC, 1996). The methodology of estimating annual quantities of N, excreted by individual kinds and categories of animals, has been already described under 2.1.4. With regard to the defined methodology, all N has been considered, i.e. N excreted in indoor housing and N excreted on pasture. To improve the estimate, it might be advisable to particularize the methodology in the future by considering a higher leaching and runoff factor for big farms and areas with intensive livestock production than for areas with un-intensive livestock production. In calculating emissions of nitrous oxide, the same emission factor has been considered as in the case of nitrogen leaching/run-off due to mineral fertilizers (0.025 kg N_2O-N/kg of leached/run-off N).

Nitrogen leaching and runoff into groundwater, surface waters, and watercourses due to sewage sludge:

Emissions of N_2O from leaching/runoff of applied or deposited nitrogen was calculated according the equation bellow:

$$N_2O_{LEACH} = N_{SS} * Frac_{LEACH} * EF_{LEACH} * 44/28$$

Where $Frac_{LEACH}$ is IPCC default 0.3 kg N/kg N input to the soils and EF_{LEACH} is IPCC default 0.025 kg N_2O-N/kg N.

6.4.3.3 Uncertainties and time-series consistency

Uncertainty estimates based on expert judgement.
Uncertainty of activity data amounts to 50%.
Uncertainty of emission factor amounts to 250%.
Combined uncertainty amounts to 254.95%.

6.4.3.4 Recalculations

The amounts of sewage sludge applied to the agricultural soils in 2003 and 2004 have been corrected and recalculations have influence on direct and indirect emissions.

6.4.3.5 Future improvements

No improvements are planned for this category.

6.5 Source specific QA/QC and verification

The source category QA/QC is covered with general QC procedures described in the chapter 1.6.

The source specific QA/QC is made by agriculture expert in inventory team but with help from experts from Agriculture Institute of Slovenia (KIS). The procedure of inventory compiling is started on EARS where all necessary data, obtained from SORS are insert into the excel spreadsheets. This file is then sent to KIS where agricultural experts check their calculations with these in the spreadsheets. All differences are then discussed and if necessary also corrected.

On the Agricultural Institute of Slovenia the special Animal Science Department was founded to make additional research on animal breeding. Two services are specially oriented on cattle and pig breeding. For calculation of CS EF for cattle and pigs some

special parameters, not available from SORS are needed. In calculations spreadsheets these values are replaced with new one when available. This work is done by experts from KIS and is well documented and the procedure is traceable.

After this procedure the electronic file is returned to EARS where all data are transferred into the new database and then into CRF Reporter. The CRF tables are at the end send to KIS for the final checks. Writing the relevant chapter for the NIR is undergoing the same procedure.

Besides QA/QC procedures described above, the following Tier 2 QA/QC procedures have been performed for the submission 2011:

- Enteric fermentation - CH_4 – Country specific CH_4 EF for cattle has been compared with IPCC default
- Manure management – CH_4 - Country specific CH_4 EFs for cattle and swine have been compared with IPCC default and with EFs used in other European countries with similar climate
- Manure management – N_2O – Nex for cattle have been compared with IPCC default, and Nex for swine have been compared with values used by other countries

The results of these procedures are presented under relevant sub-chapters

7 LULUCF (CRF sector 5)

Forest Land remaining Forest Land	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	31.70		1
2011	Level, Trend	CO_2	34.08	32.85	1

Land converted to Cropland	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	0.97		18
2011	Level, Trend	CO_2	1.10	1.10	13

Land converted to Settlements	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	1.92		8
2011	Level, Trend	CO_2	2.19	2.22	6

Land converted to Other land	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	0.85		20
2011	Level, Trend	CO_2	1.33	1.62	10

Land converted to Grassland	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CO_2	0.60		27
2011	Level, Trend	CO_2	1.86	2.78	7

Land converted to Forest Land	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	1.42		11
2011	Level, Trend	CO_2	1.37	1.19	9

Land converted to Wetlands	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO_2	0.42		29
2011	Level	CO_2	0.47	0.46	25

7.1 Overview of sector

The Land Use, Land-Use Change and Forestry (LULUCF) sector in 2011 as a whole acted as a CO_2 sink of –9.620.12 Gg CO_2 because total emissions arising from the sector were smaller than the total removals.

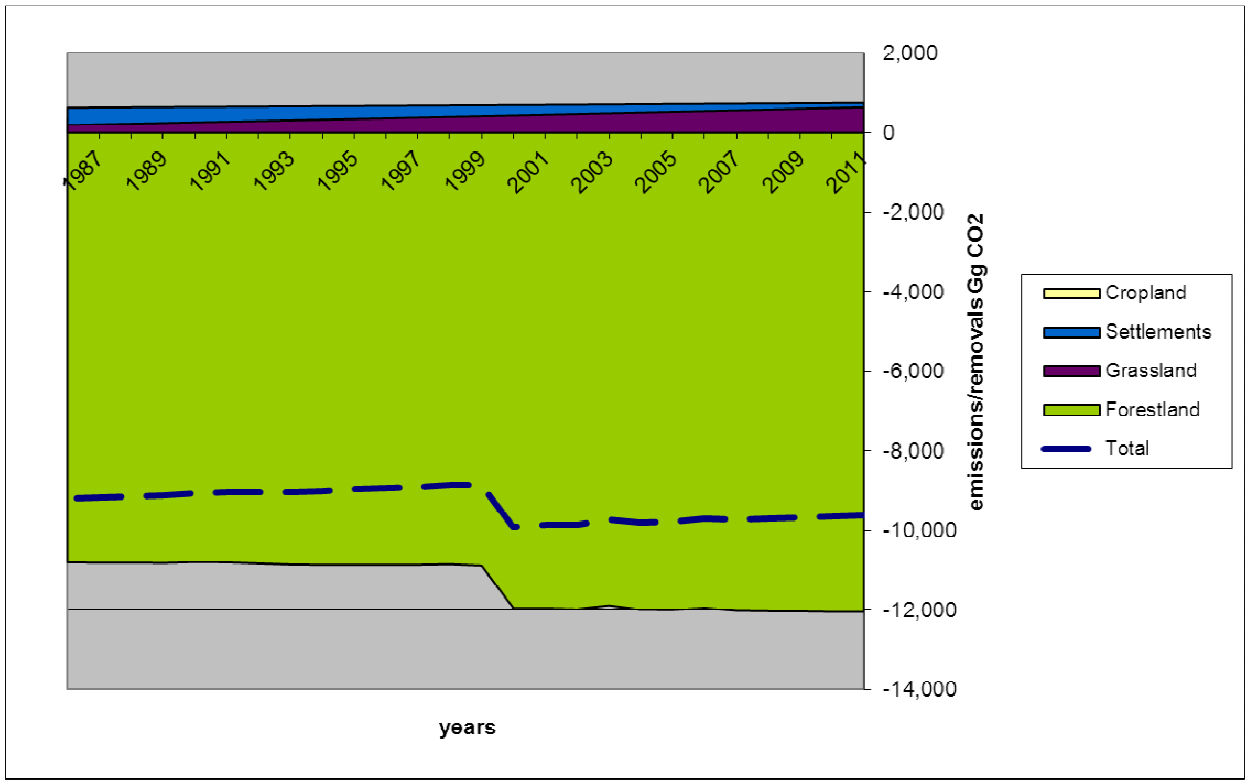


Figure 7.2: Net emissions and removals in the LULUCF sector in 1986-2011 by land-use category, Gg CO_2.

The land use, land-use change, and forestry (LULUCF) sector deals with greenhouse gas (GHG) emissions and removals resulting from land use and land use changes. According to Good Practice Guidance for LULUCF (2003) Slovenia classifies its national land into 6 land use categories — Forest land, Cropland, Grassland, Wetlands, Settlements and Other land. GHG emission and removal estimates in this sector are calculated from carbon stock changes in the five carbon pools (aboveground biomass, belowground biomass, deadwood, litter and soil), direct N_2O emissions from N fertilization, N_2O emissions from drainage of soils, N_2O emissions from disturbance associated with land-use conversion to cropland, CO_2 emissions from agricultural lime application, and non-CO_2 emissions from biomass burning.

For this inventory, above- and belowground biomass are referred to collectively as “living biomass”, and deadwood and litter collectively as “dead organic matter”. Data acquisition and calculations are based on the Good Practice Guidance for Land Use, Land- Use Change and Forestry (IPCC 2003) and are completed by country specific methodologies.

Country specific emission factors and carbon stock values for forests and partially for agricultural land and grassland are derived from surveys and measurements. For other land use categories, IPCC default values or expert judgements are used. Forest growth factors depend on climate conditions; their annual variation is therefore modelled against climatic parameters.

Areas of all land uses in reporting year are presented in Table 7.6.

Table 7.6: Land use by categories in year 2011.

Area	kha	%
Forestland	1208.75	59.62
Cropland	240.37	11.86
Grassland	424.17	20.92
Wetlands	13.98	0.69
Settlements	108.96	5.37
Other land	31.07	1.53
Sum	2027.30	100.00

Table 7.7 summarizes the CO_2 emissions and removals in consequence of carbon losses and gains for the years 1986 – 2011. The total net removals of CO_2 from LULUCF sector from 1986 to 2011 vary between -8,866.0 Gg (1998) and -9,902.3 Gg (2000). The main sink category in LULUCF in Slovenia is forest land remaining forest land.

Table 7.7: Emissions and removals from sector 5 LULUCF by sub categories in Gg CO_2

Year	Total	Forestland	Cropland	Grassland	Wetlands	Settlements	Other land
	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2
2011	-9,620.117	-12,042.544	433.393	633.397	157.932	744.520	453.185
2010	-9,652.147	-12,040.800	431.038	615.081	157.093	739.489	445.954
2009	-9,673.757	-12,028.637	428.682	596.765	156.255	734.457	438.722
2008	-9,703.393	-12,024.500	426.326	578.449	155.416	729.425	431.490
2007	-9,725.663	-12,012.996	423.971	560.133	154.577	724.394	424.259
2006	-9,694.368	-11,947.928	421.615	541.817	153.739	719.362	417.027
2005	-9,773.901	-11,993.687	419.260	523.501	152.900	714.330	409.795
2004	-9,803.372	-11,989.386	416.904	505.186	152.062	709.299	402.564
2003	-9,735.738	-11,887.978	414.548	486.870	151.223	704.267	395.332
2002	-9,854.252	-11,972.718	412.193	468.554	150.384	699.235	388.100
2001	-9,869.707	-11,954.401	409.837	450.238	149.546	694.204	380.869
2000	-9,902.302	-11,953.222	407.482	431.922	148.707	689.172	373.637
1999	-8,867.256	-10,887.071	405.326	415.147	147.940	684.569	366.834
1998	-8,865.993	-10,854.704	403.170	398.372	147.173	679.966	360.031
1997	-8,910.526	-10,868.133	401.015	381.597	146.406	675.362	353.227
1996	-8,942.644	-10,869.146	398.859	364.822	145.638	670.759	346.424
1995	-8,972.016	-10,867.414	396.703	348.047	144.871	666.156	339.621
1994	-9,004.704	-10,868.998	394.548	331.272	144.104	661.553	332.818
1993	-9,028.496	-10,861.440	392.146	314.497	143.337	656.950	326.015
1992	-9,032.430	-10,834.270	389.990	297.722	142.570	652.346	319.211
1991	-9,037.214	-10,807.949	387.835	280.947	141.802	647.743	312.408
1990	-9,061.321	-10,800.952	385.679	264.172	141.035	643.140	305.605
1989	-9,115.311	-10,823.838	383.523	247.397	140.268	638.537	298.802
1988	-9,135.065	-10,812.487	381.368	230.622	139.501	633.934	291.999
1987	-9,169.772	-10,816.090	379.212	213.847	138.734	629.331	285.196
1986	-9,193.318	-10,808.532	377.056	197.072	137.966	624.727	278.392

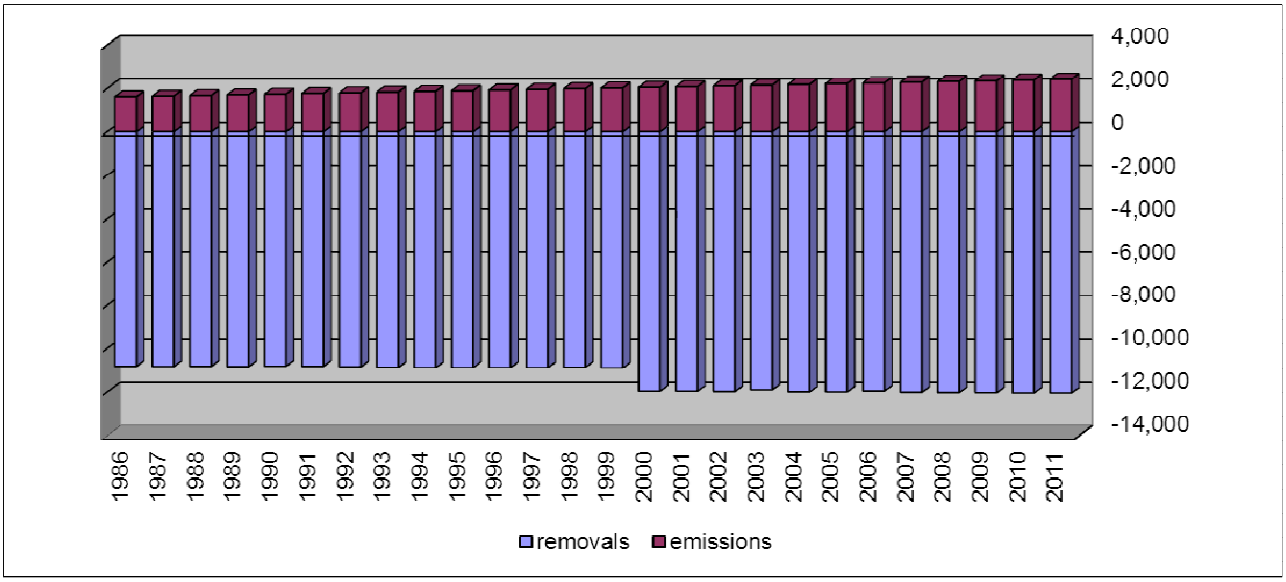


Figure 7.3: LULUCF sector emissions and removals from 1986 to 2011.

7.2 Methodological issues for LULUCF in Slovenia

7.2.1 Land use and land use change in time period 1986 -2011

In previous National Inventory Reports updated version of the Agricultural Land Use Map (ALUM) of Ministry of Agriculture, Forestry and Food (MAFF) was used. Two versions of ALUM map were used to capture land use changes: the one published in the year 2002 and the other published in 2012. This is the first Slovenian database, where directly comparable data could be used for estimation of land use change. This enabled us acquiring a much better estimation of land use cover trends, as compared to the former auxiliary and less accurate data source used to land use cover change in earlier reports.

The ALUM 2002 and 2012 have seven main categories: agricultural land, forest, built-up areas and related surfaces, swamps and other marshy areas, dried open areas with special vegetation, open areas with little or no vegetation and on the end waters (Table 7.2.2 and Table 7.2.3). According to IPCC GPG 2003 Slovenian land use category the agricultural land is separated on two categories cropland and grassland, and categories dried open areas with special vegetation, open areas with little or no vegetation are in the one class (see Table 7.2.4).

Rules and information on data processing, analysis and assessment of ALUM is defined in Slovenian legislan, in act: Rules on evidence of actual agricultural and forestal land use (UL 122/2008). ALUM is publicly available on internet on URL: http://rkg.gov.si/GERK/WebViewer .

ALUM is Slovenian implementation of LPIS – Land parcel indentification system – which is led and coordinated by European Commision (http://ies.jrc.ec.europa.eu/our-activities/support-for-member-states/lpis-iacs.html).

Definitions about specific land use from GPG 2003 for Slovenia are described below.

Definition of forest: Land spanning more than 0.25 hectares with trees higher than 5 meters and canopy cover more than 10 percent, or trees able to reach this threshold *in situ.* It includes abandoned agricultural land with natural expansion of forest. Abandoned agricultural land on area more than 0.5 ha, which have been abandoned for more than 20 years, with minimal tree height 5.00 m and have a tree crown cover between up to 75 % are defined as forests.

Definition of cropland:

- **Annual:** arable land breed more than 2 meters and grow the non woody vegetation (cereals, potatoes, forage crops, vegetable crops, oilseed, ornamental plants, herbs, strawberries, hop fields...) and agricultural fallow ground. Also temporary meadows and greenhouses.

- **Perennial:** permanent crops on arable land such as vineyards, extensive and intensive orchards, olive groves, nursery (for grapevines, fruit and forest trees), forest plantations and forest trees on agricultural land.

Table 7.8: Categories in ALUM in 2002

Main category	National class ID	remarks
Arable land		
	1100	Arable land
	1160	Hop fields
	1211	Vineyards
	1221	Intensive orchards
	1222	Extensive orchards
	1230	Olive groves
	1240	Other permanent crops
	1310	Intensive meadows and pastures
	1321	Swampy meadows and pastures
	1322	Extensive meadows and pastures
	1410	Overgrown areas
	1420	Forest plantation
	1500	Mixed land use areas (arable land and forest, small areas)
Forest		
	2000	Forest
Built-up areas and related surfaces		
	3000	Built-up areas and related surfaces
Marshy areas		
	4100	Swamps
	4210	Reeds
	4220	Other marshy areas
Dried open areas with special vegetation		
	5000	Dried open areas with special vegetation
Dried open areas with special vegetation		
	6000	Open areas with little or no vegetation
Waters		
	7000	Waters

Definition of grassland: Agricultural areas grown by grass and other herbs that are regularly cut or grazed. These areas are not in tillage or fallow ground. Included are areas covered with some of forest trees (less than 50 trees / ha) and the alpine pastures too. In this class

there are swamp pastures and meadows on organic or mineral-organic soils, where the groundwater rises few times in the year. It includes also uncultivated agriculture land.

Definition of wetlands: there are fens and raised bogs. Vegetation is higher than swamp pastures and meadows and there is no cutting of the grass or grazing. There are the areas with reeds and low placed areas frequently floated. All that areas are not in agricultural use. In this class there are the inland water bodies (major rivers, lakes and water reservoirs) too. *Definition of settlements:* all piece of land where the buildings, roads, parking places, mines, stone pits and all other infrastructure are in human use.

Definition of other land: non-forest land covered with vegetation lover than 2 meters or covered less than 75 percent, which is not used in agriculture. There are inbuilt areas with little or no vegetation as rocks, sands, sand banks (bigger than 5000 m2), waste and other opened areas. This is all land that is not classified in other land use definitions.

Table 7.9: Categories in ALUM in 2012

Main category	National class ID	remarks
Arable land		
	1100	Arable land
	1130	Temporary meadows
	1160	Hop fields
	1180	Other permanent crops on arable land
	1190	Green houses
	1211	Vineyards
	1212	Nursery
	1221	Intensive orchards
	1222	Extensive orchards
	1230	Olive groves
	1240	Other permanent crops
	1300	Meadows and pastures
	1321	Swampy meadows and pastures
	1330	Alpine meadows
	1410	Overgrown areas
	1420	Forest plantation
	1500	Mixed land use areas (arable land and forest, small areas)
	1600	Uncultivated agriculture land
	1800	Forest trees on agricultural land
Forest		
	2000	Forest
Built-up areas and related surfaces		
	3000	Built-up areas and related surfaces
Marshy areas		
	4100	Swamps
	4210	Reeds
	4220	Other marshy areas
Dried open areas with special vegetation		
	5000	Dried open areas with special vegetation
Dried open areas with special vegetation		
	6000	Open areas with little or no vegetation
Waters		
	7000	Waters

In NIR 2009 in the area of forest land three National land use classes were included: forest (ID 2000), overgrown areas (ID 1410) and dried open areas with special vegetation (ID 5000). The last category (ID 5000) is not comparable with definition of forestland. So that class is now in category Other land.
Distribution of national classes of land uses from ALUM into six main categories from GPG IPCC 2003 are presented in next tables (Table 7.8, Table 7.9 and
Table 7.11).

Table7.123: Uncertainties for ALUM database.

	% errors in land use
ALUM 2002 (agricultural land use map)	4,68
ALUM 2012	4,68 or less

Table 7.11: Categories from ALUM 2002 and 2012 delivered in six main categories from GPG IPCC 2003.

LULUCF category	LULUCF sub-category	National class ID	Category description
FOREST LAND	FL	2000	Forest
CROPLAND	CL_a	1100	Arable land
	CL_a	1130	Temporary meadows
	CL_a	1160	Hop fields
	CL_a	1190	Green houses
	CL_w	1180	Other permanent crops on arable land
	CL_w	1211	Vineyards
	CL_w	1212	Nursery
	CL_w	1221	Intensive orchards
	CL_w	1222	Extensive orchards
	CL_w	1230	Olive groves
	CL_w	1240	Other permanent crops
	CL_w	1420	Forest plantation
GRASSLAND	GL_a	1300	Meadows and pastures
	GL_a	1321	Swampy meadows and pastures
	GL_a	1330	Alpine meadows
	GL_a	1600	Uncultivated agriculture land
	GL_w	1410	Overgrown areas
	GL_w	1500	Mixed land use (arable land and forest, small areas)
	GL_w	1800	Forest trees on agricultural land
WETLANDS	WL	4100	Swamps
	WL	4210	Reeds
	WL	4220	Other marshy areas
	WL	7000	Waters (inland water bodies)
SETTLEMENTS	SL	3000	Built-up areas and related surfaces
OTHER LAND	OL	5000	Dried open areas with special vegetation
	OL	6000	Open areas with little or no vegetation

The cropland is separated in two subcategories: annual and perennial (woody) cropland.

Land use change matrix

The land areas in the period 1986-2012 are represented by geographically explicit land-use data with a resolution of 0.25 hectare (following approach 3 for representing land areas; IPCC 2003). Direct and repeated assessment of land use with full spatial coverage also enables to calculate spatially explicit land-use change matrices. In 2002 the new Slovenian land-use map (ALUM) has been launched from Ministry for agriculture, forestry and food (MAFF, now Ministry of agriculture and environment, MAE). The method is continuously repeated at MAE. We took the latest available map, the 2012 map. With these two maps of land use we could find out the land use changes between period 2002 and 2012. The annual figures for areas in transition between different land uses have been derived from basic assumption (informed by expert judgment) that known patterns of land use changes in Slovenia are constant. To estimate the land use and land-use change for each year in that period, a spatial extrapolation based on the presently available ALUM data was made. For previous period from 1986 till 2002 the same annual changes were applied.

Table 7.125: The average annual land use change matrix for IPCC land use categories.

		to							
	2002-2012	**FL**	**CL_a**	**CL_w**	**GL**	**WL**	**SL**	**OL**	**total [ha/year]**
from	**FL**		71	155	2,728	58	584	215	**3,811**
	CL_a	129		290	4,885	23	424	0	**5,751**
	CL_w	132	192		1,322	2	208	0	**1,856**
	GL	3,815	2,246	1,004		136	938	34	**8,174**
	WL	55	14	1	300		72	19	**461**
	SL	247	112	516	1,569	22		5	**2,471**
	OL	279	1	1	746	12	11		**1,049**
	total [ha/year]	**4,656**	**2,636**	**1,967**	**11,551**	**252**	**2,237**	**273**	**23,573**

kha	FL	CL_a	CL_w	GL_a	GL_w	WL	SL	OL	total_2002
FL		0.1	0.2	1.8	0.9	0.1	0.6	0.2	3.9
CL_a	0.1		0.3	4.6	0.3	NO	0.4	NO	5.7
CL_w	0.1	0.2		1.1	0.2	NO	0.2	NO	1.8
GL_a	1.9	2.2	0.9		2.2	0.1	0.8	NO	8.1
GL_w	1.9	0.1	0.1	0.9		0.1	0.1	NO	3.2
WL	0.1	NO	NO	NO	NO		NO	NO	0.1
SL	0.2	NO	NO	NO	NO	NO		NO	0.2
OL	0.3	NO	NO	NO	NO	NO	NO		0.3
total_2012	4.6	2.6	1.5	8.4	3.6	0.3	2.1	0.2	23.3

Method for establishing land use change matrix:

Vector data of map 2002 and 2012. Rasterizing the data to pixel 10m x 10m. Reclassifying according to
Table 7.11. With crosstabulation of raster data, we got the land use change matrix.

The results:

The results presented in land use change matrix (Table 7.125) are very high for our county. According to this results, 1.3 % of country area changes land use in one year, 13.2 % of the country in 10 years (2002-2012), which is non-realistic for Slovenia. The reason for this high percentage is mainly in methodology. Majority of the converted areas is in small land use changes that occur due to the differences in polygons borders. We made a survey (Zizek Kulovec, Nastran, 2013) in discovering discrepancies for deforestation (land converted from forest land). The results show that the results in land use change matrix are approximately 7-times higher than the actual change in nature. We plan to continue our effort in establishing the land use change matrix, which will more realistically represent the actual land use changes in country.

Table 7.126: Areas for land uses from 1986 to 2011 in kha.

Year	5. Total	5.A Forest Land	5.B. Cropland	5.C Grassland	5.D Wetland	5.E Settlement	5.F Other land
	kha	kha	kha	kha	kha	kha	kha
2011	2,027.30	1,208.75	240.37	424.17	13.98	108.96	31.07
2010	2,027.30	1,207.95	243.49	420.92	14.20	108.89	31.85
2009	2,027.30	1,207.15	246.62	417.67	14.43	108.82	32.62
2008	2,027.30	1,206.34	249.75	414.42	14.65	108.74	33.40
2007	2,027.30	1,205.54	252.88	411.17	14.87	108.67	34.17
2006	2,027.30	1,204.74	256.00	407.92	15.09	108.60	34.95
2005	2,027.30	1,203.94	259.13	404.67	15.31	108.52	35.72
2004	2,027.30	1,203.14	262.26	401.43	15.53	108.45	36.50
2003	2,027.30	1,202.34	265.39	398.18	15.75	108.37	37.27
2002	2,027.30	1,201.54	268.51	394.93	15.97	108.30	38.05
2001	2,027.30	1,200.73	271.64	391.68	16.20	108.23	38.82
2000	2,027.30	1,199.93	274.77	388.43	16.42	108.15	39.60
1999	2,027.30	1,199.13	277.90	385.18	16.64	108.08	40.37
1998	2,027.30	1,198.33	281.03	381.93	16.86	108.00	41.15
1997	2,027.30	1,197.53	284.15	378.68	17.08	107.93	41.92
1996	2,027.30	1,196.73	287.28	375.43	17.30	107.86	42.70
1995	2,027.30	1,195.93	290.41	372.19	17.52	107.78	43.47
1994	2,027.30	1,195.12	293.54	368.94	17.75	107.71	44.25
1993	2,027.30	1,194.32	296.66	365.69	17.97	107.64	45.02
1992	2,027.30	1,193.52	299.79	362.44	18.19	107.56	45.80
1991	2,027.30	1,192.72	302.92	359.19	18.41	107.49	46.57
1990	2,027.30	1,191.92	306.05	355.94	18.63	107.41	47.35
1989	2,027.30	1,191.12	309.18	352.69	18.85	107.34	48.12
1988	2,027.30	1,190.32	312.30	349.44	19.07	107.27	48.90
1987	2,027.30	1,189.52	315.43	346.20	19.29	107.19	49.67
1986	2,027.30	1,188.71	318.56	342.95	19.52	107.12	50.45

Land use areas for each land use were calculated using following equation.

$$Area_{LU,yearofinventory} = Area_{LU,previousinventoryyear} + Area_{landconvertedtoLU} \quad \text{(Equation 1)}$$

$Area_{LU,yearof\ inventory}$ - area of selected land use category in year of inventory [ha]
$Area_{LU,previousinventoryyear}$ - area of selected land use category in previous year [ha]
$Area_{landconvertedtoLU}$ - area of land converted to selected land use category [ha]

7.2.2 Carbon stocks in litter and soils

The existent databases in Slovenia were not established to be used for mineral soil carbon pool and litter pool assessment. For our assessment there are a total of 909 soil profiles (mineral soil) descriptions with analytical data. Soil database includes data about soil physiscal and chemical properties, but no data of soil bulk density, so pedotransfer functions were used.

LITTER

The separate estimate of carbon stock in O_l, O_f and O_h sub horizon was provided, due to fact that each organic subhorizon were sampled within an area of 25 × 25 cm. separately. Volume of roots and coarse fragments (soil skeleton > 2 mm) were subtracted from volume of soil sample. Carbon stock in litter was calculated according to equation 4:

$$C_{pool} = \sum_{i=1}^{k} (\%C_{org,i} \cdot M_{105°C,i} / 100) \quad \text{(Equation 2)}$$

C_{pool} - carbon stock [Gg ha^{-1}]
C_{org} - the organic carbon content and clay content (both in %)
$M_{105°C,i}$ - quantity [Gg ha^{-1}] of dry soil in sub horizon i
k - number of soil horizon in soil profile

Table 7.127: Average carbon stock in litter (from 8x8km grid survey).

	average carbon stock [t ha^{-1}]	n
O_l horizon	1.44 ± 0.15	143
O_{fh} horizon	8.85 ± 1.42	145
litter (O_l + O_{fh})	**10.41 ± 1.50**	**143**

SOILS

Carbon stock in mineral part of soil (SOM) was calculated from the following equation 2.

$$C_{pool} = \sum_{i=1}^{k} (\%C_{org,i} \cdot d_i \cdot \rho_i \cdot 100) \qquad \text{(Equation 3)}$$

C_{pool} - carbon stock [Gg ha^{-1}]
D_i - thickness [m] of soil horizon I
ρ_i - soil bulk density [g cm^{-3}]
k - number of sub horizon in soil profile

Because no measurements of bulk density were available, the soil bulk density [g/cm^3] was estimated from the following transfer function, equation 3.

$$\rho_i = \begin{cases} 1/(0{,}625 + 0{,}05 \cdot \%C_{org} + 0{,}0015 \cdot \%clay) \rightarrow if\ \%C_{org} \le 5\% \\ 1{,}55 - 0{,}0814 \cdot \%C_{org} \rightarrow if\ 5\% < \%C_{org} \le 15\% \\ 0{,}725 - 0{,}337 \cdot \log_{10} \%C_{org} \rightarrow if\ \%C_{org} \ge 15\% \end{cases} \qquad \text{(Equation 4)}$$

ρ_i - soil bulk density [g cm^{-3}]
C_{org} - the organic carbon content and clay content (both in %)

The top equation for mineral soils is based on data by Hoekstra and Poelman (1982), the bottom equation for peat(y) soils is derived from Van Wallenburg (1988) and the central equation is a linear interpolation (for clay=0) between the two (Reinds *et al*. 2001).

Carbon stock in mineral part of soil (SOM) was calculated for 0–30 cm soil depth. For soil horizons with the depth of the lower boundaries below 30 cm, a constant value of carbon stock within horizon were assumed.

Table 7.128: Average carbon stock (SOC) on 30 cm depth in mineral part of soil.

Land use	Average carbon stock [t ha^{-1}]	n
Cropland annual	100	187
Cropland perrenial	68	31
Forest land	105	318
Grassland	107	407

For improvements of carbon stock data for litter and mineral soil we re-analyzed (chemical and physical properties: Corg, texture) archived soil data and recalculation of changes in Carbon stock in mineral soil depth 0–20 cm, include carbon stock data for litter and soil organic matter from 8×8 km grid survey (from 145 plots).

Table 7.129: Average carbon stock in mineral soils for forest land (from 8x8km grid survey).

	average carbon stock [t ha^{-1}]	n
M_{10} horizon	35.25 ± 2.06	141
M_{40} horizon	68.32 ± 6.22	136
Mineral soils	**103.31 ± 7.90**	**136**

For estimation of temporal changes in carbon stock and changes due to land conversion, the YASSO07 model will be used. Local pedotransfer functions will be developed for improvements of bulk density estimation. This will enable us use soil profile from the past, for which data about soil bulk density were not available.

7.3 Forest Land (5A)

7.3.1 Source category description

Forest land category includes CO_2 emissions from changes in carbon stock in living biomass (above and below ground biomass), in dead organic matter (dead wood and litter) and in soils. Carbon stock changes are reported in Forest land remaining forest land and in Land converted to forest land. Also non-CO_2 emissions from biomass burning are reported.

Area of forest land in Slovenia is 1,208.75 kha and covers 59.6 % of country area. Most Slovenian forests are located within the area of beech, fir-beech and beech-oak sites (70 %), which have a relatively high production capacity. The share of growing stock of coniferous trees is 46.4 %, of deciduous trees 53.6 %. Main tree species are beech (*Fagus sylvatica*), spruce (*Picea abies*), fir (*Abies alba),* oak (*Quercus sp.*) and scotch pine (*Pinus sylvestris*). These species represents 80.0 % of total growing stock (beech – 31.0 %, spruce – 33.9 %, fir – 8.2 %, oak – 5.8 %, pine – 4.1 %).

Majority, 74 % of forests in Slovenia are private property, 26 % of forests are public (owned by the state or communes). Larger and undivided forest estates of state-owned forests enable good professional management. Private forest estates are small, with an average area of only 3 ha and even these are further fragmented into several separate plots. For the great majority of these estates forests are not of economic interest. Private forest property is becoming even more fragmented as the number of forest owners is increasing. According to the latest data there are already 314,000 (with co-owners even 489,000) forest owners in Slovenia. The major fragmentation of forest property, the number of forest owners and co-owners, present a serious obstacle to professional work in private forests, to optimal timber production and utilisation of forest potential (Slovenia Forest Service, 2011).

All forests in Slovenia are considered managed, because forest management plans are prepared for all forests, regardless ownership, conservation degree or natural conditions.

According to Slovenian Act on Forests (1995, section 2) forest land is defined as area overgrown with forest trees in the form of stands or other forest plants which provides any of the functions of a forest. Forest according to this Act also includes overgrown plots of land defined as forest in the spatial element of the forest management plan.

(2) The forest infrastructure not allocated into separate lot is an integral part of the forest land.
(3) The following are not forest within the meaning of this act: individual forest trees, groups of forest trees up to an area of 0.05 hectares, non-autochthonous riverine and windbelt trees, avenues, parks, plantations of forest trees, pens for rearing game, and pastures overgrown with forest trees if used for pasturing, irrespective of how they are described in the land register.
(4) The provisions of this act and regulations issued on the basis hereof shall also apply to forest trees which grow outside forests insofar as they are specifically defined.

According to Slovenian Act on Forests (2007), the definition of forest land was novelated. Forest land area is covered with forest trees in the form of stands with minimal tree height 5 m and with minimal area of 0.25 hectares (2,500 m^2). Abandoned agricultural land on area more than 0.25 ha, which have been abandoned for more than 20 years, with minimal tree height 5.00 m and have a tree crown cover between up to 75 % are defined as forests.

Table 7.130: Activity data for forest land (1986 – 2011) in kha.

Year	A. Total Forest Land	A.1. Forest Land remaining Forest Land	A.2. Land converted to Forest Land	A.2.1 Cropland converted to Forest Land	A.2.2 Grassland converted to Forest Land	A.2.3 Wetlands converted to Forest Land	A.2.4 Settlements converted to Forest Land	A.2.5 Other Land converted to Forest Land
	kha	kha	kha	kha	kha	kha	kha	kha
2011	1,208.7	1,116.7	91.9	4.0	76.0	2.0	4.0	5.9
2010	1,207.9	1,115.9	91.9	4.0	76.0	2.0	4.0	5.9
2009	1,207.1	1,115.1	91.9	4.0	76.0	2.0	4.0	5.9
2008	1,206.3	1,114.3	91.9	4.0	76.0	2.0	4.0	5.9
2007	1,205.5	1,113.5	91.9	4.0	76.0	2.0	4.0	5.9
2006	1,204.7	1,112.7	91.9	4.0	76.0	2.0	4.0	5.9
2005	1,203.9	1,111.9	91.9	4.0	76.0	2.0	4.0	5.9
2004	1,203.1	1,111.1	91.9	4.0	76.0	2.0	4.0	5.9
2003	1,202.3	1,110.3	91.9	4.0	76.0	2.0	4.0	5.9
2002	1,201.5	1,109.5	91.9	4.0	76.0	2.0	4.0	5.9
2001	1,200.7	1,108.7	91.9	4.0	76.0	2.0	4.0	5.9
2000	1,199.9	1,107.9	91.9	4.0	76.0	2.0	4.0	5.9
1999	1,199.1	1,107.1	91.9	4.0	76.0	2.0	4.0	5.9
1998	1,198.3	1,106.3	91.9	4.0	76.0	2.0	4.0	5.9
1997	1,197.5	1,105.5	91.9	4.0	76.0	2.0	4.0	5.9
1996	1,196.7	1,104.7	91.9	4.0	76.0	2.0	4.0	5.9
1995	1,195.9	1,103.9	91.9	4.0	76.0	2.0	4.0	5.9
1994	1,195.1	1,103.1	91.9	4.0	76.0	2.0	4.0	5.9
1993	1,194.3	1,102.3	91.9	4.0	76.0	2.0	4.0	5.9
1992	1,193.5	1,101.5	91.9	4.0	76.0	2.0	4.0	5.9
1991	1,192.7	1,100.7	91.9	4.0	76.0	2.0	4.0	5.9
1990	1,191.9	1,099.9	91.9	4.0	76.0	2.0	4.0	5.9
1989	1,191.1	1,099.1	91.9	4.0	76.0	2.0	4.0	5.9
1988	1,190.3	1,098.3	91.9	4.0	76.0	2.0	4.0	5.9
1987	1,189.5	1,097.5	91.9	4.0	76.0	2.0	4.0	5.9
1986	1,188.7	1,096.7	91.9	4.0	76.0	2.0	4.0	5.9

Table 7.131: Emissions/removals from forestland (1986 – 2011) in Gg CO_2

Year	A. Total Forest Land	A.1. Forest Land remaining Forest Land	A.2. Land converted to Forest Land	A.2. Land converted to Forest Land				
				A.2.1 Cropland converted to Forest Land	A.2.2 Grassland converted to Forest Land	A.2.3 Wetlands converted to Forest Land	A.2.4 Settlements converted to Forest Land	A.2.5 Other Land converted to Forest Land
	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2
2011	-12,042.5	-11,577.8	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2010	-12,040.8	-11,576.1	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2009	-12,028.6	-11,563.9	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2008	-12,024.5	-11,559.8	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2007	-12,013.0	-11,548.3	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2006	-11,947.9	-11,483.2	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2005	-11,993.7	-11,529.0	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2004	-11,989.4	-11,524.7	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2003	-11,888.0	-11,423.2	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2002	-11,972.7	-11,508.0	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2001	-11,954.4	-11,489.7	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
2000	-11,953.2	-11,488.5	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1999	-10,887.1	-10,422.3	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1998	-10,854.7	-10,390.0	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1997	-10,868.1	-10,403.4	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1996	-10,869.1	-10,404.4	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1995	-10,867.4	-10,402.7	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1994	-10,869.0	-10,404.3	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1993	-10,861.4	-10,396.7	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1992	-10,834.3	-10,369.5	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1991	-10,807.9	-10,343.2	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1990	-10,801.0	-10,336.2	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1989	-10,823.8	-10,359.1	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1988	-10,812.5	-10,347.8	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1987	-10,816.1	-10,351.4	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1
1986	-10,808.5	-10,343.8	-464.7	-28.7	-224.3	-39.6	-51.0	-121.1

Removals CO_2 in category forest land range from –10,808.5 Gg CO_2 (1986) to – 12,042.5 Gg CO_2 (2011).

Forest land remaining forest land (CO_2) and Land converted to forest land (CO_2) were identified as key source categories. Concerning the CH_4 or N_2O emissions, forest land remaining forest land and land converted to forest land have not resulted as a key source.

7.3.2 Methodological issues

7.3.2.1 Forestland remaining forestland

In time period from 1986 to 2011 the annual removals were between -10,336.2 Gg CO_2 (1990) and -11,577.8 Gg CO_2 (2011).

Carbon stock changes in living biomass

In accordance with the decision tree provided in the GPG-LULUCF, carbon stock changes in living biomass in Forest land remaining Forest land are estimated by Tier 3, stock change method. The method requires biomass carbon stock inventories at two points in time. Biomass change is the difference between the biomass at two points in time, divided by the number of years between the inventories. Data from national forest inventories (NFI), made in years 2000 and 2007, were used for our calculations.

For calculations the equation 3.2.3 from GPG-LULUFC was used:

$$\Delta C = \frac{(C_{t2} - C_{t1})}{t_2 - t_1} * A \qquad \text{(Equation 5)}$$

ΔC – living biomass [t CO_2]
A – area of forest land [ha]
C_t – total carbon biomass calculated at time t_1 or t_2 [t C]

The carbon stock in living biomass was calculated from the merchantable volume multiplied by wood density (WD), biomass expansion factor (BEF_2), root-to-shoot ratio (R) and carbon fraction of dry matter (CF). These parameters, except carbon fraction of dry matter, are determined separately for tree species.

$$C = (GS_j * WD_j * BEF_{2j}) * (1 + R_j) * CF \qquad \text{(Equation 6)}$$

GS – growing stock
WD – basic wood density
BEF_2 – biomass expansion factor for conversion of merchantable volume to aboveground tree biomass
R – root shoot ratio
j – tree species

Parameters

Growing stock

Growing stock is volume over bark of all living trees more than 9.99 cm in diameter at breast height (1.3 m). Includes the stem from ground to a top diameter of 6.99 cm, and may also include branches to a minimum diameter of 6.99 cm.

The data are from the Slovenian National Forest inventory (NFI). The NFI was carried out in the years 2000 and 2007. Assessment was made on grid 4 x 4 km. Growing stock in 2000 was 283.19 m^3/ha (confidence interval: 269.37 – 297.01 m^3/ha) and in year 2007 was 326.43 m^3/ha (confidence interval: 312.30 – 340.57 m^3/ha).

The NFI increment data include all possible reasons for biomass increments and losses in the forest. That means that biomass increments due to abandonment of managed land or biomass loses due to traditional (non-commercial) fuel wood consumption, forestland conversion, forest fires and other damages are already considered in calculations based on the inventory data.

For the estimation of growing stock of Slovenian forests from 1986 to 2011, the following methodology was applied:

- the initial growing stock volume is from NFI 2000 and NFI 2007;
- the growing stock between these years was interpolated;
- the growing stock from 2000 to year 1986 was extrapolated;
- the growing stock for 2008 - 2011 remains the same as in 2007 (326.43 m^3/ha).

Last NFI was conducted in 2012. Data from NFI 2012 will be available at the end of 2013, recalculations of growing stock for years 2008 – 2012 will be made in 2014 submission.

Table 7.132: Growing stock in Slovenian forests from 1986 to 2011.

Year	Growing stock		Year	Growing stock
	[m^3/ha]			[m^3/ha]
2011	326.4		1997	264.7
2010	326.4		1996	258.5
2009	326.4		1995	252.3
2008	326.4		1994	246.1
2007*	326.4		1993	240.0
2006	320.3		1992	233.8
2005	314.1		1991	227.6
2004	307.9		1990	221.4
2003	301.7		1989	215.2
2002	295.5		1988	209.1
2001	289.4		1987	202.9
2000*	283.2		1986	197.0
1999	277.0			
1998	270.8		* Inventory year	

Table 7.133: Growing stock composition (in percent) by tree species in inventory years.

% of growing stock		year	
Scientific name	Common name	2000	2007
Picea abies	Spruce	33.39	30.94
Fagus sylvatica	Beech	31.65	31.02
Abies alba	Fir	9.27	8.20
Quercus petraea	Oak	5.09	5.75
Pinus sylvestris	Scots Pine	4.09	4.12
Acer pseudoplatanus	Maple	3.24	3.22
Carpinus betulus	Hornbeam	1.62	2.30
Castanea sativa	Chestnut	1.52	1.89
Pinus nigra	Black Pine	1.16	1.57
Ostrya carpinifolia	Hop Hornbeam	0.82	1.25
Remaining		8.15	9.75
TOTAL		100.00	100.00

Biomass expansion factor (BEF_2) and Root-to-shoot ratio (R)

The default value given in the GPG-LULUCF (Table 3A.1.10) has been adopted in calculations (BEF_2 = 1.15 for conifers and broadleaves). Values were used from lower limits of the range (for temperate climatic zone), because they are more suitable for mature forests or those with high growing stock.

For two tree species – fir (*Abies alba)* and oak (*Quercus sp.)* the national biomass expansion factor (BEF_2) and Root-to-shoot ratio (R) are in determination.

Root-to-shoot ratio (R) values were adopted from Table 3A.1.8. Mean values (aboveground biomass > 150 t/ha) for conifers (0.23) and for broadleaves (0.24) were used.

Wood density (WD)

According to analyses of national data from previous researches done by Slovenian Forestry Institute (SFI), basic wood density is for *Fagus sylvatica* (WD = 0.584 t/m^3) and *Alnus glutinosa* (WD = 0.445 t/m^3). These national data are not different from default values in table 3A.1.9-1 of GPG LULUCF. Further analyses on the approach and methodology are in progress (will be finished until 2012).

Carbon fraction of dry matter (CF)

The default value given in the GPG-LULUCF has been adopted as the carbon fraction of dry matter (CF = 0.5 t C/ t d.m.).

Table 7.134: Parameters (WD, BEF_2, R and CF) used for selected tree species.

Common name	WD	BEF2	R	CF
	[t/m^3]	[dimensionless]	[dimensionless]	[t C/ t d.m.]
Spruce	0.400	1.15	0.23	0.50
Beech	0.584	1.15	0.24	0.50
Fir	0.400	1.15	0.23	0.50
Oak	0.580	1.15	0.24	0.50
Scotch Pine	0.420	1.15	0.23	0.50
Maple	0.520	1.15	0.24	0.50
Hornbeam	0.630	1.15	0.24	0.50
Chestnut	0.480	1.15	0.24	0.50
Black Pine	0.420	1.15	0.23	0.50
Hop Hornbeam	0.630	1.15	0.24	0.50

Carbon stock changes in dead organic matter

In accordance with the decision tree provided in the GPG-LULUCF, carbon stock changes in dead organic matter in Forest land remaining Forest land are estimated by Tier 2, in acoordance with equation 3.2.10. from GPG- LULUCF.

$$\Delta C_{FF_{DOM}} = \Delta C_{FF_{DW}} + \Delta C_{FF_{LT}} \quad \textbf{(Equation 7)}$$

$\Delta C_{FF_{DOM}}$ **– annual change in carbon stocks in dead organic matter [t C yr $^{-1}$]**

$\Delta C_{FF_{DW}}$ **– change in carbon stocks in dead wood [t C yr $^{-1}$]**

$\Delta C_{FF_{LT}}$ **– change in carbon stocks in litter [t C yr $^{-1}$]**

Dead wood content is all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. According to definition from NFI 2007, dead wood in Slovenia includes:

- dead trees (DBH > 10 cm);
- stumps (D > 10 cm and H > 20 cm);
- snags (D > 10 cm and H > 50 cm);
- coarse woody debris (D > 10 cm and L > 50 cm).

National data on the stock of dead wood are available just from the NFI 2007. So the dead wood biomass for year 2000 and 1990 was estimated applying with dead mass conversion percent from dead wood in NFI 2007, as only available information. For calculations the equation 3.2.12 from GPG-LULUFC was used.

$$\Delta C_{FF}(DW) = \left[A * \frac{(B_{t2} - B_{t1})}{T} \right] * CF \quad \textbf{(Equation 8)}$$

$\Delta C_{FF}(DW)$ – annual change in carbon stocks in dead wood [t yr $^{-1}$]
A – area of managed forest land remaining forest land [ha]
B_{t2} – dead wood stock at time t_2 for managed forest remaining forest [t d.m.]
B_{t1} – dead wood stock at time t_1 for managed forest remaining forest [t d.m.]
T – time period between t_1 and t_2 [yr]
CF – carbon fraction of dry matter [t d.m.]

According to NFI 2007 the dead wood stock was 8.97 t d.m./ha (18.56 m^3/ha). That represents 5.69 % of growing stock. For year 2000 value for dead wood stock was 7.47 t d.m./ha (16.12 m^3/ha) and for year 1990 was 5.83 t d.m./ha (12.60 m^3/ha).

Planned NFI 2012 will also include measurements and data of dead wood stock. Then we will have reliable data for years 2007 and 2012, because the dead wood stock will be measured and assessed with the same methodology as in the 2007 NFI. We will explore more accurate methodologies for the estimation of the carbon stock changes in dead wood for the years prior to 2007.

For calculations of carbon stock changes in litter Tier 1 methodology was used. Under Tier 1, it is assumed thet the average transfer rate into the litter pool is equal to the transfer rate out of the litter pool, so the net change is zero. Results of our preliminary expertise for period 1996 – 2006 (Kobal M., Simoncic P., 2011), show relative stable carbon stocks in litter in forest land remaining forest land. Results are explained in 'carbon stock changes in soils'. We are going to reinvestigate the current research objective and national available data.

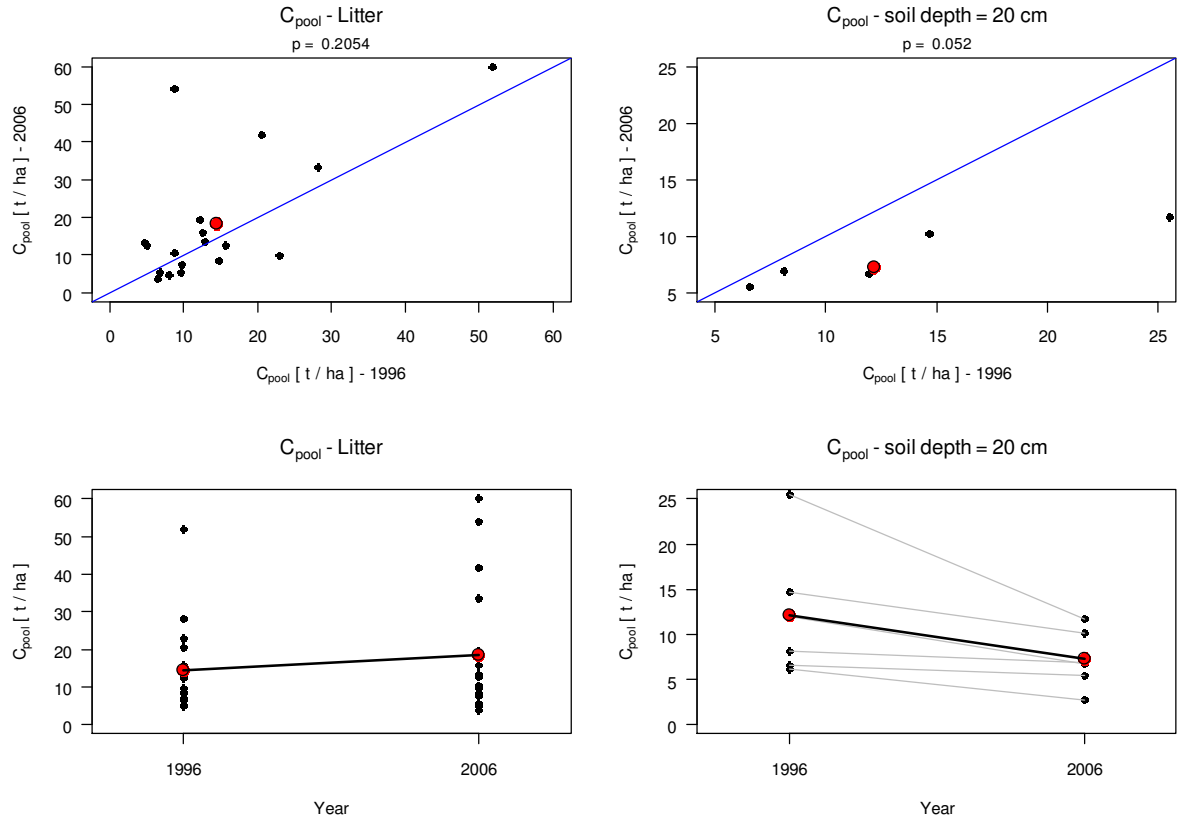
Carbon stock changes in soils

In accordance with GPG-LULUCF, carbon stock changes in soils are estimated by Tier 1 methodology. Under Tier 1, it is assumed that when forest remains forest, the carbon stock in soil organic matter does not change, regardless of change in forest management, types, and disturbances regimes; in other words that the carbon stock in mineral soil remains constant so long as the land remains forest. Results of our preliminary expertise for period 1996 – 2006 (Kobal M., Simoncic P., 2011), show relative stable carbon stocks in forest soils.

Changes in carbon stock in litter and soils in forest land remaining forest land in period 1996 – 2006

For year 1996, at each plot, three soil subsamples were taken for organic (Litter) and mineral layer (SOM). For mineral part of soil, samples were taken with soil auger (∅ = 7 cm) at fixed depth (0–5, 5–10 and 10–20 cm) and for organic layer within 25 × 25 cm square. Subsamples were taken 5 m apart from plot centre, 120°clockwise and were combined for laboratory analysis (composite samples). Volume of roots and coarse fragments (soil skeleton > 2 mm) were subtracted from volume of soil sample. For year 2006, soil survey was made according to methodology for BioSoil demonstration project. Soil subsamples for organic and mineral layer were taken as in year 1996, with 5 replicates in each plot (centre of a plot and celestial direction). Volume of roots and coarse fragments were subtracted from volume of soil sample. For evaluation of temporal changes paired t-test was performed.

Figure 7.4: Carbon stock in forest soils and litter (1996-2006).



The carbon stock changes in litter slightly increase from year 1996 to year 2006, when national forest soil surveys as a part of ICP Forest and BioSoil Soil demonstration projects/surveys, were carried out. The differences for litter stock changes are not statistically significant (p = 0.205). Carbon stock changes in mineral soils for the same period decrease, but the changes are not significant (p = 0.052).

Preliminary results on limited number of sampling plots, show us relative stable carbon stocks in forest soils for observed period with insignificant differences between organic - litter layers and also for mineral layer. If we take in account literature values for central European forests, in the moment, we conclude that there are not significant changes in forest soils within periods e.g. 5-10 years if the land use is not changed (forest remaining forest; source: SFI project report 2011). For final conclusions we will proceed with analysis of existing historical and archived soil and litter data, partly additional soil sampling and new, improved recalculations (future improvements).

7.3.2.2 Non-CO_2 greenhouse gas emission

N_2O Emissions from N Fertilization and Drainage of Soils

Fertilization of forests is not usual in Slovenia – this is not a common practice. Therefore, no emissions are reported in CRF Table 5(I).

Drainage of forests is not common practice in Slovenia. There are no survey data available, but the drained area is probably very small, if existing at all.

Emissions from Wildfires

As controlled burning is not allowed in Slovenia, all fires are assigned to "wildfires". It is assumed that all fires affected productive forests. The area of wildfires in Slovenia is very small, less than half percent in the year 2003, which was the most problematic year in the following period. For calculations the Tier 2 (country level estimated of area burned) was used and estimation of GHGs directly released in fires.

For calculations for emissions from wildfires the equation 3.2.20 was applied.

$$Lfire[tGHG] = A * B * C * D * 10^{-6} \quad \text{(Equation 9)}$$

A – area burnt [ha]
B – mass of available fuel [kg d.m. ha $^{-1}$]
C – combustion efficiency (Table 3A.1.12 in IPCC GPG – LULUCF 2003)
D – emission factor (Table 3A.1.16 in IPCC GPG – LULUCF 2003)

For all GHG, the default emission factors were applied (IPCC 2003, Table 3A.1.16). Values for emission factors for forest fires were adopted.

Table 135: Emission factors used from Table 3A.1.16 (GPG- LULUCF)

Gas		Emission factor (D)
		[g / kg d.m.]
CO_2	carbon dioxide	1580
CO	carbon oxide	130
CH_4	methane	9
NO_x	nitrogen oxide	0,7
N_2O	nitrous oxide	0,11
NMHC	non methane hydrocarbons	10

Mass of availble fuel (B) was calculated from average growing stock in the part of country, where the majority of the wildfires occur (Karst region). The fraction of the biomass combusted (C = 1–0545) was adopted from Table 3A.1.12 (GPG-LULUCF). Inserting these values in equation 3.2.20 of IPCC (2003), the GHG emissions shown in Table 7.136 were calculated.

Table 7.136: Productive forest land affected by wildfires and resulting GHG emissions 1986-2011.

Year	Area	Mass of available fuel	CO_2	CO	CH_4	NO_x	N_2O	NMHC
	ha	t d.m. / ha	t	t	t	t	t	t
2011	159.08	86.37	9,768.7	803.8	55.6	9.2	0.7	131.6
2010	52.06	86.37	3,196.9	263.0	18.2	3.0	0.2	43.1
2009	114.73	86.37	7,045.3	579.7	40.1	6.6	0.5	94.9
2008	46.69	86.37	2,867.1	235.9	16.3	2.7	0.2	38.6
2007	98.61	86.37	6,055.4	498.2	34.5	5.7	0.4	81.6
2006	1,022.81	86.37	62,808.5	5,167.8	357.8	58.1	4.4	829.9
2005	142.23	86.37	8,734.0	718.6	49.8	7.9	0.6	113.2
2004	76.87	86.37	4,720.4	388.4	26.9	4.2	0.3	60.0
2003	1,592.84	86.37	97,812.8	8,047.9	557.2	85.2	6.8	1,217.6
2002	77.47	86.37	4,757.3	391.4	27.1	4.1	0.3	58.0
2001	240.36	86.37	14,760.0	1,214.4	84.1	12.3	1.0	176.2
2000	124.14	86.37	7,623.2	627.2	43.4	6.2	0.5	89.1
1999	321.10	86.37	19,718.0	1,622.4	112.3	15.8	1.4	225.4
1998	725.10	86.37	44,526.8	3,663.6	253.6	34.8	3.1	497.6
1997	383.33	86.37	23,539.4	1,936.8	134.1	18.0	1.6	257.0
1996	243.75	86.37	14,968.1	1,231.6	85.3	11.2	1.0	159.6
1995	148.88	86.37	9,142.4	752.2	52.1	6.7	0.6	95.2
1994	n.a.	86.37	NE	NE	NE	NE	NE	NE
1993	n.a.	86.37	NE	NE	NE	NE	NE	NE
1992	319.37	86.37	19,611.8	1,613.6	111.7	13.2	1.4	189.2
1991	624.90	86.37	38,373.7	3,157.3	218.6	25.2	2.7	360.3
1990	615.77	86.37	37,813.1	3,111.2	215.4	24.2	2.6	345.4
1989	120.00	86.37	7,368.9	606.3	42.0	4.6	0.5	65.4
1988	181.75	86.37	11,160.9	918.3	63.6	6.7	0.8	96.3
1987	n.a.	86.37	NE	NE	NE	NE	NE	NE
1986	n.a.	86.37	NE	NE	NE	NE	NE	NE

All data related to burned areas are based on databases of Slovenia Forest Service (SFS). The areas are indentified and geo-located. The annual data related to fires are annually published by SFS. All GHG emission from forest fires are reported under Forest land remaining Forest Land.

7.3.2.3 Land converted to forest land

Data for land use change from other land use to forestland are described in chapter 7.2.1 and chapter 7.2.2. For the calculation of the annual change in carbon stocks in other land converted to forestland the IPCC GPG Tier 2 approach is used.

The average annual area converted from other land uses to forest land is 4.6 kha, according to land use change matrix. As described in chapter 7.2.1 the land use change to forests mainly appear from grassland and from cropland (Table 7.2.8). When conversion from cropland or grassland to forest land occurs, based on ALUM data, no distinction is made about intensity of forest management. Conversions to forest land are not direct human induced, the areas are under spontaneously expansion of forest. However, SFS

system of forest management differentiates forest lands covered by management plans according to production function and other ecological and social functions.

Definition of forest (Slovenian Forestry Act) related to management plans: Land spanning more than 0.25 hectares with trees higher than 2 meters and canopy cover more than 30 percent, or trees able to reach these threshold in situ. It includes abandoned agricultural land (cropland, grassland) with natural expansion of forest (covered with trees 20-75 %). When natural expansion during more than 20 years or more, trees covered more than 75 % and diameter in breast hight (DBH) is more than 10 cm, this land becomes forest.

Carbon stock changes in living biomass

The carbon stock change of living biomass has been calculated taking into account the increase and the decrease of carbon stock related to the areas in transition into forest land. The annual increment of stem wood over bark on areas which converted to forests was estimated with 2,16 m^3/ha (Wisdom Slovenia, 2006). For the calculation the equation 3.2.23 (following equations 3.2.4 and 3.2.5) from GPG LULUCF was used. No distinction between intensively and extensively managed forests was made, because all land converted to forest land are managed extensively (naturally regenerated forests with minimum human intervention).

$$\Delta C_{LF\ growth} = A * G_{total} * CF \qquad \text{(Equation 10)}$$

A – area of land converted to forest land [ha]
G_{total} – average annual increment rate in total biomass in units of dry matter[t d.m. ha $^{-1}$ yr $^{-1}$]
CF – carbon fraction of dry matter (default = 0.5 t C / t d.m.]

$$G_{total} = G_W * (1 + R)$$

G_W – average annual aboweground biomass increment [t d. m. ha $^{-1}$ yr $^{-1}$]
R – root shoot ratio appropriate to increments

$G_W = I_v * WD * BEF_1$
I_v – average annual net increment [m^3 ha $^{-1}$ yr $^{-1}$]
WD – basic wood desity [t d.m. m^{-3}]
BEF_1 – biomass expansion factor for conversion of annual net increment (including bark) to aboveground tree biomass increment

BEF_1 values were used according to table 3A.1.10 (GPG LULUCF, 2003) for temperate climatic zone. Values from the upper limit of the range (representing young forests or forests with low growing stock) were taken: BEF_1= 1.3 for conifers and for broadleaves.

Average wood densities were used for conifers (WD = 0.400 t d.m. m^{-3}) and for broadleaves (WD = 0.580 t d.m. m^{-3}).

Average annual increment (I_v) on areas converted to forestland was 2.16 m^3 ha $^{-1}$ yr $^{-1}$ (Wisdom Slovenia, 2006, p. 57, class 1410).

Root-to-shoot ratio (R) values were adopted from Table 3A.1.8. Mean values for conifers (R = 0.46; aboveground biomass <50 t/ha) and for broadleaves (R = 0.43; aboveground biomass <75 t/ha) were used.

Table 7.137: Factors for calculation of CO_2 accumulation in land converted to forest land.

	I_v	WD	R	BEF_1
	[m^3 ha^{-1} yr^{-1}]	[t d.m. m^{-3}]	[dimensionless]	[dimensionless]
Conifers	2.16	0.400	0.46	1.3
Broadleaves	2.16	0.580	0.43	1.3

Carbon stock changes in dead organic matter

In the Tier 1 calculation, the average transfer rate into dead wood pool equals the transfer rate out of the dead wood pool. The net change is therefore equal to zero.

It is assumed (Tier 1, default) that the litter carbon stocks in non-forest lands converting to forests are stable. Slovenia does not experience significant changes in forest types or management regimes. The net effect of emission and removal factors is therefore equal to zero (GPG-LULUCF).

Carbon stock changes in soils

For calculations of carbon stock changes in soils in land converted to forest land the Tier 2 method was applied, using equation 3.2.31 form GPG-LULUCF. As mentioned before no distinction between intensively and extensively managed forests was made, because all land converted to forest land are managed extensively (naturally regenerated forests with minimum human intervention).

$$\Delta C_{LF\,\mathrm{min}\,eral} = \frac{\lfloor (SOC_{ExtForest} - SOC_{non-forestland}) * A_{ExtForest} \rfloor}{T_{ExtForest}} \qquad \textbf{(Equation 11)}$$

$\Delta C_{LFmineral}$ – annual change in carbon stock in mineral soils [t C yr^{-1}]
$SOC_{Ext\ Forest}$ – stable soil organic carbon stocks of the new, extensively managed forest [t C ha^{-1}]
$SOC_{non\text{-}forestland}$ – soil organic carbon stocks of the non-forest land prior to its conversion [t C ha^{-1}]
$A_{Ext\ Forest}$ – land area [ha]
$T_{Ext\ Forest}$ – time [default 20 years]

$SOC_{Ext\ Forest} = SOC_{ref} * f_{forest\ type} * f_{man\ intensity} * f_{dist\ regime}$

SOC_{ref} - SOC_{30} - Slovenian national value for organic carbon stock in mineral soil for forest land [t C ha^{-1}]
$f_{forest\ type}$ – adjustment factor for a forest typoe different from the native forest vegetation
$f_{man\ intensity}$ – adjustment factor for the effect of management intensity
$f_{dist\ regime}$ – adjustment factor reflecting the effect on SOC of a disturbance regime different from the natural ones

Country specific value for SOC_{ref} (SOC_{30} = 105 t C ha^{-1}) was determined from national soil profiles data and it is presented in Table 7.128. Also values for soil organic stock of previous land uses ($SOC_{non\text{-}forestland}$: grassland = 107 t C ha^{-1}, cropland perrenial = 68 t C ha^{-1}, cropland annual = 100 t C ha^{-1},) are presented in Table 7.128 and used in calculations. According to spontaneously expansion of forest on converted areas, with minimum human

intervention, values for adjustment factors ($f_{forest\ type} = f_{man\ intensity} = f_{dist\ regime} = 1.00$) were used.

7.3.3 Uncertainties and time-series consistency

A process of using models to time-shift the forest estate forwards to represent future forest growth and forest managed, and backwards to improve historical estimates, is performed to minimize errors. As the estimation of carbon stocks is continuously being improved, both past and future will be recalculated.

The NFI is based on a very comprehensive quality assurance system, which allows the exact identification of the right location of the grid and sample points guarantees the repeated measurement of the same trees. It also indicates at once implausible figures for individual parameters during the measurements on site and any missing trees compared to the period before.

One of the goals of NFI 2007 was to obtain accurate and reliable data about the state of volume of wood growing stock (carbon stock) as basis for KP/UNFCCC reporting for all Slovenian forests. Some of indicators from NFI 2007 are in Table 7.3.8.

Table 7.138: Indicators from NFI 2007

Growing stock	326.40 m^3/ha	± 4.30 %
Living trees growing stock	8.65 m^3/ha	± 6.50 %
Dead wood	18.64 m^3/ha	± 16.60 %
Soil and litter	see chapter 7.2.2	

Estimated uncertainty in land managed factors	± 12 % (GPG-LULUCF table 3.3.4)

7.3.4 Source specific QA/QC and verification

The data based on forest statistics are produced by the Slovenian Forestry Institute (SFI). Data descriptions are available in Slovenian language.

QC measures related to national Forestry Inventory data were:

- A manual for NFI was prepared.
- Field instruments were calibrated and checked.
- All methods were tested in pilot inventory in 2006 (grid 16 x 16 km).
- In preparatory phase all field personnel was trained for:
  - correct use equipments,
  - correct measurements and classifications,
  - understanding of the guidelines and specific instructions.
- Verification measurements were carried out during field seasons - 4 teams from SFI were controlling the field measurements and work of Slovenian Forest Service (SFS) teams.
- Field data was entered in data base and checked for major discrepancies.
- All data used for our calculation is saved on our data server and are protected from unauthorized access.

All soil samples (from soil inventory on 8 x 8 km) were delivered and stored in laboratory at SFI according to internal quality management system.

7.3.5 Source specific recalculations

Calculations of emissions from biomass burning were rechecked, mass of available fuel was calculated according to growing stock in Karst region, where the vast majority of the wildfires occur. Recalcuations were also made due to change in activity data (land use change matrix).

7.3.6 Source specific planed improvements

For the 2014 submission the NFI 2012 data will be available, therefore recalculation in living biomas and dead wood emission factors will be implemented. We will also continue our efforts to establish improved land use change matrix and to gather as much as possible information on uncertanties estimates, QA/QC procedures and verification.

7.4 Cropland (5B)

7.4.1 Source category description

Cropland category includes CO_2 emissions from changes in carbon stock in living biomass and in soils. Carbon stock changes are reported in Cropland remaining cropland and in Land converted to cropland. Also CO_2 emissions from agricultural lime application.

Cropland covers 240.37 kha and that represents 11.9 % of country total area. Cropland land use is separated in two subcategories: annual cropland (arable land, temporary meadows, hop fields, green houses) and perrenial cropland (other permanent crops on arable land, vineyards, nursery, intensive orchards, extensive orchards, olive groves, other permanent crops, forest plantation).

Table 7.139: Activity data for cropland (1986 – 2011) in kha

Year	5.B. Total Cropland	5.B. Organic soil	5.B.1. Cropland remaining Cropland	5.B .2. Land converted to Cropland[12]	5.B.2.1 Forest Land converted to Cropland	5.B.2.2 Grassland converted to Cropland	5.B.2.3 Wetlands converted to Cropland	5.B.2.4 Settlements converted to Cropland	5.B.2.5 Other Land converted to Cropland
	kha	kha	kha	kha	kha	kha	kha	kha	kha
2010	240.9	NE	169.1	71.8	5.8	66.0	NO	NO	NO
2009	244.0	NE	172.2	71.8	5.8	66.0	NO	NO	NO
2008	247.1	NE	175.3	71.8	5.8	66.0	NO	NO	NO
2007	250.2	NE	178.4	71.8	5.8	66.0	NO	NO	NO
2006	253.4	NE	181.6	71.8	5.8	66.0	NO	NO	NO
2005	256.5	NE	184.7	71.8	5.8	66.0	NO	NO	NO
2004	259.6	NE	187.8	71.8	5.8	66.0	NO	NO	NO
2003	262.8	NE	191.0	71.8	5.8	66.0	NO	NO	NO
2002	265.9	NE	194.1	71.8	5.8	66.0	NO	NO	NO
2001	269.0	NE	197.2	71.8	5.8	66.0	NO	NO	NO
2000	272.1	NE	200.3	71.8	5.8	66.0	NO	NO	NO
1999	275.3	NE	203.5	71.8	5.8	66.0	NO	NO	NO
1998	278.4	NE	206.6	71.8	5.8	66.0	NO	NO	NO
1997	281.5	NE	209.7	71.8	5.8	66.0	NO	NO	NO
1996	284.7	NE	212.9	71.8	5.8	66.0	NO	NO	NO
1995	287.8	NE	216.0	71.8	5.8	66.0	NO	NO	NO
1994	290.9	NE	219.1	71.8	5.8	66.0	NO	NO	NO
1993	294.0	NE	222.2	71.8	5.8	66.0	NO	NO	NO
1992	297.2	NE	225.2	72.0	6.0	66.0	NO	NO	NO
1991	300.3	NE	228.3	72.0	6.0	66.0	NO	NO	NO
1990	303.4	NE	231.4	72.0	6.0	66.0	NO	NO	NO
1989	306.5	NE	234.5	72.0	6.0	66.0	NO	NO	NO
1988	309.7	NE	237.7	72.0	6.0	66.0	NO	NO	NO
1987	312.8	NE	240.8	72.0	6.0	66.0	NO	NO	NO
1986	315.9	NE	243.9	72.0	6.0	66.0	NO	NO	NO

Table 7.140: Emission from cropland (1986 – 2011) in Gg CO_2

Year	5.B. Total Cropland	5.B.1. Cropland remaining Cropland	5.B.2. Land converted to Cropland	5.B.2.1 Forest Land converted to Cropland	5.B.2.2 Grassland converted to Cropland	5.B.2.3 Wetlands converted to Cropland	5.B.2.4 Settlements converted to Cropland	5.B.2.5 Other Land converted to Cropland
	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2
2010	433.4	61.0	372.4	135.9	236.5	NO	NO	NO
2009	431.0	61.0	370.0	133.5	236.5	NO	NO	NO
2008	428.7	61.0	367.6	131.2	236.5	NO	NO	NO
2007	426.3	61.0	365.3	128.8	236.5	NO	NO	NO
2006	424.0	61.0	362.9	126.5	236.5	NO	NO	NO
2005	421.6	61.0	360.6	124.1	236.5	NO	NO	NO
2004	419.3	61.0	358.2	121.8	236.5	NO	NO	NO
2003	416.9	61.0	355.9	119.4	236.5	NO	NO	NO
2002	414.5	61.0	353.5	117.0	236.5	NO	NO	NO
2001	412.2	61.0	351.2	114.7	236.5	NO	NO	NO
2000	409.8	61.0	348.8	112.3	236.5	NO	NO	NO
1999	407.5	61.0	346.4	110.0	236.5	NO	NO	NO
1998	405.3	61.0	344.3	107.8	236.5	NO	NO	NO
1997	403.2	61.0	342.1	105.7	236.5	NO	NO	NO
1996	401.0	61.0	340.0	103.5	236.5	NO	NO	NO
1995	398.9	61.0	337.8	101.4	236.5	NO	NO	NO
1994	396.7	61.0	335.7	99.2	236.5	NO	NO	NO
1993	394.5	61.0	333.5	97.0	236.5	NO	NO	NO
1992	392.1	61.0	331.1	94.6	236.5	NO	NO	NO
1991	390.0	61.0	329.0	92.5	236.5	NO	NO	NO
1990	387.8	61.0	326.8	90.3	236.5	NO	NO	NO
1989	385.7	61.0	324.6	88.2	236.5	NO	NO	NO
1988	383.5	61.0	322.5	86.0	236.5	NO	NO	NO
1987	381.4	61.0	320.3	83.9	236.5	NO	NO	NO
1986	379.2	61.0	318.2	81.7	236.5	NO	NO	NO

Emissions CO_2 in category cropland range from 379.2 Gg CO_2 (1986) to 433.4 Gg CO_2 (2011).

7.4.2 Methodological issues

7.4.2.1 Cropland remaining cropland

* The chapter is under revision, the text is from previous submission.

Carbon stock changes in living biomass

Perennial cropland remaining cropland

For calculating the carbon stock change in living biomass on perennial cropland equation 3.2.2 (GPG- LULUCF) and Tier 1/Tier 2 method were applied.

(Equation 12)

*Annual change in biomass = (area of perennial cropland * biomass accumulation rate) – (area of perennial cropland before 30 years * 0,033 * biomass carbon loss)*

Table 7.141: Areas of perennial cropland in reporting years, comparing with areas of perennial cropland 30 years before.

Year	Area of perennial cropland		Year	Area of perennial cropland
	kha			kha
2010	48.379		1980	57.490
2009	49.812		1979	57.299
2008	51.245		1978	57.289
2007	52.678		1977	57.159
2006	54.111		1976	56.961
2005	55.544		1975	56.930
2004	56.977		1974	56.742
2003	58.409		1973	56.749
2002	59.842		1972	58.433
2001	61.275		1971	55.705
2000	62.708		1970	56.456
1999	64.141		1969	56.520
1998	65.574		1968	56.249
1997	67.007		1967	55.215
1996	68.439		1966	54.924
1995	69.872		1965	54.268
1994	71.305		1964	53.162
1993	72.738		1963	52.785
1992	74.171		1962	52.740
1991	75.604		1961	53.798
1990	77.036		1960	52.409
1989	78.469		1959	52.718
1988	79.902		1958	52.099
1987	81.335		1957	51.278
1986	82.768		1956	50.316

Values for the biomass accumulation rate (2.1 t C ha $^{-1}$ yr $^{-1}$) in perennial vegetation and biomass carbon loss (63.0 t C ha^{-1}) were adopted from Table 3.3.2 (GPG-LULUCF). The values for temperate climate were chosen as this is default regime applicable to Slovenia (Europe).

The observation period started in 1956 and the data were taken from SORS (Statistical office of the Republic of Slovenia). We have taken into account the 30 years rotation period for perennial cropland according to the same table mentioned above. We estimate that 3.33 % area per year of perennial cropland is harvested.

Perrenial cropland converted to annual cropland

The average annual land use change from perennial cropland to annual in the time period from 1986 to 2010 was 195 ha.

For the calculation of annual change in carbon stocks in living biomass of perrenial cropland converted to annual cropland the Tier 1/Tier 2 method was applied and equation 3.3.8 (GPG-LULUCF) was used.

(Equation 13)

*Annual change in biomass = annual area of converted land * ($L_{conversion} + \Delta C_{growth}$)*

$L_{conversion} = C_{after} - C_{before}$

C_{after} – carbon after conversion is 0
C_{before} – IPCC default value for carbon stock in wood biomass before is 63.0 t C ha^{-1}
ΔC_{growth} – IPCC default value for annual crops carbon accumulation rate 5.0 t C ha^{-1}

Value for the annual crops carbon accumulation rate (ΔC_{growth} = 5.0 t C ha^{-1} yr^{-1}) was adopted from Table 3.3.8 (GPG-LULUCF) and value for carbon stock in wood biomass before conversion (C_{before} = 63.0 t C ha^{-1}) was adopted from Table 3.3.2 (GPG-LULUCF). The values for temperate climate were chosen as this is default regime applicable to Slovenia (Europe).

Annual cropland converted to perennial cropland

The average of annual land use change from annual cropland to perennial in the time period from 1986 to 2010 was 396 ha.

For the calculation of annual change in carbon stocks in living biomass of annual cropland converted to perrenial cropland the Tier 1/Tier 2 method was applied and equation 3.3.8 (GPG-LULUCF) was used.

(Equation 14)

*Annual change in biomass = annual area of converted land * ($L_{conversion} + \Delta C_{growth}$)*

$L_{conversion} = C_{after} - C_{before}$
C_{after} – carbon after conversion is 0
C_{before} – IPCC default value for carbon stock in biomass before is 5.0 t C ha^{-1}
ΔC_{growth} – IPCC default value for perrenial crops carbon accumulation rate 2.1 t C ha^{-1}

Value for the perrenial crops carbon accumulation rate (ΔC_{growth} = 2.1 t C ha^{-1} yr^{-1}) was adopted from Table 3.3.8 (GPG-LULUCF) and value for carbon stock in annual crops biomass before conversion (C_{before} = 5.0 t C ha^{-1}) was adopted from Table 3.3.8 (GPG-LULUCF). The values for temperate climate were chosen as this is default regime applicable to Slovenia (Europe).

Carbon stock changes in soils

Mineral soils

Emissions were estimated applying the Tier1/Tier 2 methodology and equation 3.3.3 (GPG-LULUCF) was used.

$$\Delta C_{CC\,\mathrm{min}\,eral} \frac{\left[SOC_0 - SOC_{0-T}) * A\right]}{T} \quad \text{(Equation 15)}$$

$\Delta C_{CCmineral}$ – annual change in carbon stock in mineral soils [t C yr $^{-1}$]
SOC_0 – soil organic carbon stock in the inventory year [t C ha^{-1}]
SOC_{0-T} – soil organic carbon stock T years prior to the inventory [t C ha^{-1}]
T – time [default 20 years]
A – land area [ha]

$$SOC = SOC_{30} * F_{LU} * F_{MG} * F_I$$

SOC_{30} – Slovenian national value for organic carbon stock in mineral soil for cropland
F_{LU}; F_{MG}; F_I – relative stock change factors from GPG - LULUCF

Values for relative stock change factors (F_{LU}; F_{MG}; F_I) were adopted from Table 3.3.4 (GPG-LULUCF). Values for relative stock change factors: F_{LU} = 0.71 (land use, long term cultivated, temperate, wet); F_{MG} = 1.09 (tillage, reduced, temperate, wet) and F_I = 1.11 (input, high – without manure, temperate and tropical, wet).

Slovenian national value for organic carbon stock in mineral soil for cropland (cropland annual: SOC_{30} = 100 t/ha; cropland perrenial: SOC_{30} = 68 t/ha) are presented in Table 7.128.

Organic soils

Total area of organic soils in cropland category in year 2010 was 6,884 ha. The expert judgement is that areas of arable land on organic soils are constant from 1995 till 2006 and will be further on (Agricultural institute of Slovenia, 2006).

For calculations emissions from organic soil Tier 1/Tier 2 methodology and equation 3.3.5 from GPG-LULUCF was used:

$$\Delta C = \sum \left(A * EF\right) \quad \text{(Equation 16)}$$

A – land area of organic soils
EF – emission factor for climate type (10 t ha^{-1})

Emission factor (EF = 10 t ha^{-1}) for warm temperate climatic temperature regime) from Table 3.3.5 (GPG-LULUCF) was adopted.

Liming

For calculations of emissions due to liming Tier 1 methodology and equation 3.3.6 (GPG-LULUCF) were used.

$$\Delta C_{\mathrm{lim}\,e} = M_{\mathrm{lim}\,estone} * EF_{\mathrm{lim}\,estone} + M_{dolomite} * EF_{dolomite} \quad \textbf{(Equation 17)}$$

ΔC_{lime} – annual C emissions from agricultural lime application [t C yr $^{-1}$]
M – the annual amount of calic limestone or dolomite [t yr $^{-1}$]
EF – emission factor (default value 0.12)

According to expert judgement in time period 1986 and 1996 on average 100,000 Mg per year of calcic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) were used in Slovenia for liming. Default emission factor (EF = 0.12) was adopted.

7.4.2.2 Land converted to cropland

The average annual area converted from other land uses to cropland is 5.7 kha to cropland annual and 1.8 to cropland perrenial. Conversions from forest land to cropland and grassland to cropland appear. According to expert judgement there are no conversions from wetland, settlements and other land to cropland.

The average annual area converted from forest land to cropland is 226 ha (to cropland annual: 71 ha; to cropland perrenial: 155 ha). The average annual area converted from grassland to cropland is 3,250 ha (to cropland annual: 2,246 ha; to cropland perrenial: 1,004 ha).

Carbon stock changes in living biomass

For the calculations of the annual change in carbon stocks in living biomass on land converted to cropland the Tier1/Tier2 methoholody and equation 3.3.8 (GPG-LULUCF) were used.

(Equation 18)

*Annual change in biomass = annual area of converted land * ($L_{conversion} + \Delta C_{growth}$)*

$L_{conversion} = C_{after} - C_{before}$

ΔC_{growth} *– IPCC default value for carbon accumulation rate*
accumulation rates: annual crops is 5.0 t C ha^{-1}, perennial crops is 2.1 t C ha^{-1}
C_{after} *– carbon after conversion is 0*
C_{before} *– growing stock (forest land), biomass carobn stocks (grassland)*

Values for the perrenial crops carbon accumulation rate (ΔC_{growth} = 2.1 t C ha $^{-1}$) and for the annual crops accumulation rate (ΔC_{growth} = 5.0 t C ha $^{-1}$) were adopted from Table 3.3.8 (GPG-LULUCF). The growing stock in forest land (C_{before}) is represented in Table 7.132. Value for grassland biomass carbon stocks (C_{before} = 13.5 t C ha^{-1}, warm temperate, wet) was adopted from Table 3.4.9 (GPG-LULUCF).

Carbon stock changes in dead organic matter

Carbon stock changes in dead organic matter were calculated for dead wood and litter pool in conversion from forest land to cropland. The following equation was used.

$$\Delta C_{LC_{DOM}} = \Delta C_{LC_{DW}} + \Delta C_{LC_{LT}} \quad \textbf{(Equation 19)}$$

$\Delta C_{LC_{DOM}}$ **– annual change in carbon stocks in dead organic matter [t C yr^{-1}]**

$\Delta C_{LC_{DW}}$ **– change in carbon stocks in dead wood [t C yr^{-1}]**

$\Delta C_{LC_{LT}}$ **– change in carbon stocks in litter [t C yr^{-1}]**

For calculations of annual change in carbon stocks in dead wood the following equation was used:

(Equation 20)

$\Delta C_{LC_{DW}}$ = *annual area of converted land * L conversion*

L conversion = C after – C before

C after – carbon after conversion is 0
C before – carbon stock in dead wood [t C ha^{-1}]

Values for carbon stock in dead wood (C $_{before}$) were calculated from NFI 2007 data (5.69 % of growing stock).

For calculations of annual change in carbon stocks in litter the following equation was used:

$\Delta C_{LC_{LT}}$ = *annual area of converted land * L conversion*

L conversion = C after – C before
C after – carbon after conversion is 0
C before – carbon stock in liiter [t C ha^{-1}]

Value for carbon stock in litter (C $_{before}$ = 5.6 t C ha^{-1}) was used from Slovenian Forestry Institute Research study (Kobal M., Simoncic P., 2008).

Carbon stock changes in soils

Mineral soils

For calculations of emissions from soils in land converted to cropland Tier 2 methodology and equation 3.3.3 (GPG-LULUCF) were used.

$$\Delta C_{LC\,\mathrm{min}\,eral}\ \frac{\left[SOC_0 - SOC_{0-T}) * A\right]}{T}$$ (Equation 21)

$\Delta C_{LCmineral}$ – annual change in carbon stock in mineral soils [t C yr $^{-1}$]
SOC_0 – soil organic carbon stock in the inventory year [t C ha^{-1}]
SOC_{0-T} – soil organic carbon stock T years prior to the inventory [t C ha^{-1}]
T – time [default 20 years]
A – land area [ha]

$$SOC = SOC_{30} * F_{LU} * F_{MG} * F_I$$

SOC_{30} – Slovenian national value for organic carbon stock in mineral soil
F_{LU}; F_{MG}; F_I – relative stock change factors from GPG - LULUCF

Country specific value for organic carbon stock in cropland SOC_0 (SOC_{30} = 100 t C ha^{-1} for annual cropland; SOC_{30} = 68 t C ha^{-1} for perrenial cropland) was determined from national soil profiles data. Also values for soil organic stock of previous land uses (SOC_{0-T}:

grassland = 107 t C ha^{-1}, forest land = 105 t C ha^{-1},) were calculated and used in calculations.

Values for relative stock change factors (F_{LU}; F_{MG}; F_I) were adopted from Table 3.3.4 (GPG-LULUCF). Values for relative stock change factors: F_{LU} = 0.71 (land use, long term cultivated, temperate, wet); F_{MG} = 1.00 (tillage, full, temperate, dry and wet) and F_I = 1.00 (input, medium, temperate, dry and wet).

Organic soils

* The chapter is under revision, the text is from previous submission. Emissions were not estimated.

N_2O emissions in soils of land converted to cropland

For calculations of N_2O emmisions associated with land conversion to cropland Tier 1 methodology and equations 3.3.14 and 3.3.15 (GPG-LULUCF) were used.

$$N_2O - N_{conv} = N_2O_{net-\min} - N$$

(Equation 22)

$$N_2O_{net-\min} - N = EF_1 * N_{net-\min}$$

N_2O-N_{conv} – N_2O emissions as a result of the disturbance associated with land-use conversion of forest land, grassland, or other land to cropland, [kg N_2O-N yr^{-1}]

$N_{net-min}$ – N released annually by net soil organic matter mineralisation as a result of the disturbance, [kg N yr^{-1}]

EF_1 – IPCC default emission factor used to calculate emissions from agricultural land caused by added N, whether in the form of mineral fertilisers, manures, or crop residues, [kg N_2O-N/kg N]. (The default value is 0.0125 kg N_2O-N/kg N)

$$N_{net-\min} = \Delta C_{LC\,\min eral} * 1/C : N_{ratio}$$

(Equation 23)

$N_{net-min}$ – annual N released by net soil organic matter mineralisation as a result of the disturbance, [kg N yr^{-1}]

$\Delta C_{LCmineral}$ – annual carbon stock change in soils (land converted to cropland)[kg C yr^{-1}]

C:N ratio – the ratio by mass of C to N in the soil organic matter (SOM),[kg C (kg N)$^{-1}$]

According to expert judgement the C/N ratio in mineral soil organic matter was assumed to be 15.6. Values for annual carbon stock change in soils ($\Delta C_{LCmineral}$) were taken from calculations of carbon stock changes in soils for land (forest land and grassland) converted to cropland. For emission factor (EF_1), the default value (0.0125 kg N_2O-N/kg N) was used.

The average annual emissions of N_2O from land converted to cropland were 0.271 Gg N_2O.

Table 7.142: Areas of grassland and forestland converted to cropland (annual, perennial) and N_2O emissions.

	from forest land		from grassland		sum	
	ha	t N_2O-N / yr	ha	t N_2O-N /yr	ha	t N_2O-N / yr

to cropland annual	86	5.9	1,967	116.0	2,053	121.9
to cropland perennial	754	51.4	1,651	97.3	2,404	148.7
	840	57.3	3,618	213.3	4,458	270.6

7.4.3 Uncertainties and time-series consistency

Uncertainties can be analysed as uncertainty in activity data and uncertainty in variables such as emission factors, growth rates, effect of land management factors etc. It is the uncertainty in the IPCC default variables that dominates the overall uncertainty in the estimated provided by Slovenia.

The following uncertainties for 2010 were estimated. They are based on uncertainly values for IPCC default values taken from the IPCC-GPG (for the most sources these default values were used) and on expert judgement.

Variable		Uncertainty (95% CI)
Uncertainty in cropland remaining cropland		
Uncertainty in biomass accumulation rates		± 75 % (GPG-LULUCF table 3.3.2)
Uncertainty from land converted to cropland		
Carbon stocks in previous land use	Grassland	± 75 %; ± 95 %(GPG-LULUCF table 3.4.2; 3.4.3)
	Forestland	
Estimated uncertainty in land managed factors		± 12 % (GPG-LULUCF table 3.3.4)

7.4.4 Category-specific QA/QC and verification

No specific QA/QC and verification was used for cropland.

7.4.5 Category-specific recalculations

7.4.6 Source-specific planned improvements

The estimation of emissions and removals in 5B Cropland need further implementation. Due to discrepancies in land use change matrix data and other official data of cropland perennial, we did not report emissions for some activities in Cropland remaining Cropland. The improvements will be implemented in next submission.

Data about organic soils will be reviewed and synchronized with data for Agricultural sector. Also the better information about liming is in progress. Missing national uncertainties will be estimated and reported.

N_2O emissions associated with land conversion to cropland, perrenial cropland remainig perennial cropland will be revised, use of data rechecked and improvemts will be imcluded in 2014 submission.

7.5 Grassland (5C)

7.5.1 Source category description

Grassland category includes CO_2 emissions from changes in carbon stock in living biomass and in soils. Carbon stock changes are reported in Grassland remaining grassland and in Land converted to grassland. CO_2 emissions from agricultural lime application are included in cropland category.

Grassland covers 424.17 kha and that represents 20.9 % of country total area. Grassland land use includes: meadows and pastures, swampy meadows and pastures, alpine meadows, mixed land use (arable land and forest, small areas) and uncultivated agriculture land.

Table 7.143: Activity data for grassland in 1986 – 2011 in kha

Year	5.C. Total Grassland	5.C. Organic soil	5.C.1. Grassland remaining Grassland	5.C.2. Land converted to Grassland[12]	5.C.2.1 Forest Land converted to Grassland	5.C.2.2 Cropland converted to Grassland	5.C.2.3 Wetlands converted to Grassland	5.C.2.4 Settlements converted to Grassland	5.C.2.5 Other Land converted to Grassland
	kha	kha	kha	kha	kha	kha	kha	kha	kha
2011	424.2	NE	246.2	178.0	54.0	124.0	NO	NO	NO
2010	420.9	NE	242.9	178.0	54.0	124.0	NO	NO	NO
2009	417.7	NE	239.7	178.0	54.0	124.0	NO	NO	NO
2008	414.4	NE	236.4	178.0	54.0	124.0	NO	NO	NO
2007	411.2	NE	233.2	178.0	54.0	124.0	NO	NO	NO
2006	407.9	NE	229.9	178.0	54.0	124.0	NO	NO	NO
2005	404.7	NE	226.7	178.0	54.0	124.0	NO	NO	NO
2004	401.4	NE	223.4	178.0	54.0	124.0	NO	NO	NO
2003	398.2	NE	220.2	178.0	54.0	124.0	NO	NO	NO
2002	394.9	NE	216.9	178.0	54.0	124.0	NO	NO	NO
2001	391.7	NE	213.7	178.0	54.0	124.0	NO	NO	NO
2000	388.4	NE	210.4	178.0	54.0	124.0	NO	NO	NO
1999	385.2	NE	207.2	178.0	54.0	124.0	NO	NO	NO
1998	381.9	NE	203.9	178.0	54.0	124.0	NO	NO	NO
1997	378.7	NE	200.7	178.0	54.0	124.0	NO	NO	NO
1996	375.4	NE	197.4	178.0	54.0	124.0	NO	NO	NO
1995	372.2	NE	194.2	178.0	54.0	124.0	NO	NO	NO
1994	368.9	NE	190.9	178.0	54.0	124.0	NO	NO	NO
1993	365.7	NE	187.7	178.0	54.0	124.0	NO	NO	NO
1992	362.4	NE	184.4	178.0	54.0	124.0	NO	NO	NO
1991	359.2	NE	181.2	178.0	54.0	124.0	NO	NO	NO
1990	355.9	NE	177.9	178.0	54.0	124.0	NO	NO	NO
1989	352.7	NE	174.7	178.0	54.0	124.0	NO	NO	NO
1988	349.4	NE	171.4	178.0	54.0	124.0	NO	NO	NO
1987	346.2	NE	168.2	178.0	54.0	124.0	NO	NO	NO
1986	342.9	NE	164.9	178.0	54.0	124.0	NO	NO	NO

Table 7.144: Emissions from grassland (1986 – 2011) in Gg CO_2

Year	5.C. Total Grassland	5.C.1. Grassland remaining Grassland	5.C.2. Land converted to Grassland[12]	5.C.2.1 Forest Land converted to Grassland	5.C.2.2 Cropland converted to Grassland	5.C.2.3 Wetlands converted to Grassland	5.C.2.4 Settlements converted to Grassland	5.C.2.5 Other Land converted to Grassland
	Gg CO_2	Gg CO2	Gg CO2	Gg CO2	Gg CO2	Gg CO2	Gg CO2	Gg CO2
2011	633.4	NE	633.4	980.9	-347.5	NO	NO	NO
2010	615.1	NE	615.1	962.6	-347.5	NO	NO	NO
2009	596.8	NE	596.8	944.3	-347.5	NO	NO	NO
2008	578.4	NE	578.4	926.0	-347.5	NO	NO	NO
2007	560.1	NE	560.1	907.6	-347.5	NO	NO	NO
2006	541.8	NE	541.8	889.3	-347.5	NO	NO	NO
2005	523.5	NE	523.5	871.0	-347.5	NO	NO	NO
2004	505.2	NE	505.2	852.7	-347.5	NO	NO	NO
2003	486.9	NE	486.9	834.4	-347.5	NO	NO	NO
2002	468.6	NE	468.6	816.1	-347.5	NO	NO	NO
2001	450.2	NE	450.2	797.7	-347.5	NO	NO	NO
2000	431.9	NE	431.9	779.4	-347.5	NO	NO	NO
1999	415.1	NE	415.1	762.7	-347.5	NO	NO	NO
1998	398.4	NE	398.4	745.9	-347.5	NO	NO	NO
1997	381.6	NE	381.6	729.1	-347.5	NO	NO	NO
1996	364.8	NE	364.8	712.3	-347.5	NO	NO	NO
1995	348.0	NE	348.0	695.6	-347.5	NO	NO	NO
1994	331.3	NE	331.3	678.8	-347.5	NO	NO	NO
1993	314.5	NE	314.5	662.0	-347.5	NO	NO	NO
1992	297.7	NE	297.7	645.2	-347.5	NO	NO	NO
1991	280.9	NE	280.9	628.5	-347.5	NO	NO	NO
1990	264.2	NE	264.2	611.7	-347.5	NO	NO	NO
1989	247.4	NE	247.4	594.9	-347.5	NO	NO	NO
1988	230.6	NE	230.6	578.1	-347.5	NO	NO	NO
1987	213.8	NE	213.8	561.4	-347.5	NO	NO	NO
1986	197.1	NE	197.1	544.6	-347.5	NO	NO	NO

CO_2 emissions in category grassland range from 197.1 Gg CO_2 (1986) to 633.4 Gg CO_2 (2011).

Land converted to grassland (CO_2) was identified as key source category. Grassland remaining grassland (CO_2) was not identified as key source category.

7.5.2 Methodological issues

7.5.2.1 Grassland remaining grassland

Carbon stock changes in living biomass

The Tier 1 assumption is no change in living biomass carbon stocks. The rational is that in grassland where management practices are static, biomass carbon stock will be in an approximate steady-state where carbon accumulation trough plant growth is roughly balanced by losses.

Carbon stock changes in soils

For calculations of carbon stock changes in soils in grassland remaining grassland, the equation 3.4.7 (GPG-LULUCF) was used.

$$\Delta C_{GGsoils} = \Delta C_{GG\,\mathrm{min}\,eral} - \Delta C_{GGorganic} - \Delta C_{GG\,\mathrm{lim}\,ing} \quad \text{(Equation 24)}$$

$\Delta C_{GGsoils}$ - *annual change in carbon stocks in soil [t C yr $^{-1}$]*

$\Delta C_{GG\,\mathrm{min}\,eral}$ - *annual change in carbon stocks in mineral soils [t C yr $^{-1}$]*

$\Delta C_{GGorganic}$ - *annual changes in carbon stocks in organic soils [t C yr $^{-1}$]*

$\Delta C_{GG\,\mathrm{lim}\,ing}$ - *annual C emissions from lime application to grassland [t C yr $^{-1}$]*

Mineral soils

For calculations of annual carbon stock changes in mineral soils in grassland remaining grassland Tier 2 methodology and equation 3.4.8 (GPG-LULUCF) were used.

Due to the expert judgment it is assumed that there have been no change in grassland managment in the default period of 20 years. The equation includes relative stock change factor for land use (F_{LU}), for management regime (F_{MG}) and for input of organic matter (F_I) (Table 3.4.5 in GPG-LULUCF). Therefore for areas of grassland remaining grassland, the values for F_{MG}, F_I and F_{LU} are considered to be constant (F_{LU} = 1.00, all; F_{MG} = 1.00, nominally managed (non-degraded); F_I = 1.00, nominal) through whole time series. Consequently the calculation shows there is no net change in carbon stocks in soils.

Organic soils

Under revision.

Liming

All information about liming in Slovenia is included under cropland category, because there are no separate data for lime application in cropland and grassland.

7.5.2.2 Land converted to grassland

The average annual area converted from other land uses to grassland is 9,825 ha. Conversions from forest land to grassland and cropland to grassland appear. According to expert judgement there are no conversions from wetland, settlements and other land to grassland. Due to necessary assurance for Slovenian land area consistency through whole time series, also conversions from wetland, settlements, other land to grassland are included in land use change matrix.

The average annual area converted from forest land to grassland is 1,982 ha. The average annual area converted from cropland to grassland is 5,831 ha (from cropland perrenial: 1,271 ha; from cropland annual: 4,560 ha).

Carbon stock changes in living biomass

For the calculations of the annual change in carbon stocks in living biomass on land converted to grassland the Tier 2 methoholody and equation 3.4.13 (GPG-LULUCF) were used.

(Equation 25)

*Annual change in biomass = annual area of converted land * ($L_{conversion} + \Delta C_{growth}$)*

$L_{conversion} = C_{after} - C_{before}$

ΔC_{growth} *– default value for carbon accumulation rate (1.7 t d.m. ha $^{-1}$, 0.85 t C ha^{-1})*
C_{after} *– carbon after conversion is 0*
C_{before} *– carbon stock (forest land), biomass carbon stocks (cropland)*

Values for the carbon accumulation rate (ΔC_{growth} = 0.85 t C ha $^{-1}$; 1.7 t d.m. ha^{-1} * 0.5) were adopted from Table 3.4.2 (GPG-LULUCF). The carbon stock in forest land (C_{before}) is represented in Table 7.132. Value for cropland biomass carbon stocks (C_{before} = 63.0 t C ha^{-1}, warm temperate, wet) was adopted from Table 3.3.2 (GPG-LULUCF).

Carbon stock changes in dead organic matter

Carbon stock changes in dead organic matter were calculated for dead wood and litter pool in conversion from forest land to grassland. The following equation was used.

$$\Delta C_{LG_{DOM}} = \Delta C_{LG_{DW}} + \Delta C_{LG_{LT}}$$ **(Equation 26)**

$\Delta C_{LG_{DOM}}$ **– annual change in carbon stocks in dead organic matter [t C yr $^{-1}$]**

$\Delta C_{LG_{DW}}$ **– change in carbon stocks in dead wood [t C yr $^{-1}$]**

$\Delta C_{LG_{LT}}$ **– change in carbon stocks in litter [t C yr $^{-1}$]**

For calculations of annual change in carbon stocks in dead wood the following equation was used:

(Equation 27)

$\Delta C_{LG_{DW}}$ = *annual area of converted land * L conversion*

L conversion = C after – C before

C after – carbon after conversion is 0
C before – carbon stock in dead wood [t C ha^{-1}]

Values for carbon stock in dead wood (C $_{before}$) were calculated from NFI 2007 data (5.69 % of growing stock).

For calculations of annual change in carbon stocks in litter the following equation was used:

$\Delta C_{LG_{LT}}$ = *annual area of converted land * L conversion*

L conversion = C after – C before
C after – carbon after conversion is 0
C before – carbon stock in liiter [t C ha^{-1}]

Value for carbon stock in litter (C $_{before}$ = 5.6 t C ha^{-1}) was used from Slovenian Forestry Institute Research study (Kobal M., Simoncic P., 2008).

Carbon stock changes in soils

For calculations of emissions from soils in land converted to grassland Tier 2 methodology and equation 3.3.3 (GPG-LULUCF) were used.

$$\Delta C_{LG\,\min eral} \frac{[SOC_0 - SOC_{0-T}) * A]}{T}$$ (Equation 28)

ΔC$_{LGmineral}$ – annual change in carbon stock in mineral soils [t C yr^{-1}]
SOC$_0$ – soil organic carbon stock in the inventory year [t C ha^{-1}]
SOC$_{0-T}$ – soil organic carbon stock T years prior to the inventory [t C ha^{-1}]
T – time [default 20 years]
A – land area [ha]

$$SOC = SOC_{30} * F_{LU} * F_{MG} * F_I$$

SOC$_{30}$ – Slovenian national value for organic carbon stock in mineral soil
F$_{LU}$; F$_{MG}$; F$_I$ – relative stock change factors from GPG - LULUCF

Country specific value for organic carbon stock in grassland SOC$_0$ (SOC$_{30}$ = 107 t C ha^{-1} for grassland) was determined from national soil profiles data. Also values for soil organic stock of previous land uses (SOC$_{0-T}$ = 100 t C ha^{-1} for annual cropland; SOC$_{30}$ = 68 t C ha^{-1} for perrenial cropland, SOC$_{0-T}$ = 105 t C ha^{-1}for forest land) were calculated and used in calculations.

Values for relative stock change factors (F$_{LU}$; F$_{MG}$; F$_I$) were adopted from Table 3.4.10 (GPG-LULUCF). Default values for relative stock change factors in forest land are F$_{LU}$ = 1.00; F$_{MG}$ = 1.00; F$_I$ = 1.00. Values for relative stock change factors in cropland: F$_{LU}$ = 0.71

(land use, long term cultivated, temperate, wet); F_{MG} = 1,09 (tillage, reduced, temperate, wet) and F_I = 1.11 (input, high without manure, temperate and tropical, wet) adopted from Table 3.3.4.

7.5.3 Uncertainties and time-series consistency

The following uncertainties for 2011 were estimated. They are based on uncertainly values for IPCC default values taken from the IPCC-GPG (for the most sources these default values were used) and on expert judgement.

Variable		Uncertainty (95% CI)
Uncertainty in grassland remaining grassland		
Uncertainty in biomass accumulation rates		± 75 % (GPG-LULUCF table 3.4.2)
Uncertainty from land converted to grassland		
Carbon stocks in previous land use	Cropland	± 75 % (GPG-LULUCF table 3.3.2)
	Forestland	
Uncertainty total non woody biomass		± 75 % (GPG-LULUCF table 3.4.9)
Estimated uncertainty in land managed factors		± 12 % (GPG-LULUCF table 3.3.4)

7.5.4 Category-specific QA/QC and verification

No specific QA/QC and verification was used for grassland.

7.5.5 Category-specific recalculations

7.5.6 Source-specific planned improvements

Missing uncertainties will be estimated and reported.
Data about organic soils will be reviewed and synchronized with data for Agricultural sector.

7.6 Wetlands (5D)

7.6.1 Source category description

Wetlands are defined (GPG-LULUCF) as land that is covered or saturated by water for all or part of the year and that does not fall into the forestland, cropland, grassland or settlements categories. Emissions in Wetlands remaining wetlands are not estimated, conversions from other land uses to wetlands, except from forestland and grassland, do not occur in Slovenia.

Table 7.145: Activity data of wetland 1986 – 2011 in kha

Year	5.D Total wetland	5.D.1 Wetland remaining wetland	Land converted to wetland					
			5.D.2 Land converted to wetland	5.D.2.1 Forest converted to wetland	5.D.2.2 Cropland converted to wetland	5.D.2.3 Grassland converted to grassland	5.D.2.4 Settlements converted to wetland	5.D.2.5 Other land converted to wetland
	kha	kha	kha	kha	kha	kha	kha	kha
2011	14.0	8.0	6.0	2.0	NO	4.0	NO	NO
2010	14.2	8.2	6.0	2.0	NO	4.0	NO	NO
2009	14.4	8.4	6.0	2.0	NO	4.0	NO	NO
2008	14.6	8.6	6.0	2.0	NO	4.0	NO	NO
2007	14.9	8.9	6.0	2.0	NO	4.0	NO	NO
2006	15.1	9.1	6.0	2.0	NO	4.0	NO	NO
2005	15.3	9.3	6.0	2.0	NO	4.0	NO	NO
2004	15.5	9.5	6.0	2.0	NO	4.0	NO	NO
2003	15.8	9.8	6.0	2.0	NO	4.0	NO	NO
2002	16.0	10.0	6.0	2.0	NO	4.0	NO	NO
2001	16.2	10.2	6.0	2.0	NO	4.0	NO	NO
2000	16.4	10.4	6.0	2.0	NO	4.0	NO	NO
1999	16.6	10.6	6.0	2.0	NO	4.0	NO	NO
1998	16.9	10.9	6.0	2.0	NO	4.0	NO	NO
1997	17.1	11.1	6.0	2.0	NO	4.0	NO	NO
1996	17.3	11.3	6.0	2.0	NO	4.0	NO	NO
1995	17.5	11.5	6.0	2.0	NO	4.0	NO	NO
1994	17.7	11.7	6.0	2.0	NO	4.0	NO	NO
1993	18.0	12.0	6.0	2.0	NO	4.0	NO	NO
1992	18.2	12.2	6.0	2.0	NO	4.0	NO	NO
1991	18.4	12.4	6.0	2.0	NO	4.0	NO	NO
1990	18.6	12.6	6.0	2.0	NO	4.0	NO	NO
1989	18.9	12.9	6.0	2.0	NO	4.0	NO	NO
1988	19.1	13.1	6.0	2.0	NO	4.0	NO	NO
1987	19.3	13.3	6.0	2.0	NO	4.0	NO	NO
1986	19.5	13.5	6.0	2.0	NO	4.0	NO	NO

Wetlands cover 13.98 kha and that represents 0.7 % of country total area. Wetland land use includes: swamps, reeds, other marshy areas and waters (inland water bodies).

Table 146: Emission from wetlands (1986 – 2011) in Gg CO_2

Year	5.D Total wetland	5.D.1 Wetland remaining wetland	Land converted to wetland					
			5.D.2 Land converted to wetland	5.D.2.1 Forest converted to wetland	5.D.2.2 Cropland converted to wetland	5.D.2.3 Grassland converted to grassland	5.D.2.4 Settlements converted to wetland	5.D.2.5 Other land converted to wetland
	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO2
2011	157.9	NE	157.9	80.9	NO	77.0	NO	NO
2010	157.1	NE	157.1	80.0	NO	77.0	NO	NO
2009	156.3	NE	156.3	79.2	NO	77.0	NO	NO
2008	155.4	NE	155.4	78.4	NO	77.0	NO	NO
2007	154.6	NE	154.6	77.5	NO	77.0	NO	NO
2006	153.7	NE	153.7	76.7	NO	77.0	NO	NO
2005	152.9	NE	152.9	75.9	NO	77.0	NO	NO
2004	152.1	NE	152.1	75.0	NO	77.0	NO	NO
2003	151.2	NE	151.2	74.2	NO	77.0	NO	NO
2002	150.4	NE	150.4	73.3	NO	77.0	NO	NO
2001	149.5	NE	149.5	72.5	NO	77.0	NO	NO
2000	148.7	NE	148.7	71.7	NO	77.0	NO	NO
1999	147.9	NE	147.9	70.9	NO	77.0	NO	NO
1998	147.2	NE	147.2	70.1	NO	77.0	NO	NO
1997	146.4	NE	146.4	69.4	NO	77.0	NO	NO
1996	145.6	NE	145.6	68.6	NO	77.0	NO	NO
1995	144.9	NE	144.9	67.8	NO	77.0	NO	NO
1994	144.1	NE	144.1	67.1	NO	77.0	NO	NO
1993	143.3	NE	143.3	66.3	NO	77.0	NO	NO
1992	142.6	NE	142.6	65.5	NO	77.0	NO	NO
1991	141.8	NE	141.8	64.8	NO	77.0	NO	NO
1990	141.0	NE	141.0	64.0	NO	77.0	NO	NO
1989	140.3	NE	140.3	63.2	NO	77.0	NO	NO
1988	139.5	NE	139.5	62.5	NO	77.0	NO	NO
1987	138.7	NE	138.7	61.7	NO	77.0	NO	NO
1986	138.0	NE	138.0	60.9	NO	77.0	NO	NO

7.6.2 Methodological issues

7.6.2.1 Wetland remaining wetlands

A methodology for this category is not covered in GPG-LULUCF but is addressed in Appendix 3A.3 Wetlands remaining wetlands: Basic for future methodological development. Slovenia has not reported emissions from wetlands due to lack of data.
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7.6.2.2 Land converted to wetlands

According to expert judgement there are no conversions from other land uses to wetlands. Due to necessary assurance for Slovenian land area consistency through whole time series, also conversions from forest land, cropland, grassland, settlements and other land to wetlands are included in land use change matrix.

7.6.3 Uncertainties and time-series consistency

The uncertainty estimates are not reported here.

7.6.4 Category-specific QA/QC and verification

No specific QA/QC and verification was used for wetland.

7.6.5 Category-specific recalculations

There are no recalculations for this category.

7.6.6 Source-specific planned improvements

No specific improvements are planned for wetland.

7.7 Settlements (5E)

7.7.1 Source category description

This land use category is described (GPG-LULUCF) as including all development land, including transportation infrastructure and human settlements of any size, unless they are already included under other land use categories. Settlements includes trees grown along streets, in public and private gardens, and different kinds of parks and green areas, if they are included to urban area.

Table 7.147: Activity data of settlements (1986-2011) in kha.

Year	5.E Total settlement	5.E.1. Settlements remaining settlements	Land converted to settlements					
			5.E.2 Land converted to settlement	5.E.2.1 Forest converted to settlement	5.E.2.2 Cropland converted to settlement	5.E.2.3 Grassland converted to settlement	5.E.2.4 Wetland converted to settlement	5.E.2.5 Other lands converted to settlement
	kha	kha	kha	kha	kha	kha	kha	kha
2011	109.0	67.0	42.0	12.0	12.0	18.0	NO	NO
2010	108.9	66.9	42.0	12.0	12.0	18.0	NO	NO
2009	108.8	66.8	42.0	12.0	12.0	18.0	NO	NO
2008	108.7	66.7	42.0	12.0	12.0	18.0	NO	NO
2007	108.7	66.7	42.0	12.0	12.0	18.0	NO	NO
2006	108.6	66.6	42.0	12.0	12.0	18.0	NO	NO
2005	108.5	66.5	42.0	12.0	12.0	18.0	NO	NO
2004	108.4	66.4	42.0	12.0	12.0	18.0	NO	NO
2003	108.4	66.4	42.0	12.0	12.0	18.0	NO	NO
2002	108.3	66.3	42.0	12.0	12.0	18.0	NO	NO
2001	108.2	66.2	42.0	12.0	12.0	18.0	NO	NO
2000	108.2	66.2	42.0	12.0	12.0	18.0	NO	NO
1999	108.1	66.1	42.0	12.0	12.0	18.0	NO	NO
1998	108.0	66.0	42.0	12.0	12.0	18.0	NO	NO
1997	107.9	65.9	42.0	12.0	12.0	18.0	NO	NO
1996	107.9	65.9	42.0	12.0	12.0	18.0	NO	NO
1995	107.8	65.8	42.0	12.0	12.0	18.0	NO	NO
1994	107.7	65.7	42.0	12.0	12.0	18.0	NO	NO
1993	107.6	65.6	42.0	12.0	12.0	18.0	NO	NO
1992	107.6	65.6	42.0	12.0	12.0	18.0	NO	NO
1991	107.5	65.5	42.0	12.0	12.0	18.0	NO	NO
1990	107.4	65.4	42.0	12.0	12.0	18.0	NO	NO
1989	107.3	65.3	42.0	12.0	12.0	18.0	NO	NO
1988	107.3	65.3	42.0	12.0	12.0	18.0	NO	NO
1987	107.2	65.2	42.0	12.0	12.0	18.0	NO	NO
1986	107.1	65.1	42.0	12.0	12.0	18.0	NO	NO

Settlements cover 108.96 kha and that represents 5.4 % of country total area. Settlements land use includes: built-areas and related surfaces.

Table 148: Emissions from settlements (1986 – 2011) in Gg CO_2

Year	5.E Total settlement	5.E.1. Settlements remaining settlements	Land converted to settlements					
			5.E.2 Land converted to settlement	5.E.2.1 Forest converted to settlement	5.E.2.2 Cropland converted to settlement	5.E.2.3 Grassland converted to settlement	5.E.2.4 Wetland converted to settlement	5.E.2.5 Other lands converted to settlement
	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2
2011	744.5	NE	744.5	398.2	160.0	186.4	NO	NO
2010	739.5	NE	739.5	393.2	160.0	186.4	NO	NO
2009	734.5	NE	734.5	388.1	160.0	186.4	NO	NO
2008	729.4	NE	729.4	383.1	160.0	186.4	NO	NO
2007	724.4	NE	724.4	378.1	160.0	186.4	NO	NO
2006	719.4	NE	719.4	373.0	160.0	186.4	NO	NO
2005	714.3	NE	714.3	368.0	160.0	186.4	NO	NO
2004	709.3	NE	709.3	363.0	160.0	186.4	NO	NO
2003	704.3	NE	704.3	357.9	160.0	186.4	NO	NO
2002	699.2	NE	699.2	352.9	160.0	186.4	NO	NO
2001	694.2	NE	694.2	347.9	160.0	186.4	NO	NO
2000	689.2	NE	689.2	342.8	160.0	186.4	NO	NO
1999	684.6	NE	684.6	338.2	160.0	186.4	NO	NO
1998	680.0	NE	680.0	333.6	160.0	186.4	NO	NO
1997	675.4	NE	675.4	329.0	160.0	186.4	NO	NO
1996	670.8	NE	670.8	324.4	160.0	186.4	NO	NO
1995	666.2	NE	666.2	319.8	160.0	186.4	NO	NO
1994	661.6	NE	661.6	315.2	160.0	186.4	NO	NO
1993	656.9	NE	656.9	310.6	160.0	186.4	NO	NO
1992	652.3	NE	652.3	306.0	160.0	186.4	NO	NO
1991	647.7	NE	647.7	301.4	160.0	186.4	NO	NO
1990	643.1	NE	643.1	296.8	160.0	186.4	NO	NO
1989	638.5	NE	638.5	292.2	160.0	186.4	NO	NO
1988	633.9	NE	633.9	287.6	160.0	186.4	NO	NO
1987	629.3	NE	629.3	283.0	160.0	186.4	NO	NO
1986	624.7	NE	624.7	278.4	160.0	186.4	NO	NO

CO_2 emissions in category settlements range from 624.7 Gg CO_2 (1986) to 744.5 Gg CO_2 (2011).

Land converted to settlements (CO_2) was identified as key source category.

7.7.2 Methodological issues

7.7.2.1 Settlements remaining settlements

GPG-LULUCF provides a basic method for estimating CO_2 emissions/removals in settlements remaining settlements in Appendix 3A.4. The methods and available default data for this land use are preliminary and based on an estimation of changes in carbon stocks per tree crown cower area or carbon stocks per number of trees as a removal factor. Data for calculations of emissions in settlements remaining settlements are not available in Slovenia.

7.7.2.2 Land converted to settlements

The average annual area converted from other land uses to settlements is 3,174 ha. The average annual area converted from forest land to settlements is 984 ha. The average annual area converted from cropland to settlements is 962 ha (from perrenial cropland: 402 ha and from annual cropland: 560 ha) and from grassland to settlements is 1,146 ha

According to expert judgement there are no conversions from wetlands and other land to settlements. Due to necessary assurance for Slovenian land area consistency through whole time series, also these conversions were included in land use change matrix.

The fundamental equation for estimating changes in carbon stocks associated with land use conversions is the same as applied for other areas of land use conversion (land converted to forest land, cropland or grassland). The default assumption for Tier 2 estimate is that all living biomass present before conversion to settlement will be lost in the same year as the conversion takes place, and that carbon stocks in living biomass following conversion are equal to zero.

For calculations of emissions from other land uses converted to settlements Tier 2 methodology and equation 3.6.1 (GPG- LULUCF) were used.

$$\Delta C_{FS_{LB}} = A * (C_{after} - C_{before}) \quad \textbf{(Equation 29)}$$

ΔC_{FSLB} – annual change in carbon stocks in living biomass due to conversion of forest land to settlements [t C yr $^{-1}$]
A – area of land annualy converted [ha yr $^{-1}$]
C_{after} – carbon stocks in living biomass immediately following conversion to settlements [t C ha^{-1}]
C_{before} - carbon stocks in living biomass immediately before conversion to settlements [t C ha^{-1}]

7.7.3 Uncertainties and time-series consistency

The uncertainty estimates are not reported here.

7.7.4 Category-specific QA/QC and verification

No specific QA/QC and verification was used for settlements.

7.7.5 Category-specific recalculations

No recalculations were made for this category.

7.7.6 Category-specific planed improvements

No specific improvements are planned for settlements.

7.8 Other land (5F)

7.8.1 Source category description

Other land is defined (GPG-LULUCF) as including the bare soil, rock, ice and all unmanaged land areas which do not fall into any of other land use categories. This land use category is included to allow the total of identified land areas to match the national area.

Table 7.149: Activity data of other land (1986-2011) in kha.

Year	5.F Other land	5.F.1. Other land remaining other land	Land converted to other land					
			5.F.2. Land converted to other land	5.F.2.1 Forest Land converted to other land	5.F.2.2 Cropland converted to other land	5.F.2.3 Grassland converted to other land	5.F.2.4 Wetlands converted to other land	5.F.2.5 Settlements converted to other land
	kha	kha	kha	kha	kha	kha	kha	kha
2011	31.1	19.1	12.0	12.0	NO	NO	NO	NO
2010	31.8	19.8	12.0	12.0	NO	NO	NO	NO
2009	32.6	20.6	12.0	12.0	NO	NO	NO	NO
2008	33.4	21.4	12.0	12.0	NO	NO	NO	NO
2007	34.2	22.2	12.0	12.0	NO	NO	NO	NO
2006	34.9	22.9	12.0	12.0	NO	NO	NO	NO
2005	35.7	23.7	12.0	12.0	NO	NO	NO	NO
2004	36.5	24.5	12.0	12.0	NO	NO	NO	NO
2003	37.3	25.3	12.0	12.0	NO	NO	NO	NO
2002	38.0	26.0	12.0	12.0	NO	NO	NO	NO
2001	38.8	26.8	12.0	12.0	NO	NO	NO	NO
2000	39.6	27.6	12.0	12.0	NO	NO	NO	NO
1999	40.4	28.4	12.0	12.0	NO	NO	NO	NO
1998	41.1	29.1	12.0	12.0	NO	NO	NO	NO
1997	41.9	29.9	12.0	12.0	NO	NO	NO	NO
1996	42.7	30.7	12.0	12.0	NO	NO	NO	NO
1995	43.5	31.5	12.0	12.0	NO	NO	NO	NO
1994	44.2	32.2	12.0	12.0	NO	NO	NO	NO
1993	45.0	33.0	12.0	12.0	NO	NO	NO	NO
1992	45.8	33.8	12.0	12.0	NO	NO	NO	NO
1991	46.6	34.6	12.0	12.0	NO	NO	NO	NO
1990	47.3	35.3	12.0	12.0	NO	NO	NO	NO
1989	48.1	36.1	12.0	12.0	NO	NO	NO	NO
1988	48.9	36.9	12.0	12.0	NO	NO	NO	NO
1987	49.7	37.7	12.0	12.0	NO	NO	NO	NO
1986	50.4	38.4	12.0	12.0	NO	NO	NO	NO

Other land covers 31.07 kha and that represents 1.5 % of country total area. Other land includes: open areas with little or no vegetation and dried open areas with special vegetation.

Table 150: Emissions from other land (1986–2011) in Gg CO_2

Year	5.F Other land	5.F.1. Other land remaining other land	Land converted to other land					
			5.F.2. Land converted to other land	5.F.2.1 Forest Land converted to other land	5.F.2.2 Cropland converted to other land	5.F.2.3 Grassland converted to other land	5.F.2.4 Wetlands converted to other land	5.F.2.5 Settlements converted to other land
	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2	Gg CO_2
2011	NE, NO	NE	453.2	453.2	NO	NO	NO	NO
2010	NE, NO	NE	446.0	446.0	NO	NO	NO	NO
2009	NE, NO	NE	438.7	438.7	NO	NO	NO	NO
2008	NE, NO	NE	431.5	431.5	NO	NO	NO	NO
2007	NE, NO	NE	424.3	424.3	NO	NO	NO	NO
2006	NE, NO	NE	417.0	417.0	NO	NO	NO	NO
2005	NE, NO	NE	409.8	409.8	NO	NO	NO	NO
2004	NE, NO	NE	402.6	402.6	NO	NO	NO	NO
2003	NE, NO	NE	395.3	395.3	NO	NO	NO	NO
2002	NE, NO	NE	388.1	388.1	NO	NO	NO	NO
2001	NE, NO	NE	380.9	380.9	NO	NO	NO	NO
2000	NE, NO	NE	373.6	373.6	NO	NO	NO	NO
1999	NE, NO	NE	366.8	366.8	NO	NO	NO	NO
1998	NE, NO	NE	360.0	360.0	NO	NO	NO	NO
1997	NE, NO	NE	353.2	353.2	NO	NO	NO	NO
1996	NE, NO	NE	346.4	346.4	NO	NO	NO	NO
1995	NE, NO	NE	339.6	339.6	NO	NO	NO	NO
1994	NE, NO	NE	332.8	332.8	NO	NO	NO	NO
1993	NE, NO	NE	326.0	326.0	NO	NO	NO	NO
1992	NE, NO	NE	319.2	319.2	NO	NO	NO	NO
1991	NE, NO	NE	312.4	312.4	NO	NO	NO	NO
1990	NE, NO	NE	305.6	305.6	NO	NO	NO	NO
1989	NE, NO	NE	298.8	298.8	NO	NO	NO	NO
1988	NE, NO	NE	292.0	292.0	NO	NO	NO	NO
1987	NE, NO	NE	285.2	285.2	NO	NO	NO	NO
1986	NE, NO	NE	278.4	278.4	NO	NO	NO	NO

7.8.2 Methodological issues

7.8.2.1 Other land remaining other land

Consistent with the IPCC Guidelines, change in carbon stocks and non-CO_2 emissions and removals would not need to be assessed for the category of “Other land remaining Other land” assuming that it is typically managed. At present, no guidance can be given for “Other land” that is managed. “Other land” is included, however, for checking overall consistency of land area and tracking conversions to and from other land.

7.8.2.2 Land converted to other land

According to expert judgement there are only conversions from forest land to other land.

7.8.3 Uncertainties and time-series consistency

The uncertainty estimates are not reported here.

7.8.4 Category-specific QA/QC and verification

No specific QA/QC and verification was used for other land.

7.8.5 Category-specific recalculations

There are no recalculations for this category.

7.8.6 Category-specific improvements

No specific improvements are planned for other land.

8 WASTE (CRF sector 6)

Waste management and treatment of industrial and municipal wastes are sources of GHGs emissions. The inventory covers CH_4 emissions resulting from solid waste disposal on land, GHG emissions from waste incineration and CH4 emissions from treatment of liquid wastes. This section also includes estimates of emission of N_2O from municipal sewage.

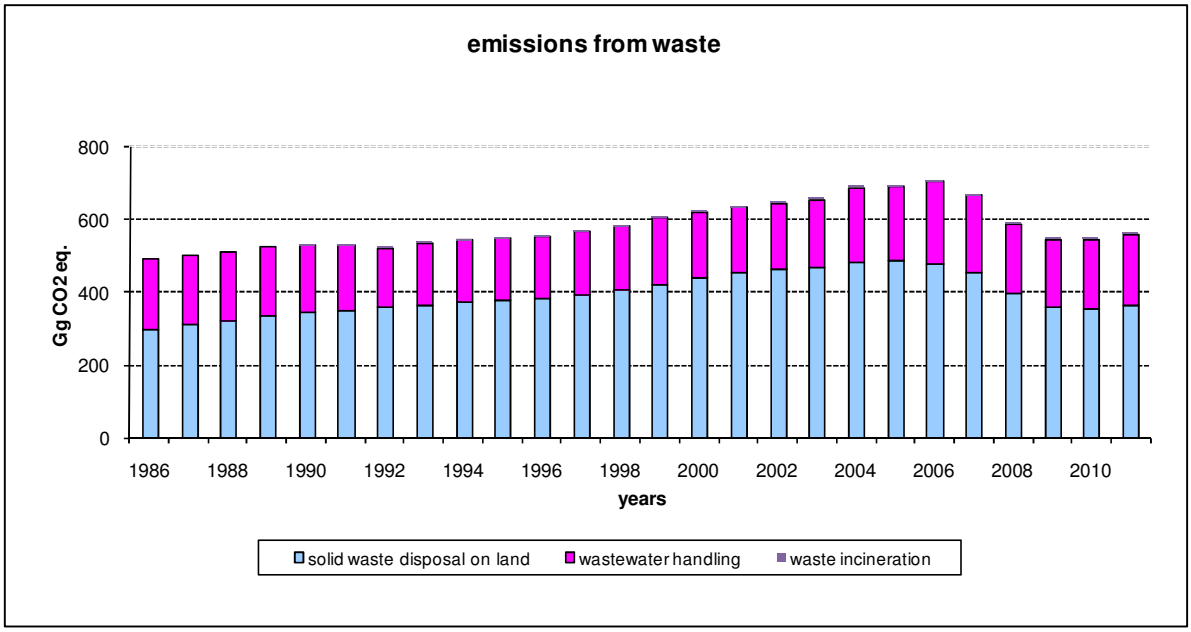

Figure 8.0.1: Emissions from solid waste disposal on land and from wastewater handling in Gg CO_2 eq.. Emissions from waste incineration are very small and therefore not visible on the figure.

8.1 CH_4 Emissions from Solid Waste Disposal sites

	KS	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level
Base Year	Level	CH_4	0.92		19
2011	Level	CH_4	1.08	1.12	14

8.1.1 Legislation

List of relevant Slovenian laws transposing the EU Landfill Directive:

- Decree on the landfill of waste (No. 32/2006), which came into force in March 2006 and was amended twice, in 2007 (No. 98/2007) and 2008 (No. 62/2008), with the Decree amending the Decree on the landfill of waste;
- Decree on the management of waste (No. 34/2008), which amended previous Rules on the management of waste;

- on the basis of EU Landfill Directive and National environmental action Programme on waste management Slovenia also issued an Operational Programme regarding waste management for the time period 2009-2013.

The Decree on the landfill of waste is the main act, in which the EU Landfill Directive was transpose. Thus in 2006, when Decree on the landfill of waste cancelled the mentioned Rules on the landfill of waste, Slovenia fully complied with the requirements of the Landfill Directive.

On the political level Slovenia started with the activities on the field of waste management in 1996, when also strategic orientations for waste management were prepared. On its basis National environmental action Programme was accepted in 2006, which set the enforcement of modern forms of waste management as priority objective. A period of systematic regulation in the field of waste management followed, with the adoption of implementing acts on the basis of EPA.

However in 1998 Rules on the management of waste already started a new regulation period in waste management. The National environmental action Programme was the basis for the Operational Programme for waste disposal with the goal of reducing deposited biodegradable waste for the period 2009-2013, which was accepted by the government in 2008. However, the Rules on the landfill of waste accepted in 2000 already had provisions regarding reduction of biodegradable waste and these are also included in the Decree on the treatment of biodegradable waste, which was accepted in 2008 and repealed the mentioned Rules.

<u>The Operational Programme is project oriented, focusing on goals:</u>
- at least 65% or more of the produced municipal waste should be redirected in other type of treatment and at least 42% of them should be reused;
- all kitchen waste should be extracted and biologically processed;
- the remainder of waste should be processed in a way that the content of organic carbon will not exceed 5%;
- in the structure of the whole deposited waste 47% of the deposited biodegradable waste should be reduced to 16% until 2013 or 2015 that means in average 5% per year.

<u>Also measures for achieving the listed goals are part of the Operational Programme:</u>
- the existing landfills should be closed down, if the adjustment to the existing provisions would be too expensive or technically difficult to manage;
- reconstruction and enlargement of the existing landfills, which will be operating until the end of 2008;
- the construction of new infrastructure for treatment, recovery and disposal of waste for regional centres for waste management and national centres for thermal treatment.

Decree on the landfill of waste also includes annex 4. It specifies the volume of biodegradable substance in municipal waste, which can be deposited in all landfills in the territory of Slovenia per year. It also sets that the amount of deposited biodegradable waste should be decreased:
- for 10% in years 2008-2009,
- for 5% in years 2009 – 2010, 2011– 2012 and 2013 – 2015 in accordance with the 1995

8.1.2 Source category description

Methane is emitted during anaerobic fermentation of degradable organic substances in solid waste disposal sites in processes, which may last several decades. If waste were not disposed of on solid waste disposal sites, the degradation would take place in aerobic conditions without methane formation. Methane emissions from waste disposal are thus of anthropogenic origin and, consequently, a constituent part of national GHG inventories in accordance in IPCC methodology.

8.1.3 Methodological issues

Methodology

In terms of methodology, IPCC lays down two levels of ascertaining methane emissions from waste management. The simpler, default tier is based on the assumption that all methane is released in the year the waste is disposed of. The default time-dependent emission profile of methane is thus of zero order. This simplified tier will give a fair description of methane emissions of time-dependence only in case if the amount and composition of deposited waste have been constant or slowly varying over a prolonged period of time.

IPCC guidelines describe a more precise method, which considers that methane emissions from disposed-of waste are released over a longer period of time. The so-called First Order Decay (FOD) method is based on the assumption of an exponential time-dependent decline of emissions. Annual emissions are thus partial sums of emissions from waste disposed of in previous periods. The FOD method is more precise, but requires data on quantity, composition and disposal conditions for a period of 20 to 30 years prior to the year for which emission are determined. At the same time, it is necessary to know the half-life of methane generation.

As methane emissions from SWDS are our key source we have to use FOD method to calculate these emissions.

This method can be represented by the equation (1) and (2):

$$CH_4 \text{ generated in year t (Gg/yr)} = \sum_x [(A \cdot k \cdot MSW(x) \cdot L_O(x)) \cdot e^{-k(t-x)}] \quad (1)$$

for x = initial year to t

where:

t = year of inventory
x = years for which input data should be added
$A = (1 - e^{-k})/k$; normalisation factor which corrects the summation
k = methane generation rate constant (1/yr)
MSW(x) = total municipal solid waste landfilled (Gg/yr)
L_0 = methane generation potential (Gg CH_4/Gg waste)

Methane generation rate k has been taken from GPG, 2000 and is 0.05. This value is appropriate for countries with average humid climate and for mixture of slow and fast degradable components in the waste. The half time period is 14 years.

The methane generation potential (Lo) depends upon the composition of waste, on waste disposal practices and on the physical characteristics of the SWDS. It is estimated by the formula:

$Lo = MCF \bullet DOC \bullet DOC_F \bullet F \bullet 16/12$

where:

MCF = CH_4 correction factor (fraction)
DOC = degradable organic carbon (fraction) (Gg C/Gg waste)
DOC_F = fraction DOC dissimilated
F = fraction by volume of CH_4 in landfill gas
16/12 = conversion from C to CH_4

The estimation of CH_4 emitted each year, results from equation (2):

CH4 emitted = (CH4 generated – R) * (1 - OX)

where:

R = CH_4 recovered (Gg/yr)

OX = oxidation factor (fraction)

Activity data and parameters

Presently, most waste in Slovenia is landfilled (69.4%) and only to a lesser degree reused or recycled (30.1%). There is no thermal processing of waste, except for minor quantities of some types of waste (0.5%). In 2004, the recovery of landfill gas has been set up on some major solid waste disposal sites, and its use for generating energy has been started at three largest solid waste disposal sites (Ljubljana-Barje, Maribor-Pobrežje, Celje-Bukovžlak), which cover some 30% of the entire population.

The amount of waste in the period 1964 – 1994
There are no data on the amount of waste prior to 1995. The first regulated municipal solid waste disposal site, the Ljubljana Barje SWDS, started its operation in 1964. An estimate for the period 1964 - 1994 arrived on presumption that in 1964 50% of population was included in municipal waste collection system and that this percentage have slightly increased end reach 60% in 1977 and 76% in 1995. The composition of which was deemed same all time. We are fully aware that this is a rough estimate, but since methane emissions from that period exert a significantly smaller influence on emissions in the reported period, this error is not considerable.

We have also assumed that in that period an amount of waste per person was 470 kg/year or 1.29 kg/day. This amount is in the middle if we compare with the country specific values from other European countries, presented in the Table 6-1 in The Revised 1996 IPCC guidelines. This value is intentionally higher from values in the neighbouring countries

because also biogradable industrial waste has been deposited on municipal SWDS. For 1995 on we have used actual data on amount of waste.

Table 8.1.1: Quantities of landfilled waste in the period 1964 - 1994.

year	Urban population	Coverage in %	Waste generation (disposal) rate in kg/per./y.	Municipal solid waste (t)
1964	815,277	50.0	470	383,180
1965	825,207	50.0	470	387,847
1966	851,499	51.0	470	400,205
1967	862,379	51.0	470	405,318
1968	885,928	52.0	470	416,386
1969	891,291	52.0	470	418,907
1970	915,052	53.0	470	430,074
1971	921,194	53.0	470	432,961
1972	945,813	54.0	470	444,532
1973	953,708	54.0	470	448,243
1974	980,359	55.0	470	460,768
1975	1,026,013	57.0	470	482,226
1976	1,073,373	59.0	470	504,485
1977	1,103,615	60.0	470	518,699
1978	1,134,129	60.9	470	533,040
1979	1,162,846	61.8	470	546,537
1980	1,191,424	62.7	470	559,969
1981	1,218,658	63.6	470	572,769
1982	1,240,476	64.4	470	583,024
1983	1,262,961	65.3	470	593,592
1984	1,286,567	66.2	470	604,686
1985	1,324,204	67.1	470	622,376
1986	1,346,888	68.0	470	633,037
1987	1,370,518	68.9	470	644,144
1988	1,395,547	69.8	470	655,907
1989	1,412,912	70.7	470	664,069
1990	1,429,744	71.6	470	671,980
1991	1,450,170	72.4	470	681,580
1992	1,463,610	73.3	470	687,897
1993	1,477,485	74.2	470	694,418
1994	1,493,847	75.1	470	702,108

The amount of waste in the period 1995 – 2000

According to data provided by the SURS (data submitted to EUROSTAT), over 1 million tons of municipal waste were produced in that period. It is inferred that that amount, due to unclear definition of municipal waste, included industrial waste as well. The calculation of quantities in the table above takes into account the assumption that all collected municipal waste was landfilled (which for Slovenian circumstances is quite accurate).

Table 8.1.2: Quantities of landfilled waste in the period 1995 - 2000.

year	Urban population	Coverage in %	Waste disposal rate in kg/per./y.	Municipal solid waste (t)
1995	1,510,504	76.0	468	707,000
1996	1,561,674	78.4	464	725,000
1997	1,606,565	80.9	462	743,000
1998	1,651,310	83.3	461	761,000
1999	1,702,019	85.7	458	780,000
2000	1,749,847	87.9	457	800,000

The amount of waste in the period 2001 - 2011

The initial parameters for calculating methane emissions are the total annual amount of municipal waste and the fraction of landfilled municipal waste. In calculating, we used data of the Slovenian Environment Agency, which on a regular basis collects data on the formation and handling all types of waste in Slovenia. Data are collected by means of forms which are set down by the law and which the reporting agent must fill in once a year (for the preceding year). Beside the quantities of collected mixed waste and separate fractions of municipal waste from households, reporting agents also provide data on the quantities of collected mixed and separate fractions of municipal waste and related waste which is produced in economic and service activities. On the basis of these data, the Statistical Office of the Republic of Slovenia generates its annual reports on waste handling.

Table 8.1.3: Quantities of landfilled waste in the period 2001 - 2010.

year	Urban population	Coverage in %	Waste disposal rate in kg/per./y.	Municipal solid waste (t)
2001	1,795,222	90.1	457	820,000
2002	1,854,535	92.3	443	822,339
2003	1,874,203	92.5	451	844,606
2004	1,873,992	93.0	433	810,647
2005	1,881,047	94.0	422	793,118
2006	1,881,713	93.6	446	838,883
2007	1,884,055	93.0	431	811,674
2008	1,886,601	93.0	441	831,834
2009	1,889,147	93.0	405	731.008
2010	1,905,813	93.0	391	623.224
2011	1,911,610	93.0	415	646.318

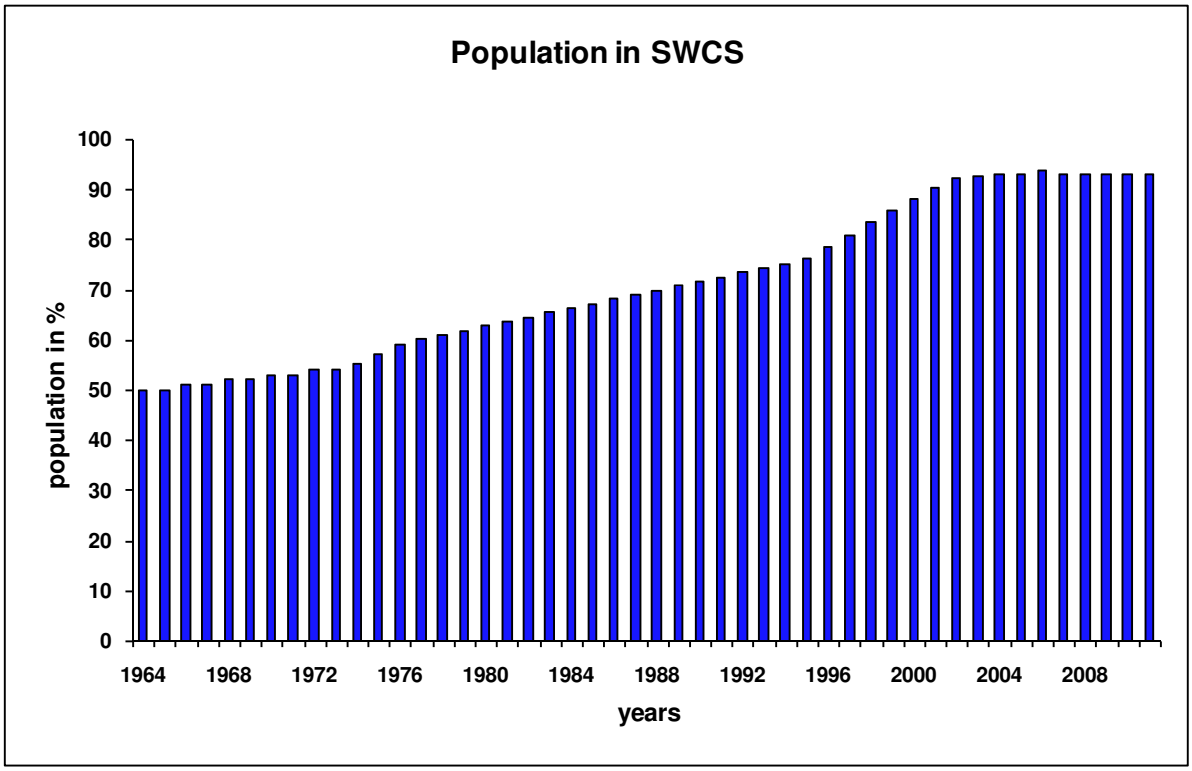

Figure 8.1.1: Population served by solid waste collection systems

Despite the fact that data on the amount of waste in period 1995-2000 were provided by the Statistical Office and for 2001-2010 were obtained from Slovenian Environmental

Agency the time consistency is ensured. In both sets data are gathered from all SWDS in Slovenia. The only difference is that questioners are now send from and returned to EARS what means that EARS have the right to individual data. Before according to Statistical law EARS get only aggregated data and no control of individual SWDS have been possible. All data gathered from EARS are sent to SORS where they are processed and published.

Table 8.1.4: The share of recovered and deposited municipal waste with regard to waste management methods

		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
other operations of disposal	%	0.2	0	0	0	0	0	0	0	0	0
waste disposal	%	97.5	97.3	83.9	83.2	87.2	68.7	67.2	63.5	63.0	58.0
waste incineration	%	0	0	0	0.1	0.8	0	0	0	0	2.0
other operations of recovery	%	0.7	0.9	0.2	0.4	0.5	0.2	0.3	0.1	0.1	0.0
waste use as a fuel	%	0.6	0.2	1.8	0.3	0	0	1.2	1.4	1.7	2.0
recovery	%	1	1.6	14.1	16	11.5	31.0	31.3	35.0	35.2	34.0
composting	%	0	0	0	0	0	0	0	0	0	6.0

Table 8.1.5: Quantities of landfilled waste in the period 1964 - 2011.

Year	Municipal waste (t)	Biodegradable waste (t)	Year	Municipal waste (t)	Biodegradable waste (t)
1964	383,180	180,095	1988	655,907	321,395
1965	387,847	182,288	1989	664,069	332,034
1966	400,205	188,096	1990	671,980	342,710
1967	405,318	190,499	1991	681,580	354,421
1968	416,386	195,702	1992	687,897	364,585
1969	418,907	196,886	1993	694,418	374,986
1970	430,074	202,135	1994	702,108	386,160
1971	432,961	203,492	1995	707,000	445,410
1972	444,532	208,930	1996	725,000	456,750
1973	448,243	210,674	1997	743,000	468,090
1974	460,768	216,561	1998	761,000	479,430
1975	482,226	226,646	1999	780,000	491,400
1976	504,485	237,108	2000	800,000	504,000
1977	518,699	243,789	2001	820,000	483,800
1978	533,040	250,529	2002	840,000	470,400
1979	546,537	256,873	2003	844,606	430,749
1980	559,969	263,185	2004	810,647	381,004
1981	572,769	269,202	2005	793,118	348,972
1982	583,024	274,021	2006	838,883	347,298
1983	593,592	278,988	2007	811,674	294,747
1984	604,686	284,203	2008	831,834	284,743
1985	622,376	292,517	2009	731,008	260,298
1986	633,037	297,528	2010	623,224	187,146
1987	644,144	309,189	2011	646.318	124.995

The quantities of municipal waste have marked a slight decrease in recent years. There are several possible explanations for this, one of them being that the quantities in previous years have mostly been arrived at by estimation, whereas in the last three years we had at our disposal very accurate data from all SWDS. At the same time, the area where waste is collected separately and then recycled is getting ever wider.

Methane correction factor (MCF) accounts for the effect of management practices on CH_4 generation. Unmanaged disposal sites present lower methane-generating potential, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.
The IPCC guidelines describes managed SWDS site as site with one off the following:

- cover material
- mechanical compacting
- levelling of waste

In 1964, the Ljubljana-Barje SWDS started to operate as our first managed solid waste disposal site. Other existing solid waste disposal sites were unmanaged at that time. In our estimate, roughly half of the waste was collected at managed SWDS, half at unmanaged SWDS. As the depth of unmanaged SWDS at that time is unknown, we considered them as non-categorised and assumed a MCF of 0.6 for them, while assuming a MCF of 1 for managed SWDS . For the entire period 1964-1976, emissions have been calculated with an average value of MCF, i.e. 0.8.

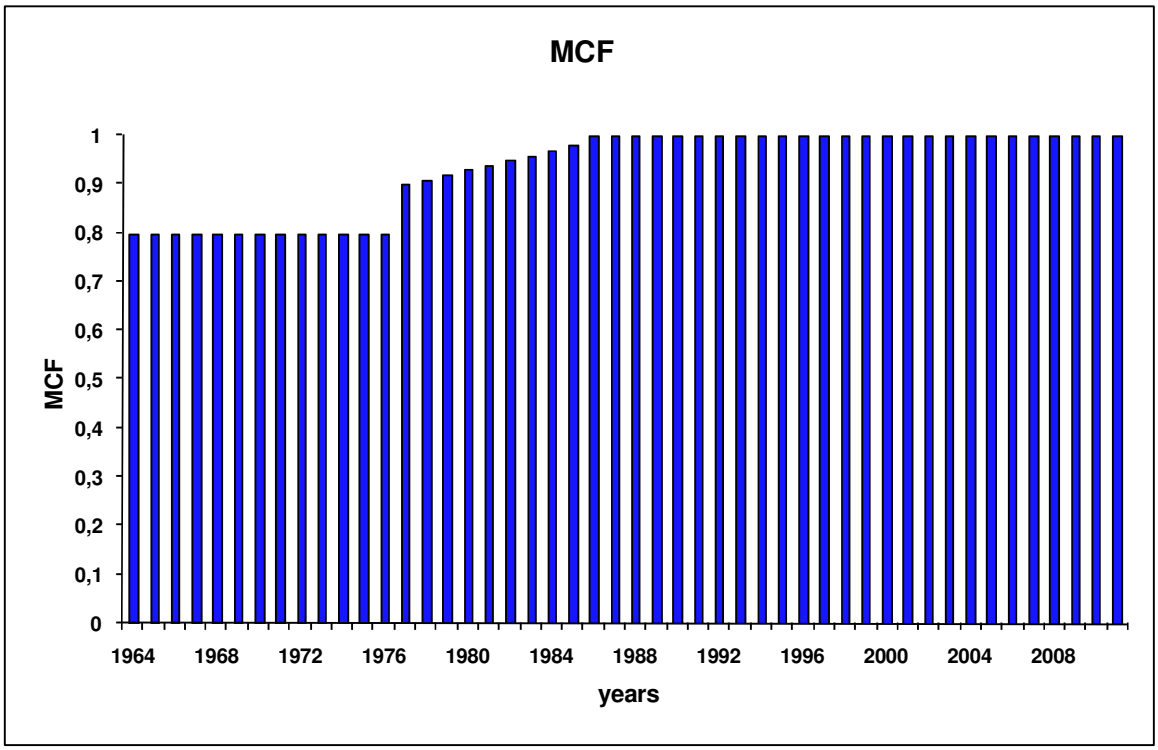

Figure 8.1.2: Methane correction factor.

1977 saw an accelerated rate of controlled placement of waste, with the result that three quarters of waste were disposed of on managed solid waste disposal sites in that year, and we therefore assumed a MCF of 0.90. Following that year, all other solid waste disposal sites progressively introduced managing practices and since 1986 all other SWDS in Slovenia may be classified as managed SWDS. Accordingly, MCF was increased linearly for the period from 1977 to 1986 MCF, and since 1986 it is equal to 1.

Degradable organic carbon (DOC) is the organic carbon that is accessible to biochemical decomposition. It is a function of the composition of waste and can be calculated from a weighted average of carbon content of various components of waste.

DOC = (0.4 • A) + (0.17 • B) + (0.15 • C) + (0.3 • D)

where:

A = fraction of waste that is paper and textiles

B = fraction of waste that is garden waste, park waste or other non-food organic putrescibles

C = fraction of waste that is food waste

D = fraction of waste that is wood or straw

For mixed waste, which represents the major part of municipal and similar types of waste, we assumed the composition or fractions A, B, C in D, as stated in the Operational programme of waste disposal to be the same for the entire period: A:12%, B:5%, C:25%, D:5%. Later this number has been changed to A:15%, B:8%, C:32%, D:8% for 1995 (the base year for the Operational programme).

The composition of waste and the composition of its biodegradable part are taken from the results of certain screening analyses in Slovenia.

Table 8.1.6: Fractions of degradable waste in municipal waste and degradable organic carbon (DOC).

year	A paper textiles	B garden waste	C food waste	D wood straw	Degradable waste in %	DOC in %
1964-1986	12.0	5.0	25.0	5.0	47.0	10.9
1987	12.0	5.0	25.0	5.0	48.0	10.9
1988	12.0	5.0	25.0	5.0	49.0	10.9
1989	13.0	6.0	26.0	6.0	50.0	11.92
1990	13.0	6.0	27.0	6.0	51.0	12.07
1991	13.0	6.0	28.0	6.0	52.0	12.22
1992	14.0	7.0	29.0	7.0	53.0	13.24
1993	14.0	7.0	30.0	7.0	54.0	13.39
1994	14.0	7.0	31.0	7.0	55.0	13.54
1995	15.0	8.0	32.0	8.0	63.0	14.56
1996	15.0	8.0	32.0	8.0	63.0	14.56
1997	15.0	8.0	32.0	8.0	63.0	14.56
1998	16.0	8.0	31.0	8.0	63.0	14.81
1999	16.0	8.0	31.0	8.0	63.0	14.81
2000	17.0	8.0	30.0	8.0	63.0	15.06
2001	17.0	6.0	28.0	8.0	59.0	14.42
2002	18.0	4.0	26.0	8.0	56.0	14.18
2003	18.0	2.0	23.0	8.0	51.0	13.39
2004	19.0	0.0	21.0	7.0	47.0	12.85
2005	20.4	0.0	16.5	7.1	44.0	12.765
2006	20.8	0.0	14.2	6.4	41.4	12.37
2007	16.7	0.0	10.7	8.9	36.3	10.96
2008	15.9	0.0	11.0	7.3	34.2	10.21
2009	11.4	0.0	15.6	8.6	35.6	9.48
2010	12.6	0.0	11.8	5.6	30.0	8.50
2011	8.4	0.0	7.2	3.7	19.3	5.6

In the year 2005 and partly in the year 2006 a new screening analyzes of mixed municipal waste have been performed. The results have been as followed: 22.1% A, 17.5% C in 7.5% D, or summed together 47% of degradable wastes. When we considered all waste disposed in the SWDS and fraction of degradable waste in other types of disposed wastes we have estimate the following composition of waste for 2005: A:20.4%, C:16.5% and D:7.1%. The fraction of waste that is garden waste or park waste is zero because of legislation which prohibited the deposition of such type of waste on SWDS. From 2005 the screening analyze has been done many times per year.

For the composition of industrial waste we have no data for the years before 2001. In last four years because of legislation no degradable industrial waste is allowed to be disposed on MSWD. This type of industrial waste is mostly transformed to compost in aerobic process without methane formation. We decided to take conservative approach not considering degradable industrial waste the same composition as was ascribed to municipal waste, whereas for the last three years the composition was calculated on the basis of data provided by ARSO.

Fraction of degradable organic carbon dissimilated (DOC_F) is an estimate of the fraction of carbon that is ultimately degraded and converted into landfill gas, and reflects the fact that some organic carbon does not degrade, or degrades very slowly, when deposited in SWDS.

The IPCC Guidelines, 1996 provide a default value of 0.77 for DOC_F. Based on a review of recent literature, it appears that this default value may be an overestimate. It should only be used if lignin C is excluded from the DOC value. It is a good practice to use a value of 0.5-0.6 as the default. In our calculations, we assumed a DOC_F value of 0.55 as a median value of the recommended interval.

Process Fraction of CH_4 in landfill gas (F) reflects the fact that biogas is mainly consisted of CH_4 and CO_2 (usually considered half of each gas). We use 0.5 as most usually taken value in our estimates.

CH_4 recovery (R) is the amount of CH_4 generated at SWDS that is recovered and combusted (e.g. flared or used for energy). The amount of methane that is recovered and flared or oxidised in gas engines is subtracted from the annual methane emissions

Table 8.1.7: Recovery of methane, generated at SWDS

	Unit	1998	1999	2000	2001	2002	2003	2004
Recovery	t CH_4	3794	4036	4278	4520	4820	5210	5165
Recovery	TJ	191	203	216	228	243	263	260
used for electricity	TJ	102	120	107	149	178	221	241
Difference - flared	TJ	89	83	109	79	65	42	19
flared	t CH_4	1770	1655	2155	1564	1288	825	383

	Unit	2005	2006	2007	2008	2009	2010	2011
Recovery	t CH_4	5422	6366	7633	8165	10011	9816	8514
Recovery	TJ	273	321	385	411	505	495	429
used for electricity	TJ	253	288	317	343	349	324	298
Difference - flared	TJ	20	33	68	68	156	171	131
flared	t CH_4	402	651	1344	1359	3087	3396	3602

Data on the quantities of recovered methane from 2000 on were provided by the Waste Sector (ARSO) and for previous years directly from disposal sites. Since there are no data on the amount of recovered methane for 2001, an interpolated value was used in calculation.

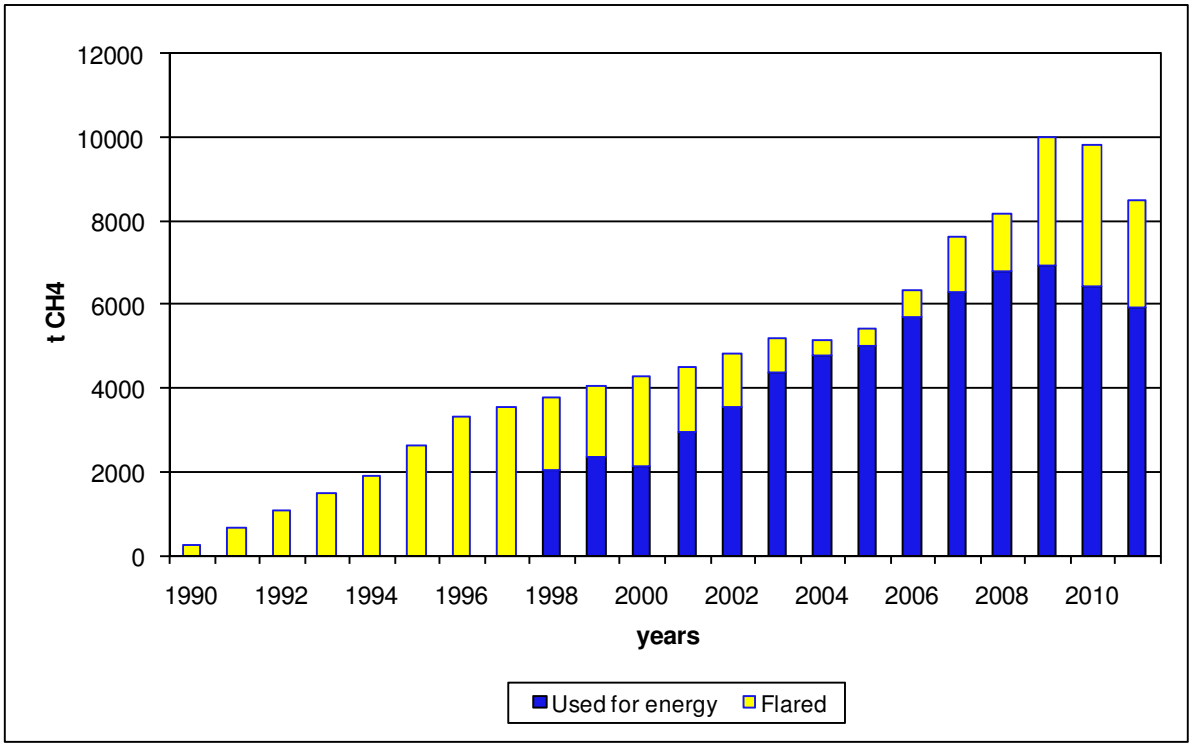

Figure 8.1.3: Methane recovery in tons.

From 1998 energy use of methane is reported in Energy sector in 1.A.1.a Public electricity and heat production, and remaining amount is assumed to be flared. Before 1998 all methane recovered on SWDS is flared. Emissions from flaring are reported under biomass used in commercial sector.

Oxidation factor (OX) reflects the portion of CH_4 from SWDS that is oxidised in the soil or other material covering the waste. The amount of CH_4 that oxidises turns primarily to CO_2. If the OX is zero, no oxidation takes place, and if OX is 1 then 100% of CH_4 is oxidised. We assumed that, in our case, OX was very close to zero until 2008, when we start using 0.1. The oxidation value of 0.1 is justified for well-managed landfills which are covered with soil or other material. In the past very few SWDSs in Slovenia, although they were managed, use the cover material. In 2006 Slovenia started to implement EU legislation and until 2008 all SWDSs became well managed (are covered with soil or other material). It is very hard to estimate the oxidation factor before 2008 but according to the GPG, use of 0.1 is appropriate since 2008 only.

Emissions estimates according to default method (Tier1) and first order decay method are presented in the Figure 8.1.4.

The essential difference between the results obtained by these two methods is in emissions of the reference year and in the response of certain emissions to waste-management measures. The quantities of disposed of waste have been rising in the last 30 years and therefore emissions calculated according to the first order decay method for the reference year are, as a rule, lower. The first order decay method takes into account also

the contribution of waste disposed of in the past, therefore the reduction of quantity of disposed of biodegradable waste in certain emissions shows only after a certain time delay.

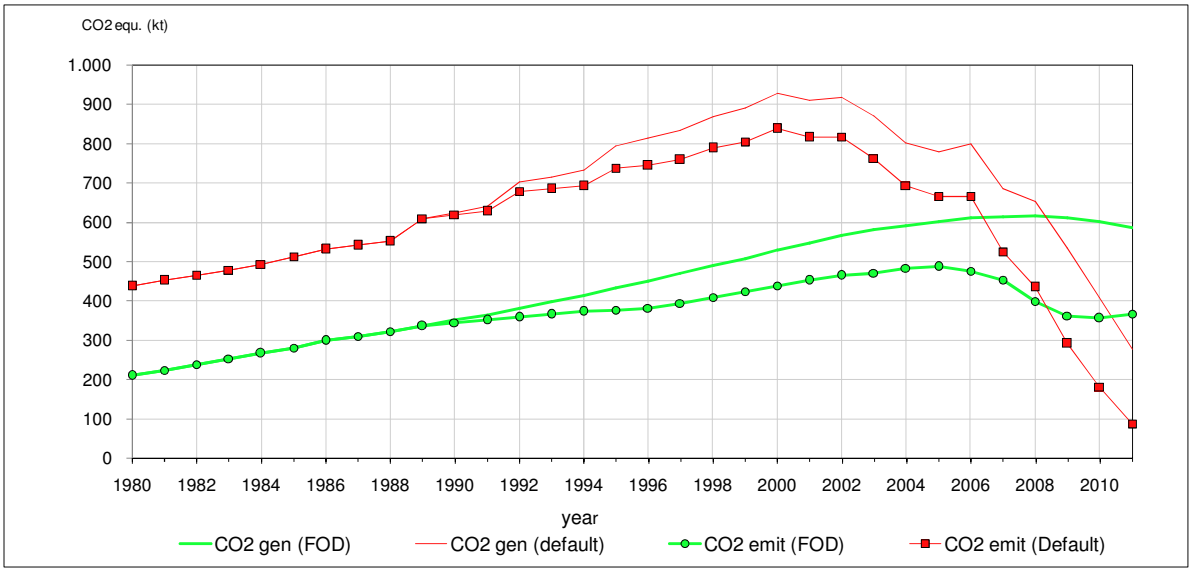

Figure 8.1.4: Methane emissions from SWDS in Gg CO_2.

8.1.4 Source specific recalculations

No recalculations have been made in this category.

8.1.5 Future improvements

No improvements are planned for this category.

8.2 Emissions from Wastewater Handling

Key source - base year: no
Key source - 2011: no

8.2.1 Source category description

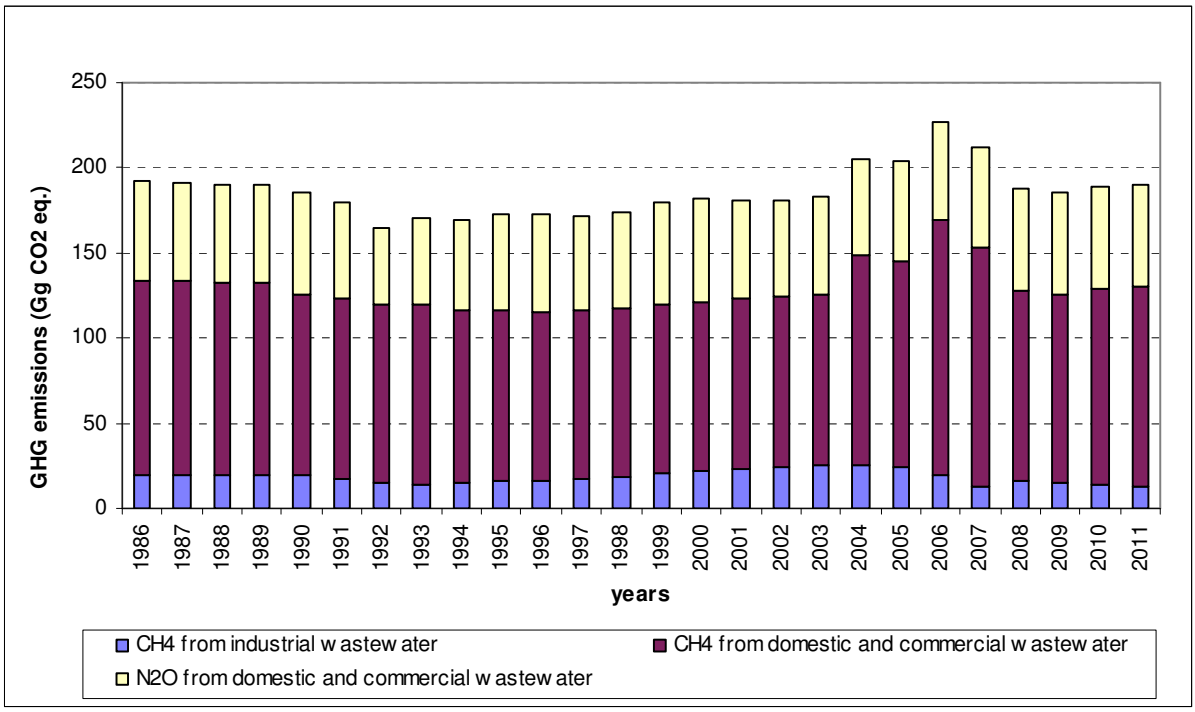

Figure 8.2.1: Emissions of methane and nitrous oxide from wastewater handling.

Wastewater could be a source of methane when treated or disposed anaerobically. It can also be a source of nitrous oxide emissions. Wastewater originates from a variety of domestic and industrial sources and may be treated on site (uncollected), sewered to a centralized plant (collected) or disposed untreated nearby or via an outfall. IPCC methodology recommends separate handling of domestic and industrial wastewater. The research projects on emissions of methane from wastewater handling for Slovenia have been carried out by the Ministry of Environment, Spatial Planning and Energy (Dolenc, Žitko-Štemberger, 1999) and National Institute of Chemistry, Ljubljana, 2009. This report brings the basic procedures and results of calculations that demonstrate the relations with IPCC methodology. Detailed calculations are specified in quoted sources. Nitrous oxide emissions from human sewage are included in this chapter as well. Figure 8.2.1 and Table 8.2.1 show CH_4 and N_2O emissions from domestic and industrial wastewater treatment for the period 1986-2011. Emissions in Figure 8.2.1 are expressed in Gg CO_2 equivalent. Conversion factors of 21 for CH_4 and 310 for N_2O were used in the calculations. Referring to the third IPCC assessment report, 1 g CH_4 and 1 g N_2O have the greenhouse effect of 21 and 310 g CO_2, respectively.

Table 8.2.1: Methane and nitrous oxide emissions from wastewater treatment.

Year	Industrial wastewater	Domestic and commercial wastewater	Domestic and commercial wastewater	Industrial wastewater	Domestic and commercial wastewater	Domestic and commercial wastewater
	CH4 emissions (Gg)	CH4 emissions (Gg)	N2O emissions (Gg)	CH4 emissions (in Gg CO2 eq.)	CH4 emissions (in Gg CO2 eq.)	N2O emissions (in Gg CO2 eq.)
1986	0.95	5.39	0.19	19.9	113.2	58.9
1987	0.95	5.39	0.19	19.9	113.2	57.9
1988	0.94	5.39	0.18	19.7	113.2	57.2
1989	0.93	5.39	0.18	19.6	113.2	57.2
1990	0.93	5.07	0.19	19.5	106.5	59.6
1991	0.84	5.04	0.18	17.7	105.8	56.0
1992	0.71	4.99	0.14	14.9	104.9	44.5
1993	0.65	5.04	0.16	13.8	105.9	50.8
1994	0.73	4.81	0.17	15.3	100.9	53.0
1995	0.78	4.78	0.18	16.3	100.4	55.6
1996	0.75	4.75	0.19	15.7	99.8	57.6
1997	0.82	4.70	0.18	17.2	98.8	56.2
1998	0.89	4.72	0.18	18.8	99.2	55.7
1999	0.97	4.74	0.19	20.3	99.6	60.1
2000	1.02	4.76	0.19	21.4	100.0	60.2
2001	1.07	4.78	0.19	22.5	100.4	57.7
2002	1.13	4.80	0.18	23.7	100.9	56.8
2003	1.18	4.82	0.19	24.8	101.3	57.5
2004	1.22	5.84	0.18	25.7	122.7	56.5
2005	1.16	5.77	0.19	24.5	121.1	58.0
2006	0.95	7.10	0.19	19.9	149.1	57.9
2007	0.61	6.70	0.19	12.7	140.7	58.4
2008	0.74	5.35	0.19	15.6	112.4	59.5
2009	0.70	5.26	0.19	14.8	110.5	60.1
2010	0.64	5.49	0.19	13.4	115.4	60.2
2011	0.61	5.60	0.19	12.8	117.5	60.3

8.2.2 Methodological issues

Domestic and Commercial Wastewater

CH_4 EMISSIONS

IPCC methodology has been used in calculating the emission of methane from domestic wastewater handling.

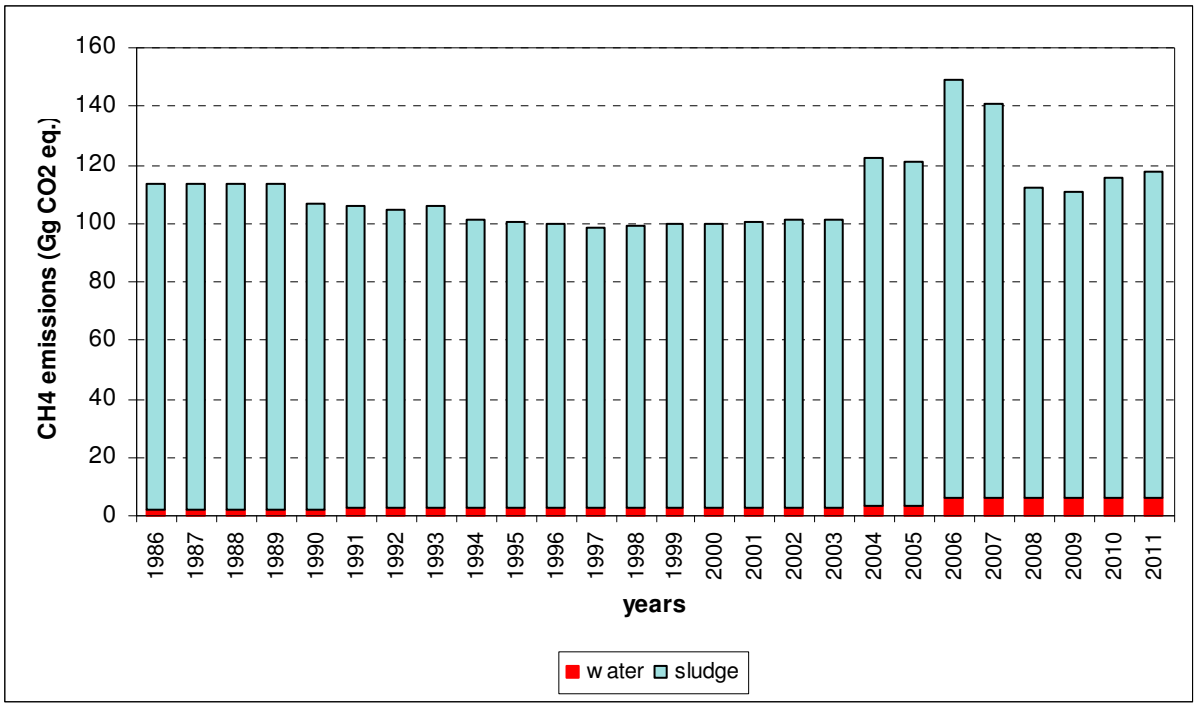

Figure 8.2.2: CH_4 emissions from domestic and commercial wastewater treatment.

As a first step, it is necessary to determine the quantity of total organic decomposable matter in the wastewater (TOW_{dom}) and sludge (TOS_{dom}). TOW_{dom} and TOS_{dom} are expressed in kg BOD/year.

$$TOW_{DOM} = P * D_{DOM} * (1 - DS_{DOM})$$
$$TOS_{DOM} = P * D_{DOM} * DS_{DOM}$$

P – population (in 1000 persons),
D_{DOM} – degradable organic component in wastewater (kg BOD/1000 persons/year),
DS_{DOM} – fraction of degradable organic component removed as sludge.

Secondly, the emission factor for wastewater and sludge is estimated. Emission factor in kg CH_4/kg of degradable organic component for:

$$EF_i = B_0 * \sum_x (WS_{Ix} * MCF_{ix}) \quad \text{for wastewater}$$
$$EF_j = B_0 * \sum_y (SS_{jy} * MCF_{jy}) \quad \text{for sludge}$$

B_0 – maximum methane-producing capacity for the wastewater or sludge (kg CH_4/kg BOD),
Ws_{ix} – fraction of wastewater from source i treated in system x,
MCF_{ix} – methane conversion factor for an individual type of wastewater handling system (fraction),
SS_{jy} – fraction of sludge from source j treated in system y,
MCF_{jy} – methane conversion factor for sludge handling (fraction).

Total emissions of methane from wastewater and sludge handling are:

$$WM = \sum_i (TOWi * EF_i - MR_i)$$
$$SM = \sum_j (TOW_j * EF_j - MR_j)$$

$MR_{i/j}$ - Quantity of methane recovered or flared from a wastewater or sludge

Total emission of methane from municipal wastewater treatment and from handling of sludge from municipal wastewater amounts to:

$$TM = WM + SM$$

CH_4 emissions (in Gg CO_2 eq.) from domestic wastewater treatment for the period 1986 - 2011 are shown in Figure 8.2.2. Referring to the third IPCC assessment report, 1 g CH_4 has the greenhouse effect of 21 g CO_2.

Population

Dispersed settlement and a large number of communities with less than 2000 inhabitants exert a strong influence on the extent and structure of municipal infrastructure as well as on the organisation of municipal activities. In 2011, about 97% of inhabitants have been connected to one way of treatment and 3% of population did not have any wastewater treatment. Wastewater treatment is done in various ways. About 50% undergoes secondary and tertiary treatment and 48 % of population use septic tanks. With regard to CH_4 emissions, municipal wastewater that undergoes only coarse treatment may be regarded as untreated water. Sector 6B Wastewater handling comprises emissions from all types of waste water handling including emissions from septic tanks.

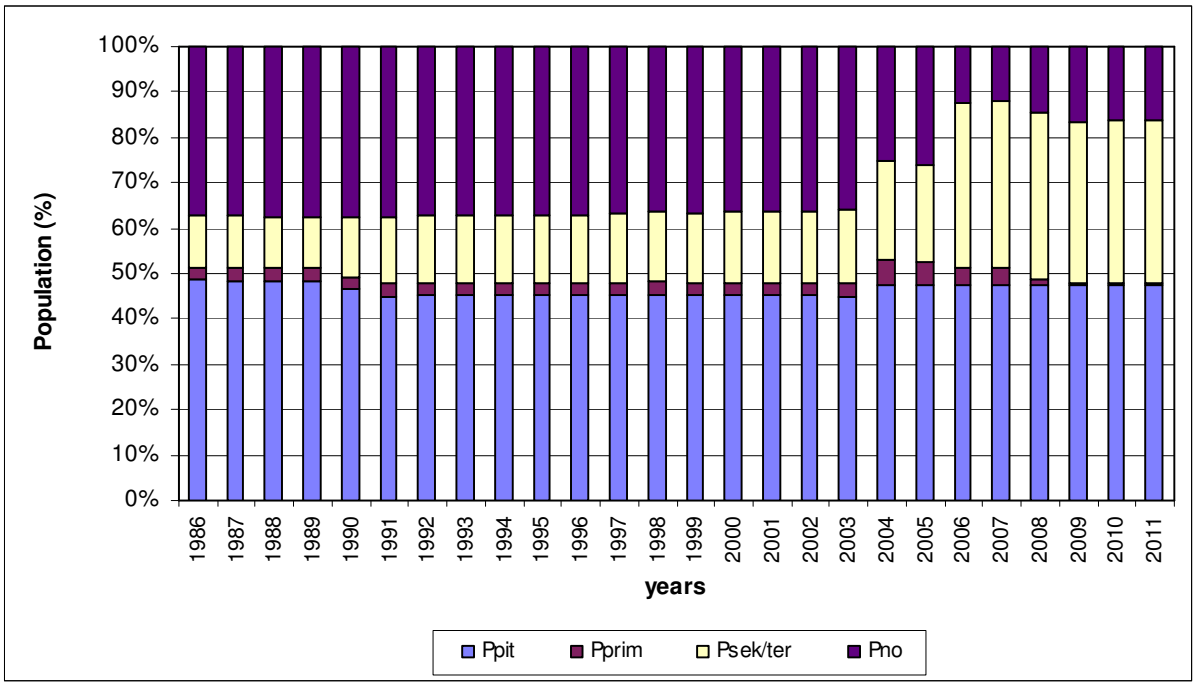

Figure 8.2.3: Fraction of inhabitants included into various types of domestic wastewater treatment (septic tanks (pit), primary treatment, secondary/tertiary treatment and no treatment).

The fraction of inhabitants according to various types of domestic wastewater treatment is shown in figure 8.2.3. Data are taken from Statistical Office of the Republic of Slovenia (SORS) and the database on municipal wastewater treatment plants collected by the Slovenian Environment Agency.

Degradable organic component (D_{DOM}):

For domestic wastewater and sludge, biochemical oxygen demand (BOD) is recommended degradable organic component indicator. Default 60 g BOD/person/day or 21900 kg BOD/1000 person/year was used for emission calculations.

Fraction of degradable organic component removed as sludge (DS_{DOM}):
The results of mass balances of operation of biological wastewater treatment plants show that the fraction of degradable organic compounds which will decompose as sludge is around 40%.

Maximum methane producing capacity (B_0)
The methane producing potential (Bo) is the maximum amount of CH_4 that can be produced from a given quantity of wastewater or sludge. The CH_4 producing potential varies by the composition of the wastewater/sludge and its degradability, but the IPCC Guidelines provide only one default value of B_0. The default (theoretical) value for Bo - 0.6 kg CH_4/kg BOD was used for emission calculations.

Methane conversion factor (MCF):
The calculated amount of generated methane is dependent on the methane conversion factor, which tells us what fraction is actually transformed into methane. MCF is 0 for completely aerobic systems and 1 for completely anaerobic systems. Wastewaters are mostly handled aerobically, only for secondary treated wastewaters we assumed that MCF equalled 0.05, which was to account for slight irregularities in wastewater treatment in biological wastewater treatment plants.

In calculating emission factor for sludge, we assumed a value of 0.8 for MCF in handling sludge from wastewater treatment plants and in calculating the contribution of methane emissions from septic tanks. For untreated or only mechanically dehydrated sludge, which is disposed of on waste disposal sites, we assumed that the value of MCF was 1.

Methane recovery (MR_i)
In calculating methane emissions the quantity of methane recovered in sludge treatment in wastewater treatment plants is subtracted from the total methane production. Data on methane recovered for the period 2006-2011 were obtained from SORS. Data on recovery for previous years were collected in the frame of research project carried out by the Ministry of Environment, Spatial Planning and Energy. Data on methane recovered from domestic wastewater treatment is shown in the table 8.2.2. Energy use of methane is reported in Energy sector in 1.A.1.a Public electricity and heat production.

Table 8.2.2: Methane recovery from domestic wastewater treatment.

Year	CH4 Recovery (Gg)	Year	CH4 Recovery (Gg)	Year	CH4 Recovery (Gg)	Year	CH4 Recovery (Gg)
1986	0.066	**1993**	0.469	**2000**	0.828	**2007**	1.409
1987	0.066	**1994**	0.705	**2001**	0.828	**2008**	2.579
1988	0.066	**1995**	0.729	**2002**	0.828	**2009**	2.503
1989	0.066	**1996**	0.758	**2003**	0.828	**2010**	2.325
1990	0.417	**1997**	0.828	**2004**	0.828	**2011**	2.242
1991	0.475	**1998**	0.828	**2005**	0.828		
1992	0.517	**1999**	0.828	**2006**	0.933		

N_2O EMISSIONS

IPCC methodology for calculation of N_2O emissions is based on the number of inhabitants in a certain country as well as average consumption of protein per inhabitant in any individual year. The model presumes 0.16 kg N/kg protein as a default fraction of nitrogen in protein as well as an emission factor of 0.01 kg of N_2O-N/kg of consumed nitrogen. For emission calculation statistical data on the population from Statistical Office of Republic of Slovenia and data on the consumption of protein from United Nations Food and Agriculture Organization (FAO) have been used. Relatively low amounts of N_2O formation can substantially contribute to the GHGs emissions, which is due to a very high global warming

potential of N_2O. Referring to the third IPCC assessment report, 1 g N_2O has the greenhouse effect of 310 g CO_2 (Table 8.2.3).

Table 8.2.3: Population, protein consumption and N_2O emissions in the period 1986-2011.

Year	Population	Protein in (kg/person/year)	N_2O emissions (Gg)	N_2O emissions (in Gg CO_2 eq.)
1986	1985486	38.0	0.190	58.86
1987	1994066	37.2	0.187	57.86
1988	1996325	36.8	0.184	57.19
1989	1996377	36.8	0.185	57.25
1990	1999945	38.2	0.192	59.57
1991	1998912	35.9	0.181	55.96
1992	1994084	28.6	0.144	44.52
1993	1989408	32.8	0.164	50.78
1994	1989477	34.2	0.171	53.04
1995	1990266	35.8	0.179	55.59
1996	1986989	37.2	0.186	57.62
1997	1984923	36.4	0.181	56.25
1998	1978334	36.1	0.180	55.67
1999	1987755	38.8	0.194	60.13
2000	1990094	38.8	0.194	60.20
2001	1994026	37.2	0.186	57.74
2002	1995033	36.5	0.183	56.76
2003	1996433	37.0	0.186	57.51
2004	1997590	36.3	0.182	56.52
2005	2003358	37.2	0.187	58.03
2006	2010377	36.9	0.187	57.86
2007	2025866	37.0	0.188	58.40
2008	2032362	37.6	0.192	59.50
2009	2046976	37.7	0.194	60.10
2010	2050189	37.7	0.194	60.19
2011	2055496	37.7	0.195	60.35

The publication of protein consumption data on the FAO's statistical database (FAOSTAT) has a time lag of three years. The last available consumption rate is applied to the years with missing data. Since the consumption protein data has not been available for the years 2009 and 2010, data for the year 2008 has been applied for the following years as well. We have checked also other potential sources of required data, but no other institution collects up-to-date data on protein consumption.
Methodology and activity data used for calculation of N_2O is presented. Applied methodology is taken from Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, 6.28.
The emissions of N_2O from human sewage are calculated as follows:

$$N_2O = \mathrm{Pr}otein * Frac_{NPR} * EF * NR_{people}$$

N_2O –- emissions of N_2O from human sewage (kg N2O-N/year)
Protein – annual consumption of protein per capita (kg/person/year)
NR_{people} –- number of people in country (population)
EF –- emissions factor (kg N2O-N/kg sewage-N produced)
$Frac_{NPR}$ –- fraction of nitrogen in protein

Industrial Wastewater

CH_4 EMISSIONS

IPCC methodology has been used in calculating the emission of methane from industrial wastewater handling. Calculation of methane emissions has been performed according to a procedure similar to that for domestic wastewater explained in previous chapter. CH_4 emissions (in Gg CO_2 eq.) from industrial wastewater treatment for the period 1986-2011 are shown in Figure 8.2.4. Referring to the third IPCC assessment report, 1 g CH_4 has the greenhouse effect of 21 g CO_2.

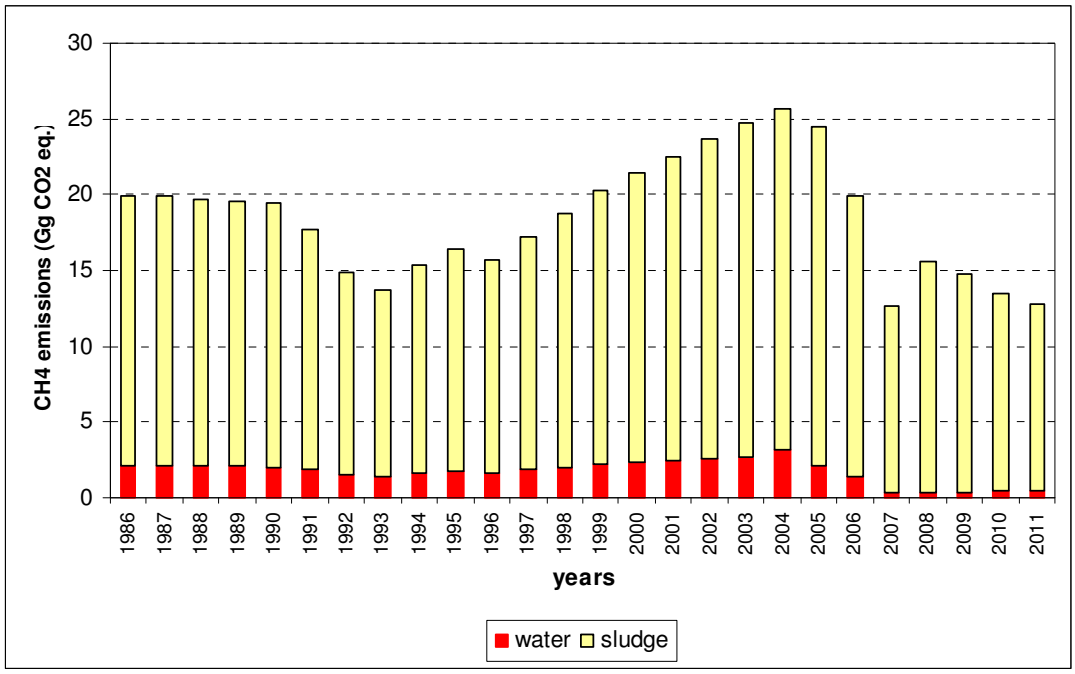

Figure 8.2.4: CH_4 emissions from industrial wastewater treatment.

Emissions of methane from industrial wastewater are calculated for the chosen industrial sectors with a large output of wastewater and high content of degradable organic components. In Slovenia, these are in particular the pulp and paper industry followed by production of soft drinks and alcohol beverage, pharmaceutical industry and meat processing, while minor quantities of organically degradable organic components are produced also by some other sectors. The greater part of emissions was contributed by sludge treatment, while wastewaters contributed few percents. Methane emissions in 2011 with regard to various industries are presented in Table 8.2.4.

Calculation of methane emissions for the whole period 1986-2011 has been performed using the following procedure. Firstly, the total output of organic components in wastewater for each individual industry (TOW_{ind}) and in sludge for each individual industry (TOS_{ind}) were determined. For calculation of TOW_{ind} and TOS_{ind} data on quantity (volume) of wastewater, concentration of organic component in the wastewater and fraction of degradable organic component removed as sludge were used for the whole period. Emission factors for waste water and sludge for each industry were calculated as a product of methane conversion factors (MCF) and maximum methane producing capacity (B_0). Total emissions for waste water and sludge for each industry were calculated by multiplying emissions factors with TOW_{ind} and TOS_{ind}. Values of quantity of wastewater, concentration of organic component in the wastewater for an individual industry and other parameters for the period 2004-2011 were estimated on the basis of data from reports on operational monitoring, on the basis of cooperation with representatives of individual industries,

theoretical values outlined in guidelines and experts' knowledge of processes and their experiences.

Table 8.2.4: Methane emissions in 2011 with regard to various industries.

Industry Type	CH_4 from water (Gg)	CH_4 from sludge (Gg)	CH_4 total (Gg)	Share (%)
Production of leather	0,0007	0,000043	0,0007	0,1
Production of soft drinks and alcohol beverage	0,0729	0,003616	0,0765	12,6
Production of meat	0,0697	0,001698	0,0714	11,7
Production of pulp and paper	0,3399	0,004356	0,3442	56,6
Production of milk	0,0349	0,000236	0,0351	5,8
Production of food	0,0064	0,000058	0,0065	1,1
Production of pharmaceutical products	0,0624	0,011757	0,0742	12,2
Total	0,58683	0,02176	0,60860	100,0

Important source of information were questionnaires sent to the industry relating to handling of wastewater and sludge. Database of monitoring industrial effluents was used for estimations as well. Parameters for estimation of methane emissions from industrial waste water were obtained in the scope of the project performed by National Institute of Chemistry, Ljubljana, 2009. Since actual monitored volumes of wastewater are not available before the year 2004, estimation of volumes of wastewater for the years 1986-2003 was performed. Estimation was based on ratio between data of actual volumes and data of production units for individual industries. We estimated volumes of wastewater for the period 1986-2003 in such way that we multiplied these ratios for the year 2004 with data on annual production of individual industry. We decided to choose ratios for the year 2004, since this year most closely represents situation in previous years. Detailed description is presented in NIR 2012. Other parameters needed for emission calculation for the period 1986-2003 were adopted from 2004 data.

Data on amount of wastewater output for individual industries for the whole period 1986-2011 are presented in Table 8.2.5.

Methane conversion factor (MCF):

Most methane is produced in sludge treatment, while wastewater treatment contributes only a small part in methane production.

Wastewater is mostly handled aerobically. Production of methane from waste water handling is very low. MCF assumed to be 0.03. Most of sludge is incinerated, composted and exported, only a smaller part is disposed on solid waste disposal sites. We assumed a value of 0.1 for MCF for sludge handling.

Maximum methane producing capacity (B_0)

The methane producing potential (B_0) is the maximum amount of CH_4 that can be produced from a given quantity of wastewater or sludge. The CH_4 producing potential varies by the composition of the wastewater/sludge and its degradability. The default IPCC Guidelines value of 0.25 kg CH_4/kg COD was used for wastewater and for sludge for all types of industries, except for production of pulp and paper. B_0 for pulp and paper industry was estimated from real operational data and amounted 0.16 kg CH_4/kg COD. Calculation based on formation of methane in anaerobic reactor.

Table 8.2.5: Wastewater output with regard to various industries.

Year	Production of pulp and paper	Production of leather	Production of soft drinks and alcohol beverage	Production of food	Production of milk	Production of meat	Production of pharmaceutical products
	Wastewater output (m3)						
1986	18612812	960966	1993330	513066	992776	854301	
1987	18560824	948137	1993276	479440	1008278	908295	
1988	18199349	935331	1993223	445821	1023777	962289	
1989	17992579	922503	1993164	412196	1039279	1016283	
1990	17785835	909674	1993106	378570	1054778	1070278	
1991	15813639	778661	1897174	369069	1034204	1059647	
1992	13167759	736567	1773698	245566	921828	764296	
1993	12056736	686178	1812219	272168	767155	650592	
1994	13879156	678212	1906083	296905	835621	634050	
1995	15431625	459865	1879191	304715	911369	574572	
1996	14369458	529332	1881993	300437	885387	662932	
1997	16266638	496348	1941510	282961	926754	663706	
1998	18163843	463364	2001042	265483	968119	664480	
1999	20061023	430379	2060559	248007	1009486	665255	
2000	21397736	397395	2120086	230529	1050850	666029	
2001	22734450	364411	2179603	213054	1092218	666803	
2002	24071163	331427	2239130	195578	1133582	667578	
2003	25407851	298442	2298652	178100	1174950	668352	
2004	27672000	274700	1970685	136139	1133979	662367	1577989
2005	26947000	233185	1362038	178404	1230059	1420996	1368549
2006	21112000	238400	2074000	164120	986677	1143262	1544907
2007	12231000	281863	1771724	85040	984528	1393753	1487780
2008	16508000	228651	1572889	191920	981910	1334951	1523185
2009	15881919	11617	1533764	223853	901292	1162973	1765726
2010	13596494	9224	1737723	167710	865144	1268351	1633612
2011	12514742	22597	1785722	213732	871805	1161579	1560375

Methane recovery

Controlled process of anaerobic formation of biogas (mixture of CH_4 and CO_2) in anaerobic reactor is included two types of industry: production of soft drinks and alcohol beverage and production of pulp and paper industry. Data on designed methane production is shown in the table 8.2.6. Share of recovered methane from total emitted methane from industrial waste water treatment is about 50%. Energy use of methane is reported in Energy sector in 1.A.1.a Public electricity and heat production.

Values of concentration of organic component in the wastewater (D_{ind}), fraction of degradable organic component removed as sludge (DS_{ind}), maximum methane producing capacity (B_0) and methane conversion factor (MCF) for individual industry for the year 2011 are specified in Table 8.2.7. Specified values have been used in subsequent calculations.

Table 8.2.6: Methane recovery from industrial wastewater treatment.

Year	Industry type	
	Production of soft drinks and alcohol beverage	Production of pulp and paper
	Recovery CH_4 (Gg)	
2004	0.259	0.764
2005	0.249	0.722
2006	0.318	0.747
2007	0.301	0.751
2008	0.297	0.646
2009	0.280	0.757
2010	0.271	0.770
2011	0.278	0.686

Table 8.2.7: Quantities of concentration of organic component in the wastewater, fraction of degradable organic component removed as sludge, maximum methane producing capacity and methane conversion factor for selected industries.

Industry Type	D_{ind} (kg COD/m^3 wastewater)	DS_{ind}	B_0	MCF sludge	MCF water
Production of pulp and paper	2.4	0.85	0.16	0.10	0.03
Production of meat	4.0	0.6	0.25	0.10	0.03
Production of milk	2.0	0.8	0.25	0.10	0.03
Production of leather	3.0	0.4	0.25	0.10	0.03
Production of pharmaceutical products	2.0	0.8	0.25	0.10	0.03
Production of food	1.5	0.8	0.25	0.10	0.03
Production of soft drinks and alcohol beverage	3.5	0.8	0.25	0.10	0.03

8.2.3 Source-specific recalculations

CH_4 emissions from industrial waste water treatment were recalculated for the year 2010 due to new data on total output of organic components for food industry obtained.
CH_4 emissions from domestic waste water treatment were recalculated for the period 2004-2010 due to new data obtained on inhabitants included into various types of wastewater treatment (primary, secondary/tertiary treatment).
N_2O emissions from human sewage were recalculated for the period 2008-2010 due to updated values of protein consumption obtained from FAOSAT.

8.2.4 Future improvements

No improvements are planned for this category.

8.3 Waste incineration

Key source - base year: NO
Key source - 2011: no

8.3.1 Source category description

To reduce the number of the not estimated sources to the extent possible emissions from the waste incineration have been calculated and reported for the first time in the submission 2010. As purpose of waste incineration until 2008 in Slovenia was to remove waste which is not allowed to deposit on SWDS the amount of incinerated waste was small and emissions from this source were insignificant (5.2 Gg CO2 eq. in 2010).

8.3.2 Methodological issues

Activity data

Amount on waste which was incinerated in Slovenia have been obtained from Slovenian Environment Agency. The data are available for individual plant from yearly reports for the period 2000-2010 for every category from waste classification. Before only total amount of clinical and hazardous waste is available and before 1990 there is absolutely no data available on this issue. Incinerated waste was divided to biogenic and non-biogenic part and non-biogenic part was further disaggregated in three types of waste (hazardous, clinical and municipal).

Table 8.3.1: Amount of waste incinerated in Slovenia in the period 1990 - 2011.

Year	biogenic	Municipal solid waste	clinical waste	hazardous waste
1990	0	0	0	815
1991	0	0	0	815
1992	0	0	0	815
1993	0	0	0	815
1994	0	0	132	456
1995	0	0	0	268
1996	0	0	0	389
1997	0	0	214	73
1998	10	0	205	335
1999	0	0	85	1031
2000	0	0	109	1261
2001	0	0	280	1190
2002	260	0	441	946
2003	235	0	534	1382
2004	110	15	138	1366
2005	291	2	113	1325
2006	345	4	108	1616
2007	676	9	160	1987
2008	533	33	148	2091
2009	630	19	193	2585
2010	31	21	671	2836
2011	251	9	660	2860

Emission factors

Emission factors have been taken from IPCC Good practice guidance and have been calculated as follows:

Table 8.3.2: Emission factors used in the period 1990 - 2011.

	unit	biogenic waste	municipal solid waste	clinical waste	hazardous waste
CO2	t / t waste	1.289	0.55733	0.836	1.64175
CH4	t / t waste	NA	NA	NA	NA
N2O	t / t waste	0.0004	0.00015	NA	NA

CO2 emission factor for biogenic waste is calculated using default EF from 1996 IPCC Guidelines, Table 1.1 for solid biomass (29.9 t C/TJ), NCV for biomass (12 TJ/kt) and Combustion efficiency for solid fuel (0.98)

CO2 EF (t/t waste) = (29.9 * 12 *0.98 * 44/12) / 1000

CO2 emission factors for other types of waste are calculated from default parameters presented in the table 8.3.3 below (source Table 5.6, GPG 2000) and using the following equation:

CO2 EF (t/t waste) = C Content of waste (%) * Fossil C of Total C * Combustion efficiency * 44/12

Table 8.3.3: Parameters for calculation of CO2 EF.

	unit	municipal solid waste	clinical waste	hazardous waste
C Content of waste	%	40	60	50
Fossil Carbon as % of Total Carbon	%	40	40	90
Combustion efficiency	%	95	95	99.5

For calculation N2O emissions the upper values of EF for “heart or grate” incineration plant, presented in the Table 5.7 in GPG, 2000 have been used.

8.3.3 Source-specific recalculations

No recalculations have been performed for this category.

8.3.4 Future improvements

No improvements are planned for this category.

8.4 Uncertainty and time series consistency

Uncertainty estimates are mostly based on expert judgement.

CH4 from solid wastes
Uncertainty of activity data amounts to 30%.
Uncertainty of emission factor amounts to 40%

CH4 from domestic waters:
Uncertainty of activity data amounts to 10%.
Uncertainty of emission factor amounts to 100%.

N2O from domestic waters:
Uncertainty of activity data amounts to 15%.
Uncertainty of emission factor amounts to 250%.

CH4 from industrial waters:
Uncertainty of activity data amounts to 25%.
Uncertainty of emission factor amounts to 50%.

Waste incineration:
Uncertainty of activity data amounts to 5%.
Uncertainty of CO2 EF: 97% (IPCC Guidelines)
Uncertainty of N2O EF: 100% (IPCC Guidelines)

The combined uncertainty of waste sector was 46.7%.

8.5 Source specific QA/QC

Besides general QC checks source specific checks have been performed for 2011 submission.
.
The following procedures have been done:

- Comparing CS values on MSW generated and waste composition with IPCC default values
- Comparing emission rates with those in similar countries
- Comparing of the recovery data gathered for tax purpose with SORS data

The peer review of waste water was conducted in 2011, no important errors have been found.

9 OTHER

No emissions have been reported under other.

10 RECALCULATIONS AND IMPROVEMENTS

Most recalculation which have been performed for 2013 submission have followed recommendations from the review of our 2011 submission made by EU. We have also included some improvement based on correspondence with the ERT during UNFCCC review week while AAR (not even draft) is not available, yet.

10.1 Justifications of recalculations and implication for emission levels

Recalculations occurred for the whole period 1986-2010. The impact of recalculations on total GHG emissions is presented in the Table 3.1.1.

Table 10.1.1: Total changes due to recalculation with respect to the previous submission.

	1986	1990	1995	2000	2005	2008	2009	2010
1. Energy	-10.7	-16.4	69.5	100.8	-12.0	5.4	-17.0	-14.0
2. Industrial Processes						-0.3	-0.5	8.9
3. Solvents								
4. Agriculture	-7.8	-6.6	-5.3	-3.8	-3.1	-1.6	-1.2	-7.9
5. LULUCF	-1,587	-1,854	-1,739	-2,707	-1,369	-1,295	-1,282	-1,161
6. Waste					-20.3	-27.9	-23.9	-27.2
Total w/o LULUCF	**-18**	**-23**	**64**	**97**	**-35**	**-24**	**-43**	**-40**
Total with LULUCF	**-1,605**	**-1,877**	**-1,674**	**-2,610**	**-1405**	**-1,320**	**-1,325**	**-1,201**
Total in % w/o LULUCF	-0.01	-0.12	0.35	0.52	-0.17	-0.11	-0.22	-0.21
Total in % with LULUCF	-12.7	-16.7	-14.9	-22.4	-11.7	-10.1	-12.0	-10.9

10.1.1 Energy

1.A.1.a Energy Industries / Public electricity and heat production, CO2, CH4, N2O
For MSW incinerated in the Slovenia only incineration plant the updated values of biomass fraction have been obtained and therefore GHG emissions from this plant related to the other and biomass fuel have been recalculated for the period since 2009. This is the year when the incineration plant has started to work. Following the recommendation from EU TERT the CH4 and N2O emissions from the waste incineration plant have been also calculated, they were reported as NO in the previous submissions.

1.A.3. b Road transportation, CO2, CH4, N2O
Recalculations of CO_2, CH_4 and N_2O emissions were performed for entire period 1986-2010 due to a new version of model Copert 4 used. We have used Copert 4, version 9.0 for emission calculations.

1.A.3. b Other transportation, CO2, CH4, N2O
Following the recommendation from 2012 UNFCCC review the emissions from natural gas transmission (combustion on compressor station) have been reallocated from 1.A.4.a Other sectors / Institutional and commercial sector to the 1.A.3.e Transport sector / Other transportation. Data are available since 2008, therefore the CO2, CH4, and N2O emissions have been recalculated for the period 2008-2010 while before 2008 the notation key IE has been used.

1.A.4.a Other Sectors / Institutional and Commercial, CO2, CH4, N2O
The CO2, CH4, and N2O emissions from natural gas combustion for NG transmission for the period 2008-2010 have been excluded from this sector and reported under transport emissions. See also the paragraph above.

1.A.4.c Other Sectors / Agriculture and forestry, CO2
During UNFCCC review process in 2012 it has been found out that wrong CO2 EF for diesel (72.6 Gg CO2/TJ) have been used for fuel used in agriculture and forestry. For the present submission the 73.3 Gg CO2/TJ has been used instead of 72.6 Gg CO2/TJ and CO2 emissions have been recalculated for the entire period 1986-2010.

Table 3.1.2: Changes due to recalculation with respect to the previous submission in Energy sector in Gg CO_2 eq.

Energy	1986	1990	1995	2000	2005	2008	2009	2010
A. Fuel Combustion	**-10.70**	**-16.41**	**69.52**	**100.80**	**-12.03**	**5.40**	**-17.01**	**-13.97**
1. Energy Industries							-3.85	-5.04
2. Manufacturing Ind.								
3. Transport	-14.39	-19.27	67.32	98.71	-14.10	5.38	-11.62	-6.44
4. Other Sectors	3.69	2.86	2.19	2.09	2.07	0.03	-1.54	-2.49
5. Other								
B. Fugitive Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels								
2. Oil and Natural Gas								
Total in Gg CO_2 eq	**-10.70**	**-16.41**	**69.52**	**100.80**	**-12.03**	**5.40**	**-17.01**	**-13.97**
Total of Energy in %	**-0.07**	**-0.11**	**0.47**	**0.67**	**-0.09**	**0.03**	**-0.11**	**-0.09**

10.1.2 Industrial processes

2.F Consumption of HFC and SF6, all relevant HFCs
Due to updated data on 1st filling obtained from our database, the HFC emissions from Refrigeration and AC have been recalculated for 2010.
A small correction has been also done to HFC emissions from aerosols and MDI for the period 2007-2010 due to the harmonization with the Austrian estimates.

Table 3.1.3: Changes due to recalculation with respect to the previous submission in Industrial processes sector in Gg CO_2 eq.

Industrial Processes	2007	2008	2009	2010
A. Mineral production	0.00	0.00	0.00	0.00
B. Chemical Industry	0.00	0.00	0.00	0.00
C. Metal Production	0.00	0.00	0.00	0.00
F. Consumption of HFC and SF6	-0.24	-0.32	-0.46	8.87
2.F.1 Refrigeration and AC Equipment	0.00	0.00	0.00	9.17
2.F.2 Foam Blowing	0.00	0.00	0.00	0.00
2.F.3 Fire Extinguishers	0.00	0.00	0.00	0.00
2.F.4 Aerosols / MDI	-0.24	-0.32	-0.46	-0.39
2.F.8 Electrical Equipment	0.00	0.00	0.00	0.00
Total in Gg CO_2 eq	**-0.24**	**-0.32**	**-0.46**	**8.87**
Total of sectoral emissions in %	**-0.02**	**-0.02**	**-0.05**	**0.91**

10.1.3 Agriculture

4.A Enteric fermentation, CH4

Swine: Following recommendations from 2012 technical review of the greenhouse gas emission inventory conducted by EU emissions have been recalculated in category 4.A.8 Swine for the entire period 1986-2010 using IPCC default EF instead of CS.
Non-dairy cattle: Very minor recalculations have been performed also for category non-dairy cattle in 2010 due to the updated value on slaughter weight.

4.B Manure management, CH4

Swine: Following recommendations from 2012 technical review of the greenhouse gas emission inventory conducted by EU CH4 emissions have been recalculated also in category 4.B.8 Swine for the entire period 1986-2010 using IPCC default value for production of volatile solids per day instead of CS.

4.B Manure management, N2O

Poultry: Following recommendations from 2012 technical review of the greenhouse gas emission inventory conducted by EU N2O emissions from poultry have been recalculated in category 4.B.11 Liquid systems and 4.B.13 Other systems for the entire period 1986-2010. At first all poultry manure were reallocated from liquid to other system for entire period.N2O emissions from poultry manure have been then recalculated using corresponding EF for other system instead of liquid.
Swine : Due to updated data the swine manure which was allocated to anaerobic lagoon in 2010 was reallocated to liquid and corresponding N2O emissions have been recalculated.

4.D Agricultural soils, N2O

The amount of sewage sludge applied to the agricultural soils in 2003 and 2004 have been corrected and very minor recalculations have influence on direct and indirect emissions.

Table 3.1.4: Changes due to recalculation with respect to the previous submission in Agriculture sector in Gg CO_2 eq.

Agriculture	1986	1990	1995	2000	2005	2008	2009	2010
A. Enteric fermentation	-4.32	-3.70	-2.94	-2.18	-1.75	-1.07	-0.92	-0.31
B. Manure management	-3.53	-2.71	-2.40	-1.64	-1.38	-0.53	-0.30	-7.3
D. Agricultural sols	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total in Gg CO_2 eq	**-7.85**	**-6.26**	**-5.34**	**-3.81**	**-3.13**	**-1.60**	**-1.23**	**-7.95**
Total of Agriculture in %	**-0.35**	**-0.31**	**-0.26**	**-0.18**	**-0.16**	**-0.08**	**-0.06**	**-0.41**

10.1.4 LULUCF

5.A Forest Land
5.B Cropland
5.C Grassland
5.D Wetlands
5.E Settlements
5.F Other Land

CO2 emissions from all LU categories have been recalculated for the entire period 1986-2010 due to the updated land use change matrix. Emissions from the Wetlands and Other lands have been calculated and reported for the first time.

Land use change matrix for time period 1986-2012 was under revision in year 2012. All available data on land uses in this time period was gathered and re-checked.

The conclusions of the land use changes research show, that we have available reliable data of land use areas for years 1986, 1995, 2002 and 2012. Data from 2002 on, is available for whole country and for all categories (FL, CL, GL, WL, SL and OL). Data for 1986 and 1995 is available from sampling based research and for aggregated categories (FL, CL+GL, WL+SL+OL), due to the quality of for that time available orthophoto images.
With some auxiliary data on individual land use categories and interpolation between years, this series of land use area data can give us areas of land use categories in period 1986-2012. From this series of land use areas, we have also information on net-net change of area for each category.

For the period 2002 – 2012 we have information also on gross change for all categories. But for the years before that, gross change data cannot be calculated for all categories. It can be calculated for i.e. FL to WL+SL+OL, but not for individual category changes. Therefore we use the same land use change matrix for the time period 1986-2002.
Land use change matrix needs further improvements for the time period 1986-2002.

Table 10.1.5: Changes due to recalculation with respect to the previous submission in LULUCF sector in Gg CO_2 eq.

5. LULUCF	1986	1990	1995	2000	2005	2008	2009	2010
A. Forest Land	-1,379	-1,417	-1,401	-2,454	-989	-982	-991	-903
B. Cropland	-913	-1,022	-1,068	-1,127	-1,231	-1,259	-1,268	-1,265
C. Grassland	133	42	126	210	180	235	254	272
D. Wetlands	138	141	145	149	153	155	156	157
E. Settlements	156	96	119	142	108	123	128	133
F. Other Land	278	306	340	374	410	431	439	446
Total in Gg CO_2 eq	**-1,587**	**-1,854**	**-1,739**	**-2,707**	**-1,369**	**-1,295**	**-1,282**	**-1,161**
Total of LULUC in %	**17.3**	**20.5**	**19.4**	**27.3**	**14.0**	**13.4**	**13.3**	**12.0**

10.1.5 Waste

6.B.1 Industrial wastewater

CH_4 emissions from industrial waste water treatment were recalculated for the year 2010 due to new data on total output of organic components for food industry obtained.

6.B.2.1 Domestic and Commercial waste water

CH_4 emissions from domestic waste water treatment were recalculated for the period 2004-2010 due to new data obtained on inhabitants included into various types of wastewater treatment (primary, secondary/tertiary treatment).

6.B.2.2 Human sewage

N_2O emissions from human sewage were recalculated for the period 2008-2010 due to updated values of protein consumption obtained from FAOSAT.

Table 10.1.6: Changes due to recalculation with respect to the previous submission in Waste sector in Gg CO_2 eq.

6. Waste	2004	2005	2006	2007	2008	2009	2010
A. SWD on Land							
B. WW Handling	-11.23	-20.26	-23.12	-23.53	-27.90	-23.93	-27.21
C. Incineration							
D. Other							
Total in Gg CO_2 eq	**-11.23**	**-20.26**	**-23,12**	**-23,53**	**-27,90**	**-23,93**	**-27,21**
Total of Waste in %	**-1.60**	**-2.84**	**-3.17**	**-3.40**	**-4.50**	**-4.16**	**-4.71**

10.2 Response to the EU and UNFCCC Review Process

There have been two reviews of the Slovenian GHG inventory since the publication of the 2012 NIR, one was conducted by EU and one by UNFCCC Secretariat..

In the period from April to August 2012 EU conducted technical review of the greenhouse gas emission inventory of Slovenia to support the determination of annual emission allocations under Decision 406/2009/EC. The findings from this review and our consideration of recommendations are presented in the table 3.2.1.

The UNFCCC conducted a Centralised Review of the Slovenian 2012 greenhouse gas inventory submission in accordance with decision 22/CMP.1. This review took place from 3 to 8 September 2012 in Bonn, Germany. We haven't received the draft ARR yet, although no Potential Problems and Further Questions from the ERT have been formulated in the course of the 2012 review of the greenhouse gas inventories of Slovenia.

Table 10.2.1 provides an overview of the actions taken to improve the NIR and the inventory in response to the comments made by EU technical review in 2012.

Table 10.2.1: Recommendations from 2012 EU technical review of the greenhouse gas emission inventory of Slovenia

Key category	Gas, fuel, activity	Observation	Recommendation	Slovenia's response
No	1.A.1.a. Public electricity and heat production CH_4, N_2O other fuels 2009, 2010	Slovenia reports CH_4 and N_2O emission from other fuels in 1.A.1.a. (waste incineration) as NO. In response to a question from the TERT, Slovenia explained that no nitrogen was in the waste itself, so no N_2O emissions occurred. However, the TERT notes that nitrogen in combustion is also a result of N_2 in the air used in the combustion process. Slovenia agreed that small amounts of N_2O are emitted in the incineration of plastics and that they will use the 2006 IPCC Guidelines EF for waste plastics of 170 g N_2O/t waste. During the review Slovenia provided estimates for N2O emission from waste incineration for 2009 and 2010. The TERT agreed with the estimates.	The TERT recommends that the revised estimates are reflected in future submissions. Furthermore, the TERT recommends Slovenia explores the opportunity to estimate and report CH4 emissions associated with waste incineration.	Has been implemented in the submission 2013.
No	1.A.4. Other sectors All gases, solid fuels 2008	Slovenia reports solid fuels in sector 1.A.4. for 2005, 2009 and 2010 but the TERT noted that for 2006, 2007 and 2008, solid fuel emissions are reported to be NO. During the review week, Slovenia provided revised estimates for solid fuels for 2006, 2007 and 2008. The TERT agreed with the revised estimates.	The TERT recommends that the revised estimates are reflected in future submissions. Furthermore, the TERT recommends that time-series consistency is ensured by implementing the revision for all relevant years of the time-series.	We have carefully investigated the TERT recommendation and we decided to not apply this recommendation due to the possibilities that this is a double counting.

Key category	Gas, fuel, activity	Observation	Recommendation	Slovenia's response
No	1.B.2.b.ii. Production (4)/Processing Activity data 2008–2010	There is a difference in the AD of natural gas produced reported by Slovenia in the CRF Reference Approach (RA) and in Sectoral Approach (SA) calculations. Neither of the two sets of natural gas production data agrees with the data available from EUROSTAT, although the data are similar in magnitude. The difference in these two sets of gas production data can be seen in a decline in the values of the implied heating value (TJ/m^3) in the years 2008, 2009 and 2010 compared to earlier years in the time series. The value in later years is around 30 TJ natural gas produced/m^3 produced. A value close to 36 would be expected.	The TERT recommends that Slovenia investigates this discrepancy in the gas production data between the SA and the RA.	Under investigation - the results will be implemented in the next submission.
No	2.F(a).4. Aerosols HFC All years	Slovenia estimates HFC emissions from aerosols/metered dose inhalers using Austria's HFC-134a emissions from aerosols/metered dose inhalers divided by 4 (population ratio). The TERT noted that this may not be a representative approach as trend fluctuates IEF relate to changes in production of a country-specific aerosol in Austria. In addition, Slovenia uses 2009 data for 2010 as 2010 data is not available in time from the Austrian GHG inventory. . Following comments from the TERT Slovenia provided a revised estimate for 2010 (3.95). However this revised estimate did not match the estimate made by the TERT (4.95) using the method described by Slovenia in its NIR. The TERT concluded that Slovenia could be underestimating emissions. This could be an underestimation of emissions.	The TERT recommends Slovenia to double check its calculation for all years of the time series and especially 2010. In order to increase the accuracy of the estimates the TERT recommends Slovenia to use country specific data to estimate the estimates or if this is not possible, to improve the method and assumptions by, for instance, quantifying the number of manufacturers of aerosols and the number of end users in both Slovenia and Austria, to develop more detailed and country specific ratios to	The time series has been recalculated using the last GHG inventory submission from Austria (January 2013) for the years 2007-2010 while for the year 2011 the national data have been obtained. Emissions are very similar to those, calculated

Key category	Gas, fuel, activity	Observation	Recommendation	Slovenia's response
			apply. The TERT also recommends that Slovenia improve the time series consistency by applying the same method during the whole time series and avoiding annual revision of the end year data.	from Austrian inventory.
No	4.A.8. Swine CH_4 All years	Slovenia is using a modified tier 1 default method for CH4 emission from enteric fermentation from pigs on commercial farms and an increased value for private farms assuming that pigs on private farms are larger than those on commercial farms giving an approximate EF of 2.3 kg CH_4/head/yr compared to the default value of 1.5 kg CH_4/head/yr. The TERT notes that the tier 1 default CH4 parameters assume a conservative estimate covering an average of all slaughter weights in a country and that Slovenia cannot apply the default to a subset (the commercial farms only) without justification that these represent a similar average of slaughter weights. During the review Slovenia provided revised estimates using the default EF for all swine. The TERT agreed with the revised estimate.	The TERT recommends that the revised estimates are reflected in future submissions. Furthermore, the TERT recommends that time-series consistency is ensured by implementing the revision for all relevant years of the time-series.	Has been implemented in the submission 2013.
No	4.B.8. Swine CH_4 All years	Slovenia has in its inventory reported that pig manure is stored in anaerobic lagoons. Such systems have very high CH_4 emission, because virtually all organic matter is converted to CO_2 and CH_4. The use of an MCF value of 90 % could lead to an overestimation of emissions. During the review Slovenia	The TERT recommends that the revised estimates are reflected in future submissions. Furthermore, the TERT recommends that time-series consistency is ensured by	For consistency with other MCF used (all from GPG 2000) this recommendation

Key category	Gas, fuel, activity	Observation	Recommendation	Slovenia's response
		provided revised estimates based on newer scientific literature (Mangino et al.). This showed that a MCF of 68 % was more realistic for the conditions in Slovenia. The TERT agreed with the revised estimates.	implementing the revision for all relevant years of the time-series.	has not been implemented. Since 2010 allocation of swine manure to the anaerobic lagoons has not occurred any more.
No	4.B.9. Poultry CH4 All years	Slovenia assumes that poultry litter is handled in liquid manure management systems. In responses to the TERT questions on liquid poultry manure handling, Slovenia indicated that the manure is from caged hens and removed using, among other techniques conveyor belts. Liquid manure is normally considered fluid, can be pumped and is stored in slurry tanks with a maximum dry matter content of 10–12 %. Although Slovenia uses a tier 1 approach and default EF to estimate emissions, the TERT does not find that the explanation provided by Slovenia is consistent with liquid manure management systems and that the description was misleading.	Slovenia is therefore recommended to reclassify this amount of manure to a correct classification 'Other poultry manure' according to 2000 IPCC GPG Table 4.11.	Has been implemented in the submission 2013.

Table 10.2.2: An overview table with 'changes in methodological descriptions

GHG SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methodological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries			
2. Manufacturing Ind. And Construction			
3. Transport			
4. Other Sectors			
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products			
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6			
G. Other			
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management			
C. Rice Cultivation			
D. Agricultural Soils			
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land			
B. Cropland			
C. Grassland			
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land			
B. Waste-water Handling			
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO2 Emissions from Biomass			

NIR Chapter	DESCRIPTION		REFERENCE
	Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		If ticked please provide some more detailed information for example reference to pages in the NIR
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan			

PART II: SUPPLEMENTARI INFORMATION UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

11.1.1 General information

Under Article 3, paragraph 3, of the Kyoto Protocol (KP), Slovenia reports emissions and removals from Deforestation (D), and under Article 3, paragraph 4, Slovenia reports emissions and removals from Forest management (FM). The estimates for emissions and removals under Articles 3.3 and 3.4 are prepared and reported consistent with the IPCC GPG LULUCF 2003 and Decisions 15/CMP.1 and 16/CMP.1 of the Kyoto Protocol.

Emissions from Article 3.3 activity (D) in 2011 were 232.84 Gg CO_2 eq. The area subjected to D was 6.572 kha at the end of the fourth year of the commitment period.

Removals from Article 3.4 activity (FM) in 2011 were -11,576.43 Gg CO_2 eq.. The area subjected to FM was 1,116.75 kha at the end of the fourth year of the commitment period.

11.1.2 Definition of forest and any other criteria

Definition of forest: Land spanning more than 0.25 hectares with trees higher than 2 meters and canopy cover more than 30 percent, or trees able to reach these threshold *in situ.* It includes abandoned agricultural land on area more than 0.25 ha, which have been abandoned for more than 20 years, with minimal tree height 5.00 m and have a tree crown cover between up to 75 % are defined as forests.

Table 4: Elected values for forest parameters.

Parameter	range	Selected value
Minimum land area	0.05 -1 ha	0.25 ha
Minimum crown cover	10 – 30 %	30 %
Minimum tree height	2 – 5 m	2 m

Values of forest land areas under KP and under UNFCCC reporting are not completely comparable, due to methodological differences in data acquirements. Data of forest land areas in forest management plans (data for KP reporting) are updated annually for 1/10 of forest management units (10 years period cycle for whole country). Data of forest land areas from land cover map (ALUM) of Ministry of Agriculture, Forestry and Food (data for UNFCCC reporting), represents land uses in specific year.

All land converted to forest land occurs through process of natural afforestation of abandoned agricultural lands. There was no human planting or seedling of forests in the specified time period. According to national policy it is also unlikely that this will occur in the future. Areas of land converted to forest land are included in areas under FM.

The selected threshold values are consistent with those values used in the reporting to the FAO and FRA 2005 forest definition. Differences of definitions are not relevant for final estimation of CO_2 sinks under Articles 3.3 and 3.4.

11.1.3 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

In accordance with Paragraph 6 of the Annex to Decision 16/CMP.1 Slovenia has decided to elect the activity Forest Management (FM) under Article 3.4 of the Kyoto Protocol, for inclusion in the accounting for the first commitment period.

For all forests fulfulling the definition of forest (Table 4), forest management plans are prepared, regardless ownership, conservation degree or natural conditions. Also practically all these forests are used either for wood harvesting, protecting and protective purposes, recreation and/or to a greater or smaller extent for hunting and picking berries.

11.1.4 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The information about the areas for activities under Articles 3.3. and 3.4 for time period 1990 – 1993 is adopted from annual reports of Statistical office of Republic of Slovenia (SORS). The needed data for time period 1994 – 2010 is adopted from Slovenia Forest Service (SFS) database. SFS will continue with providing data about areas for activities under Articles 3.3. and 3.4.

11.1.5 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Slovenia has elected to report forest management under Article 3.4 activities. Therefore there is no need to build up a hierarchy between forest management and other Article 3.4 activities. To ensure that the reported forest management activities have occurred on forest land, the total land area was classified into six land-use categories as for the UNFCCC reporting, and each land area was classified only under one land-use category.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

The spatial assessment unit to determine the area of units of land under Article 3.3 is 0.25 ha, which is the same as the minimum area of the forest.

11.2.2 Methodology used to develop the land transition matrix

Table 5: Land transition matrix for 2011.

From previous inventory year (2009) \ To current inventory year (2010)		Article 3.3 activities		Article 3.4 activities				Other [5]	Total area at the beginning of the current inventory year[6]
		Afforestation and Reforestation	Deforestation	Forest Management (if elected)	Cropland Management (if elected)	Grazing Land Management (if elected)	Revegetation (if elected)		
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	0.00	0.00						0.00
	Deforestation		6.05						6.05
Article 3.4 activities	Forest Management (if elected)		0.52	1,115.95					1,116.47
	Cropland Management[4] (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management[4] (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation[4] (if elected)	NA			NA	NA	NA		NA
Other [5]		NA	NA	0.80	NA	NA	NA	903.98	904.78
Total area at the end of the current inventory year		0.00	6.05	1,116.75	NA	NA	NA	903.98	2,027.30

Annual and total areas under Articles 3.3 and 3.4 for Deforestation (D) and Forest management (FM) were adopted from Slovenia Forest Service (SFS) and Statistical Office of the Republic of Slovenia (SORS). Areas of D were subtracted from areas of FM. Areas of spontaneous expansion of forest were added from Other to FM.

Some discrepancies were noticed during NIR preparation and land use change matrix is being revised. Improvements and necessary recalculations will be implemented in 2014 submission.

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Forestry spatial information system, managed by SFS, is based on stand level inventory for forest management purposes. Smallest spatial unit for forest management is compartment (2 – 5 ha). All data is georefferenced and can be aggregated to higher levels.

Due to strict environmental legislation at all conversions from forest, a permit from SFS is needed. Therefore, all areas converted from forests are documented in forestry spatial information system database and included in annual reports. Slovenian legislation forbids clear cutting as forest management practices. Deforestation activities occur mostly due to infrastructure projects (e.g. roads, housing areas, commercial areas …).

Areas of spontaneous expansion of forest are annually documented in forestry spatial information system database for 1/10 of forest management units (10 years period cycle for whole country) and added to FM area and included in annual reports.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

Methodological principles used for estimatons of carbon stock changes and greenhouse gas emissions/removals under Kyoto Protocol were the same as for estimations under UNFCCC reporting. Calculations were made in accordance with Good Practice Guidance for LULUCF (2003).

Under Article 3.3 activities (D) estimation of carbon stock changes in living biomass (above and belowground biomass), dead organic matter (dead wood, litter) and soils were made. Also calculations for N_2O emission from disturbance associated with conversion of forest land to cropland are presented below.

Main methodological approach for calculations of carbon stock change estimates during the commitment period was by determining the carbon stocks in all pools prior to and after deforestation event. Carbon stock after deforestation was assumed to be equal to zero. More detailed description of calculations for conversion of forest to other land uses were made in accordance to chapters 7.4.2.2 , 7.5.2.2 and 7.7.2.2.

Under Article 3.4 activities (FM) estimation of carbon stock changes in living biomass (above and belowground biomass), dead organic matter (dead wood, litter) and soils were made. Also calculations for N_2O emission from biomass burning are presented below.

Carbon stock changes in living biomass

In accordance with the decision tree provided in the GPG-LULUCF, carbon stock changes in living biomass in Forest land remaining Forest land are estimated by Tier 3, stock change method. The method requires biomass carbon stock inventories at two points in time. Biomass change is the difference between the biomass at two points in time, divided by the number of years between the inventories. Data from national forest inventories (NFI), made in years 2000 and 2007, were used for our calculations.

Carbon stock changes in dead organic matter

In accordance with the decision tree provided in the GPG-LULUCF, carbon stock changes in dead organic matter in Forest land remaining Forest land are estimated by Tier 2.

For calculations of carbon stock changes in litter Tier 1 methodology was used. Under Tier 1, it is assumed thet the average transfer rate into the litter pool is equal to the transfer rate out of the litter pool, so the net change is zero. Results of our preliminary expertise for period 1996 – 2006 (Kobal M., Simoncic P., 2011), show relative stable carbon stocks in litter in forest land remaining forest land and confirm Tier 1 assumption.

Carbon stock changes in soils

In accordance with GPG-LULUCF, carbon stock changes in soils are estimated by Tier 1 methodology. Under Tier 1, it is assumed that when forest remains forest, the carbon stock in soil organic matter does not change, regardless of change in forest management, types, and disturbances regimes; in other words that the carbon stock in mineral soil remains constant so long as the land remains forest. Results of our preliminary expertise for period 1996 – 2006 (Kobal M., Simoncic P., 2011), show relative stable carbon stocks in forest soils and confirm Tier 1 assumption.

Emissions from Wildfires

As controlled burning is not allowed in Slovenia, all fires are assigned to "wildfires". It is assumed that all fires affected productive forests. The area of wildfires in Slovenia is very small, less than half percent in the year 2003, which was the most problematic year in the following period. For calculations the Tier 2 (country level estimated of area burned) was used and estimation of GHGs directly released in fires.

More detailed explanations about calculations are described in chapter 7.3.2 (7.3.2.1 Forest land remaining forest land and 7.3.2.2 Non-CO_2 greenhouse gas emission).

11.3.1.2 Justification when omitting any carbon pool or GHG emissions and removals from activities under Article 3.3 and elected activities Article 3.4

Table 6: NIR 1, summary table.

Activity		Change in carbon pool reported					Greenhouse gas sources reported						
		Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil	Fertilization	Drainage of soils under forest management	Disturbance associated with land-use conversion to croplands	Liming	Biomass burning		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
Article 3.3 activities	Afforestation and Reforestation	NO	NO	NO	NO	NO	NO			NO	NO	NO	NO
	Deforestation	R	R	R	R	R			R	NO	NO	NO	NO
Article 3.4 activities	Forest Management	R	R	NR	R	NR	NO	NO		NO	R	R	R
	Cropland Management	NA	NA	NA	NA	NA			NA	NA	NA	NA	NA
	Grazing Land Management	NA	NA	NA	NA	NA				NA	NA	NA	NA
	Revegetation	NA	NA	NA	NA	NA				NA	NA	NA	NA

For calculations of carbon stock changes in litter and soils Tier 1 methodology (GPG-LULUCF) was used. According to Tier 1 assumption, the net emissions/removals from litter and soils is balanced and therefore equal to zero. Results of our preliminary expertise for period 1996 – 2006 (Kobal M., Simoncic P., 2011), show relative stable carbon stocks in litter in forest land remaining forest land and confirm Tier 1 assumption. Estimates under FM for carbon stock changes in litter and soils were not reported.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Slovenia has not factored out emissions or removals from elevated carbon dioxide concentrations, indirect nitrogen deposition or the dynamic effects of age structure resulting from activities prior to 1 January 1990. The IPCC do not give methods for factoring out.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

Considering ERT revision report and recommendations data and methodologies were internally revised and recalculations were made.

11.3.1.5 Uncertainty estimates

The uncertainties for Article 3.4 have not been estimated separately for lands under FM. It was assumed that uncertainty estimates for forest land remaining forest land apply also for lands under FM (Section 7.3.3). The uncertanties for Article 3.3 activities have not been estimated seperately.

11.3.1.6 Information on other methodological issues

Slovenia has decided to account for the emissions and removals under Article 3, paragraphs 3 and 4 at the end of the commitment period. Slovenia will further develop the methods for area estimation as well the methods to estimate emissions and removals of greenhouse gases and their uncertainties. For that reason, the estimates presented in submissions for 2008 and 2009, may change for the final report of the commitment period.

National Forest Inventory (NFI) provides data about growing stock, dead organic matter and soils (in forest land). The argument for applying NFI data is that it is the only large scale sample plot based monitoring system in Slovenia that covers all forest land and gives reliable estimates for the living biomass and dead organic matter. It is also a system, which can produce the input data for the soil model.

11.3.1.7 For the purpose of accounting as required in paragraph 18 of the annex to draft decision -/CMP. 1 (Land use, land-use change and forestry) attached to decision 11/CP.7, an indication of the year of the onset of an activity, if after 2008.

No indication of an activity in this submission.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

All data for areas under Articles 3.3 were adopted from annual reports of SORS and SFS for time period 1990 – 2011.

Deforestation in Slovenia is human induced, because for all conversions of forest to other land uses have to be permitted by legal entities. Act of Forests (Section 2, paragraph 1) states: "A permit for a spatial intervention in accordance with regulations on regional planning shall be necessary for interventions in forests or a forest land. The Forest Service must give its agreement to the permit for a spatial intervention (clearing a forest)." Human induced Afforestation/Reforestation (AR) do not occur in Slovenia, because all land converted to forest land occurs through process of natural afforestation of abandoned agricultural lands. There was no human planting or seedling of forests in the specified time period. According to national policy it is also unlikely that this will occur in the first commitment period.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Extensive forest disturbances have been rare in Slovenia. If a large forest area is mainly or tottaly damaged, the legislation on prevention of insect and fungus disturbances binds owners to remove the rest of the damaged trees. After that, the reastablishment work should be started immediatelly if possible. That areas remain registrated as forest land in forestry spatial information system database.

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

All areas converted from forests are documented in forestry spatial information system database and are included in annual reports. Therefore, there are no forest areas without forest cover, which are not yet classified as deforested.

11.4.4 Emissions and removals from Deforestation

Deforestation was a net source in 2008, 2009, 2010, and in 2011. The net emissions from carbon stock changes were 126.66 Gg CO2 eq. (in 2008), 271.56 Gg CO2 eq. (in 2009), 306.46 Gg CO2 eq. (in 2010) and 232.84 Gg CO2 eq (in 2011).

Area of deforestation under KP is not the same as sum of areas forest land converted to other land uses reported under Convention, due to different methodological approaches. Land use change matrix assumes higher changes, due to methodology used - also small

sliver polygons are still included in land use change matrix, but they do not represent actual deforestation. All deforestated areas are spatially located (geo-referenced) and are documented in annual report of Slovenia Forest Service, which is entitled by legislation to approve all conversions from forest (deforestation). In their annual reports, they include also illegally deforested areas.

11.5 Article 3.4

11.5.1 Information that demonstrates that activities under Article 3.4 have occurred since January 1990 and are human-induced

All data for areas under Articles 3.4 were adopted from annual reports of SORS and SFS for time period 1990 – 2010. All selected forest areas (for KP reporting) were at 1 January 1990 under FM activities, because Slovenia includes all these forests in forest management plans.

11.5.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

Slovenia has not elected Cropland Management, Grazing Land Management or Revegetation under Article 3.4.

11.5.3 Information relating to Forest Management:

All forests in Slovenia are considered managed, because forest management plans are prepared for all forests, regardless ownership, conservation degree or natural conditions.

Slovenian forests are part of sustainable and multipurpose management with the principles of environmental protection and natural values. Our main concerns are: permanent and optimal functioning of forest as ecosystems and implementation of all of their functions (productive, ecological and social) on a permanent basis.

11.5.4 Emissions and removals from Forest management

Forest management was a net sink in 2008, 2009, 2010, and in 2011. The net removals from carbon stock changes were -11,559.36 Gg CO2 eq. (in 2008), -11,562.91 Gg CO2 eq. (in 2009), -11,575.61 Gg CO2 eq. (in 2010) and – 11,576.43 Gg CO2 eq. (in 2011).

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC good practice guidance for LULUCF (IPCC 2003). The key categories, also reported in CRF table NIR.3, are CO_2 emissions from deforestation (conversion to grassland). CO_2 removals due to forest management is also a key category.

11.7 Information relating to Article 6

There are no Article 6 activities concerning the LULUCF sector in Slovenia.

11.8 Legal entities authorized to participate in mechanisms under Article 6, 12 and 17 of the Kyoto Protocol

In order to reduce GHG emissions installation operators may use up to 15.761 % of their issued allowances in the period 2008-2012.They can surrender emission reduction units (ERU) from the projects of joint investment (JI) and certified emission reductions (CER) from the projects of clean development mechanism (CDM).

There is no project under Article 6, 12 or 17 of the Kyoto Protocol in Slovenia.

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

Slovenian Standard Electronic Format (SEF) report for 2012 (SEF_SI_2013_2_12-54-55 8-4-2013.xls), containing the information required in paragraph 11 of the annex to decision 15/CMP.1 and adhering to the guidelines of the SEF, has been submitted to the UNFCCC Secretariat electronically (Table 12.2.1). The SEF tables show the numbers of Kyoto units held in various accounts of the national registry and they are reproduced in Annex 6.

12.2 Summary of information reported in the SEF tables

Unit holdings, additions and subtractions in Slovenian National Emission Trading Registry in 2012 consisted of assigned amount units (AAUs) and certified emissions reductions (CERs) only.

Table 12.2.1: Information on the SEF

Annual Submission Item	Report
15/CMP.1 annex I.E paragraph 11: Standard electronic format (SEF)	The Standard Electronic Format report for 2012 containing the information required in paragraph 11 of the annex to decision 15/CMP.1 and adhering to the guidelines of the SEF has been submitted to the UNFCCC Secretariat electronically. SEF_SI_2013_2_12-54-55 8-4-2013.xls The contents of the SEF report (R1) can also be found in Annex 6 of this document.

12.3 Discrepancies and notifications

There were no discrepant transactions in 2011 and no CDM notifications were received by the national registry (Table 12.3.1).

Table 12.3.1: Discrepancies and notifications

Annual Submission Item	Report
15/CMP.1 annex I.E paragraph 12: List of discrepant transactions	No discrepant transactions occurred in 2012. Refer to Separate Electronic Attachment “SIAR Reports 2013-SI v 1.0.xls” Worksheet R2.
15/CMP.1 annex I.E paragraph 13 & 14:	No CDM notifications occurred in 2012.

Annual Submission Item	Report
List of CDM notifications	Refer to Separate Electronic Attachment "SIAR Reports 2013-SI v 1.0.xls" Worksheet R3.
15/CMP.1 annex I.E paragraph 15: List of non-replacements	No non-replacements occurred in 2012. Refer to Separate Electronic Attachment "SIAR Reports 2013-SI v 1.0.xls" Worksheet R4.
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2012. Refer to Separate Electronic Attachment "SIAR Reports 2013-SI v 1.0.xls" Worksheet R5.
15/CMP.1 annex I.E paragraph 17: Actions and changes to address discrepancies	No actions and changes to address discrepancies occurred in 2012.

12.4 Publicly accessible information

The public has access via the registry website to information on registry account types and account holders, information regarding Article 6 projects, information on transactions and the list of account holders authorised to hold Kyoto units in their account (Table 12.4.1).

Table 12.4.1: Publicly Accessible Information

Annual Submission Item	Report
15/CMP.1 annex I.E Publicly accessible information	Public available information could be accessed via registry website, URL: http://www.arso.gov.si/ with selection "Register emisijskih kuponov" Publicly accessible information is provided with specific reference to paragraphs 44-48 (Section E) in the annex to decision 13/CMP.1.

12.5 Calculation of the commitment period reserve

The assigned amount is calculated according to Articles 3.7 and 3.8 of the Kyoto Protocol, on the basis of the latest base year inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol.

Slovenia's estimate of its assigned amount is derived from the base year emissions (1986, 1995 for F-gasses), multiplied by the limit implied by the Slovenia's 8% Kyoto target i.e. 0.92, multiplied by 5 representing the five years of the first commitment period.

Table 12.5.1: Slovenia's assigned amount

	Emission (Gg CO_2 eq.,)
Emissions (without F-gasses and LUCF) in 1986	20,027.878
Emissions of F-gasses in 1995	326.164
TOTAL Base Year Emission	20,354.042
Kyoto target	-8%
Annual average emissions (2008-2012)	18,725.719
Estimated assigned amount	**93,628.593**

Slovenia's AA= 20,354.042 x 0.92 x 5 = **93,628.593 Gg CO_2 equivalent**
Slovenia's CPR = 93,628.593 x 0.90 = **84,265.734 Gg CO_2 equivalent**

12.6 KP-LULUCF accounting

Slovenia has chosen to account for emissions and removals from the LULUCF for the entire commitment period at the end of the commitment period.

13 OTHER INFORMATION

13.1 Changes to the national system

There have been no changes to the national inventory system in Slovenia.

13.2 Changes to the registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

- With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
- The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
- With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
- The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
- In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of Slovenia have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

Table 13.2.1: Changes to the registry

Reporting Item	Report
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	Addition of contact details: Ms. Miša Bizjak was replaced by Ms Romana Stare. Ms. Romana Stare Slovenian Environment Agency Vojkova 1b, SI-1000 Ljubljana Email: romana.stare@gov.si Telephone: +386 1478 4087 Fax: +386 14784051. Additional registry administrator was nominated: Ms. Irena Koteska Slovenian Environment Agency Vojkova 1b, SI-1000 Ljubljana Email: romana.stare@gov.si Telephone: +386 1478 4546 Fax: +386 14784051.
15/CMP.1 annex II.E paragraph 32.(b) Change of cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • **Readiness questionnaire** • **Application logging** • **Change management procedure** • **Disaster recovery** • **Manual Intervention** • **Operational Plan** • **Roles and responsibilities** • **Security Plan** • **Time Validation Plan** • **Version change Management** The documents above are provided as an appendix to this document. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.

Reporting Item	Report
15/CMP.1 annex II.E paragraph 32.(c) Change to database or the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June 2012.**
15/CMP.1 annex II.E paragraph 32.(d) Change of conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012,
15/CMP.1 Annex II.E Paragraph 32.(e) Change of discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(f) Change of security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.

Reporting Item	Report
15/CMP.1 annex II.E paragraph 32.(g) Change of list of publicly available information	Publicly accessible information is provided with specific reference to paragraphs 44-48 in the annex to decision 13/CMP.1. Public available information could be accessed via registry website, URL: http://www.arso.gov.si/ with selection "Register emisijskih kuponov" /Javno dostopna poročila and at EUTL website: http://ec.europa.eu/environment/ets/. According to the Commission Regulation No 920/2010 and security reasons representative name and contact information held as confidential.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	The new internet address of the Slovenian registry is: https://ets-registry.webgate.ec.europa.eu/euregistrySlovenia/index.xhtml
15/CMP.1 annex II.E paragraph 32.(i) Change of data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j) Change of test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations	The UNFCCC conducted a Centralized review of the Slovenian 2012 greenhouse gas inventory submission in accordance with decision 22/CMP.1. This review took place from 3 to 8 September 2012 in Bonn, Germany. At the time of preparation of this submission the draft ARR was not yet available.

13.3 Information on minimization of adverse impacts in accordance with Article 3, paragraph 14

In 2004, Slovenia prepared the first draft of the Operational Programme for Reduction of Greenhouse Gas Emissions which was then adopted by the Government. Since 2004, the Programme is being regularly updated, and Government Office of Climate Change reports to the Government each year on its implementation. In the Operational Programme approximately 85 policies and measures in all sectors and for all greenhouse gases have been identified and financially evaluated, and their emissions reduction potential has been estimated. Focusing on many policies and measures in all sectors instead of only few major ones, helps limiting or eliminating their adverse economic, environmental and social impacts on developing countries and in general. Recently, due to the new Government structure, the Government Office of Climate Change has been integrated into the new Ministry of Agriculture and Environment, which will be in charge of updating existing Operational Programme, and also of preparing a new one for the period beyond 2012.

Of course, it should not be neglected that the purpose of the Kyoto Protocol itself is to minimise adverse impacts of climate change on all countries, particularly on those most vulnerable and least able to face these impacts. Slovenia is striving to contribute to these international efforts proportionally, taking into account its Kyoto target of -8 %. Nevertheless, Slovenia is very mindful of the principle that all its policies and measures to reduce greenhouse gas emissions are designed in a way to have no, or minimum, adverse impacts on developing countries, particularly on least developed ones. One of the examples in this regard is the possibility of carbon leakage which would entail higher greenhouse gas emissions in countries which have lower environmental standards. Slovenia is trying to create such environment that carbon leakage would not take place.

Slovenia executes additional activities from this area as an EU member. In 2004, the EU adopted an action plan from the area of climate change and development, the objective of which is to provide aid to developing countries for the achievement of economic progress. Also in 2004, the EU substantiated its commitment to help developing countries tackle climate change by adopting an Action Plan on Climate Change in the context of Development Cooperation for the period up to 2008. The Action Plan was centred on mainstreaming aspects of climate change into development cooperation in four strategic areas: policy dialogue, mitigation, adaptation and capacity building. One of the Action Plan’s strategic objectives was to raise the policy profile of climate change. This is being achieved in practice, by ensuring that climate change is systematically addressed in the context of the EU’s relations with international partners, at the multilateral, regional and bilateral levels. Many projects and programmes dealing with water, agriculture, forests, fisheries, rural development, health, the promotion of energy efficiency and renewable energies and the conservation of natural areas are relevant for climate change. It is mainly in these sectors in which the cooperation has been promoting adaptation and mitigation synergies, alongside poverty alleviation.

Additionally, Slovenia started or joined some projects with developing countries with financial contribution in the framework of the Fast Start Finance for the period 2010-2012, as agreed upon at the COP15 in Copenhagen. The projects are taking place in the Balkan region. They focus on energy reconstruction and heating systems on biomass, reforestation, capacity building for emissions data collection, preparation of low carbon strategies, participation in the Regional Programme for adaptation to Climate Change programme for South-Eastern European countries. All these projects are designed to have no adverse impacts on the (developing) countries involved, but rather have positive impacts.

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