



ENVIRONMENTAL AGENCY  
OF THE REPUBLIC OF SLOVENIA

# **SLOVENIA'S NATIONAL INVENTORY REPORT 2012**

Submission under the Decision 280/2004/EC

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and under the Kyoto Protocol

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## *SLOVENIA'S NATIONAL INVENTORY REPORT 2012*

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## PREFACE

The Environmental Agency of the Republic of Slovenia 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 1986-2010 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<sub>2</sub> emissions from fossil fuel combustion

Annex 3: Other detailed descriptions for agriculture and LULUCF sector

Annex 4: CO<sub>2</sub> 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 Testing Plan

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

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Introduction *Tajda Mekinda Majaron*

Trends in GHG emissions *Tajda Mekinda Majaron*

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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<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), nitrogen oxides (NO<sub>x</sub>), 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<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, PFCs, HFCs and SF<sub>6</sub>). 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<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>), as well as estimates for indirect GHGs, including carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), and non-methane volatile organic compounds (NMVOC). Data are also reported for sulphur oxides (SO<sub>x</sub>).

### 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<sub>2</sub>, and therefore GWP-weighted emissions are measured in Gg of CO<sub>2</sub> equivalents (Tg CO<sub>2</sub> 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 <sub>2</sub> )	1
Methane (CH <sub>4</sub> )*	21
Nitrous oxide (N <sub>2</sub> O)	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 <sub>4</sub>	6,500
C <sub>2</sub> F <sub>6</sub>	9,200
C <sub>4</sub> F <sub>10</sub>	7,000
C <sub>6</sub> F <sub>14</sub>	7,400
SF <sub>6</sub>	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<sub>2</sub>

is not included. Global warming potentials are not provided for CO, NO<sub>x</sub>, NMVOCs, SO<sub>2</sub> 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 Environmental Agency of the Republic of Slovenia. In accordance with its tasks and obligations to international institutions, the 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	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy Balances, annual energy statistics</li> <li>• Environmental Agency of the Republic of Slovenia: ETS data</li> </ul>
	CRF 1A2 - Manufacturing Industries and Construction	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy Balances, annual energy statistics</li> <li>• Environmental Agency of the Republic of Slovenia: ETS data</li> </ul>
	CRF 1A3 – Transport	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy balances</li> <li>• Ministry of Transport, Directorate for National Roads (DRSC)</li> <li>• Ministry of Internal affairs (vehicle stock)</li> </ul>
	CRF 1A4 – Other Sectors	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia:</li> </ul>
CRF 1 B – Fugitive Emissions from Fuels		<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia:</li> <li>• natural gas distributors</li> </ul>
CRF 2 – Industrial Processes	CRF 2A – Mineral Products	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia:</li> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>
	CRF 2B – Chemical Industry	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia:</li> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>
	CRF 2C – Metal Production	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia:</li> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>
	CRF 2D – Other Production	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia:</li> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>
	CRF 2F – Consumption of Halocarbons and SF <sub>6</sub>	<ul style="list-style-type: none"> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>
CRF 3 – Solvent and Other Product Use		<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia</li> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>
CRF 4 – Agriculture		<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia</li> <li>• Agricultural Institute of Slovenia</li> </ul>
CRF 5 – Land Use, Land Use Change, and Forestry		<ul style="list-style-type: none"> <li>• Slovenian Forestry Institute</li> </ul>
CRF 6 – Waste	CRF 6A – Solid Waste Disposal on Land	<ul style="list-style-type: none"> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>
	CRF 6B – Wastewater Handling	<ul style="list-style-type: none"> <li>• Statistical Office of the Republic of Slovenia</li> <li>• Environmental Agency of the Republic of Slovenia</li> </ul>

In Slovenia, the institution responsible for GHG inventories is the Environmental Agency of the Republic of Slovenia. In accordance with its tasks and obligations to international

institutions, the 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.

The chief sources of data are the Statistical Office of the Republic of Slovenia (SORS) and the Ministry of Environment and Spatial Planning; however, the 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 Environmental Agency of the Republic of Slovenia 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 Environmental

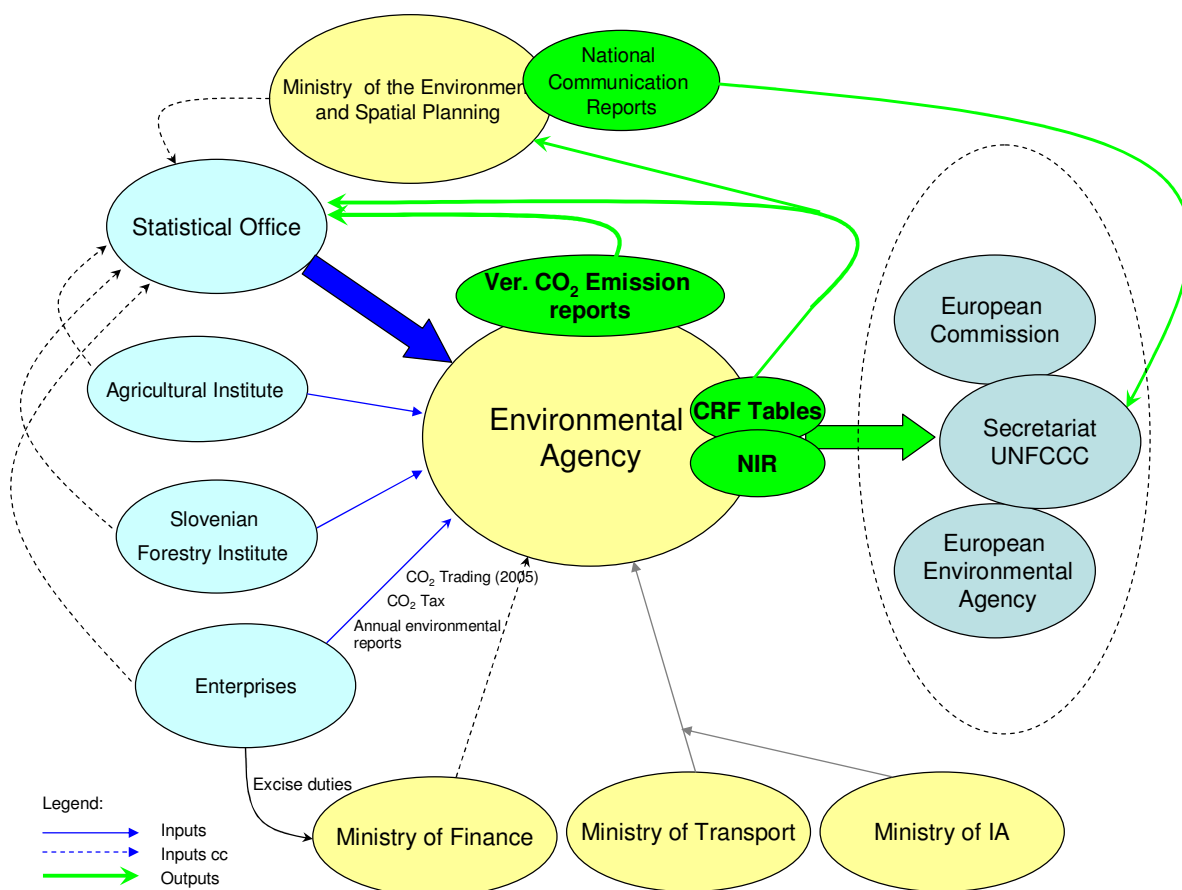


Figure 1.3.1: Data flow in the Slovenian Inventory System

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

At the beginning of 2007, the agreement between Statistical Office of the Republic of Slovenia and the 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 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 updated in 2008. In 2009, the QA/QC plan as part of the Manual was developed and mostly implemented.

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

In 2006, we started to develop a joint database for GHGs and other pollutants. It already contains all activity data, emission factors and other parameters together with a description of sources from 1980 on for other pollutants, and from 1986 on for GHG emissions. At defined control points, QC procedures are included. In the final stage we are going to develop a direct bulk import file from the database to CRF Reporter. Some phases of the database were concluded, but the whole process has been finished in 2011.

#### **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. National emission factors were used for assessment of emissions from domestic 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. Default IPCC emission factors and oxidation fractions were used for energy consumption of liquid fossil fuels. GHG emissions in road transport were determined with the COPERT 4 model.

Emission factors for fugitive emissions of CO<sub>2</sub> and CH<sub>4</sub> 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<sub>2</sub> 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<sub>4</sub> 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<sub>6</sub> 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<sub>2</sub>O, which arises from evaporation during the use of N<sub>2</sub>O, mostly for anaesthesia.

In agriculture, methane emissions from enteric fermentation in bovine animals were determined using Tier 2 approach. For emissions from manure management, the Tier 2 approach was used for pig production and bovine animal production. The Tier 1 approach was used for other animals that represent a smaller fraction in methane emissions. Input data for N<sub>2</sub>O emissions from manure handling and from indirect emissions from fertilisation with animal fertilisers were obtained in the process of estimating methane emissions.



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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO <sub>2</sub>		CH <sub>4</sub>		N <sub>2</sub> O		HFCs		PFCs		SF <sub>6</sub>	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	EF	Method applied	EF	Method applied	EF
<b>1. Energy</b>	<b>M,T1,T2,T3</b>	<b>CS,D,M,PS</b>	<b>M,T1,T3</b>	<b>CS,D,M</b>	<b>M,T1</b>	<b>D,M</b>						
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	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						
<b>2. Industrial Processes</b>	<b>CS,D,T2</b>	<b>CS,D,PS</b>	<b>D</b>	<b>D</b>	<b>NA</b>	<b>NA</b>	<b>T1,T2</b>	<b>CS,D</b>	<b>T3</b>	<b>PS</b>	<b>T2</b>	<b>T1,T2</b>
A. Mineral Products	CS,D,T2	CS,D	NA	NA	NA	NA						
B. Chemical Industry	D	D	D	D	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 <sub>6</sub>							NA	NA	NA	NA	NA	NA
F. Consumption of Halocarbons and SF <sub>6</sub>							T1,T2	CS,D	NA	NA	T2	T1,T2
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<b>3. Solvent and Other Product Use</b>	<b>NA</b>	<b>NA</b>			<b>D</b>	<b>D</b>						
<b>4. Agriculture</b>			<b>T1,T2</b>	<b>CS,D</b>	<b>D,T1,T1a,T1b</b>	<b>CS,D</b>						
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						
<b>5. Land Use, Land-Use Change and Forestry</b>	<b>CS,D,T1,T2,T3</b>	<b>CS,D</b>	<b>D,T1</b>	<b>D</b>	<b>D,T1</b>	<b>D</b>						
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	D,T1	D						
C. Grassland	D,T1,T2	CS,D	NA	NA	NA	NA						
D. Wetlands	NA	NA	NA	NA	NA	NA						
E. Settlements	D,T1	D	NA	NA	NA	NA						
F. Other Land	NA	NA	NA	NA	NA	NA						
G. Other	NA	NA	NA	NA	NA	NA						
<b>6. Waste</b>	<b>D</b>	<b>D</b>	<b>T1,T2</b>	<b>CS,D</b>	<b>D,T1</b>	<b>D</b>						
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						
<b>7. Other (as specified in Summary 1.A)</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>

For N<sub>2</sub>O emissions, default IPCC factors for determining the conversion of nitrogen into N<sub>2</sub>O were used.

Emissions and removals from the LULUCF sector are calculated for forest land, crop land and grassland. For other land use categories, emissions and removals are not reported and are negligible. 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<sub>4</sub> and N<sub>2</sub>O 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 2010. A level assessment was undertaken for 1986 and 2010, and a trend assessment was performed for 2010. The KCA has been performed with and without LULUCF sector.

On the basis of the tier 1 the analysis including LULUCF, 26 categories were selected as a key, representing 95.1% of emissions in 2010 according to the level assessment, and 11 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 26 key categories the most are from Energy sector: 8 categories are CO<sub>2</sub> emissions from fuel combustion and one is CH<sub>4</sub> emissions from Coal mining and handling, their contribution to the level is 45.6 %. The second most representative sector is LULUCF with 6 key source categories and 41.2% to the level. The same number of key categories is in the Agriculture sector; 4 are related to methane emissions and 2 to N<sub>2</sub>O emissions. Their contribution to the total is only 4.8%. In the industrial processes are 3 KC and in the Waste sector are 2, together they contribute 3.5% of GHG emissions.

On the basis of the tier 1 the analysis excluding LULUCF, 25 categories were selected as a key, representing 95.2% of emissions in 2010 according to the level assessment, and 10 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 25 key categories the most are from Energy sector: 11 categories are CO<sub>2</sub> emissions from fuel combustion and one is CH<sub>4</sub> emissions from Coal mining and handling, their contribution to the level is 79.7%. The second most representative sector is Agriculture sector with 8 KC; 5 are related to methane emissions and 3 to N<sub>2</sub>O emissions. Their contribution to the total is only 9.5%. In the industrial processes are 3 KC and in the Waste sector are 2, together they contribute 6% of GHG emissions.

On the following pages Tier 1 key categories estimates are presented with and without LULUCF. On both tables EFs and methodology used for key categories are also presented.

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**Table 1.5.1: IPCC KS Categories for 2010, Tier 1 with LULUCF.**

rank	CRF				GHG emissions		contribution to level		contribution	key category		rank
2010	#	Sector	Category	gas	1986	2010	1986	2010	to trend	2010	1986	1986
1	5	LULUCF/ A Forest land	1. Forest Land remaining Forest Land	CO2	9160,3	10869,4	29,10	32,63	10,28	L, T	L	1
2	1A	1. Energy Industries	a. Public Electricity and Heat Production	CO2	6533,8	6174,3	20,76	18,54	6,39	L, T	L	2
3	1A	3. Transport	b. Road Transportation	CO2	1910,2	5142,9	6,07	15,44	27,14	L, T	L	3
4	5	LULUCF/ B Cropland	2. Land converted to Cropland	CO2	1082,7	1200,8	3,44	3,61	0,49	L, T	L	7
5	1A	4. Other Sectors	b. Residential	CO2	1100,2	1194,1	3,50	3,58	0,27	L	L	6
6	1A	2. Manufacturing Industries and Construction	f. Other	CO2	1774,8	981,4	5,64	2,95	7,78	L, T	L	4
7	1A	4. Other Sectors	a. Commercial/Institutional	CO2	612,1	647,4	1,94	1,94	0,00	L	L	9
8	5	LULUCF/ E Settlements	2. Land converted to Settlements	CO2	468,3	606,7	1,49	1,82	0,97	L, T	L	11
9	5	LULUCF/ B Cropland	1. Cropland remaining Cropland	CO2	124,0	411,9	0,39	1,24	2,44	L, T	L	28
10	4	A. Enteric Fermentation	1. Non-Dairy Cattle	CH4	263,1	385,1	0,84	1,16	0,93	L, T	L	22
11	4	D. Agricultural Soils	1. Direct Soil Emissions	N2O	435,3	380,6	1,38	1,14	0,69	L, T	L	13
12	1A	2. Manufacturing Industries and Construction	d. Pulp, Paper and Print	CO2	649,6	380,5	2,06	1,14	2,66	L, T	L	8
13	2	Industrial Processes	1. Cement Production	CO2	514,6	367,9	1,63	1,10	1,53	L, T	L	10
14	6	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	CH4	298,8	356,0	0,95	1,07	0,35	L	L	18
15	5	LULUCF/ C Grassland	2. Land converted to Grassland	CO2	64,3	343,0	0,20	1,03	2,39	L, T		39
16	4	D. Agricultural Soils	3. Indirect Emissions	N2O	334,7	293,0	1,06	0,88	0,53	L, T	L	17
17	5	LULUCF/ A Forest land	2. Land converted to Forest Land	CO2	268,9	268,9	0,85	0,81	0,13	L	L	20
18	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CH4	358,9	249,3	1,14	0,75	1,13	L, T	L	16
19	4	A. Enteric Fermentation	1. Dairy Cattle	CH4	383,6	235,9	1,22	0,71	1,48	L, T	L	15
20	1A	4. Other Sectors	c. Agriculture/Forestry/Fisheries	CO2	424,7	207,1	1,35	0,62	2,10	L, T	L	14
21	1A	2. Manufacturing Industries and Construction	a. Iron and Steel	CO2	1141,6	197,7	3,62	0,59	8,77	L, T	L	5
22	2	Industrial Processes	1. Refrigeration and AC Equipment	HFC		190,4	0,00	0,57	1,65	L, T		NO
23	4	B. Manure Management	1. Non-Dairy Cattle	CH4	66,0	168,4	0,21	0,51	0,86	L, T		38
24	2	Industrial Processes	3. Limestone and Dolomite Use	CO2	47,4	152,2	0,15	0,46	0,89	L, T		44
25	6	B. Waste Water Handling	2. Domestic and Commercial Waste Water	CH4	113,2	143,7	0,36	0,43	0,21	L		30
26	4	B. Manure Management	1. Dairy Cattle	CH4	152,4	131,9	0,48	0,40	0,25	L	L	26
27	4	B. Manure Management	13. Solid Storage and Dry Lot	N2O	267,3	129,6	0,85	0,39	1,33	T	L	21
28	1A	4. Other Sectors	b. Residential	CH4	134,6	124,9	0,43	0,38	0,15		L	27
29	4	B. Manure Management	8. Swine	CH4	232,9	121,2	0,74	0,36	1,09	T	L	24
31	1A	2. Manufacturing Industries and Construction	e. Food Processing, Bev. and Tobacco	CO2	247,8	111,6	0,79	0,33	1,31	T	L	23
32	2	Industrial Processes	2. Lime Production	CO2	220,2	90,2	0,70	0,27	1,24	T	L	25
33	1A	2. Manufacturing Industries and Construction	b. Non-Ferrous Metals	CO2	440,3	88,4	1,40	0,27	3,28	T	L	12
35	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CO2	120,2	80,6	0,38	0,24	0,40	T	L	29
42	3	Solvent and Other Product Use	D. 1. Use of N2O for Anaesthesia	N2O	81,9	30,4	0,26	0,09	0,49	T		36
50	1A	1. Energy Industries	b. Petroleum Refining	CO2	62,2	14,4	0,20	0,04	0,45	T		40
51	2	Industrial Processes	3. Aluminium Production	PFC	276,3	13,7	0,88	0,04	2,42	T	L	19
76	2	Industrial Processes	4. Carbide Production	CO2	45,0	1,1	0,14	0,00	0,40	T		45
80	1A	1. Energy Industries	c. Manufacture of Solid Fuels and Other EI	CO2	104,7	0,8	0,33	0,00	0,96	T		31

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Table 1.5.2: IPCC KS Categories for 2010, methodology and EF used, Tier 1 with LULUCF.

Rank 2010	CRF	Sector	Category	gas	GHG 2010	KC 2010	KC 1986	Method used	EF Used
1	5	LULUCF/ A Forest land	1. Forest Land remaining Forest Land	CO2	10869	L, T	L	CS, D, T1, T3	CS, D
2	1A	1. Energy Industries	a. Public Electricity and Heat Production	CO2	6166	L, T	L	T1, T2	CS, D
3	1A	3. Transport	b. Road Transportation	CO2	5143	L, T	L	M	M
4	5	LULUCF/ B Cropland	2. Land converted to Cropland	CO2	1201	L, T	L	D, T1, T2	CS, D
5	1A	4. Other Sectors	b. Residential	CO2	1194	L	L	T1	CS, D
6	1A	2. Manufacturing Industries and Construction	f. Other	CO2	981	L, T	L	T1	CS, D
7	1A	4. Other Sectors	a. Commercial/Institutional	CO2	647	L	L	T1	CS, D
8	5	LULUCF/ E Settlements	2. Land converted to Settlements	CO2	607	L, T	L	D	D
9	5	LULUCF/ B Cropland	1. Cropland remaining Cropland	CO2	412	L, T	L	D, T1, T2	CS, D
10	4	A. Enteric Fermentation	1. Non-Dairy Cattle	CH4	385	L, T	L	T2	CS
11	4	D. Agricultural Soils	1. Direct Soil Emissions	N2O	381	L, T	L	D, T1, T1b	CS, D
12	1A	2. Manufacturing Industries and Construction	d. Pulp, Paper and Print	CO2	380	L, T	L	T1	CS, D
13	2	Industrial Processes	1. Cement Production	CO2	368	L, T	L	T2	CS
14	6	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	CH4	356	L	L	T2	CS, D
15	5	LULUCF/ C Grassland	2. Land converted to Grassland	CO2	343	L, T		D, T1, T2	CS, D
16	4	D. Agricultural Soils	3. Indirect Emissions	N2O	293	L, T	L	D, T1a	D
17	5	LULUCF/ A Forest land	2. Land converted to Forest Land	CO2	269	L	L	CS, D, T1, T3	CS, D
18	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CH4	249	L, T	L	T3	CS
19	4	A. Enteric Fermentation	1. Dairy Cattle	CH4	236	L, T	L	T2	CS
20	1A	4. Other Sectors	c. Agriculture/Forestry/Fisheries	CO2	207	L, T	L	T1	D
21	1A	2. Manufacturing Industries and Construction	a. Iron and Steel	CO2	198	L, T	L	T1	CS, D
22	2	Industrial Processes	1. Refrigeration and AC Equipment	HFC	190	L, T		T2	D
23	4	B. Manure Management	1. Non-Dairy Cattle	CH4	168	L, T		T2	CS
24	2	Industrial Processes	3. Limestone and Dolomite Use	CO2	142	L, T		D	D
25	6	B. Waste Water Handling	2. Domestic and Commercial Waste Water	CH4	144	L		T1	D
26	4	B. Manure Management	1. Dairy Cattle	CH4	132	L	L	T2	CS
27	4	B. Manure Management	13. Solid Storage and Dry Lot	N2O	130	T	L	D	CS
28	1A	4. Other Sectors	b. Residential	CH4	125		L	T1	CS, D
29	4	B. Manure Management	8. Swine	CH4	121	T	L	T1	D
31	1A	2. Manufacturing Industries and Construction	e. Food Processing, Bev. and Tobacco	CO2	112	T	L	T1	CS
32	2	Industrial Processes	2. Lime Production	CO2	90	T	L	D	CS, D
33	1A	2. Manufacturing Industries and Construction	b. Non-Ferrous Metals	CO2	88	T	L	T1	CS
35	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CO2	81	T	L	T3	CS, D
42	3	Solvent and Other Product Use	D. 1. Use of N2O for Anaesthesia	N2O	30	T		D	CS
50	1A	1. Energy Industries	b. Petroleum Refining	CO2	14	T		T1	D
51	2	Industrial Processes	3. Aluminium Production	PFC	14	T	L	T3	CS, D
76	2	Industrial Processes	4. Carbide Production	CO2	1	T		D	D
79	1A	1. Energy Industries	c. Manufacture of Solid Fuels and Other EI	CO2	1	T		T1	CS, D

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**Table 1.5.3: IPCC KS Categories for 2010 Tier 1 w/o LULUCF.**

rank	CRF				GHG emissions		contribution to level		contribution	key category		rank
2010	#	Sector	Category	gas	1986	2010	1986	2010	to trend	2010	1986	1986
1	1A	1. Energy Industries	a. Public Electricity and Heat Production	CO2	6533,8	6174,3	32,27	31,63	1,47	L, T	L	1
2	1A	3. Transport	b. Road Transportation	CO2	1910,2	5142,9	9,44	26,34	38,50	L, T	L	2
3	1A	4. Other Sectors	b. Residential	CO2	1100,2	1194,1	5,43	6,12	1,55	L, T	L	5
4	1A	2. Manufacturing Industries and Construction	f. Other	CO2	1774,8	981,4	8,77	5,03	8,51	L, T	L	3
5	1A	4. Other Sectors	a. Commercial/Institutional	CO2	612,1	647,4	3,02	3,32	0,67	L, T	L	7
6	4	A. Enteric Fermentation	1. Non-Dairy Cattle	CH4	263,1	385,1	1,30	1,97	1,53	L, T	L	18
7	4	D. Agricultural Soils	1. Direct Soil Emissions	N2O	435,3	380,6	2,15	1,95	0,45	L, T	L	10
8	1A	2. Manufacturing Industries and Construction	d. Pulp, Paper and Print	CO2	649,6	380,5	3,21	1,95	2,87	L, T	L	6
9	2	Industrial Processes	1. Cement Production	CO2	514,6	367,9	2,54	1,88	1,50	L, T	L	8
10	6	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	CH4	298,8	356,0	1,48	1,82	0,79	L, T	L	15
11	4	D. Agricultural Soils	3. Indirect Emissions	N2O	334,7	293,0	1,65	1,50	0,34	L	L	14
12	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CH4	358,9	249,3	1,77	1,28	1,13	L, T	L	13
13	4	A. Enteric Fermentation	1. Dairy Cattle	CH4	383,6	235,9	1,89	1,21	1,56	L, T	L	12
14	1A	4. Other Sectors	c. Agriculture/Forestry/Fisheries	CO2	424,7	207,1	2,10	1,06	2,36	L, T	L	11
15	1A	2. Manufacturing Industries and Construction	a. Iron and Steel	CO2	1141,6	197,7	5,64	1,01	10,53	L, T	L	4
16	2	Industrial Processes	1. Refrigeration and AC Equipment	HFC	NO	190,4	0,00	0,98	2,22	L, T		NO
17	4	B. Manure Management	1. Non-Dairy Cattle	CH4	66,0	168,4	0,33	0,86	1,22	L, T		32
18	2	Industrial Processes	3. Limestone and Dolomite Use	CO2	36,5	152,2	0,18	0,78	1,37	L, T		40
19	6	B. Waste Water Handling	2. Domestic and Commercial Waste Water	CH4	113,2	143,7	0,56	0,74	0,40	L		25
20	4	B. Manure Management	1. Dairy Cattle	CH4	152,4	131,9	0,75	0,68	0,18	L	L	22
21	4	B. Manure Management	13. Solid Storage and Dry Lot	N2O	267,3	129,6	1,32	0,66	1,50	L, T	L	17
22	1A	4. Other Sectors	b. Residential	CH4	134,6	124,9	0,66	0,64	0,06	L	L	23
23	4	B. Manure Management	8. Swine	CH4	232,9	121,2	1,15	0,62	1,20	L, T	L	20
24	1A	2. Manufacturing Industries and Construction	c. Chemicals	CO2	98,1	114,9	0,48	0,59	0,24	L		27
25	1A	2. Manufacturing Industries and Construction	e. Food Processing, Beverages and Tobacco	CO2	247,8	111,6	1,22	0,57	1,49	L, T	L	19
26	2	Industrial Processes	2. Lime Production	CO2	220,2	90,2	1,09	0,46	1,42	T	L	21
27	1A	2. Manufacturing Industries and Construction	b. Non-Ferrous Metals	CO2	440,3	88,4	2,17	0,45	3,92	T	L	9
28	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CO2	120,2	80,6	0,59	0,41	0,41	T	L	24
29	1A	3. Transport	b. Road Transportation	N2O	28,6	75,6	0,14	0,39	0,56	T		42
35	3	Solvent and Other Product Use	D. 1. Use of N2O for Anaesthesia	N2O	81,9	30,4	0,40	0,16	0,57	T		30
43	1A	1. Energy Industries	b. Petroleum Refining	CO2	62,2	14,4	0,31	0,07	0,53	T		33
44	2	Industrial Processes	3. Aluminium Production	PFC	276,3	13,7	1,36	0,07	2,95	T	L	16
59	1A	5. Other	b. Mobile – Military use of fuel	CO2	41,1	2,87	0,20	0,01	0,43	T		39
69	2	Industrial Processes	4. Carbide Production	CO2	45,0	1,1	0,22	0,01	0,49	T		38
71	1A	1. Energy Industries	c. Manufacture of Solid Fuels and Other EI	CO2	104,7	0,8	0,52	0,00	1,17	T		26

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Table 1.5.4: IPCC KS Categories for 2010, methodology and EF used, Tier 1 with LULUCF.

Rank 2010	CRF	Sector	Category	gas	GHG 2010	KC 2010	KC 1986	Method used	EF Used
1	1A	1. Energy Industries	a. Public Electricity and Heat Production	CO2	6166	L, T	L	T1, T2	CS, D
2	1A	3. Transport	b. Road Transportation	CO2	5143	L, T	L	M	M
3	1A	4. Other Sectors	b. Residential	CO2	1194	L, T	L	T1	CS, D
4	1A	2. Manufacturing Industries and Construction	f. Other	CO2	981	L, T	L	T1	CS, D
5	1A	4. Other Sectors	a. Commercial/Institutional	CO2	647	L, T	L	T1	CS, D
6	4	A. Enteric Fermentation	1. Non-Dairy Cattle	CH4	385	L, T	L	T2	CS
7	4	D. Agricultural Soils	1. Direct Soil Emissions	N2O	381	L, T	L	D, T1, T1b	CS, D
8	1A	2. Manufacturing Industries and Construction	d. Pulp, Paper and Print	CO2	380	L, T	L	T1	CS, D
9	2	Industrial Processes	1. Cement Production	CO2	368	L, T	L	T2	CS
10	6	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	CH4	356	L, T	L	T2	CS, D
11	4	D. Agricultural Soils	3. Indirect Emissions	N2O	293	L	L	D, T1a	D
12	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CH4	249	L, T	L	T3	CS
13	4	A. Enteric Fermentation	1. Dairy Cattle	CH4	236	L, T	L	T2	CS
14	1A	4. Other Sectors	c. Agriculture/Forestry/Fisheries	CO2	207	L, T	L	T1	D
15	1A	2. Manufacturing Industries and Construction	a. Iron and Steel	CO2	198	L, T	L	T1	CS, D
16	2	Industrial Processes	1. Refrigeration and AC Equipment	HFC	190	L, T		T2	D
17	4	B. Manure Management	1. Non-Dairy Cattle	CH4	168	L, T		T2	CS
18	2	Industrial Processes	3. Limestone and Dolomite Use	CO2	142	L, T		D	D
19	6	B. Waste Water Handling	2. Domestic and Commercial Waste Water	CH4	144	L		T1	D
20	4	B. Manure Management	1. Dairy Cattle	CH4	132	L	L	T2	CS
21	4	B. Manure Management	13. Solid Storage and Dry Lot	N2O	130	L, T	L	D	CS
22	1A	4. Other Sectors	b. Residential	CH4	125	L	L	T1	CS, D
23	4	B. Manure Management	8. Swine	CH4	121	L, T	L	T1	CS
24	1A	2. Manufacturing Industries and Construction	c. Chemicals	CO2	115	L		T1	CS,D
25	1A	2. Manufacturing Industries and Construction	e. Food Processing, Bev. and Tobacco	CO2	112	L, T	L	T1	CS,D
26	2	Industrial Processes	2. Lime Production	CO2	90	T	L	D	CS
27	1A	2. Manufacturing Industries and Construction	b. Non-Ferrous Metals	CO2	88	T	L	T1	CS, D
28	1B	Fugitive Emissions from Fuels (1.Solid Fuels)	a. Coal Mining and Handling	CO2	81	T	L	T3	CS
29	1A	3. Transport	b. Road Transportation	N2O	76	T		M	M
35	3	Solvent and Other Product Use	D. 1. Use of N2O for Anaesthesia	N2O	30	T		D	D
43	1A	1. Energy Industries	b. Petroleum Refining	CO2	14	T		T1	CS, D
44	2	Industrial Processes	3. Aluminium Production	PFC	14	T	L	T3	PS
59	1A	5. Other	b. Mobile – Military use of fuel	CO2	3	T		T1	D
69	2	Industrial Processes	4. Carbide Production	CO2	1	T		D	D
71	1A	1. Energy Industries	c. Manufacture of Solid Fuels and Other EI	CO2	1	T		T1	CS,D

## **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. At the beginning of 2009, a QA/QC manager at the inventory agency was designated.

Quality Control (QC) is a system of routine technical activities to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- provide routine and consistent checks to ensure data integrity, correctness and completeness;
- identify and address errors and omissions;
- document and archive inventory material and record all QC activities.

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

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

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

As all calculations are performed in the database with software generated for this purpose, no human errors, common in calculations made in Excel spreadsheets, are expected. After these procedures, the activity data (fuel consumption and NCV) are transferred into the database, while EFs are imported manually. Then emissions are calculated automatically according to the built-in formulas. For 2008 and 2009, GHG emissions were also calculated in Excel spreadsheets. Both estimates were compared and all differences were carefully investigated and corrected.

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

### **Check of methodological and data changes resulting in recalculations**

- Check for temporal consistency in time series input data for each source category.
- Check for consistency in the algorithm/method used for calculations throughout the time series.

### **Completeness checks**

- Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory.
- Check that known data gaps that result in incomplete source category emissions estimates are documented.

- Compare estimates to previous estimates: for each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any differences.

#### **Check of activity data, emission factors and other parameters**

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

#### **Check of emissions estimates**

For the entire period 1986–2010, 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:

#### **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 and archived

#### **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 the Environment and Spatial Planning to perform on-site inspections. The use of (EU) ETS data is described in more detail in the relevant chapter on Energy and Industrial Processes sectors.

#### **QA**

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 will be reviewed during the two days visit in JRC Ispra, which is planned for 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 2008–2012 (<http://www.stat.si/doc/drzstat/SPSR-eng.pdf>). The strategic directions from the Medium-term Programme of Statistical Surveys are presented in detail at [http://www.stat.si/doc/drzstat/kakovost/TQMStrategy\\_2006\\_eng.doc](http://www.stat.si/doc/drzstat/kakovost/TQMStrategy_2006_eng.doc) in the Total Quality Management Strategy 2006–2008.

### **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 Environmental and Spatial Planning. 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<sub>2</sub> 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 investigated 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 (40%). The detailed results are in the table below.

In the 1986 the uncertainty of the inventory was 39.82% (8.95 w/o LULUCF).

In the 2010 the uncertainty was 30.03% (6.91 w/o LULUCF). The biggest contributions to the lower uncertainty have the energy and LULUCF sector.

**Table 1.7.1: Inventory Institutional Arrangements and Data Sources**

	1986	2010
<b>1A Fuel combustion</b>	6.76%	2.63%
<b>1B Fugitive</b>	40.18%	39.87%
<b>2&amp;3 Processes/Solvents emissions</b>	7.31%	14.05%
<b>4 Agriculture</b>	64.62%	63.09%
<b>5 LULUCF</b>	61.61%	33.27%
<b>6 Waste</b>	48.82%	47.28%
<b>TOTAL COMBINED UNCERTAINTY</b>	<b>39.82%</b>	<b>30.03%</b>

**TOTAL trend uncertainty (2010/1986) = 4.17% (2.69% 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<sub>2</sub>O 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 CO<sub>2</sub> emissions from agricultural lime application are reported under cropland as limestone (all other categories are reported as IE)

### 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<sub>4</sub> from enteric fermentation from poultry

The potential emissions of SF<sub>6</sub> have still not been estimated, because of lack of data. Potential emissions for HFC have been evaluated for 1995-2010 for the whole sector only while the estimation for sub-sectors are missing.

There are still few missing sources in the LULUCF sector in Wetlands, Settlements and Other land. The emissions and sinks are not estimated because of lack of relevant data but they are expected to be negligible.

### 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 2010, sinks not considered, amounted to 19,522.13 kt CO<sub>2</sub> eq., which represents a 3.8% decrease of emissions compared to the year 1986 and 4.3% 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 emissions stayed almost the same as in 2009.

### ***2.2 Description and interpretation of emission trends by gas***

CO<sub>2</sub> emissions in 2010 represented 82.7% of overall emissions of greenhouse gases. CO<sub>2</sub> 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 2010 they decreased by 1.4%. CH<sub>4</sub> emissions represented 10.5% of total emissions in 2010 (11.6% in 1986) and were lower than in 1986 by 10.1%. N<sub>2</sub>O emissions represented 5.8% of total emissions and were lower than N<sub>2</sub>O emissions in 1986 by 18.3%. F-gases represent 1.0% of total emissions and some (HFCs and SF<sub>6</sub>) 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.

#### ***Carbon dioxide – CO<sub>2</sub>***

CO<sub>2</sub> emissions in the period 1986–2010 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<sub>2</sub> emissions in 2002 thus amounted to 16.27 Mt of CO<sub>2</sub>, which is nearly the same as in the 1986 base year. Although in 2003, CO<sub>2</sub> 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<sub>2</sub> emissions decreased due to global financial crisis by 10.6% while in 2010 stayed almost the same (0.2% increase).

In entire period of time, the strongest increase in CO<sub>2</sub> emissions was in transport, by as much as 202%, from 2.0 Mt CO<sub>2</sub> eq. in 1986 to 6.2 Mt CO<sub>2</sub> 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.

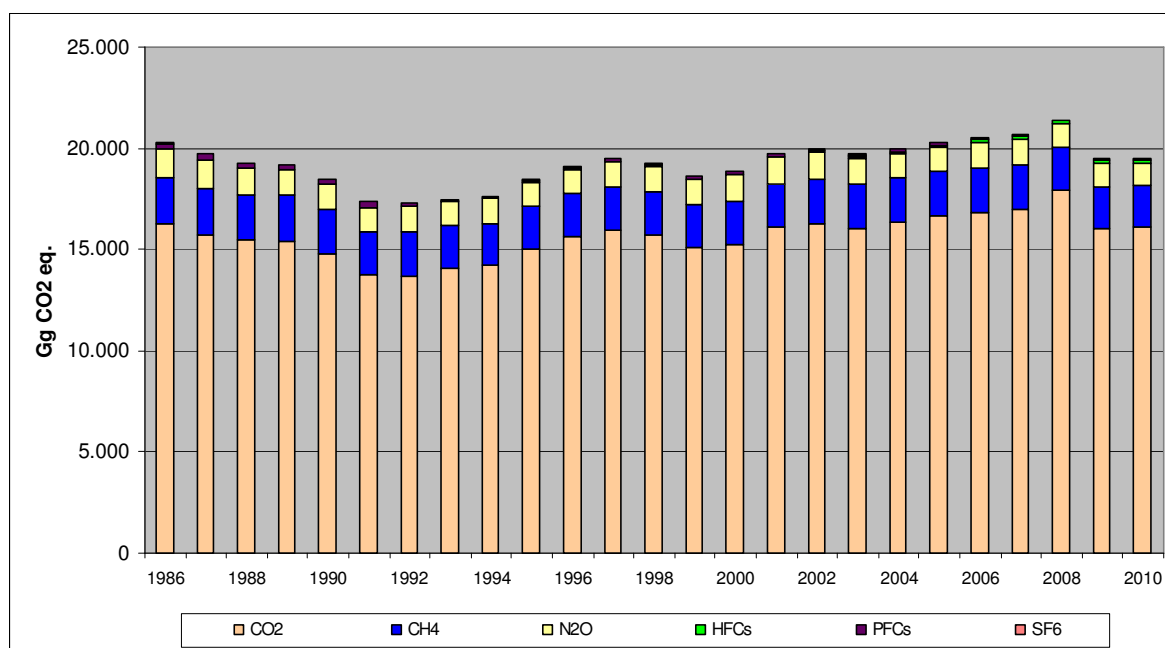
The Industrial Processes sector contributed 4.5% to total CO<sub>2</sub> emissions in 2010, while contributions of other sectors are negligible or zero. The LULUCF sector represents sink for CO<sub>2</sub> emissions, in the 1986-2010 the level of sinks is rather constant and amounted to nearly half of CO<sub>2</sub> emissions.

### **Methane – CH<sub>4</sub>**

Between 1986 and 2010, methane emissions were slightly decrease, from 2.26 Mt CO<sub>2</sub> eq. in 1986 to 2.04 Mt CO<sub>2</sub> eq. in 2010. CH<sub>4</sub> emissions diminished by 10.1% in spite of increased emissions from solid waste (by 1.8%, compared to 1986). The larger contribution to decrease has a reduction of methane emissions in Fugitive emissions from fuel and from Manure management.

### **Nitrous oxide – N<sub>2</sub>O**

N<sub>2</sub>O emissions were down from 1.39 Mt CO<sub>2</sub> eq. in 1986 to 1.14 Mt CO<sub>2</sub> eq. in 2010. In Agriculture, which is the main source of N<sub>2</sub>O 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.



**Figure 2.2.1: GHG Emissions in Slovenia by gas**

**Hydro-fluorocarbons – HFC**

HFC emissions have grown from year to year. In 2010, emissions increased by 2.1% compared to the previous year, which is mostly the consequence of an increasing number of air conditioners in motor vehicles.

**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<sub>2</sub> 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.

**Sulphur-hexafluoride – SF<sub>6</sub>**

The main source of SF<sub>6</sub> emissions is high-voltage gas-insulated switchgear and circuit breakers. SF<sub>6</sub> 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 2010 accounted for 82.0% of total GHG emissions. In this sector emissions have decreased by 0.6%, compared to the 1986. Within this sector, in the period 1986–2010, GHG emissions from the Energy Industry, as the biggest sub-sector, decreased by 7.7%. 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 2010 GHG emissions from transport decreased for 13.2% compare to 2008. The traffic emissions have further decreased by 1.2% in 2010. 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% and in 2010 by 0.9% 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 emissions stayed almost the same. The most important GHG of this sector was carbon dioxide, with 78.3% of emissions from this category, followed by HFCs with 18.1%, PFCs and SF<sub>6</sub> with 23.2% and CH<sub>4</sub> with 0.4%. Since 2006 N<sub>2</sub>O 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 0.2% 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<sub>2</sub> eq. to 30 kt CO<sub>2</sub> eq., only from N<sub>2</sub>O emissions.

In Agriculture as the second most important sector, emissions in 2010 amounted to 1963 Gg CO<sub>2</sub> eq, which represents 10.1% of all emissions. Agriculture represents the main source of methane and N<sub>2</sub>O emissions, namely 53.9% of all methane emissions and 76.3% of all N<sub>2</sub>O emissions. In the agricultural sector, N<sub>2</sub>O emissions account for 44.1% of emissions, and CH<sub>4</sub> emissions account for 55.9% of emissions.

GHG emissions from agriculture show small oscillations for individual years, but the general trend is on the decrease. In 2010, emissions were 11.5% below the base year. The most important sub-sector is emissions from agricultural soils, which contribute 37.0% of all emissions from agriculture, followed by emissions from enteric fermentation, with 33.9%; the rest is contributed by emissions of methane and N<sub>2</sub>O from animal manure (29.1%).

In the LULUCF sector, the CO<sub>2</sub> sink was estimated in 2010 at 8,491 Gg CO<sub>2</sub> eq, which is 11.6% 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 21.1% of all methane emissions in Slovenia in 2010. The fraction of methane emissions in this sector amounts to 88.9%, while the remaining part represents N<sub>2</sub>O (10.2%), CO<sub>2</sub> emissions are nearly negligible (0.9%). Solid waste handling contributes 61.7% to the total emissions from this sector, wastewater handling 37.4% and incineration of waste 0.9%.

Compared to the base year, emissions have risen by 1.8%, which is mostly due to emissions from SWDSs, which show an increase of 19.1%. 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 higher than in the base year by 12.6%. 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.

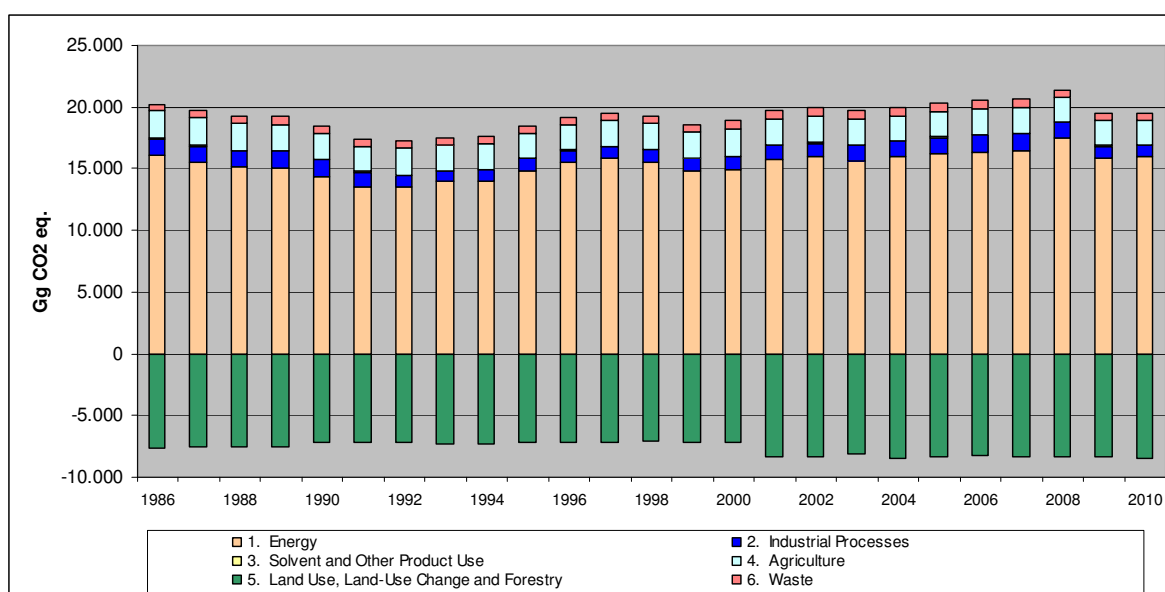


Figure 2.3.1: GHG Emissions in Slovenia by sector



SLOVENIA'S NATIONAL INVENTORY REPORT 2012

**Table 2.3.1: GHG emissions and removals in Slovenia by sectors and sub-sectors 1986-2010**

GHG SOURCE AND SINK CATEGORIES	1986	1990	1995	2000	2005	2009	2010	Change (%)
<b>TOTAL net emissions (with LULUCF) in Gg CO<sub>2</sub> eq.</b>	12,616	11,264	11,234	11,629	11,940	11,078	11,031	-12.6
<b>1. Energy</b>	<b>16,114</b>	<b>14,432</b>	<b>14,850</b>	<b>14,958</b>	<b>16,209</b>	<b>15,895</b>	<b>15,980</b>	<b>-0.8</b>
A. Fuel Combustion	15,578	13,973	14,437	14,583	15,839	15,536	15,621	0.3
1. Energy Industries	6,729	6,265	5,627	5,498	6,325	6,091	6,219	-7.6
2. Manufacturing Industries and Construct.	4,404	3,119	2,615	2,269	2,486	1,918	1,900	-56.9
3. Transport	2,040	2,749	3,757	3,763	4,442	5,337	5,272	158.4
4. Other Sectors	2,363	1,808	2,437	3,051	2,583	2,187	2,228	-5.7
5. Other	41	32	1	3	3	3	3	-93.0
B. Fugitive Emissions from Fuels	536	459	413	374	370	358	359	-33.0
1. Solid Fuels	479	401	358	331	337	329	330	-31.1
2. Oil and Natural Gas	57	58	55	43	33	29	29	-48.6
<b>2. Industrial Processes</b>	<b>1,317</b>	<b>1,318</b>	<b>1002</b>	<b>1,063</b>	<b>1,373</b>	<b>973</b>	<b>971</b>	<b>-26.3</b>
A. Mineral Products	795	725	609	682	761	663	629	-21.1
B. Chemical Industry	49	40	31	33	52	5	5	-90.6
C. Metal Production	463	542	318	291	408	92	123	-73.5
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF <sub>6</sub>	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
F. Consumption of Halocarbons and SF <sub>6</sub>	10	10	44	57	152	212	215	2,000.22
G. Other	NA	NA	NA	NA	NA	NA	NA	NA
<b>3. Solvent and Other Product Use</b>	<b>82</b>	<b>43</b>	<b>17</b>	<b>43</b>	<b>43</b>	<b>31</b>	<b>30</b>	<b>-62.9</b>
<b>4. Agriculture</b>	<b>2,219</b>	<b>2,141</b>	<b>2,047</b>	<b>2,137</b>	<b>2,006</b>	<b>1,996</b>	<b>1,963</b>	<b>-11.5</b>
A. Enteric Fermentation	681	656	647	694	662	674	666	-2.1
B. Manure Management	744	737	638	630	595	580	570	-23.4
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	794	748	762	813	749	742	726	-8.4
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

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GHG SOURCE AND SINK CATEGORIES	1986	1990	1995	2000	2005	2009	2010	Change (%)
<b>5. Land Use, Land-Use Change and Forestry (LULUCF)</b>	-7,606	-7,202	-7,232	-7,194	-8,404	-8,391	-8,491	11.6
A. Forest Land	-9,429	-9,378	-9,465	-9,498	-11,004	-11,037	-11,137	18.1
B. Cropland	1,291	1,408	1,465	1,535	1,650	1,697	1,697	31.5
C. Grassland	64	222	222	222	343	343	343	433.1
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
E. Settlements	468	547	547	547	607	607	607	29.5
F. Other Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
<b>6. Waste</b>	491	532	549	623	713	575	577	1.8
A. Solid Waste Disposal on Land	299	345	376	439	486	361	356	19.1
B. Waste-water Handling	192	186	172	182	224	209	216	12.6
C. Waste Incineration	NO	1	0	2	2	4	5	NA
D. Other	NA	NA	NA	NA	NA	NA	NA	NA
<b>7. Other</b>	NA	NA	NA	NA	NA	NA	NA	NA
<b>Memo Items:</b>								
<b>International Bunkers</b>	58	48	57	68	61	196	141	42.9
Aviation	58	48	57	68	61	78	74	-25.1
Marine	NA	NA	NA	NA	NA	117	67	NA
<b>Multilateral Operations</b>	NA	NA	NA	1	0	0	0	NA
<b>CO2 Emissions from Biomass</b>	2,254	2,088	2,036	1,897	2,299	2,583	2,798	24.1
<b>Total CO2 Equivalent Emissions without LULUCF</b>	20,222	18,466	18,465	18,823	20,344	19,469	19,522	-3.5

## 2.4 Description and interpretation of emission trends for indirect GHGs and SO<sub>2</sub>

The highest contribution to the total emission of SO<sub>2</sub> is that of thermal power plants and power cogeneration plants. In 1995, SO<sub>2</sub> 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<sub>2</sub> happened after 2006 due to operation of wet flue gas desulphurisation in TE Trbovlje.

The biggest contribution to the overall NO<sub>x</sub> emissions is that of mobile sources (road traffic). After 1992, NO<sub>x</sub> 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, NO<sub>x</sub> 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 2010 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, NO<sub>x</sub>, SO<sub>2</sub> and NMVOC in Slovenia excluding LULUCF (kt)**

	1990	2000	2005	2006	2007	2008	2009	2010
<b>NO<sub>x</sub></b>	59	52	53	53	54	53	46	45
<b>CO</b>	318	194	143	135	128	136	151	155
<b>NMVOC</b>	47	52	49	41	39	34	34	34
<b>SO<sub>2</sub></b>	197	98	41	18	15	13	11	10

**Table 2.4.2: Emissions of CO, NO<sub>x</sub>, SO<sub>2</sub> and NMVOC in Slovenia including LULUCF (kt)**

	1990	2000	2005	2006	2007	2008	2009	2010
<b>NO<sub>x</sub></b>	59	52	53	53	54	53	46	45
<b>CO</b>	323	196	145	148	130	137	153	156
<b>NMVOC</b>	48	52	49	42	39	34	34	34
<b>SO<sub>2</sub></b>	197	98	41	18	15	13	11	10

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 82.0% of overall CO<sub>2</sub> eq. emissions (w/o considering LULUCF). Emissions from this sector arise from fuel combustion, accounting for 97.8% emissions from the energy sector, and as fugitive emissions from fuels, accounting for 2.2% of emissions.

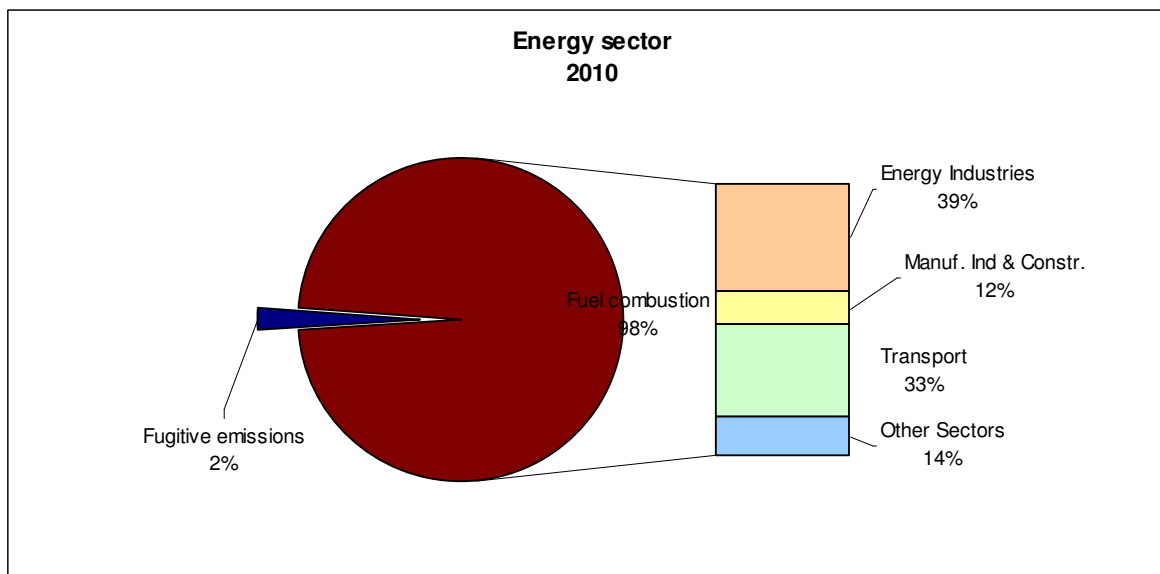


Figure 3.1.1: Emissions of GHG in Energy Sector by categories in 2010

GHG emissions from fuel combustion in 2010 have, compared to 2009, increased by 0.5% and were thus 0.6% lower than in the 1986 base year. The most important sub-sector is Energy Industries with 38.9% of emission of CO<sub>2</sub> eq., followed by Traffic with 33.0%. 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 the same also in 2010.

The strongest reduction of emissions was recorded in Manufacturing Industries and Construction, which accounted for 11.9% of emissions. Emissions in this sector have, chiefly due to substitution of coal and liquid fuels, diminished by as much as 56.9% since 1986.

In the Other sector consumption, which accounts for 14.0% of emissions, Residential sector prevails.

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 2010, 4.7 TWh (i.e. 29%) of electrical energy was produced in public hydroelectric power plants, 5.7 TWh (i.e. 35%) in the Krško Nuclear Power Plant, while the remaining 6.1 TWh was produced in thermal power plants (i.e. 36%). 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<sub>2</sub> eq.**

	1986	1990	1995	2000	2005	2009	2010	Change (%)
<b>1. Energy</b>	<b>16,114</b>	<b>14,432</b>	<b>14,850</b>	<b>14,958</b>	<b>16,209</b>	<b>15,895</b>	<b>15,980</b>	<b>-0.8</b>
<b>A. Fuel Combustion</b>	<b>15,578</b>	<b>13,973</b>	<b>14,437</b>	<b>14,583</b>	<b>15,839</b>	<b>15,536</b>	<b>15,621</b>	<b>0.3</b>
1. Energy Industries	6,729	6,265	5,627	5,498	6,325	6,091	6,219	-7.6
2. Manufacturing Ind. and Constr.	4,404	3,119	2,615	2,269	2,486	1,918	1,900	-56.9
3. Transport	2,040	2,749	3,757	3,763	4,442	5,337	5,272	158.4
4. Other Sectors	2,363	1,808	2,437	3,051	2,583	2,187	2,228	-5.7
5. Other	41	32	1	3	3	3	3	-93.0
<b>B. Fugitive Emissions from Fuels</b>	<b>536</b>	<b>459</b>	<b>413</b>	<b>374</b>	<b>370</b>	<b>358</b>	<b>359</b>	<b>-33.0</b>
1. Solid Fuels	479	401	358	331	337	329	330	-31.1
2. Oil and Natural Gas	57	58	55	43	33	29	29	-48.6

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<sub>2</sub> emissions from flue gas desulphurisation (SO<sub>2</sub> scrubbing) are included in Industrial processes under Limestone and dolomite use and not under 1.B.1.c Other, what is recommended in the IPCC guidances. 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<sub>2</sub> emissions from biomass have been computed as well, but have not been included in the calculation; however, all other greenhouse gases (CH<sub>4</sub>, N<sub>2</sub>O) 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<sub>2</sub> emissions between the sectoral approach and the reference approach in 2010 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.

For 2012 submission the following changes/improvements have been done:

- EB data on gasoline, other kerosene, gas diesel oil, residual fuel oil, bitumen, lubricants, and natural gas have been taken from Joint Questionnaires.
- Heating gas oil has been reported together with the transport diesel under “gas/diesel oil” instead under “Residual fuel oil” for all years
- EB data on naphtha, refinery feedstock, other oil, and white spirit have been reported for the first time.

- NCVs for natural gas and bitumen have been corrected.
- EB data on gaseous biomass have been included in the RA for the first time.

**Table 3.1.2: Differences in energy consumption in PJ (Reference approach/National Approach)**

	1986	1990	1995	2000	2005	2008	2009	2010
liquid	-2.02	2.84	1.84	-0.02	2.22	-0.36	0.86	1.76
solid	0.24	1.76	0.32	1.18	-0.49	-0.02	-0.05	0.14
gaseous	4.46	-4.97	-2.65	-0.50	0.63	0.002	-0.002	-0.008
total	-0.03	0.93	0.61	0.16	0.86	-0.44	0.09	0.28

**Table 3.1.3: Differences in CO<sub>2</sub> emissions in Gg CO<sub>2</sub> eq (Reference approach/National Approach)**

	1986	1990	1995	2000	2005	2008	2009	2010
liquid	-1.58	3.39	7.17	-2.76	2.88	-0.15	0.20	1.10
solid	0.17	1.80	0.39	1.22	-1.15	0.12	-0.14	-0.29
gaseous	-4.15	-8.37	-0.53	0.29	0.54	-0.13	-0.06	-0.49
total	-0.87	-1.49	3.52	0.45	0.75	-0.25	-0.29	-0.19

### 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 3.1.4: International Navigation Bunkers**

	2005	2006	2007	2008	2009	2010
fuel in TJ	880	1206	2030	2737	1347	768
Gg CO <sub>2</sub> eq.	77	105	177	238	117	67

#### 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 have 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 3.1.5: International Aviation Bunkers**

	1986	1990	1995	2000	2005	2006	2007	2008	2009	2010
<b>fuel in TJ</b>	799	672	786	945	852	976	1306	1452	1087	1022
<b>Gg CO<sub>2</sub> eq.</b>	58	48	57	68	61	70	94	105	78	74

### 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 2010 about 5 TJ of jet kerosene were used on international missions what is amounted to 0.4 Gg CO<sub>2</sub> 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

Emissions from the Army have been estimated for the period 1986-2007, excluded from international bunkers and reported under 1.A.5.b Other/Mobile.

Emissions from the Army international missions have been estimated for the period 1997-2007, excluded from international aviation and reported under 1.C.2 Multilateral operations.

### 3.1.3 Feedstock and non-energy use of fuels

#### Natural gas

Table 3.1.6: Non-energy use of natural gas

		1986	1990	1995	2000	2005	2008	2009	2010
Natural Gas	1000 m <sup>3</sup>	67666	69524	91577	136740	164407	118091	111149	97004
Fraction of C stored		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
Stored CO <sub>2</sub>	Gg	125.3	131.0	172.6	257.6	292.4	222.6	209.5	190.3

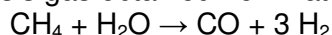
Source of activity: from 1985 to 1995 Statistical office, LPI  
 from 1995-1996, Statistical office, DGP  
 from 1997-2003 LEG, Table Tg/6-3  
 from 2004 on SURS excel file and JQ

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<sup>3</sup> of natural gas in 2010. It is entirely used as the raw 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.



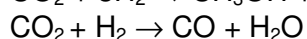
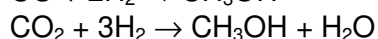
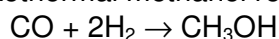
Figure 3.1.2: Methanol production in Nafta-Petrochem Lendava.

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



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:





is operated at high pressure and unconverted gas is recycled.

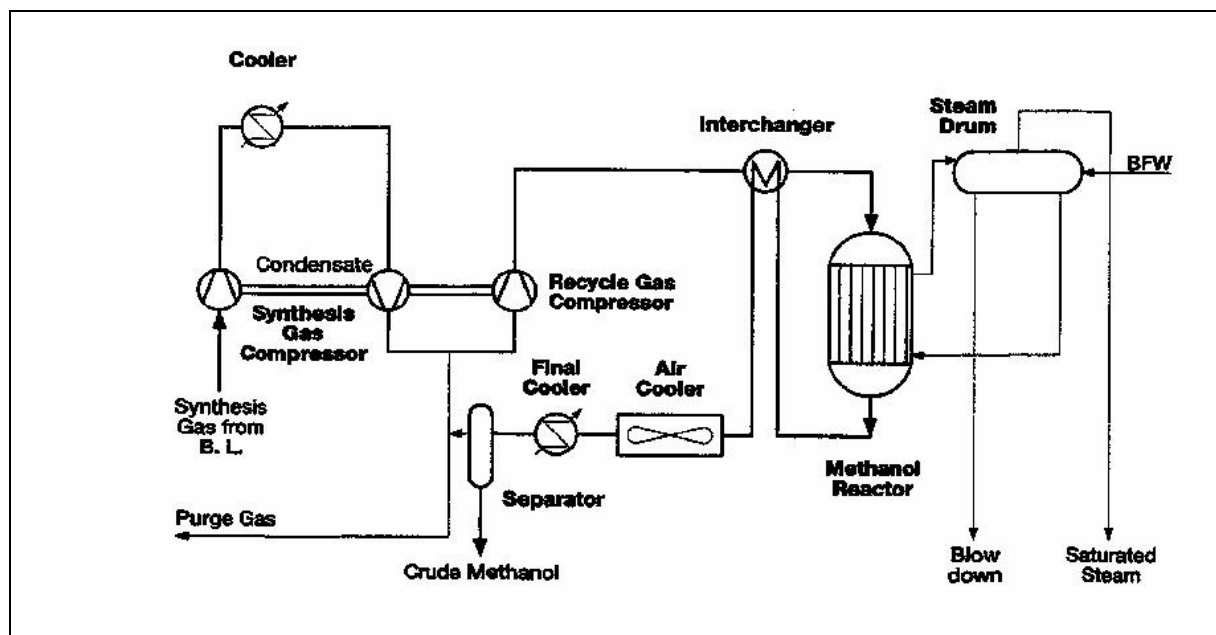


Figure 3.1.3: Schematic diagram of methanol production.

Stored CO<sub>2</sub> 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 raw material for production of organic and inorganic chemicals and plastics. The detailed data are presented in the Table 3.1.7.

Table 3.1.7: Non-energy use of natural gas for different products.

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

Table 3.1.8: 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 Environmental Agency of the Republic of Slovenia 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 have 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. To assure consistency of the reporting the country specific values for fraction of carbon stored have been used in the reference approach. The values are in the range from 44 to 95%.

#### 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<sub>2</sub> has been calculated on the basis of the formula from IPCC guidelines, 1996, p. I.28., I. 23, I.13.

**Table 3.1.9: Oil and Lubricants**

		2004	2005	2006	2007	2008	2009	2010
<b>Oil and Lubricants</b>	t	28623	17465	30000	22000	16000	12000	12000
<b>Waste oil - combusted</b>	t	3878	4404	4502	4281	4228	4582	6763
<b>NCV</b>	TJ/kt	40.2	40.2	40.2	40.2	40.2	40.2	40.2
<b>Fraction of C stored</b>		0.865	0.748	0.850	0.805	0.736	0.618	0.436
<b>Carbon EF</b>	$\frac{t}{C/TJ}$	20	20	20	20	20	20	20
<b>Stored CO<sub>2</sub></b>	Gg	73	39	75	52	35	22	15

**Table 3.1.10: 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<sub>2</sub> capture from flue gases and subsequent CO<sub>2</sub> storage**

There are no plants for recovery and storage of CO<sub>2</sub> in Slovenia.

## 3.2 Fuel combustion (CRF 1.A)

### 3.2.1 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.

### 3.2.2 Country-specific EFs

#### Lignite – CO<sub>2</sub> EF

**Table 3.2.1: National CO<sub>2</sub> emission factor for domestic lignite from Velenje pit.**

	1986	1987	1988	1989	1990	1991	1992	1993	1994
t CO <sub>2</sub> /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 <sub>2</sub> /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		
t CO <sub>2</sub> /TJ	105.85	107.94	106.32	106.15	105.64	104.76	104.52		

**Table 3.2.2: National CO<sub>2</sub> EF for domestic lignite from Velenje pit including oxidation.**

	1986	1987	1988	1989	1990	1991	1992	1993	1994
t CO <sub>2</sub> /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 <sub>2</sub> /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		
t CO <sub>2</sub> /TJ	103.74	105.78	104.19	104.03	103.52	102.67	102.43		

With regard to the need to upgrade GHG emissions inventories, in 2004, national CO<sub>2</sub> emission factors for domestic coal were developed. CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> emission factor for domestic brown coal from Trbovlje pit.**

	2005	2006	2007	2008	2009	2010
t CO <sub>2</sub> /TJ	101.94	102.89	101.66	101.81	102.71	101.33

**Table 3.2.4: National CO<sub>2</sub> EF for domestic brown coal from Trbovlje pit including oxidation.**

	2005	2006	2007	2008	2009	2010
t CO <sub>2</sub> /TJ	99.90	100.83	99.63	99.77	100.65	99.30

### **Natural gas – CO<sub>2</sub> EF**

We use slightly modified EF also for natural gas. CO<sub>2</sub> 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<sub>2</sub> 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) 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<sub>2</sub> 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<sub>2</sub> emission factor for combustion of natural gas.**

EF (t CO <sub>2</sub> /TJ)	1986-1991	1992	1993	1994	1995	1996-2020
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<sub>4</sub> 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<sub>4</sub> EF are available for natural

gas and for oil, but our energy experts have considered that LPG has to have lower CH<sub>4</sub> 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<sub>4</sub> 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<sub>4</sub> EF for LPG and for natural gas to 1 kg/TJ for combustion in all sectors.

### 3.2.3 Oxidation factor

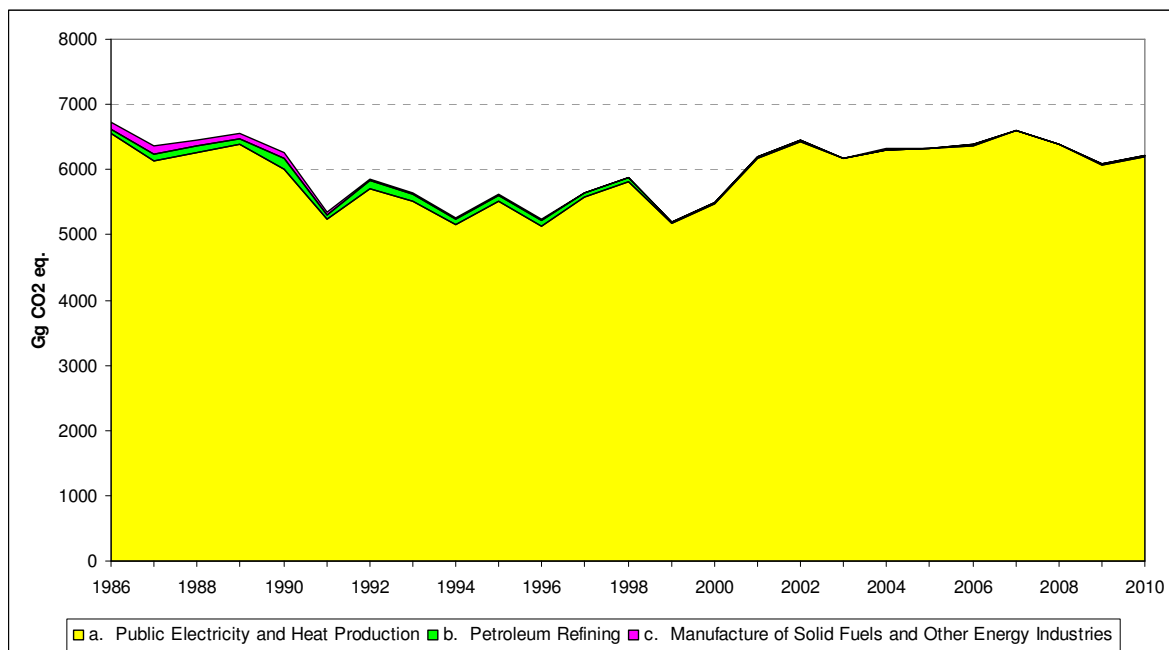
For inventory purpose we have used default oxidation factor from IPCC Reference Manual, 1996. They are as follows:

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

### 3.2.4 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 2010. 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 CO<sub>2</sub> eq.**

in Gg CO <sub>2</sub> eq.	1986	1990	1995	2000	2005	2008	2009	2010
<b>1. Energy Industries</b>	<b>6729</b>	<b>6265</b>	<b>5627</b>	<b>5498</b>	<b>6325</b>	<b>6388</b>	<b>6091</b>	<b>6219</b>
a. Public Electricity and Heat Production	6562	6015	5513	5466	6321	6379	6083	6203
b. Petroleum Refining	62	169	92	32	1	1	6	14
c. Manufacture of Solid Fuels and Other...	105	81	21	0	2	9	2	1

## 3.2.4.1 Public Electricity and Heat Production (CRF 1A1a)

	KS	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level
<b>Base Year</b>	Level	CO <sub>2</sub>	20.76		2
<b>2010</b>	Level, Trend	CO <sub>2</sub>	18.54	6.39	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 woodweg
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 Brežanica – 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 Net Calorific value x EF per energy of Fuel x

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	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood
	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	42.600	41.420	46.050	34.080	9.871

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<sub>2</sub> 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 <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N <sub>2</sub> O 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 <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N <sub>2</sub> O 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 <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N <sub>2</sub> O 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 <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N <sub>2</sub> O 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 2010

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub- bituminous Coal	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N <sub>2</sub> O 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	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO <sub>2</sub> EF	t/TJ	104.517	101.328	100.408	77.4	74.0	63.0	55.291	108.5
EF*OF	t/TJ	102.427	99.302	98.400	76.6	73.3	62.4	55.015	107.4
CH <sub>4</sub> EF	t/TJ	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.03
N <sub>2</sub> O EF	t/TJ	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.

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. Nitrous oxide (N<sub>2</sub>O) emissions can also occur from incomplete combustion process but we have assume that this is not the case in the modern waste incineration plants. Since the plastic considered here does not contain any nitrogen, there are no N<sub>2</sub>O emissions associated with combusting plastic. Therefore N<sub>2</sub>O emissions are zero as well as CH<sub>4</sub> emissions and notation key NO has been used for both.

CO<sub>2</sub> emissions from combusting plastic depend on the carbon content of the plastic and the amount of carbon that is converted to CO<sub>2</sub> during the combustion process. 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<sub>2</sub>/TJ).

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<sub>2</sub> emission trading in the period 2005-2007 on the territory of the European Union. For this reason the country specific CO<sub>2</sub> 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 3.2.15: Levels of pretentiousness (Tiers) for fuel used in TPP in Slovenia in 2005-2010.**

	<b>AD</b>	<b>NCV</b>	<b>CO2 EF</b>
<b>Natural gas</b>	Tier 4	Tier 2a	Tier 2a
<b>Solid fuel</b>	Tier 3	Tier 3	Tier 3
<b>Fuel oil</b>	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  $\pm 7.5\%$  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  $\pm 5.0\%$  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  $\pm 2.5\%$  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  $\pm 1.5\%$  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.

Source specific QA/QC activities

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

Recalculations

In the previous submission emission factor for the MSW has been used to calculate CO<sub>2</sub> and N<sub>2</sub>O emissions from non-biogenic part of waste incinerated in the Slovenian only waste incineration thermal power plant. From additional information on waste type it shows up that most of the waste is plastics and that the CO<sub>2</sub> EF for MSW is not appropriate. Instead of 0.55 t CO<sub>2</sub>/t waste the emission factor 20 t C/TJ has been used (73.3 t CO<sub>2</sub>/TJ). Since the plastic does not contain any nitrogen, there are no N<sub>2</sub>O emissions associated with combusting plastic. Therefore N<sub>2</sub>O emissions are zero and notation key NO has been used. Recalculations have occurred to the 2009 only as this is year when the incineration plant has started to work.

Future improvements

No improvements are planned for this sector.

**3.2.4.2 Petroleum Refining (CRF 1A1b)**

	<b>KS</b>	<b>Gas</b>	<b>Contribution to Level %</b>	<b>Contribution to Trend %</b>	<b>Rank KS level</b>
<b>Base Year</b>	no	CO <sub>2</sub>	0.20		40
<b>2010</b>	Trend	CO <sub>2</sub>	0.04	0.45	50

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

Methodology

To estimate emissions from Petroleum refining, the 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.

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

Consumptions for individual energy products, collected in tables LEG as follows:

For the period 1986-1996 under „Oil Industry”

From 1997 onwards under „DF–Production of coke, refined petroleum products and nuclear fuel”

- For the consumption of liquid fuels                      Table Tg/3 or Table Pg/6 for LPG
- For the consumption of solid fuels                      Table Pr/6
- For the consumption of gaseous fuels                      Table Pg/6

For the period 1992 to 1994, LEG reported substantial consumption of residual fuel oil and gas oil in the category Internal Consumption and Losses (LEG Table Zb/1). These quantities were supposed to have been consumed in the Nafta Lendava Refinery. consequently. they were added to the consumption in the oil industry. For the years 1986, 1990, 1991, 1995, and 1996 in this category (Internal Consumption and Losses), the consumption of residual fuel oil and gas oil has not been reported.

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 1997-2010 are comparable to the period 1986-1996.

Emission factors

We have used country specific CO<sub>2</sub> 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 3.2.16: Emission factors used for all period**

Year	Unit	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
CO <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.002	0.002	0.004	0.002	0.005
N <sub>2</sub> O EF	t/TJ	0.0006	0.0006	0.03	0.0006	0.0001

Net calorific values**Table 3.2.17: NCVs for the fuel used in energy industry.**

Year	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	MJ/Sm3
1986	41.82	39.74	42.70	46.00	33.500
1987	41.87	39.80	42.70	46.00	33,500
1988	41.87	39.80	42.70	46.00	34,080
1989	41.87	39.80	42.70	46.00	34,100
1990	41.87	39.80	42.70	46.00	34.100
1991	41.88	39.80	42.70	46.00	34.100
1992	41.90	39.90	42.70	46.00	34.100
1993	41.90	39.80	42.70	46.00	34.100
1994	41.90	39.86	42.70	46.00	34.100
1995	41.90	40.00	42.70	46.00	34.100
1996	41.90	40.00	42.70	46.00	34.100
1997	41.90	40.00	42.70	46.05	34.080
1998	41.90	40.00	42.70	46.05	34.080
1999	41.90	40.00	42.70	46.05	34.080
2000	41.90	40.00	42.70	46.05	34.080
2001	41.90	40.00	42.70	46.05	34.080
2002	41.90	40.00	42.70	46.05	34.080
2003	41.90	40.00	42.70	46.05	34.080
2004	41.90	40.00	42.70	46.05	34.080
2005	41.90	40.00	42.70	46.05	34.080
2006	41.90	40.00	42.60	46.05	34.080
2007	41.90	40.00	42.61	46.05	34.072
2008	41.90	40.00	42.60	46.05	34.096
2009	41.90	40.00	42.60	46.05	34.074
2010	41.90	40.00	42.60	46.05	34.080

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvement is planned for this category.

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

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
<b>Base Year</b>	no	CO <sub>2</sub>	0.33		31
<b>2010</b>	Trend	CO <sub>2</sub>	0.00	0.96	79

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

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

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, and are presented in the table 3.2.19.

Emission factors

We have used country specific CO<sub>2</sub> 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 period**

Year	Unit	Sub-bituminous Coal	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
CO <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.010	0.002	0.002	0.002	0.004	0.005
N <sub>2</sub> O EF	t/TJ	0.0014	0.0006	0.0006	0.0006	0.03	0.0001



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

Year	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Gas 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	39.74	42.70	46.00	33.50
1987	11.820		41.87	39.80	42.70	46.00	34.10
1988	12.000		41.87	39.80	42.70	46.00	34.10
1989	12.050		41.87	39.80	42.70	46.00	34.10
1990	12.760		41.87	39.80	42.70	46.00	34.10
1991	12.879		41.88	39.80	42.70	46.00	34.10
1992	12.589		41.90	39.90	42.70	46.00	34.10
1993	13.351		41.90	39.80	42.70	46.00	34.10
1994	12.666		41.90	39.86	42.70	46.00	34.10
1995		17.404	41.90	40.00	42.70	46.00	34.10
1996		16.353	41.90	40.00	42.70	46.00	34.10
1997		17.712	41.90	40.00	42.70	46.05	34.08
1998		20.664	41.90	40.00	42.70	46.05	34.08
1999		20.806	41.90	40.00	42.70	46.05	34.08
2000		20.782	41.90	40.00	42.70	46.05	34.08
2001		20.947	41.90	40.00	42.70	46.05	34.08
2002			41.90	40.00	42.70	46.05	34.08
2003			41.90	40.00	42.70	46.05	34.08
2004			41.90	40.00	42.70	46.05	34.08
2005			41.90	40.00	42.70	46.05	34.08
2006			41.90	40.00	42.70	46.05	34.08
2007			41.90	40.00	42.70	46.05	34.072
2008			41.90	40.00	42.70	46.05	34.096
2009			41.90	40.00	42.70	46.05	34.074
2010			41.90	40.00	42.70	46.05	34.080

Recalculations

No recalculations were performed in this sector.

Future improvements

No improvement are planned for this sector

## 3.2.5 Manufacturing Industries and Construction (IPCC: I A 2)

Iron and Steel	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	3.63		5
2010	Level, Trend	CO <sub>2</sub>	0.59	8.77	21

Non-ferrous Metals	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	1.40		12
2010	Trend	CO <sub>2</sub>	0.27	3.28	33

Chemicals	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CO <sub>2</sub>	0.31		32
2010	no	CO <sub>2</sub>	0.36	1.09	30

Pulp, Paper and Print	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	2.06		8
2010	Level, Trend	CO <sub>2</sub>	1.14	2.66	12

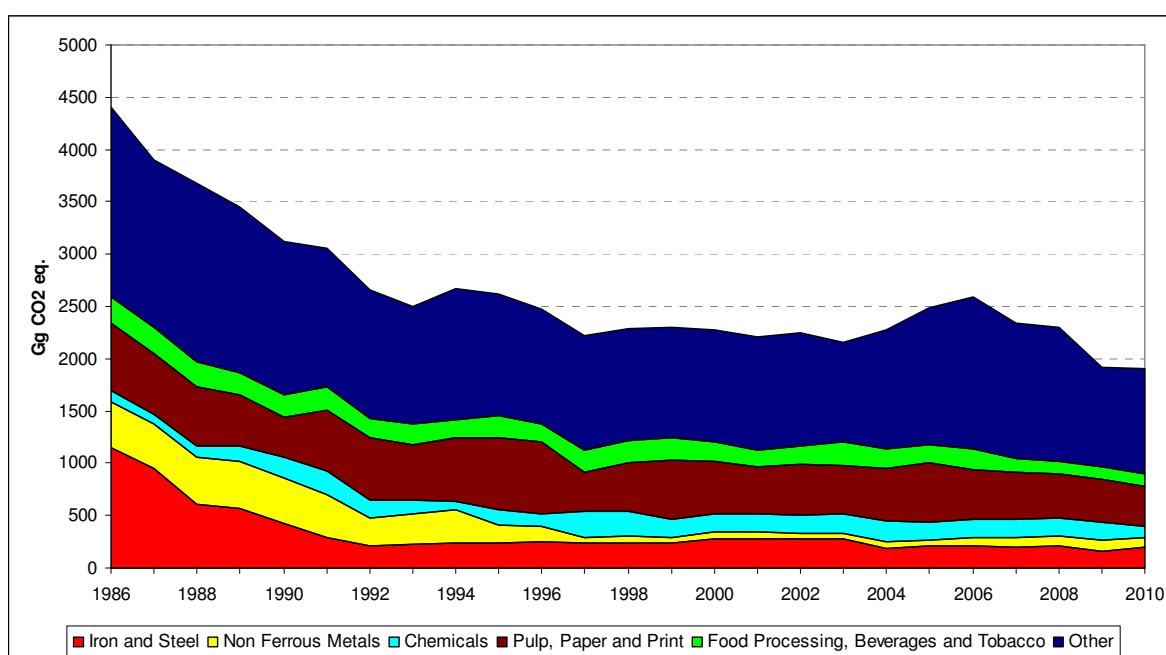
Food, Bev. and Tob.	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	0.79		23
2010	Trend	CO <sub>2</sub>	0.33	1.31	31

Other	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	5.64		4
2010	Level, Trend	CO <sub>2</sub>	2.95	7.78	6

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 3.2.20: GHG emissions from Manufacturing Industries and Construction in Gg CO<sub>2</sub> eq.**

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

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

ISIC – 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 3.2.22: Conversion table between national energy statistics (LEG) and CRF**

ISIC- 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 3.2.23: Conversion table between national energy statistics (LEG) and CRF**

ISIC – 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 3.2.24: Conversion table between national energy statistics (LEG) and CRF**

ISIC- 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 - 2010*

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

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

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

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

**Table 3.2.27: Conversion table between national energy statistics and CRF**

ISIC- CATEGORY	LEG Classification
Other	C 23 - Manufacture of other non-metallic mineral products
	C 25 – Manufacture of metallic products
	C 13 - Manufacture of textiles
	C 14 – Manufacture of wearing apparel
	C 15 - Manufacture of leather and related products
	C 16 – Manufacture of wood and of products of wood and cork, except furniture, manufacture of articles of straw and plaiting materials
	C 21 – Manufacture of basic pharmaceutical products and pharmaceutical preparations
	C 22 - Manufacture of rubber and plastic products
	C 28 - Production of machines and devices
	C 26 - Production of electrical and optical equipment
	C 27
	C 29 – Production of vehicles
	C 30 – Production of vessels
	C 31- Production of furniture
	C 32 - . not included elsewhere
	C 33 -
	F - Construction

### Inclusion of auto producers into Manufacturing Industries sector

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

In the 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 2000-2010

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.

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Table 3.2.28: 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
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	34.08	12.17
2007	42.60	41.42	42.70	43.08	46.05	34.072	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	34.074	12.17
2010	42.60	41.42	42.70	43.85	46.05	34.074	10.77



**Table 3.2.29: NCVs for the solid fuel used in manufacturing industry and construction in 2010.**

Industry - 2010	Unit	Sub-bituminous Coal - imported	Other Bituminous Coal	Coke
Iron and steel	TJ/kt			30.361
Non-Ferrous metals	TJ/kt		25.000	
Pulp. Paper and Print	TJ/kt	16.326	23.867	
Other	TJ/kt	15.987	25.400	29.000

Emission factors

We have used country specific CO<sub>2</sub> 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 3.2.30: 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 <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.010	0.010	0.010	0.010	0.010	0.010
N <sub>2</sub> O 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 <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.0100	0.002	0.002	0.004	0.05	0.002	0.005	0.030
N <sub>2</sub> O EF	t/TJ	0.0014	0.0006	0.0006	0.03	0.002	0.0006	0.0001	0.0040

**Table 3.2.31: CO<sub>2</sub> EF (EF\*OX) for the solid fuel used in manufacturing industry and construction in 2010.**

Industry - 2010	Unit	Sub-bituminous Coal - imported	Other Bituminous Coal	Sub-bituminous Coal - imported	Other Bituminous Coal
Non-Ferrous metals	t/TJ		94.6		92.7
Pulp. Paper and Print	t/TJ	99.647	98.7	97.654	96.7
Other	t/TJ	101.224	97.278	99.200	95.332

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 3.2.32: 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

**Table 3.2.33: 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

**Table 3.2.34: EFs for waste incinerated in the cement plant.**

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	t/TJ	t/TJ	t/TJ	t/TJ	t/TJ
<b>CO<sub>2</sub> EF</b>	72.60	70.01	70.01	70.01	70.01
<b>CH<sub>4</sub> EF</b>	0.0020	0.0300	0.0300	0.0300	0.0300
<b>N<sub>2</sub>O EF</b>	0.0006	0.0040	0.0040	0.0040	0.0040

**Table 3.2.35: EFs for waste incinerated in the cement plant 2010**

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	t/TJ	t/TJ	t/TJ	t/TJ	t/TJ
<b>CO<sub>2</sub> EF</b>	70.27	70.01	70.01	54.854	60.472
<b>CH<sub>4</sub> EF</b>	0.0020	0.0300	0.0300	0.0300	0.0300
<b>N<sub>2</sub>O EF</b>	0.0006	0.0040	0.0040	0.0040	0.0040

Recalculations

Due to the use of updated value on biogas used in the other industry, emissions in 2009 has been recalculated.

Future improvements

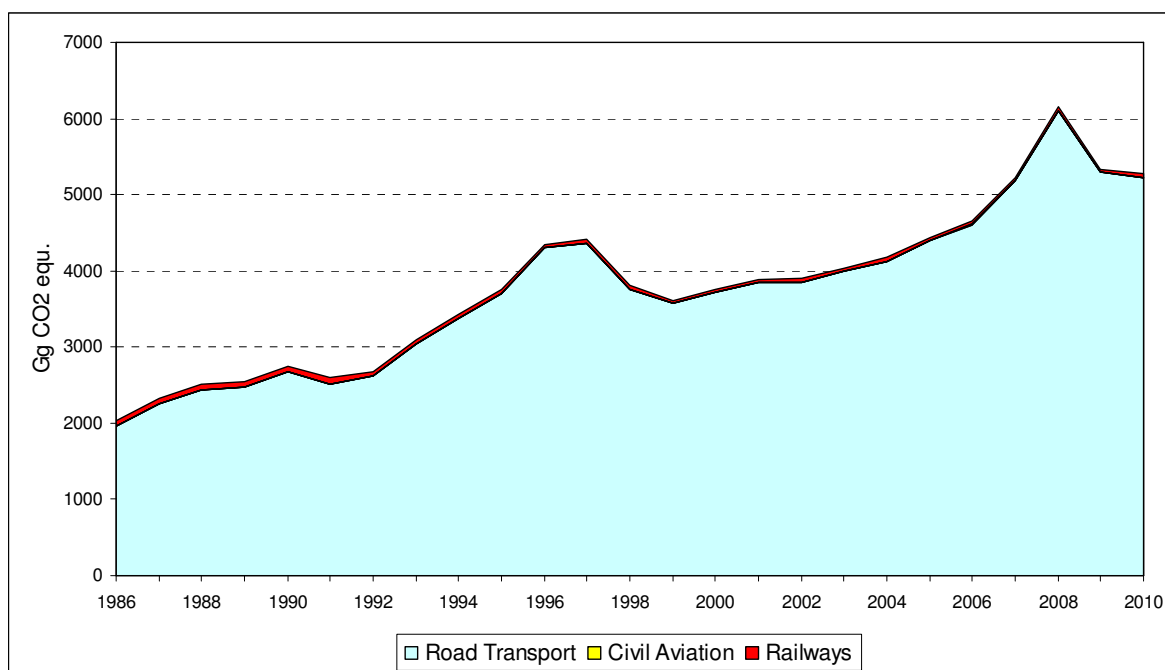
No improvements are planned for this sector.

### 3.2.6 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 (SO<sub>x</sub>), nitrous oxides (NO<sub>x</sub>), carbon monoxide (CO), non volatile organic compounds (NMVOC), and consequently are indirectly responsible for the formation of ozone (O<sub>3</sub>) in lower troposphere.

**Table 3.2.36: GHG emissions from Transport in Gg CO<sub>2</sub> eq.**

in Gg CO <sub>2</sub> eq.	1986	1990	1995	2000	2005	2008	2009	2010
<b>3. Transport</b>	<b>2040</b>	<b>2749</b>	<b>3757</b>	<b>3763</b>	<b>4442</b>	<b>6152</b>	<b>5337</b>	<b>5272</b>
a. Civil Aviation	1	1	2	3	2	1	2	2
b. Road Transportation	1962	2675	3706	3717	4398	6105	5293	5228
c. Railways	77	73	49	43	42	46	42	42



**Figure 3.2.3: GHG emissions from Transport.**

### 3.2.6.1 Road transport

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
<b>Base Year</b>	Level	CO <sub>2</sub>	6.07		3
<b>2010</b>	Level, Trend	CO <sub>2</sub>	15.44	27.14	3

Clearly, the most important source is road traffic, which accounts for 99% of all traffic emissions; GHG emissions have more than tripled, compared to the base year. Due to the ever-increasing fraction of motor vehicles equipped with catalytic converters, in the 1986-2010 period, N<sub>2</sub>O emissions rose a bit less than 3 times, thus becoming a key source.

### Methodology

COPERT 4 (version 6.1) methodology has been used for the calculation of national emission estimates from road transport for the entire 1986-2010 period. The methodology is fully incorporated in the computer software programme COPERT 4 which facilitates its application. The actual calculations have been therefore performed by using this computer software.

COPERT 4 estimates emissions of greenhouse gas emissions (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>) as well as of all major air pollutants (CO, NO<sub>x</sub>, NMVOC, Particulate Matter (PM), NH<sub>3</sub>, SO<sub>2</sub>, Heavy metals) produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty trucks, buses, mopeds and motorcycles). The programme also provides speciation of Polyaromatic Hydrocarbons (PAHs) and Persistent Organic pollutants (POPs), Dioxins and Furans. Emissions estimated are distinguished in three sources: Emissions produced during thermally stabilized engine operation (hot emissions), emissions occurring during engine start from ambient temperature (cold-start and warming-up effects) and NMVOC emissions due to fuel evaporation. The total emissions are calculated as a product of activity data provided by the user and speed-dependent emission factors calculated by the software.

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

Applied methodology is fully described in the following literature:

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

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

## Vehicle fleet

The COPERT 4 methodology requires a detailed knowledge of the structure of the vehicle fleet composition. Table 3.2.37 provides a summary of all vehicle categories and technologies covered by the applied methodology.

**Table 3.2.37: 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
	Gasoline 1.4 - 2.0l	Improved Conventional Open Loop Euro 1 - 91/441/EEC Euro 2 - 94/12/EEC
	Gasoline >2.0l	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	Conventional Euro 1 - 91/441/EEC Euro 2 - 94/12/EEC
	Diesel >2.0l	Euro 3 - 98/69/EC Stage 2000 Euro 4 - 98/69/EC Stage 2005 Euro 5 – EC 715/2007 Euro 6 – EC 715/2007
	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

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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	<50cm <sup>3</sup>	Conventional 97/24/EC Stage I Euro 1 97/24/EC Stage II Euro 2 Euro 3 proposal
Motorcycles	2 Stroke >50cm <sup>3</sup>	Conventional 97/24/EC – Euro 1 2002/51/EC Stage I Euro 2 2002/51/EC Stage II Euro 3
	4 stroke 50 - 250cm <sup>3</sup>	
	4 stroke 250 - 750cm <sup>3</sup>	
	4 stroke >750cm <sup>3</sup>	

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 1992–2010 was taken from the official database of registered motor and trailer vehicles in the Republic of Slovenia provided by the Ministry of the Interior. Since no database exists on licensed motor and trailer vehicles in the Republic

of Slovenia for the years 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 1986–2010 are shown in Annex 1 (Table 3.2.4 : Road transport : Fleet data (number of vehicles) 1986–2010).

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 2010.

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.

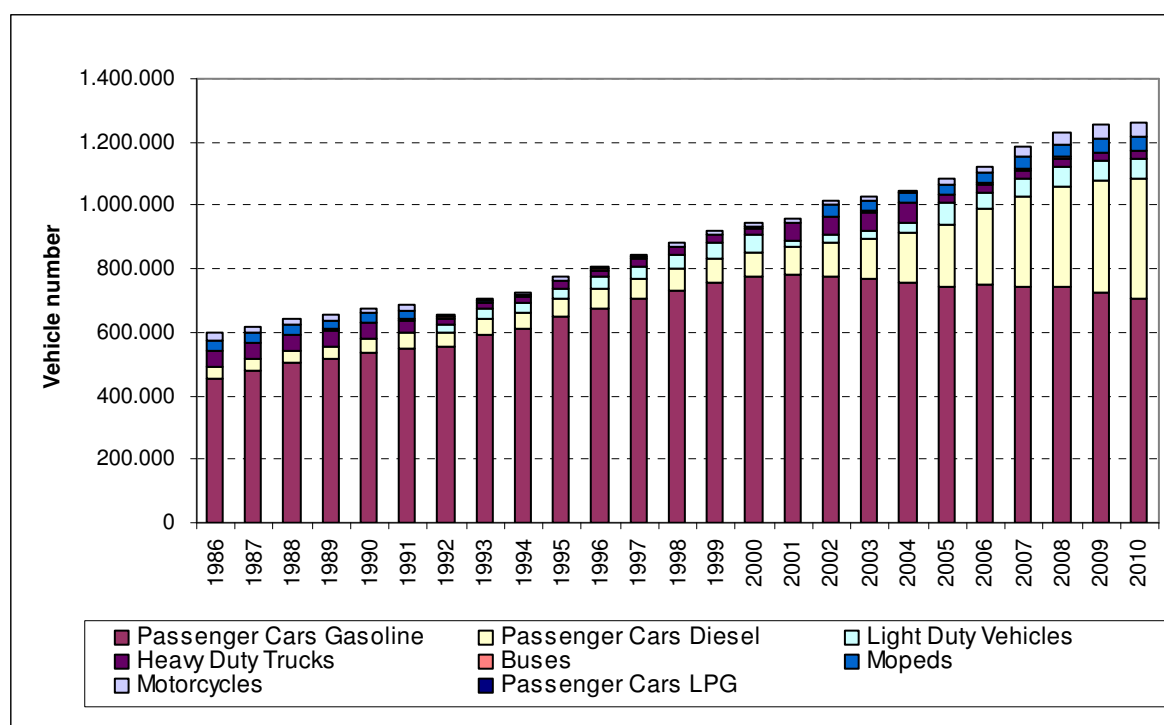


Figure 3.2.4. Vehicle fleet 1986–2010.

### 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  $[Mf_c^k] = \text{km}$

$N_k$  ... 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  $[M^k] = \text{km}$

- 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:

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

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

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

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

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

Mileage in the highway mode of driving:

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

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

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

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

Classification of the national road network changed in the year 1998. Until the year 1997 inclusive, state roads were classified into highways, main roads and regional roads. After the year 1998 these same were classified into highways, high-speed roads, main roads and regional roads. Since 1998 the  $Mf_{HC}^k$  has been available for all vehicle categories.

The  $Mf_{AC}^k$ ,  $Mf_{GC}^k$  and  $Mf_{RC}^k$  are available for passenger cars from 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 1986–2010).

#### 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.

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

$$m_H^{PC} = \frac{5M_H^{PC}}{M^{GSm} + M^{GMe} + M^{GLa} + M^{DSm} + M^{DLa}}$$

$$m_R^{PC} = 100 - m_U^{PC} - m_H^{PC}$$

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 2010 ( $M^{GSm}$ ,  $M^{GMe}$ ,  $M^{GLa}$ ,  $M^{DSm}$ ,  $M^{DLa}$ ).

#### 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  $Corr_{U+R+H}^{LdV}$  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  $Corr_{U+R+H}^{LdV}$  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:

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

$$M_R^{LdV} = (M^{LdV} - M_H^{LdV}) p_R^{LdV}$$

$$M_U^{LdV} = (M^{LdV} - M_H^{LdV}) (1 - p_R^{LdV})$$

Mileage shares are the following:

$$m_U^{LdV} = \frac{M_U^{LdV}}{M^{LdV}}$$

$$m_R^{LdV} = \frac{M_R^{LdV}}{M^{LdV}}$$

$$m_H^{LdV} = \frac{M_H^{LdV}}{M^{LdV}}$$

#### 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  $Corr_{U+R+H}^{HdV}$  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  $Corr_{U+R+H}^{HdV}$  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:

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

$$M_R^{HdV} = (M^{HdV} - M_H^{HdV}) p_R^{HdV}$$

$$M_U^{HdV} = (M^{HdV} - M_H^{HdV}) (1 - p_R^{HdV})$$

Average mileage shares are the following:

$$m_U^{HdV} = \frac{M_U^{HdV}}{M^{HdV}}$$

$$m_R^{HdV} = \frac{M_R^{HdV}}{M^{HdV}}$$

$$m_H^{HdV} = \frac{M_H^{HdV}}{M^{HdV}}$$

### 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 ( $Mf_{Rdc,H}^{Cbus}$ ) 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:

$$M_U^{Ubus} = \frac{Mf_U^{Ubus}}{N_{Ubus}}$$

$$M_R^{Ubus} = 0$$

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:

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

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:

$$M_R^{Cbus} \cong M_{Rdc}^{Cbus}$$

Average mileage shares are the following:

$$m_U^{Ubus} = 100\%$$

$$m_R^{Ubus} = 0$$

$$m_H^{Ubus} = 0$$

$$m_U^{Cbus} = 0 \quad m_R^{Cbus} = \frac{M_R^{Cbus}}{M_R^{Cbus} + M_H^{Cbus}} \quad m_H^{Cbus} = \frac{M_H^{Cbus}}{M_R^{Cbus} + M_H^{Cbus}}$$

### 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  $Corr_{U+R+H}^{MoT}$  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 be estimated as well ( $p_R^{MoT}$ ). The  $Corr_{U+R+H}^{MoT}$  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:

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

$$M_R^{MoT} = (M^{MoT} - M_H^{MoT}) p_R^{MoT}$$

$$M_U^{MoT} = (M^{MoT} - M_H^{MoT}) (1 - p_R^{MoT})$$

Average mileage shares are the following:

$$m_U^{MoT} = \frac{M_U^{MoT}}{M^{MoT}} \quad m_R^{MoT} = \frac{M_R^{MoT}}{M^{MoT}} \quad m_H^{MoT} = \frac{M_H^{MoT}}{M^{MoT}}$$

## 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 1986–2010*).

## Fuel Consumption

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

As shown in Figure 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. Lower consumption of fuel was due to the world economical crisis. In the year 2005 sale of diesel fuel exceeded the sale of gasoline. In 2010 the fuel use shares for diesel and gasoline were about 66% and 33%, respectively. The share of liquefied petroleum gas (LPG) was below 0.5%.

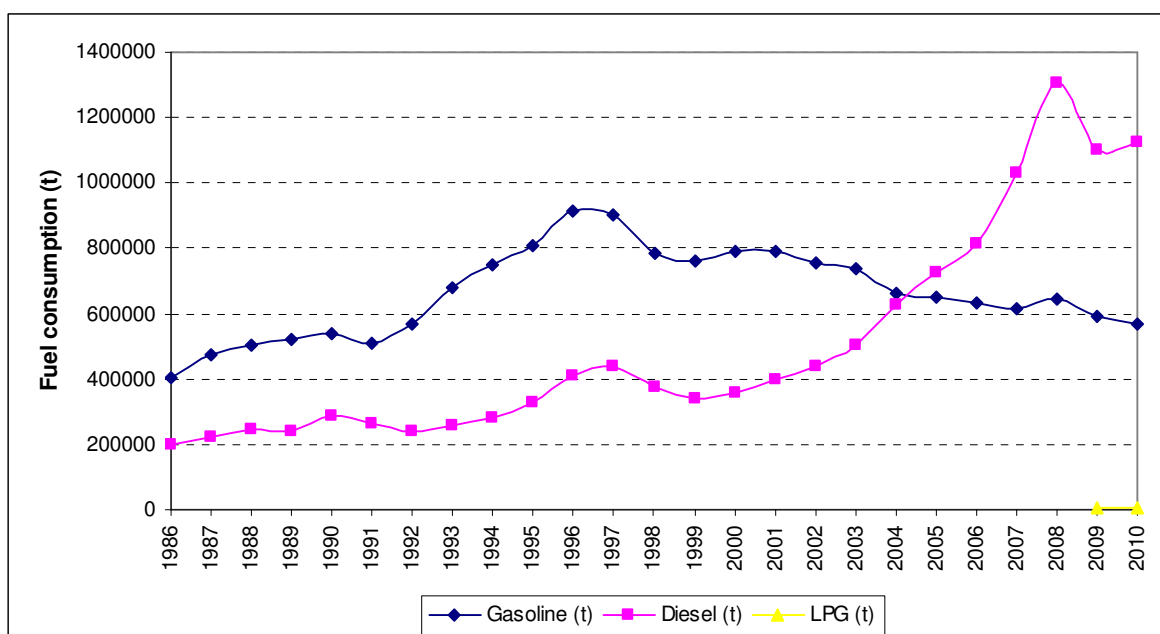


Figure 3.2.5. Fuel consumption in road transport for 1986–2010.

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 is shown in the table in Annex 2 (*Table 1.7: Road transport: Fuel Consumption by types of vehicles 1986–2010*).

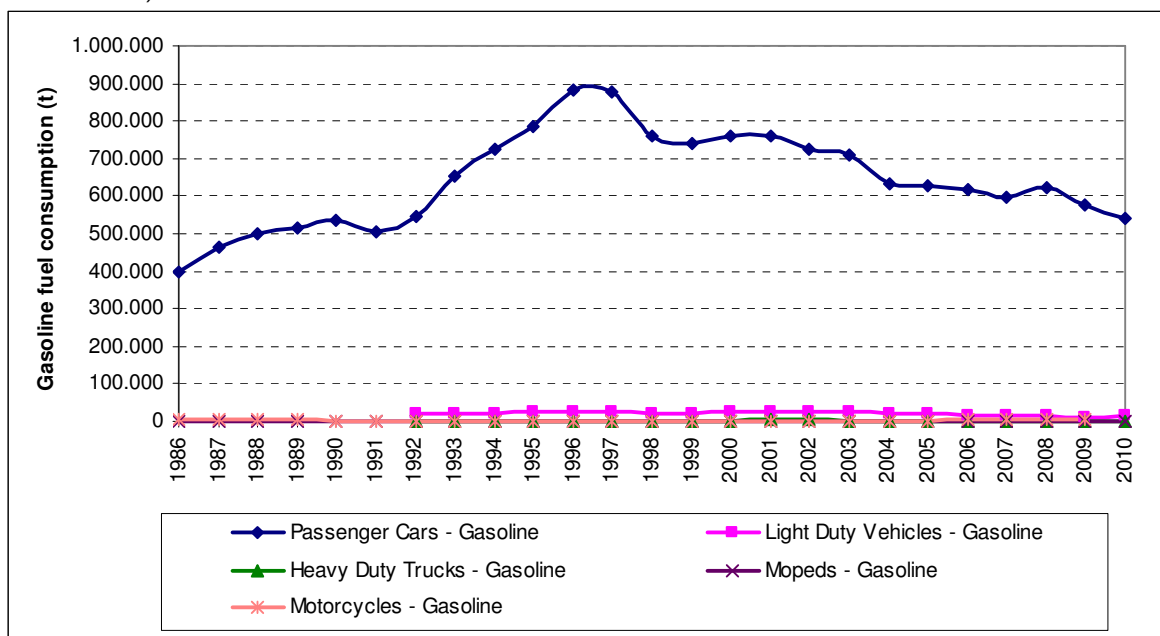


Figure 3.2.6. Gasoline fuel consumption per vehicle type for road transport 1986–2010.

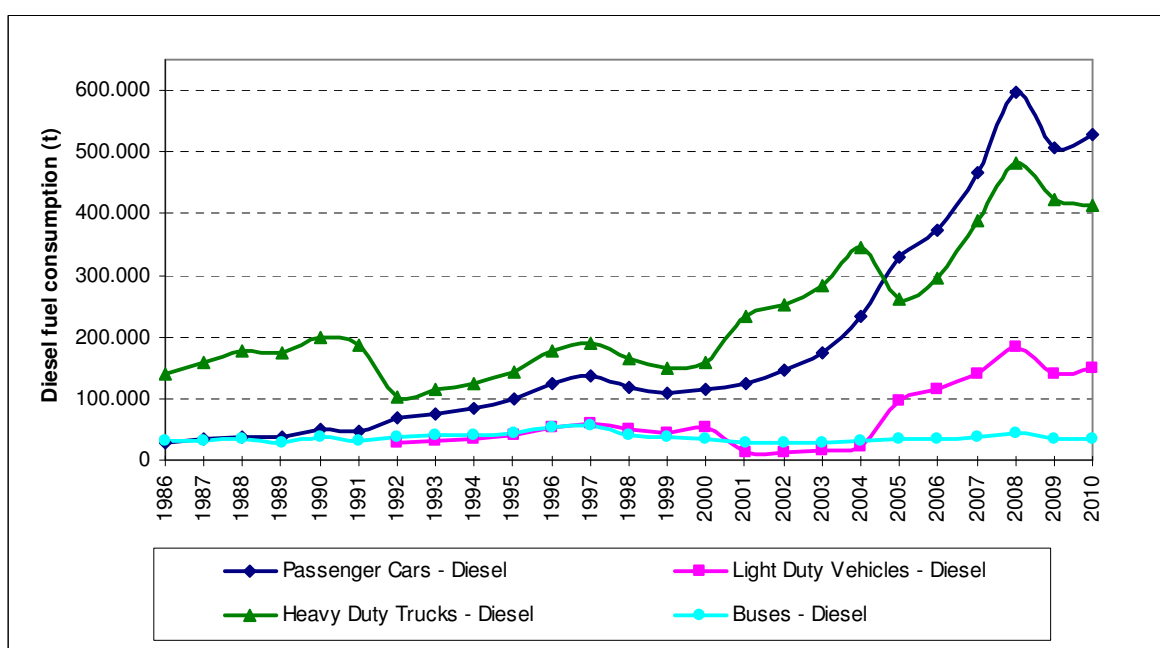
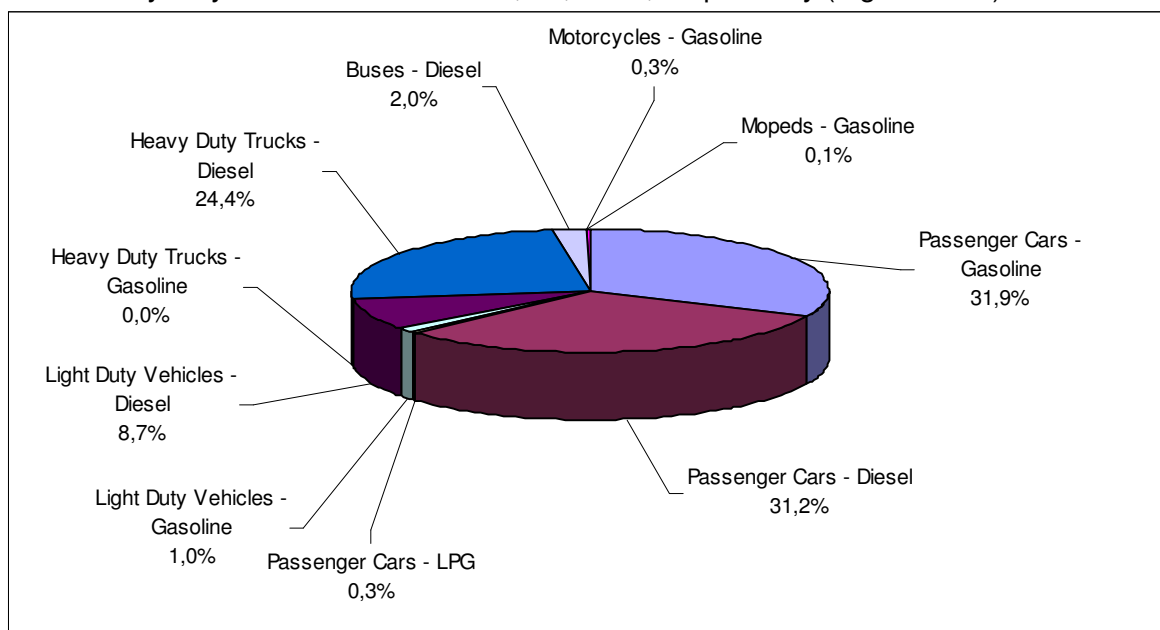


Figure 3.2.7. Diesel fuel consumption per vehicle type for road transport 1986–2010.



In 2010, fuel consumption shares for gasoline passenger cars, diesel passenger cars diesel heavy duty trucks were about 32, 31, 25 %, respectively (Figure 3.2.8).



**Figure 3.2.8. Fuel consumption share per vehicle type for road transport in 2010.**

### 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 COPERT4.

RVP values used were 70 kPa for winter period (1 October – 30 April) and 60 kPa for summer period (1 May – 30 September). The lead and sulphur contents were set as presented in Tables 3.2.38 and 3.2.39.

**Table 3.2.38: 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
	2002-2010	0.005

**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
	2009-2010	0.001
Diesel	1980-1994	1
	1995	0.25
	1996-2001	0.20
	2002-2004	0.035
	2005-2008	0.005
	2009-2010	0.001

### Monthly minimum and maximum air temperatures

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

### Other input data

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

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

### Emission factors

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

### Emissions of CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>

From 1986 to 2010 the road transport emissions of CO<sub>2</sub> and N<sub>2</sub>O have increased by 170 % and 164 %, respectively. The emissions of CH<sub>4</sub> have decreased for 61 %. 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 in the year 2010 as well even slightly lower emissions of all GHG were observed in 2010. Referring to the third IPCC assessment report, 1 g CH<sub>4</sub> and 1 g N<sub>2</sub>O have the greenhouse effect of 21 and 310 g CO<sub>2</sub>, respectively. In spite of the relatively large CH<sub>4</sub> and N<sub>2</sub>O global warming potentials, the largest contribution to the total CO<sub>2</sub> emission equivalents for road transport comes from CO<sub>2</sub> (Figure 3.2.9).

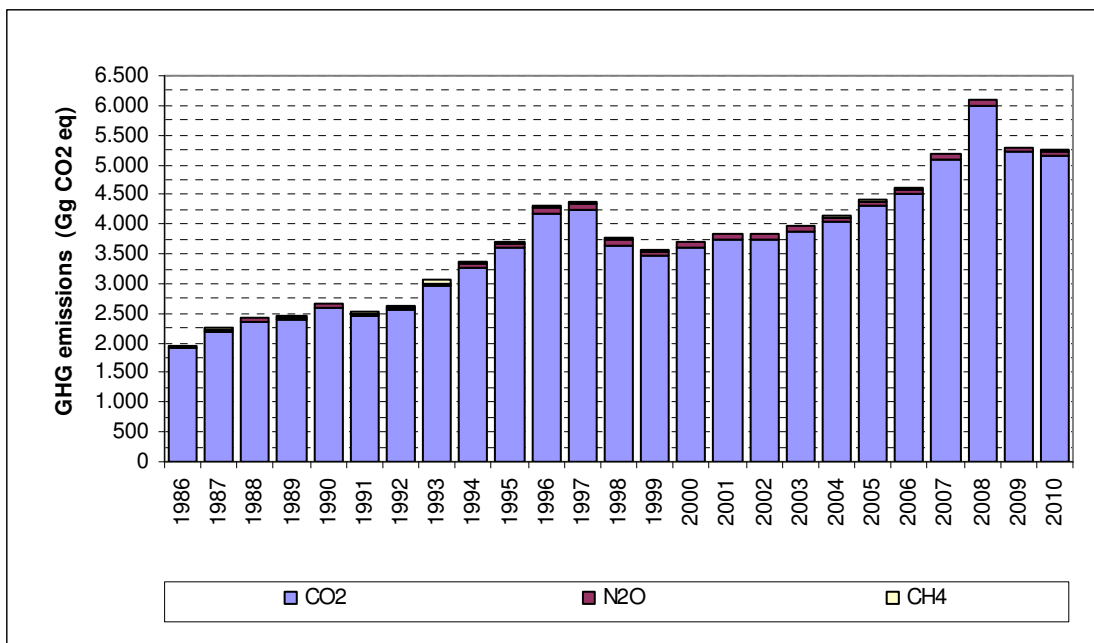
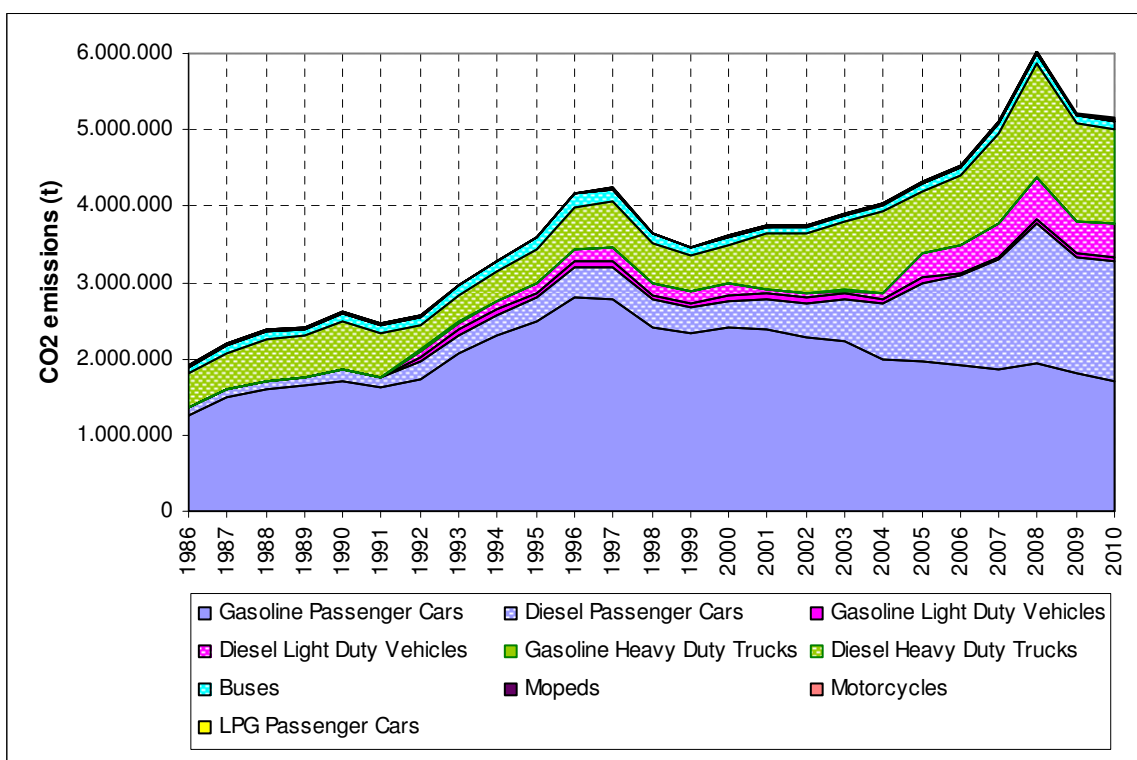
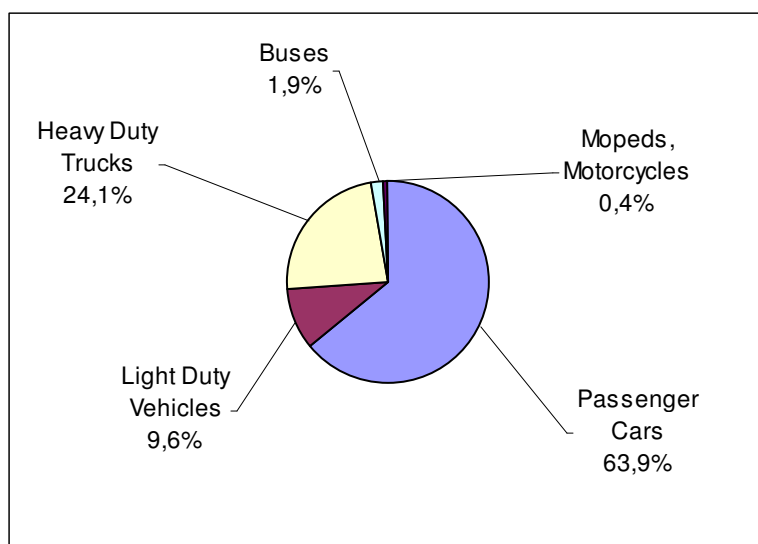
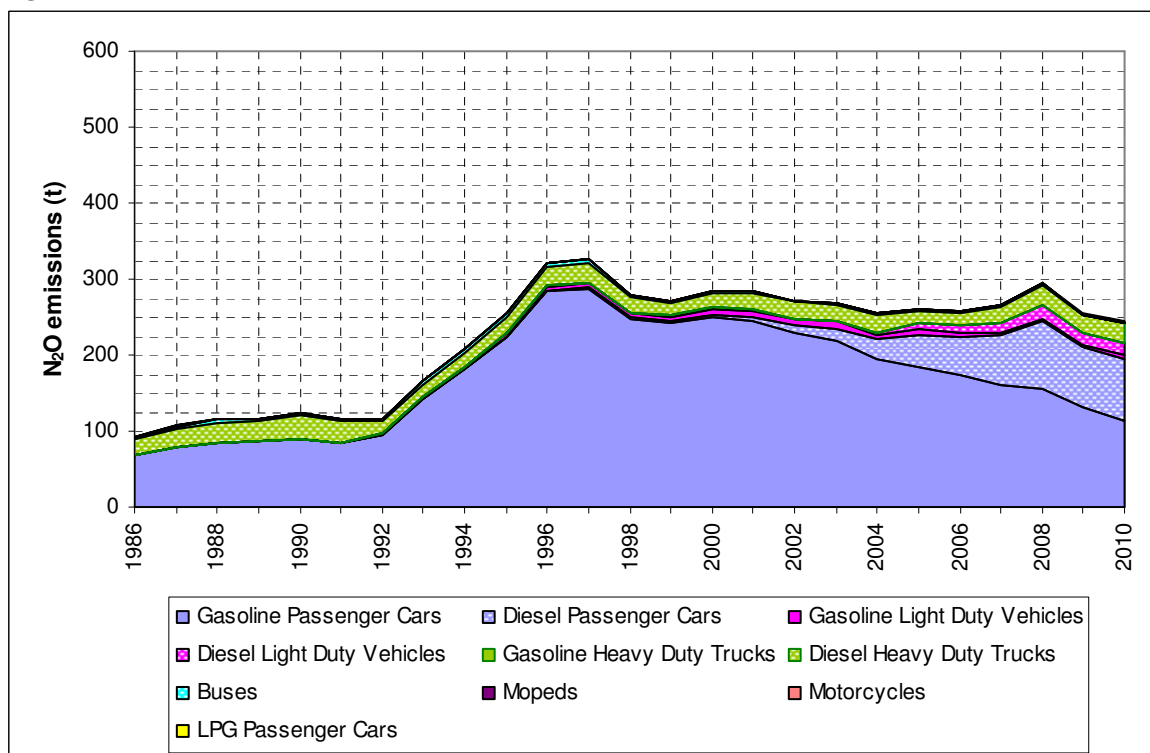


Figure 3.2.9. CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub> emissions for road transport 1986–2010.



**Figure 3.2.10. CO<sub>2</sub> emissions (kt) per vehicle type for road transport 1986–2010.**

Due to the direct dependency of CO<sub>2</sub> emissions on fuel consumption, the total growth in CO<sub>2</sub> emissions reflects the trend of increased fuel consumption till 2008. In 2009 significant drop of CO<sub>2</sub> emissions was due to smaller fuel consumption. The same trend is shown for 2010. 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 2010, the respective emission shares were about 64, 24, 10, 2 and 0,4%, respectively.

**Figure 3.2.11. CO<sub>2</sub> emission share per vehicle type for road transport for 2010.****Figure 3.2.12. N<sub>2</sub>O emissions (t) per vehicle type for road transport 1986–2010.**

CO<sub>2</sub> emissions of passenger cars were gradually increasing from 1991–1996, and later slightly dropped. After the year 1999 stabilisation of CO<sub>2</sub> emissions of passenger cars was observed. The fall of CO<sub>2</sub> 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.

An undesirable environmental side effect of the introduction of catalyst cars is the increase in the emissions of N<sub>2</sub>O. N<sub>2</sub>O emissions have increased significantly from 1991 onwards, mostly due to the growing number of passenger cars with catalysts. In 2010, emission shares for passenger cars, heavy duty trucks and light duty vehicles were about 80, 11 and 8 %, of the total road transport N<sub>2</sub>O, respectively (Figures 3.2.12 and 3.2.13).

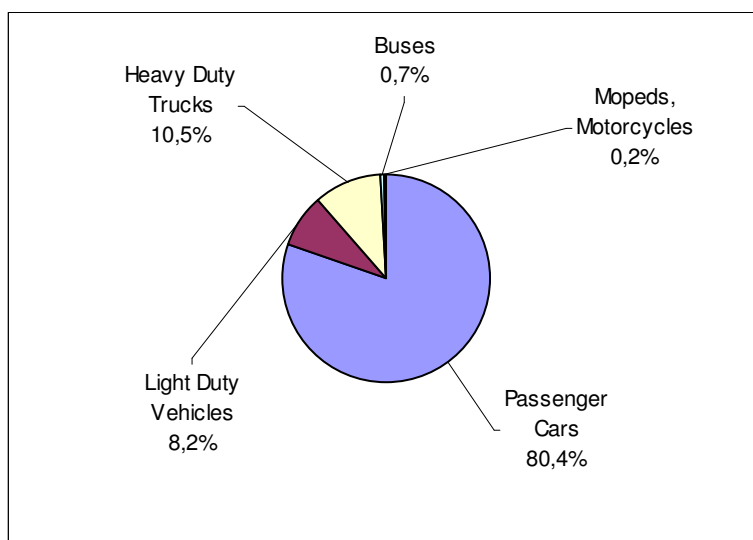
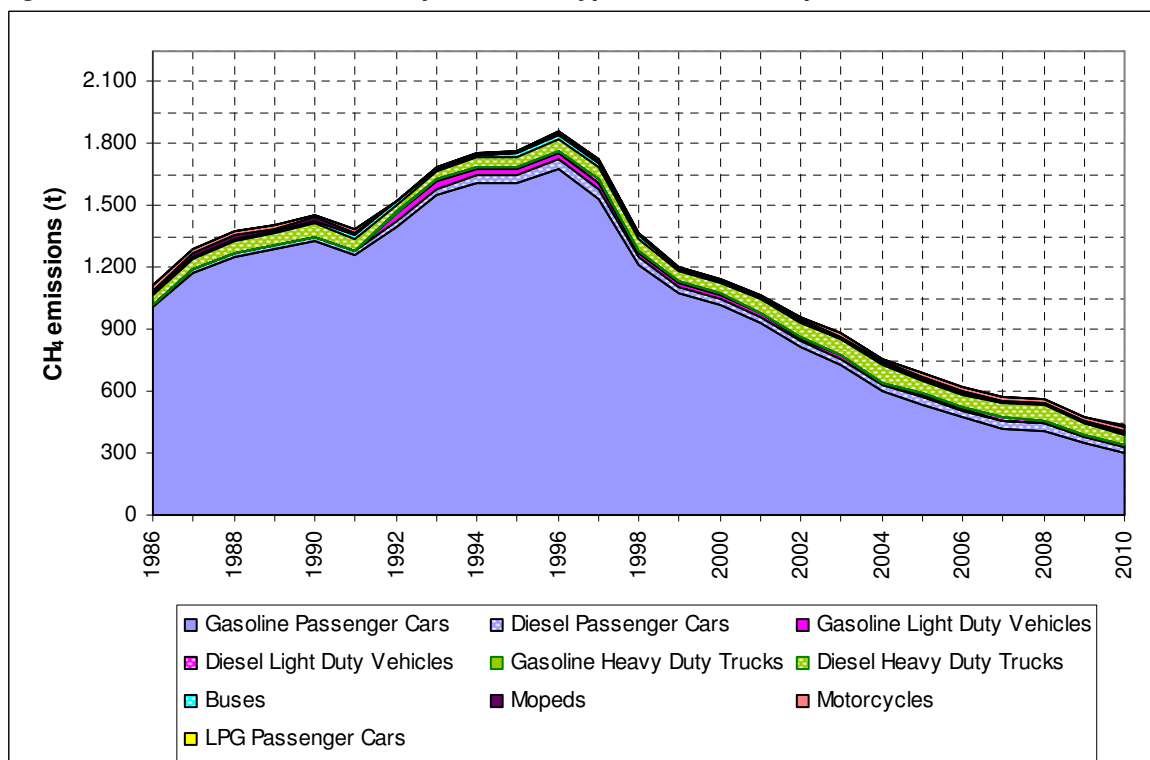
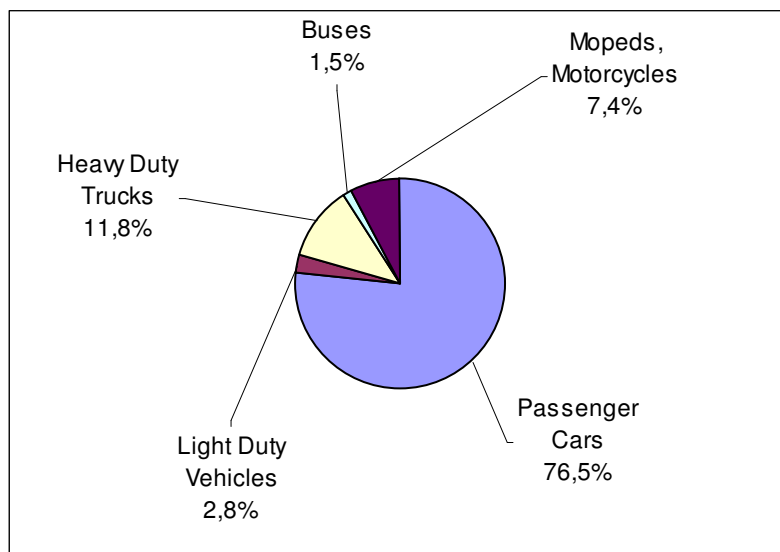


Figure 3.2.13. N<sub>2</sub>O emission share per vehicle type for road transport for 2010.



**Figure 3.2.14. CH<sub>4</sub> emissions (t) per vehicle type for road transport 1986–2010.**

The majority of CH<sub>4</sub> 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<sub>4</sub> emission factors than conventional gasoline vehicles. The 2010 emission shares for CH<sub>4</sub> were about 77, 12 and 7 % for passenger cars, heavy duty trucks and 2-wheelers respectively (Figures 3.2.14 and 3.2.15).

**Figure 3.2.15. CH<sub>4</sub> emission share per vehicle type for road transport for 2010.**

### 3.2.6.1.1 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. 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> emission factors, expressed in t CO<sub>2</sub>/ TJ fuel, are calculated automatically by CRF Reporter and used for reporting requirements only.

Thorough examination showed that all input data and calculated CO<sub>2</sub> emissions reported in CRF Tables are accurate. CO<sub>2</sub> emission factors (g CO<sub>2</sub>/ kg fuel) used for emission calculation are comparable with the Revised 1996 IPCC Guidelines. Differences between CO<sub>2</sub> emissions factors (t CO<sub>2</sub>/ TJ) presented in CRF Tables and those stated in the Revised 1996 IPCC Guidelines arise from differences in applied net calorific values. In period 2006–2010 additional slight deviations are due to use of bio fuel. Information on CO<sub>2</sub> implied emission factors (IEFs) for gasoline and diesel is presented in Annex 2 (*Table 1.8: Road transport: CO<sub>2</sub> implied emission factors 1986–2010*).

### 3.2.6.1.2 *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.

### 3.2.6.1.3 *Recalculations*

No recalculations have been performed since last submission.

### 3.2.6.1.4 *Planned improvements*

The latest version of COPERT 4 methodology (for the time being: version 9.0) will be used for emission calculation in next submission.

## 3.2.6.2 *Railway*

Key sector - Base year: no

Key sector - Year 2010: no

**Table 3.2.40: GHG Emissions in the period 1986-2010.**

	1986	1990	1995	2000	2005	2007	2008	2009	2010
<b>fuel in TJ</b>	930	879	588	514	512	511	554	511	511
<b>Gg CO<sub>2</sub> eq.</b>	77	73	49	43	42	42	46	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 3.2.41: EFs for fuel used in railways.**

EF	Unit	Gas Oil	Brown coal
CO <sub>2</sub> EF	t/TJ	74.0	101.2
EF*OF	t/TJ	73.3	99.2
CH <sub>4</sub> EF	t/TJ	0.004	0.01
N <sub>2</sub> O 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.

### 3.2.6.3 Aviation

Key sector - Base year: no

Key sector - Year 2010: no

**Table 3.2.42: GHG Emissions in the period 1986-2010.**

	1986	1990	1995	2000	2005	2006	2007	2008	2009	2010
<b>fuel in TJ</b>	9	15	28	40	24	21	24	20	22	23
<b>Gg CO<sub>2</sub> eq.</b>	1	1	2	3	2	2	2	1	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<sub>2</sub>/TJ, 0.001 t CH<sub>4</sub>/TJ and 0.002 t N<sub>2</sub>O/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.

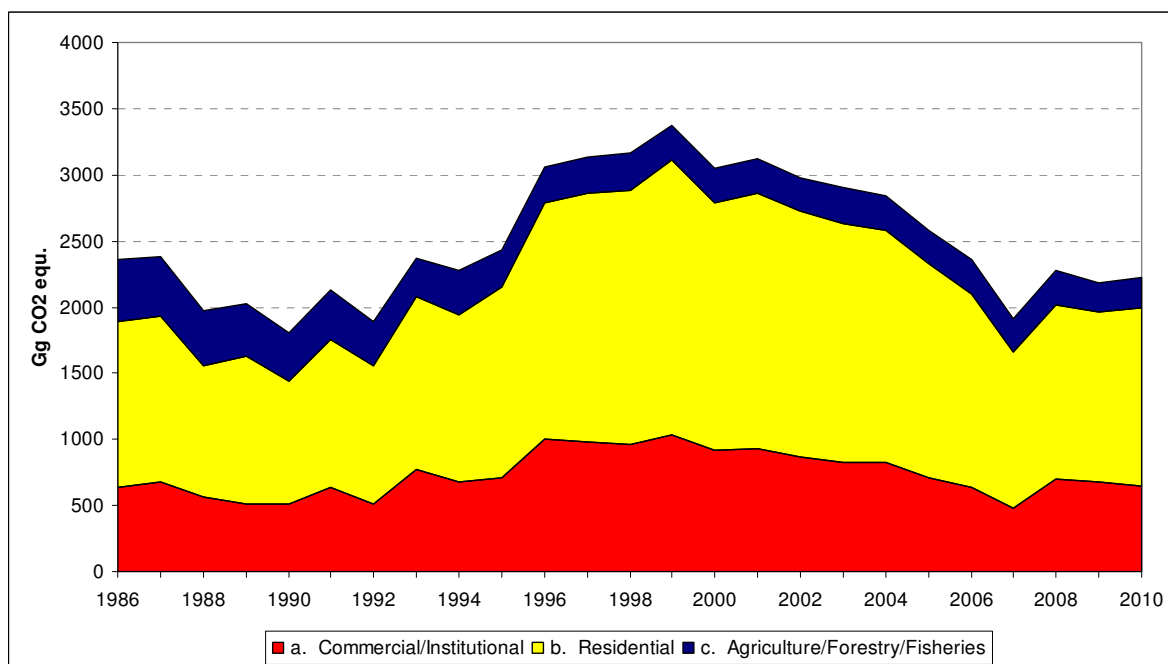
### 3.2.7 Other sector (IPCC: I A 4)

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 3.2.43: GWP of GHG emissions from Other Sector.**

in Gg CO <sub>2</sub> eq.	1986	1990	1995	2000	2005	2008	2009	2010
<b>4. Other Sectors</b>	<b>2363</b>	<b>1808</b>	<b>2437</b>	<b>3051</b>	2583	2277	2187	2228
a. Commercial/Institutional	632	515	712	922	714	700	682	651
b. Residential	1256	924	1444	1871	1613	1314	1279	1345
c. Agriculture/Forestry/Fisheries	475	368	281	259	256	263	227	233



**Figure 3.2.16: GHG emissions from Other Sector.**

**3.2.7.1 Commercial/Institutional Sector (IPCC: I A 4 a) and****3.2.7.2 Residential Sector (IPCC: I A 4 b)**

Commercial/ Institutional	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level	KS
<b>Base Year</b>	Level	CO <sub>2</sub>	1.94		9
<b>2010</b>	Level	CO <sub>2</sub>	1.94	0.00	7

Residential	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level	KS
<b>Base Year</b>	Level	CO <sub>2</sub>	3.50		6
<b>2010</b>	Level	CO <sub>2</sub>	3.58	0.27	5
<b>Base Year</b>	Level	CH <sub>4</sub>	0.43		27
<b>2010</b>	no	CH <sub>4</sub>	0.38	0.15	28

Methodology

Emissions were estimated using Tier 2 methodology described in IPCC 96. The following basic formula was used:

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

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 3.2.44: 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./I nst (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 3.2.45: NCVs for the fuel used in Commercial Sector and Households.**

Year	Lignite (Velenje) TJ/kt	Sub- bituminous Coal - domestic TJ/kt	Sub- bituminous Coal - imported TJ/kt	Gas Oil TJ/kt	Residual Fuel Oil TJ/kt	LPG TJ/kt	Natural Gas TJ/Mm3	Wood and Other Biomass 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

Emission factors

We have used country specific CO<sub>2</sub> 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 3.2.46: EFs for the fuel used in Commercial Sector.**

Year	Unit	Lignite (Velenje)	Sub- bituminous Coal - domestic	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
CO <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.010	0.010	0.01	0.01	0.005	0.005	0.30
N <sub>2</sub> O EF	t/TJ	0.0014	0.0014	0.0006	0.0006	0.0001	0.0001	0.0040

**Table 3.2.47: EFs for the fuel used in Households.**

Year	Unit	Lignite (Velenje)	Sub- bituminous Coal - domestic	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO <sub>2</sub> 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 <sub>4</sub> EF	t/TJ	0.3	0.3	0.01	0.005	0.005	0.30
N <sub>2</sub> O EF	t/TJ	0.0014	0.0014	0.0006	0.0001	0.0001	0.0040

### Recalculations

In 2011 the SORS settled the results from the questioner about energy and fuel use in residential sector, carried out under the project, which was financially supported by Eurostat. One of the result was improved data on biomass consumption in this sector. The new data is available for 2009 and 2010 only. It shows out that amount of wooden biomass in tonnes, which was used in previous reports was quite good estimates but the NCV used for inventory was too low. In 2009 we have used NCV of 12.17 TJ/kt (30% water) while NCV from the new SORS data is 14.71 MJ/kt. To reach this value the fuel wood have to be dried with cover what was not the case in the past. In the last period also the use of wood briquettes with the NCV value around 28 MJ/kt have been observed. We have interpolated NCV value back to the year 2000.

Recalculations occurred also due to the use of small amount of brown coal for which we believed it is not used in the residential sector since 2005.

Small changes occurred also in the commercial sector in 2009 due to the correction of data for LPG consumption and flaring of methane from SWDS.

### Future Improvements

No improvement is planned for this sector.

### **3.2.7.3 Agriculture and Forestry (IPCC: I A 4 c)**

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
<b>Base Year</b>	Level	CO <sub>2</sub>	1.35		14
<b>2010</b>	Level, Trend	CO <sub>2</sub>	0.62	2.10	20

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:

$$\text{Emission}_{(p,y)} = \text{EF}_{(p)} * \text{Cons}_{\text{Fuel}(y)}$$

Where

$\text{Emission}_{(p,y)}$  - Emission of pollutant p in year y (ton/yr);

$\text{EF}_{(p)}$  - Quantity of pollutant p emitted (ton/TJ);

$\text{Cons}_{\text{Fuel}(y)}$  - 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 have been calculated from data on fuel consumption in state owned agriculture enterpris 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 3.2.48: Estimate of Consumption of Gasoline in Agriculture.**

	1986	1990	1995	2000	2005	2008	2009	2010
Cultivated Land in State owned Agriculture ent. (1000 ha)	70	77	62	31	-	-	-	-
Total Cultivated Land (1000 ha)	647	653	634	509	485	489	468	483
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	7.1
Estimated Consumption of Gasoline in Total Agriculture (1000 t)	12.016	9.227	6.647	3.626	3.458	3.482	3.338	3.440

**Table 3.2.49: Estimate of Consumption of Diesel in Agriculture.**

	1986	1990	1995	2000	2005	2008	2009	2010
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	123
Estimated consumption of Diesel Fuels in Total Agriculture (1000 t)	108.326	85.255	65.353	62.596	59.702	60.113	57.619	59.379

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

**Table 3.2.50: The Calculation of the Consumption of Fuels in State Owned Forest**

	1986	1990	1995	2000	2005	2008	2009	2010
Consumption of Fuel in State owned Forest (1000 t)	6.902	5.922	3.680	2.808				
Cut in State owned Forest (1000 m <sup>3</sup> )	1438	1230	862	907	919	1195	1131	1138
Consumption of Fuel per Cut Quantities (tons per 1000 m <sup>3</sup> )	4.8	4.8	4.3	3.1	3.23	3.55	1.27	1.21
Consumption of gasoline per Cut Quantities (tons per 1000 m <sup>3</sup> )					0.28	0.27	0.16	0.18
Consumption of diesel per Cut Quantities (tons per 1000 m <sup>3</sup> )					2.95	3.27	1.11	1.03
Total Cut (1000 m <sup>3</sup> )	3501	2435	2092	2609	3236	3427	3374	3374
Total Consumption of Fuel in Forestry (1000 t)	16.804	11.720	8.931	8.077				
Gasoline (1000 tones)	1.680	1,172	0.893	0.808	0.917	0.935	0.555	0.616
Diesel (1000 tones)	15.124	10,548	8.038	7.272	9.536	11.219	3.735	3.486

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 3.2.51: EFs of the Consumption of Fuels in Agriculture and Forestry.**

Year	Unit	gasoline	Gas/Diesel Oil
CO <sub>2</sub> EF	t/TJ	71.7	73.3
EF*OF	t/TJ	71.0	72.6
CH <sub>4</sub> EF	t/TJ	0.08	0.004
N <sub>2</sub> O EF	t/TJ	0.002	0.03



Recalculations

No changes have been made on this source sector

Future Improvements

No improvement is planned for this sector.

**3.2.8 Other (IPCC: 1 A 5)****3.2.8.1 Other mobile (IPCC: 2 A 5 b)**

Key sector - Base year: no  
Key sector - Year 2010: trend

**Table 3.2.52: GHG Emissions in the period 1986-2010.**

	1986	1990	1995	2000	2005	2006	2007	2008	2009	2010
<b>fuel in TJ</b>	577	444	19	43	46	46	48	49	46	40
<b>Gg CO<sub>2</sub> eq.</b>	41	32	1	3	3	3	3	4	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 have 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<sub>2</sub>/TJ, 0.001 t CH<sub>4</sub>/TJ and 0.002 t N<sub>2</sub>O/TJ for jet kerosene as well.

Recalculations

Emissions from the Army have been estimated for the period 1986-2007, excluded from international bunkers and reported under 1.A.5.b Other/Mobile.

Future Improvements

No improvement is planned for this category.

### 3.2.9 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 3.2.53: Uncertainties of activity data as used in the 2012 submission.**

		IPCC GPG	1986	2010
Electricity and heat production	Liquid	Less than 1%	5	3
	Solid		10	3
	Gaseous		5	2
	Biomass		10	10
Industrial combustion	Liquid	2-5%	5	3
	Solid		10	3
	Gaseous		5	2
	Biomass		10	10
	Other		10	10
Road Transport	Liquid		5	2
	Biomass			2
Commercial, institutional and residential	Liquid	3-5%	5	5
	Solid		10	10
	Gaseous		3	3
	Biomass		20	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.

### **3.2.10 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).

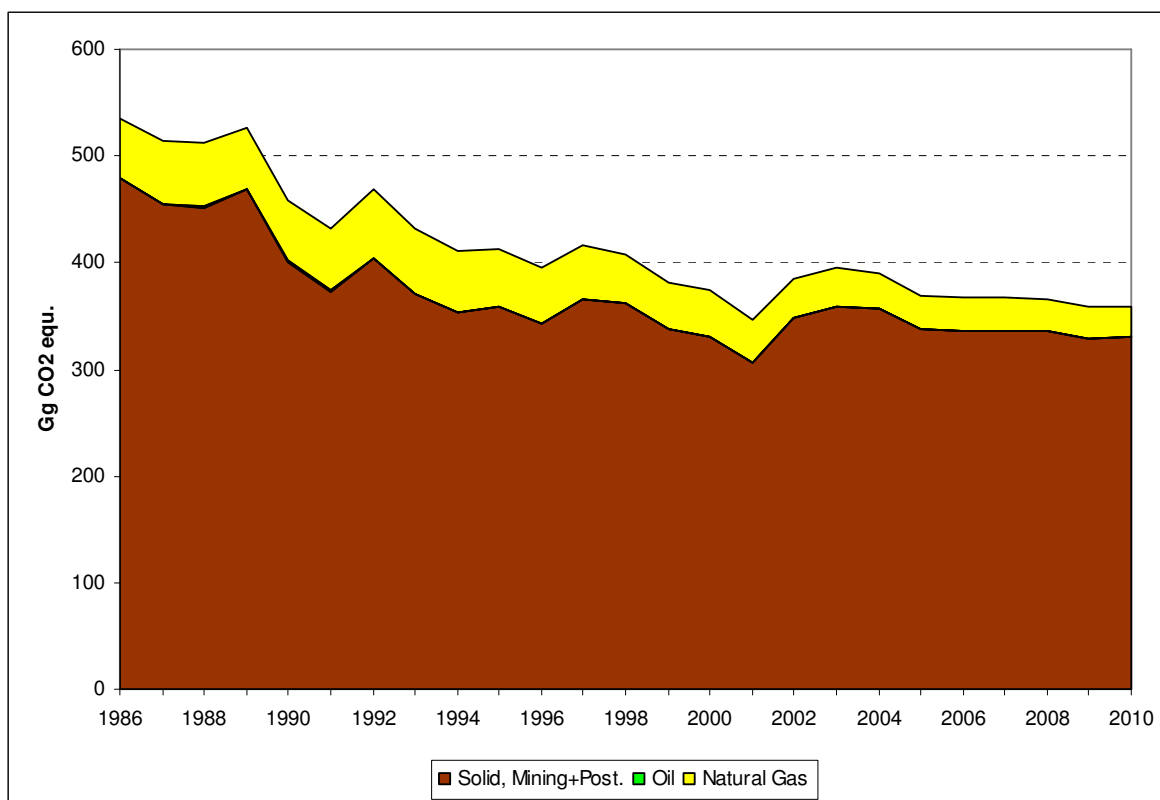
### 3.3 Fugitive emissions from solid fuels and oil and natural gas (CRF 1.B)

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	2008	2009	2010
<b>Total</b>	<b>536</b>	<b>459</b>	<b>413</b>	<b>374</b>	<b>370</b>	<b>366</b>	<b>359</b>	<b>359</b>
Coal Mining and Hand.	479	401	358	331	337	336	329	330
Fug. Emiss. from oil	0.4	0.4	0.4	0.1	0	0	0	0
Fug. Emiss. from nat. gas	56	58	54	43	33	30	30	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
<b>Base Year</b>	Level	CO <sub>2</sub>	0.38		29
<b>2010</b>	Trend	CO <sub>2</sub>	0.24	0.40	35
<b>Base Year</b>	Level	CH <sub>4</sub>	1.14		16
<b>2010</b>	Level, Trend	CH <sub>4</sub>	0.75	1.13	18

This chapter encompasses emissions arising from the production, processing, and storage of coal. The most important component of those emissions is CH<sub>4</sub> emissions that arise in mining and post-mining activities although CO<sub>2</sub> emissions occur as well.

#### Methodology

*Methane emission (t) = (EF1(m<sup>3</sup> CH<sub>4</sub>/t) + EF2(m<sup>3</sup> CH<sub>4</sub>/t)) \* excavated coal (t/year) \* 0.67*

*CO<sub>2</sub> emission (t) = EF3(m<sup>3</sup> CO<sub>2</sub>/t) \* excavated coal (t/year) \* 1.8*

EF1 = Methane emission factor in coal excavation (m<sup>3</sup> CH<sub>4</sub>/t)

EF2 = Methane emission factors in post-mining activities for coal (m<sup>3</sup> CH<sub>4</sub>/t)

EF3 = CO<sub>2</sub> emission factor in coal excavation (m<sup>3</sup> CO<sub>2</sub>/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

**Table 3.3.2: Excavation of Coal in Slovenia 1986 – 2010**

Pit	1986	1990	2000	2005	2008	2009	2010
<b>Velenje</b>	5,000.5	4,210.0	3,743.1	3945.1	4,031.5	3,918.0	4,010.9
<b>Trbovlje - Hrastnik</b>	1,241.6	904.6	736.6	594.5	488.8	510.8	419.5
<b>Zagorje</b>	314.6	244.1	(closed)	(closed)	(closed)	(closed)	(closed)
<b>Senovo</b>	120.0	108.0	(closed)	(closed)	(closed)	(closed)	(closed)
<b>Kanižarica</b>	126.2	94.4	(closed)	(closed)	(closed)	(closed)	(closed)
<b>Laško</b>	25.0	(closed)	(closed)	(closed)	(closed)	(closed)	(closed)
<b>Total Coal Excavation (Gg)</b>	<b>6,827.9</b>	<b>5,561.1</b>	<b>4,479.7</b>	<b>4,539.6</b>	<b>4,520.3</b>	<b>4,428.8</b>	<b>4,430.4</b>

#### 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<sub>4</sub> in Coal Excavation 1986 – 2010 (m<sup>3</sup> CH<sub>4</sub>/t coal)**

Pit	1986	1990	2000-2010
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<sub>4</sub> in Post Mining Activities 1986 – 2010 (m<sup>3</sup> CH<sub>4</sub>/t coal)**

Pit	1986	1990	2000-2010
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<sub>2</sub> in Coal Excavation 1986 – 2010 (m<sup>3</sup> CO<sub>2</sub>/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<sub>4</sub> from Mining & Post Mining Activities 1986 – 2010 (Gg CH<sub>4</sub>)**

(1000 ton)	1986	1990	2000	2005	2008	2009	2010
Mining Activities	4.13	2.12	8.02	8.33	8.43	8.22	8.34
Post-Mining Activities	12.96	12.30	3.99	3.84	3.68	3.65	3.53
Total	17.09	14.42	12.01	12.17	12.11	11.87	11.87

**Table 3.3.7: Emission of CO<sub>2</sub> from Mining Activities 1986 – 2010 (Gg CO<sub>2</sub>)**

(1000 ton)	1986	1990	2000	2005	2008	2009	2010
Mining Activities	120.2	98.4	79.0	81.3	81.8	79.9	80.6

#### Recalculations

No recalculations have been performed for this category.

### 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 2010: 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

$$CH_4 \text{ emissions} = CH_4 \text{ emission1} + CH_4 \text{ emission2} + CH_4 \text{ emission3}$$

#### *CH<sub>4</sub> emission1:*

Emission in the production of crude oil = production of crude oil (ton) x calorific value x emission factor (kgCH<sub>4</sub>/TJ)

#### *CH<sub>4</sub> emission2:*

Emission in the processing of crude oil = quantities processed in Slovenia (ton) x calorific value x emission factor (kgCH<sub>4</sub>/TJ)

#### *CH<sub>4</sub> emission3:*

Emission in storage of crude oil = quantities processed in Slovenia (ton) x calorific value x emission factor (kgCH<sub>4</sub>/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<sub>4</sub>/PJ, and for processing from 90 to 1400 kg CH<sub>4</sub>/PJ).

For oil production:

$$\text{Emiss. Factor} = \frac{300 + 5000}{2} = 2650 \text{ kg CH}_4/\text{PJ}$$

For oil processing:

$$\text{Emiss. Factor} = \frac{90 + 1400}{2} = 745 \text{ kg CH}_4/\text{PJ}$$

For oil storage:

$$\text{Emiss. Factor} = \frac{20 + 250}{2} = 135 \text{ kg CH}_4/\text{PJ}$$

**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
<b>Total (Gg)</b>	<b>0.0201</b>	<b>0.0204</b>	<b>0.0197</b>	<b>0.0056</b>	<b>0.0001</b>	<b>0.0001</b>	<b>0.0000</b>

### 3.3.2.2 Natural Gas (IPCC: I B 2)

Key sector - Base year: no

Key sector - Year 2010: no

#### CH<sub>4</sub> emissions

*CH<sub>4</sub> emissions = Production + Transport + Distribution + Leakages at consumers*

**Table 3.3.9: Fugitive emissions from Natural gas in Gg CH<sub>4</sub>**

	1986	1990	1995	2000	2005	2008	2009	2010
<b>production</b>	0.010	0.033	0.024	0.008	0.006	0.003	0.003	0.009
<b>transport</b>	0.854	0.886	0.823	0.489	0.273	0.207	0.195	0.195
<b>distribution</b>	1.632	1.615	1.441	1.207	0.952	0.843	0.806	0.769
<b>gas use</b>	0.181	0.205	0.289	0.349	0.339	0.382	0.397	0.413
<b>total</b>	<b>2.676</b>	<b>2.739</b>	<b>2.577</b>	<b>2.052</b>	<b>1.571</b>	<b>1.436</b>	<b>1.402</b>	<b>1.386</b>

#### Production

**Table 3.3.10: Fugitive emissions from production of Natural gas in 1000 Sm<sup>3</sup> of CH<sub>4</sub>.**

	unit	1986	1990	1995	2000	2005	2008	2009	2010
<b>production</b>	1000 m <sup>3</sup>	7371	24800	18200	6000	4335	2610	2575	6673
<b>emissions</b>	1000 m <sup>3</sup>	15	50	36	12	9	5	5	13

#### Activity data

Quantity of natural gas in Slovenia is very small, in 2010 it was 6,673 km<sup>3</sup>.



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 Iepenke 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, 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 Lieferbedingungen) 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: Methanemissionene durch den Einsatz von Gas in Deutschland 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<sup>3</sup> of CH<sub>4</sub>.**

	1986	1990	1995	2000	2005	2008	2009	2010
<b>pipelines</b>	950	1007	864	515	309	228	214	214
<b>pneumatic stations</b>	124	124	165	120	66	66	66	66
<b>M&amp;R stations</b>	198	187	132	0	0	0	0	0
<b>Routine mending</b>	8	10	11	7	2	2	2	2
<b>AC building / damage</b>	2	3	62	90	32	15	10	10
<b>compressor station</b>					0.136	0.136	0.136	0.136
<b>TOTAL</b>	<b>1282</b>	<b>1320</b>	<b>1233</b>	<b>732</b>	<b>409</b>	<b>311</b>	<b>292</b>	<b>292</b>

### 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<sub>2</sub> Emission Factor in Energy Use and CH<sub>4</sub> 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<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/km for west Germany is used.

Table 3.3.13: EFs for fugitive emissions from transport pipelines.

	1986	1990	1995	2000	2005	2008	2009	2010
EF in 1000 Sm <sup>3</sup> /km	1,284	1,284	932	544	322	237	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<sup>3</sup> of CH<sub>4</sub>.

	1986	1990	1995	2000	2005	2008	2009	2010
distribution pipelines	1162.5	1055.0	913.1	698.1	522.5	438.9	413.3	389.1
M&R stations	7.5	9.7	12.7	24.6	31.3	34.3	35.4	36.4
construction...	0.4	0.5	1.3	2.7	3.8	3.8	3.8	3.8
gas meters	0.02	0.02	0.03	0.05	0.04	0.04	0.04	0.04
service pipelines	1278.5	1358.5	1233.2	1083.7	870.2	787.0	755.9	724.1
total	2448.9	2423.7	2160.4	1809.2	1427.7	1264.1	1208.4	1153.3

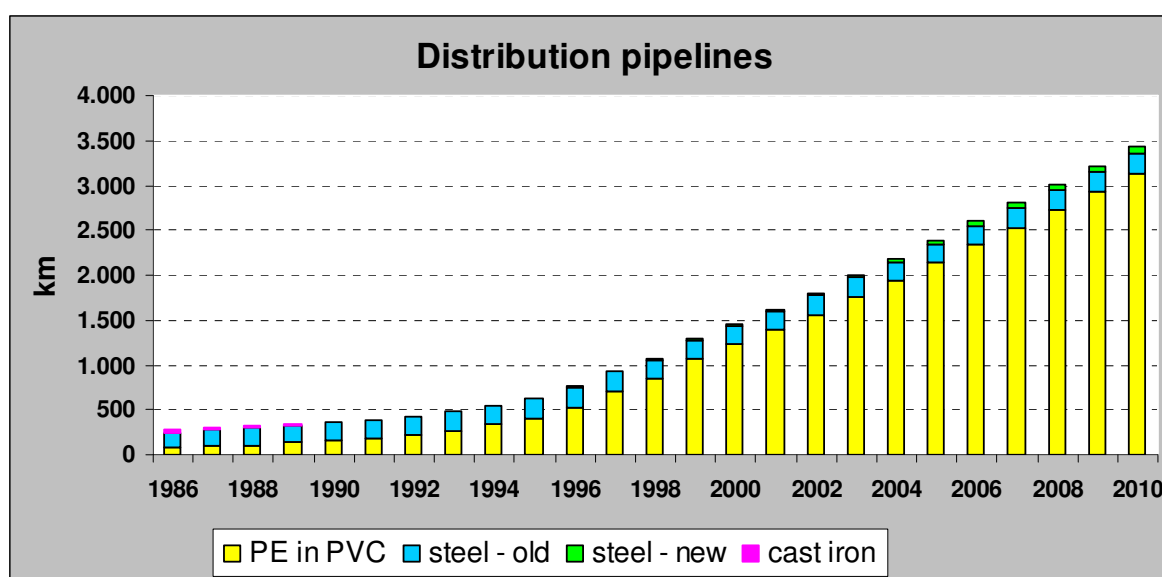


Figure 3.3.4: Length of distribution pipelines by material.

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	2008	2009	2010
<b>PE+PVC</b>	78	161	409	1,223	2,134	2,734	2,934	3,134
<b>steel(old)</b>	166	199	216	216	216	216	216	216
<b>steel new</b>	0	0	7	16	39	63	71	79
<b>cast iron</b>	36	0	0	0	0	0	0	0
<b>Total (km)</b>	<b>281</b>	<b>360</b>	<b>632</b>	<b>1,455</b>	<b>2,389</b>	<b>3,013</b>	<b>3,221</b>	<b>3,429</b>

**Table 3.3.16: Number of meter-regulation stations**

	1986	1990	1995	2000	2005	2008	2009	2010
<b>M&amp;R stations</b>	37	48	63	122	155	170	175	180

**Table 3.3.17: Number of inspected gas meters**

gas meter	1986	1990	1995	2000	2005	2008	2009	2010
<b>G4</b>	9062	8414	12228	19992	17261	17261	17261	17261
<b>G6 DO G10</b>	56	71	80	101	89	89	89	89
<b>over G10</b>	110	135	231	381	349	349	349	349
<b>total</b>	<b>9228</b>	<b>8620</b>	<b>12539</b>	<b>20474</b>	<b>17699</b>	<b>17699</b>	<b>17699</b>	<b>17699</b>

A volume of gas meters are: type G4 has 0.002 m<sup>3</sup>, from G6 to G10 we have taken average of 0.006 m<sup>3</sup> and for bigger meters 0.016 m<sup>3</sup>.

**Table 3.3.18: Length of service pipelines in km.**

	1986	1990	1995	2000	2005	2008	2009	2010
<b>PE and PVC</b>	46	95	251	756	1328	1682	1800	1917
<b>steel (old)</b>	98	117	117	92	57	57	57	57
<b>steel (new)</b>	0	0	4	9	23	37	42	46
<b>cast iron</b>	21	0	0	0	0	0	0	0
<b>total</b>	<b>166</b>	<b>212</b>	<b>373</b>	<b>858</b>	<b>1408</b>	<b>1776</b>	<b>1898</b>	<b>2021</b>

Emission factors

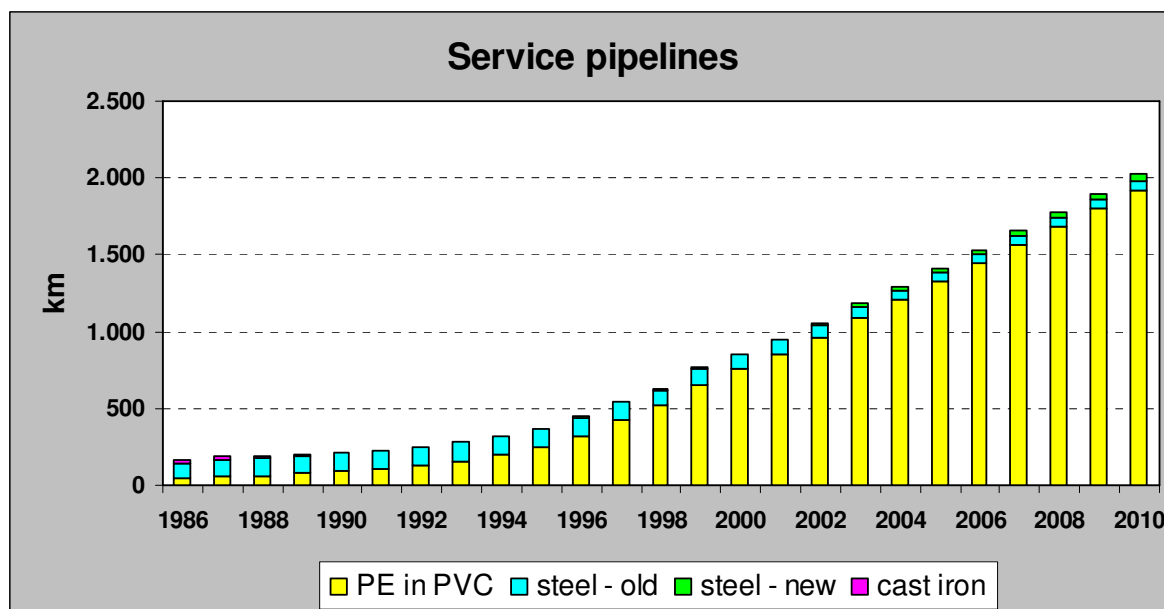
Emission factors for the emission of methane from the distribution pipelines have been taken from German article. For emissions from pipeline for period 1986 to 1992 EF for east Germany has been used. From 1993 the 10% reduction of emissions annually has been taken in account.



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

	1986	1990	1995	2000	2005	2008	2009	2010
PE and PVC	445	445	324	192	113	82	74	67
steel (old)	4945	4945	3605	2129	1257	916	825	742
steel (new)	-	-	247	247	247	247	247	247
cast iron	8396	-	-	-	-	-	-	-

For emission from M&R stations EF 202 m<sup>3</sup>/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.**

	1986	1990	1995	2000	2005	2008	2009	2010
PE and PVC	2101	2101	1532	904	534	389	350	315
steel (old)	9890	9890	7210	4257	2514	1833	1649	1484
steel (new)	-	-	742	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<sub>4</sub> 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<sup>3</sup> CH<sub>4</sub>.**

	1986	1990	1995	2000	2005	2008	2009	2010
<b>households</b>	271	308	433	523	509	572	595	619

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	2008	2009	2010
<b>households</b>	54,282	61,570	78,368	112,431	141,353	159,003	165,363	171,978
<b>appliances</b>	54,282	61,570	101,878	174,268	254,435	286,205	297,653	309,560

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 m<sup>3</sup>/appliance/yr for period 1986-1992 and low value 2 m<sup>3</sup>/ 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	2005-2010
<b>Emission factor</b>	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).

### **CO<sub>2</sub> emissions from transmission of natural gas**

According to the recommendations in the "Saturday e-mail" during 2009 review process fugitive CO<sub>2</sub> emission from transmission of natural gas has been calculated for entire period.

There is no methodology available for calculation CO<sub>2</sub> 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<sub>2</sub> emissions using the same methodology as for calculation fugitive emissions of CH<sub>4</sub> from natural gas and using country specific data for fraction of CO<sub>2</sub> 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 CO<sub>2</sub> is 1,828 kg/m<sup>3</sup>.

#### Recalculations

Fugitive emissions from distribution of natural gas have been recalculated for the period 2006-2008 due to the very small correction of EF used for low pressure PVC pipelines.

#### 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<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, and PFCs. Some industrial sources also produce NO<sub>x</sub>, NMVOCs, CO, and SO<sub>2</sub>.

Some fluorinated compounds (HFCs, PFCs and SF<sub>6</sub>) 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 5.0% of total national GHG emissions, excluding LULUCF. They amounted to 1,317 Gg CO<sub>2</sub> equivalents in the base year and to 971 Gg CO<sub>2</sub> equivalents in 2010. The main source of emissions is mineral industry with about 65% of emissions, followed by consumption of F-gases with 22% and metal production with 13% of emissions. Significantly lower are contributions from chemical industry (0.5%). The main source of emissions from this sector is cement industry, which is responsible for 38% of GHG emissions. Due to the world economical crises emissions of GHG from industrial processes considerably decreased in 2009 and remained low also in 2010. Process emissions of all GHG (in Gg CO<sub>2</sub> eq.) for 1986-2010 are shown in figure 4.0.1.

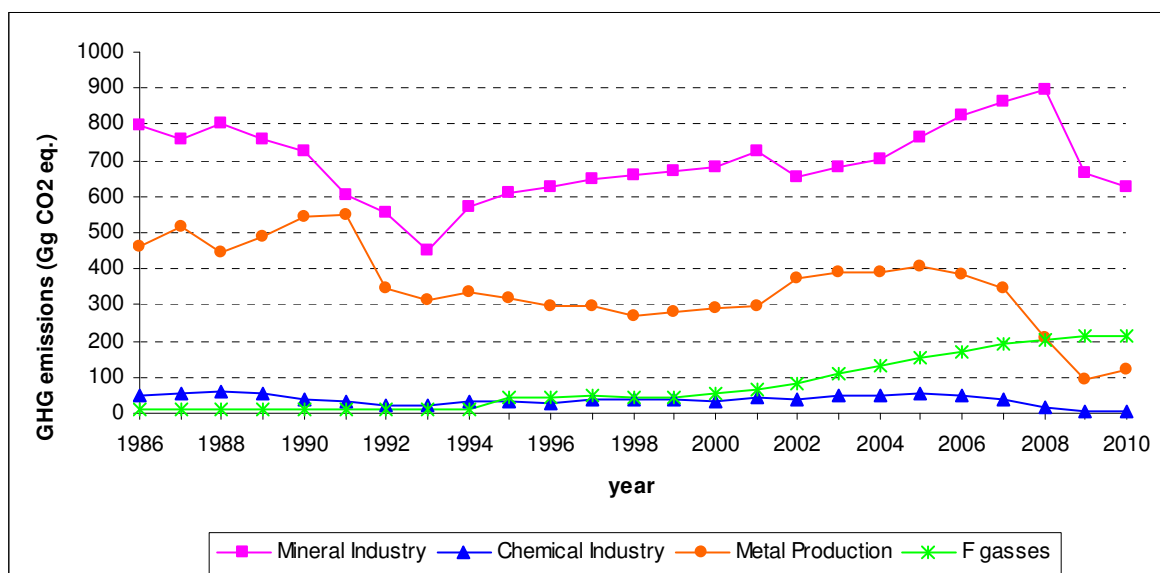


Figure 4.0.1: Process emissions of GHG from different types of industries.

## MINERAL INDUSTRY

### 4.1 Cement Production

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
<b>Base Year</b>	Level	CO <sub>2</sub>	1.64		10
<b>2010</b>	Level, Trend	CO <sub>2</sub>	1.10	1.53	13

#### 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<sub>3</sub>), is prepared by mixing limestone and clay components: from such with 35% of CaCO<sub>3</sub> to limestone with more than 95% of CaCO<sub>3</sub>. 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<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, and Fe<sub>2</sub>O<sub>3</sub>. 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<sub>3</sub>, the main constituent of limestone, to lime (CaO), while CO<sub>2</sub> 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<sub>2</sub>, most of the SO<sub>2</sub> 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<sub>2</sub> 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 1999–2010.

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<sub>2</sub>/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 2005–2010, 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<sub>2</sub> 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 CO <sub>2</sub> /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

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<sub>2</sub> 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<sub>2</sub> 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://rte.arso.gov.si/CommonCode/Modules/Poročilo%20o%20izpolnitvi%20obveznosti%20za%20leto%202010.pdf>

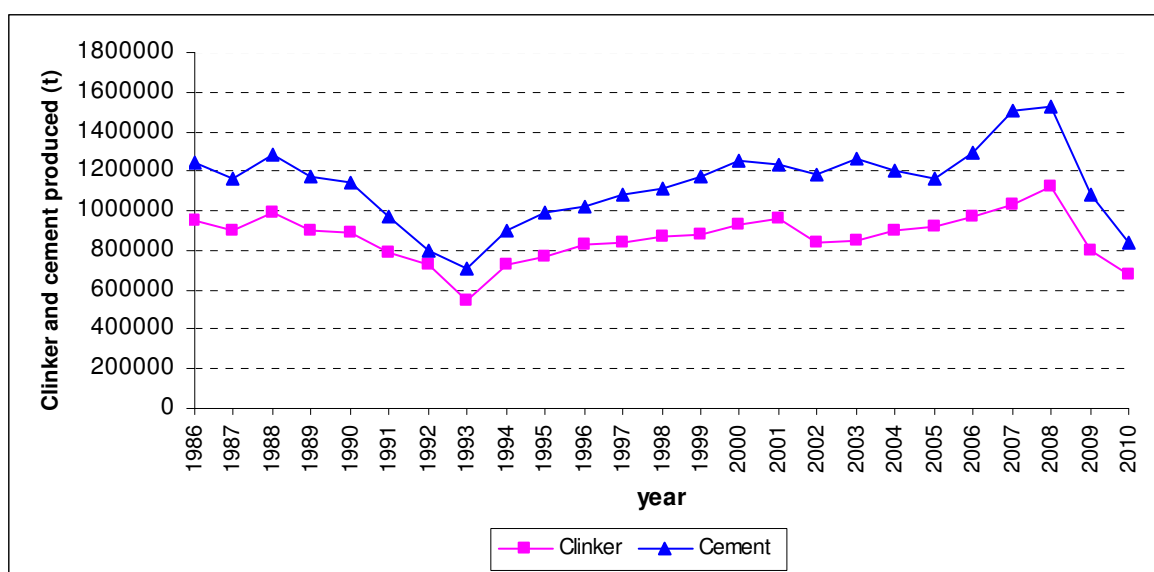


Figure 4.1.1: Cement and clinker production in ton/year.

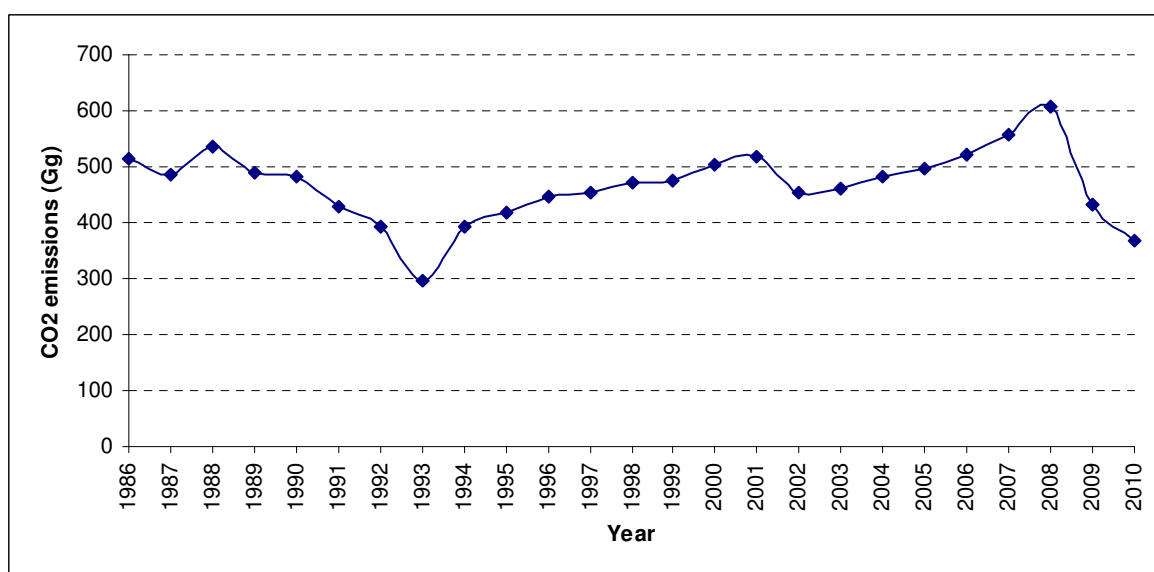


Figure 4.1.2: CO<sub>2</sub> emissions from cement production.

### 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.

## 4.2 Lime Production

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	0.70		25
2010	Trend	CO <sub>2</sub>	0.27	1.24	32

### 4.2.1 Source category description

CO<sub>2</sub> 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 2010). In Slovenia, there are three lime producers.

Lime is generated by heating the input raw material, i.e. limestone, to high temperature (900-1200°C). During this process, limestone is converted into CaO and emits CO<sub>2</sub>.

### 4.2.2 Methodological issues

#### CARBON DIOXIDE EMISSIONS

CO<sub>2</sub> emission was calculated according to IPCC methodology. Similar to cement production, for allocation plan purposes more detailed data directly from producers for 1999-2004 were obtained. 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<sub>2</sub>/ton of lime and applied this emission factor to calculate the CO<sub>2</sub> emissions for 1986–1998. Emissions for the years 1999-2004 have been calculated using the year-specific EFs. The EFs for the period 2005-2010 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

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 2005 and for EU ETS data 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<sub>3</sub> and amount of lime produced) obtained from these three producers.

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

Year	Emission factor (t CO <sub>2</sub> /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

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<sub>2</sub> 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<sub>2</sub> 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 <sub>2</sub> /t) CaO	EF (tCO <sub>2</sub> /t) MgO	Emissions CO <sub>2</sub> (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

Table 4.2.3: Lime production emissions from producer 2.

Year	CaO (t)	MgO (t)	EF (tCO <sub>2</sub> /t) CaO	EF (tCO <sub>2</sub> /t) MgO	Emissions CO <sub>2</sub> (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

Table 4.2.4: Lime production emissions from producer 3.

Year	CaCO <sub>3</sub> (t)	EF (tCO <sub>2</sub> /t)	Emissions CO <sub>2</sub> (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

Table 4.2.5: Total CO<sub>2</sub> emissions of all three producers, total lime production and calculated IEF.

Year	2005	2006	2007	2008	2009	2010
Lime Produced (t)	165125	185240	170464	152227	97970	125117
Total emissions CO <sub>2</sub> (t)	121346	134462	123426	110007	71000	90248
IEF (kg CO <sub>2</sub> /t)	735	726	724	723	725	721

The limestone used for lime production contains mostly CaCO<sub>3</sub>. The limestone has also small amount of dolomite, which next to CaCO<sub>3</sub> consists also of MgCO<sub>3</sub>. High-calcium lime is the main type of lime. Quicklime and hydrated lime are the main types of lime produced in Slovenia.

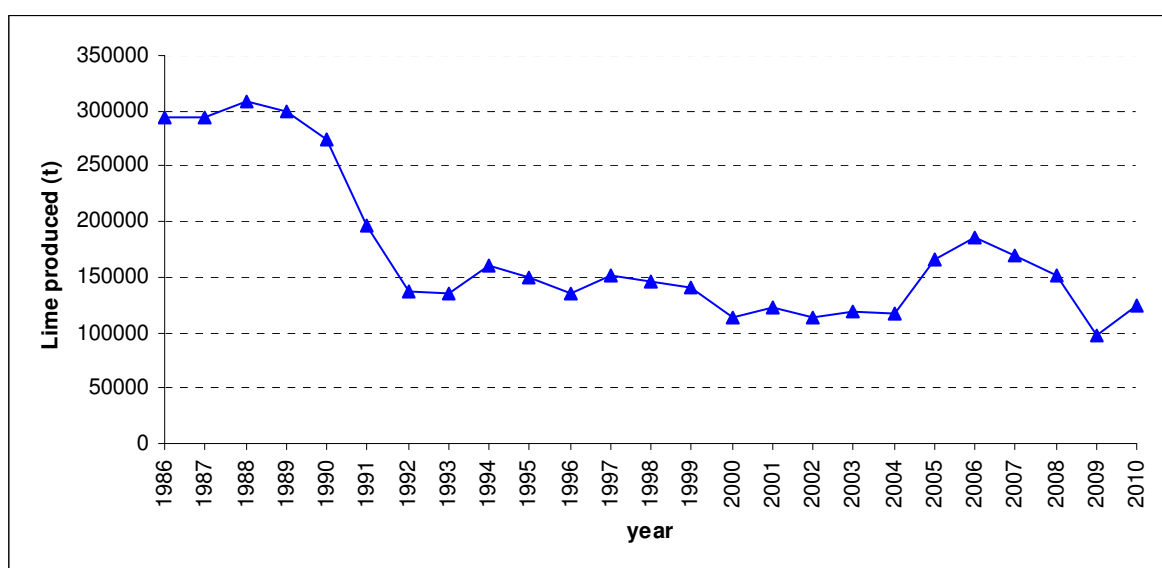


Figure 4.2.1: Lime production in ton/year.



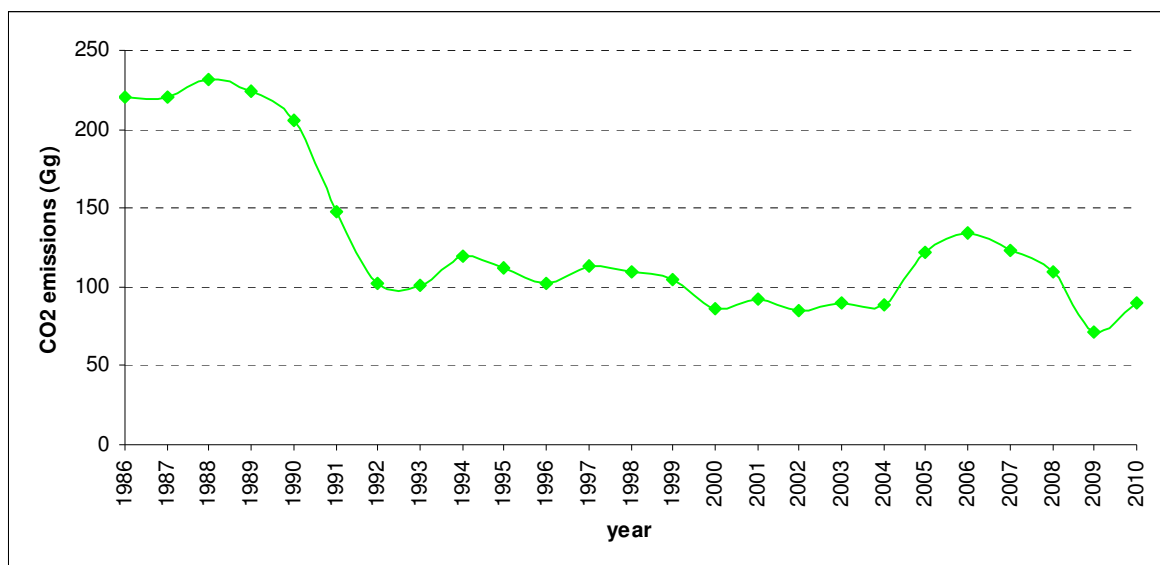


Figure 4.2.2: CO<sub>2</sub> emissions from lime production.

#### 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 <sub>2</sub>	0.15		44
2010	Level, Trend	CO <sub>2</sub>	0.46	0,99	24

#### 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<sub>2</sub>. 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<sub>2</sub> emissions in the process of consumption of coal, in ceramics production, mineral wool production and production of TiO<sub>2</sub>. Total CO<sub>2</sub> 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<sub>2</sub> 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<sub>3</sub> consumption were obtained directly from iron and steel producers. CO<sub>2</sub> emissions have been calculated according to IPCC methodology. Default emission factor, 440 kg CO<sub>2</sub>/ton limestone, has been applied for the whole period.

##### **SO<sub>2</sub> Scrubbing**

Using the technology for the reduction of SO<sub>2</sub> emissions in the process of consumption of coal is causing emissions of CO<sub>2</sub>. CO<sub>2</sub> emissions from scrubbing have been calculated from consumption of additive CaCO<sub>3</sub> and appropriate emission factor.

Activity data on CaCO<sub>3</sub> 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<sub>2</sub> in Slovenia. Data on CaCO<sub>3</sub> and MgCO<sub>3</sub> for the period 2005–2010 have been obtained from verified ETS reports. Default emission factor, 440 kg CO<sub>2</sub>/ton limestone and 522 kg CO<sub>2</sub>/ton magnesium carbonate, were applied for the whole period.

##### **Ceramics production**

Following the ERT recommendation limestone and dolomite use in bricks and ceramics production was additionally taken into account. Activity data on CaCO<sub>3</sub> and MgCO<sub>3</sub> due to limestone and dolomite use in ceramics production for the period 2005–2010 have been obtained from verified ETS reports. Default emission factor, 440 kg CO<sub>2</sub>/ton limestone and 522 kg CO<sub>2</sub>/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<sub>2</sub>/ton dolomite was applied for the whole period 1986-2010.

## Manufacture of dyes and pigments

Limestone has been used in manufacturing of  $\text{TiO}_2$  pigment for neutralization processes. Activity data on  $\text{CaCO}_3$  use for the period 1986–2010 have been obtained from the producer. Default emission factor 440 kg  $\text{CO}_2$ /ton calcium carbonate has applied for the whole period.

**Table 4.3.1:  $\text{CO}_2$  emissions from limestone and dolomite use.**

	Units	1986	1990	2005	2008	2009	2010
<b><math>\text{CaCO}_3</math> consumption in iron and steel production</b>	t	43297	1896	1928	3191	2038	2156
<b>EF <math>\text{CaCO}_3</math></b>	t $\text{CO}_2$ /t	0.44	0.44	0.44	0.44	0.44	0.44
<b><math>\text{CO}_2</math> emission from iron and steel production</b>	Gg	19.1	0.83	0.85	1.40	0.90	0.95
<b>Consumption of additive <math>\text{CaCO}_3</math></b>	t	0.0	0.0	187221	199501	206482	206975
<b>EF <math>\text{CaCO}_3</math></b>	t $\text{CO}_2$ /t	0.44	0.44	0.44	0.44	0.44	0.44
<b>Consumption of additive <math>\text{MgCO}_3</math></b>	t	0.0	0.0	0.0	436	633	547
<b>EF <math>\text{MgCO}_3</math></b>	t $\text{CO}_2$ /t	0.522	0.522	0.522	0.522	0.522	0.522
<b><math>\text{CO}_2</math> emissions from <math>\text{SO}_2</math> scrubbing</b>	Gg	0.0	0.0	82.4	88.0	91.2	91.4
<b><math>\text{CaCO}_3</math> consumption in ceramics production</b>	t	0.0	0.0	1998	2160	1537	1791
<b>EF <math>\text{CaCO}_3</math></b>	t $\text{CO}_2$ /t	0.44	0.44	0.44	0.44	0.44	0.44
<b><math>\text{MgCO}_3</math> consumption in ceramics production</b>	t	0.0	0.0	1	0.72	15.5	18.4
<b>EF <math>\text{MgCO}_3</math></b>	t $\text{CO}_2$ /t	0.522	0.522	0.522	0.522	0.522	0.522
<b><math>\text{CO}_2</math> emissions from ceramics production</b>	Gg	0.0	0.0	0.88	0.95	0.68	0.80
<b><math>\text{CaCO}_3</math> consumption in production of dyes and pigments</b>	t	39579	36089	78381	100614	99519	110479
<b>EF <math>\text{CaCO}_3</math></b>	t $\text{CO}_2$ /t	0.44	0.44	0.44	0.44	0.44	0.44
<b><math>\text{CO}_2</math> emissions from production of dyes and pigments</b>	Gg	17.4	15.9	34.5	44.3	43.8	48.6
<b>Dolomite consumption in production of mineral wool</b>	t	22901	20624	24844	22328	21873	22042
<b>EF dolomite</b>	t $\text{CO}_2$ /t	0.477	0.477	0.477	0.477	0.477	0.477
<b><math>\text{CO}_2</math> emissions from production of mineral wool</b>	Gg	10.9	9.83	11.9	10.7	10.4	10.5
<b>Total <math>\text{CO}_2</math> emissions</b>	Gg	47.4	26.5	130.4	145.3	147.0	152.2

### 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

Recalculation of CO<sub>2</sub> emissions for the period 1986-2009 have been performed since last submission due to inclusion of new sources. CaCO<sub>3</sub> and MgCO<sub>3</sub> consumption in production of ceramics, dyes and pigments and mineral wool were added to the sector limestone and dolomite use.

#### 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 2010: no

#### 4.4.1 Source category description

Soda ash (Na<sub>2</sub>CO<sub>3</sub>) is used as a raw material in numerous industrial processes: production of glass, soap and detergent, production of paper. CO<sub>2</sub> 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 1998-2010 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<sub>2</sub> emissions from consumption have been calculated according to IPCC methodology, applying an emission factor of 415 kg CO<sub>2</sub>/ton of Na<sub>2</sub>CO<sub>3</sub>.

#### 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 2010: no

### **4.5.1 Source category description**

This chapter comprises CO<sub>2</sub> emissions from glass manufacturing. They are reported in sector 2.A.7.1 Glass Production.

### **4.5.2 Methodological issues**

Following the ERT recommendation description of methods used for CO<sub>2</sub> emissions calculation in different periods is included.

CO<sub>2</sub> emissions from glass production for the years 1999-2010 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<sub>3</sub>), magnesium carbonate (MgCO<sub>3</sub>), soda ash (Na<sub>2</sub>CO<sub>3</sub>), potash (K<sub>2</sub>CO<sub>3</sub>) and barium carbonate (BaCO<sub>3</sub>). Default IPCC emission factors have been used for calculation of CO<sub>2</sub> emissions. Those are 440 kg CO<sub>2</sub>/ton limestone, 522 kg CO<sub>2</sub>/ton magnesium carbonate, 318 kg CO<sub>2</sub>/ton potassium carbonate, 223 kg CO<sub>2</sub>/t barium carbonate, 415 kg CO<sub>2</sub>/t sodium carbonate.

Calculation of CO<sub>2</sub> emissions from glass production for the years 1986-1998 have 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 2010: no

#### 4.6.1 Source category description

The production of nitric acid ( $\text{HNO}_3$ ) generates nitrous oxide ( $\text{N}_2\text{O}$ ) as a by-product of the high temperature catalytic oxidation of ammonia ( $\text{NH}_3$ ). 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  $\text{N}_2\text{O}$ /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  $\text{N}_2\text{O}$  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 2010: 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 1995.

$\text{CO}_2$  emissions arise both in the production of calcium carbide as well as in its consumption. Calcium carbide ( $\text{CaC}_2$ ) is produced by heating calcium carbonate and subsequently reducing  $\text{CaO}$  with carbon. Both steps lead to emissions of  $\text{CO}_2$ . In Slovenia, calcium carbide was not produced from limestone but from lime, hence  $\text{CO}_2$  emissions arise only in the reduction with carbon.  $\text{CO}_2$  emissions have been arising also in the consumption of calcium carbide.

In the production of silicon carbide ( $\text{SiC}$ ),  $\text{CO}_2$  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<sub>2</sub> 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 on 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

The input data for calculation of CO<sub>2</sub> emissions arising from production of calcium carbide are the data on annual production of CaC<sub>2</sub>. Until 1997, those data were obtained from the Statistical Office of the Republic of Slovenia, but afterwards SORS changed its methodology of gathering and presenting carbides. SORS data became inapplicable. We found alternative source of data of CaC<sub>2</sub> produced. We have obtained data directly from the producer and applied them for emissions calculation for the entire period. In the year 2010 there was no production of calcium carbide, since the only one carbide factory was closed down in the first quarter of 2008. CO<sub>2</sub> emissions from production had been calculated using suggested IPCC emission factor 1090 kg CO<sub>2</sub>/ton of calcium carbide.

Emission arises also in consumption. Data on consumption of CaC<sub>2</sub> were obtained from Statistical Office of the Republic of Slovenia until 1997, later 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<sub>2</sub> using moving averages. As a result we have been used estimated data on CaC<sub>2</sub> consumption for calculation of CO<sub>2</sub> emissions for the period 1998-2010. CO<sub>2</sub> emissions from calcium carbide consumption have been calculated using recommended IPCC emission factor 1100 kg CO<sub>2</sub>/ton of calcium carbide.

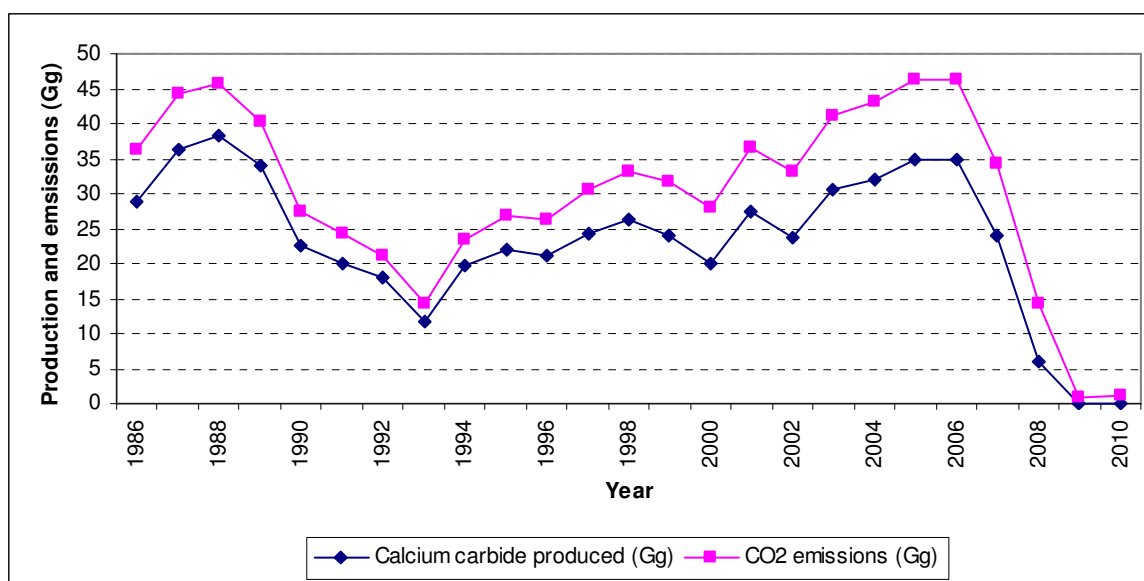


Figure 4.7.1: Production of calcium carbide and CO<sub>2</sub> emissions arising from production and consumption of calcium carbide.

#### **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 2010: 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<sub>2</sub>O 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<sub>4</sub>/t methanol was applied.

Production data of methanol have been obtained from the Statistical Office of the Republic of Slovenia for the whole period.

#### **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<sub>4</sub> 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 2010: 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<sub>2</sub>. 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.

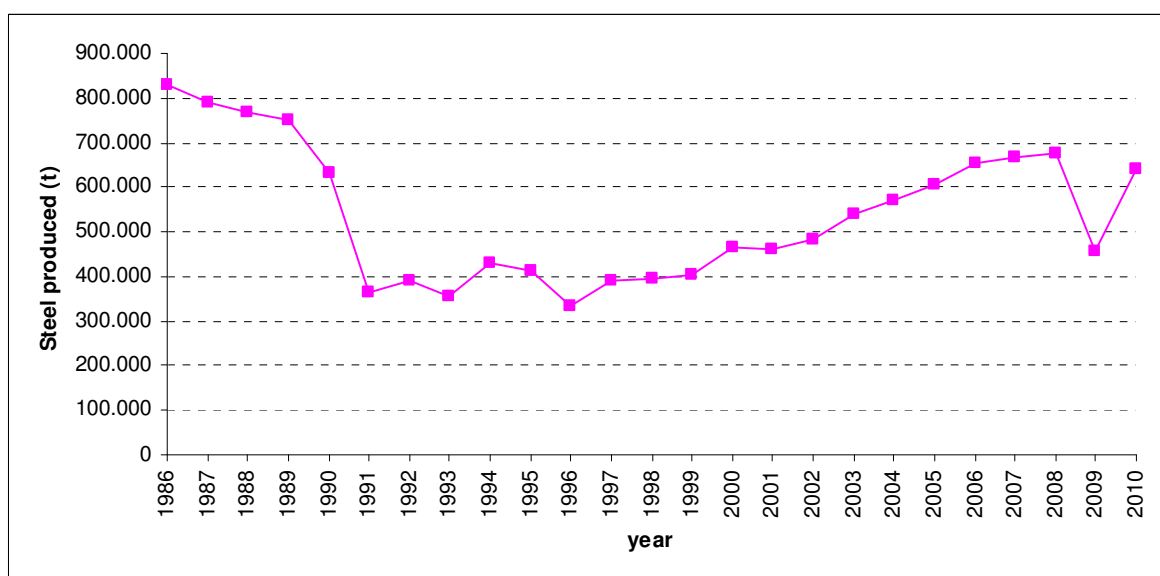


Figure 4.9.1: Production of steel in ton/year.

#### 4.9.2 Methodological issues

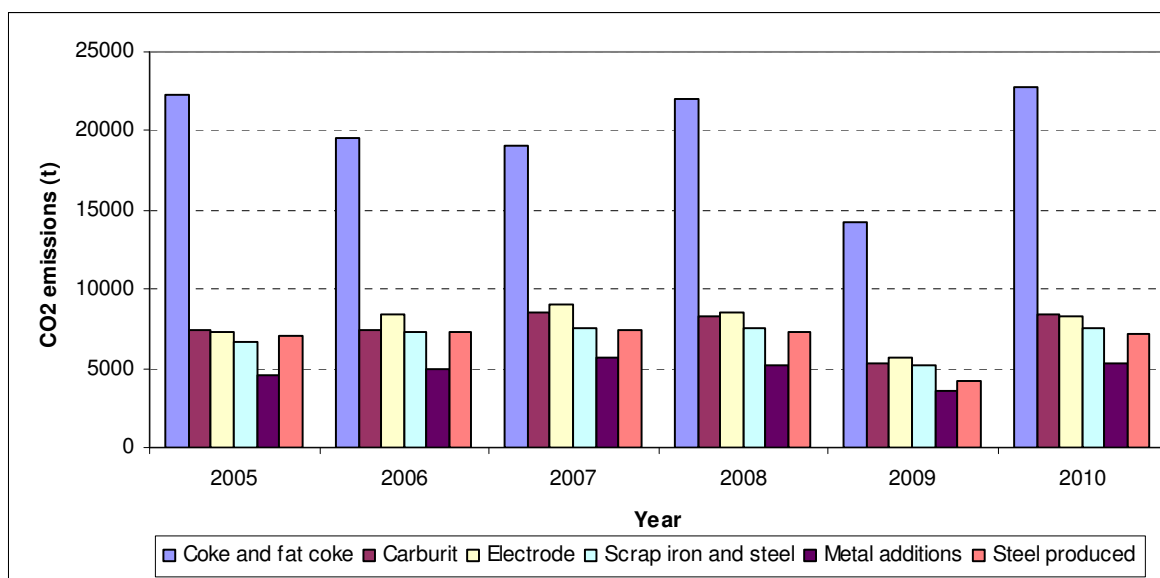
##### CARBON DIOXIDE EMISSIONS

Process emissions of carbon dioxide in an iron and steel plant take place as a result of coke oxidation. During steel production, CO<sub>2</sub> emissions also take place as a result of graphite electrode consumption in the EAF. CO<sub>2</sub> 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. So for these two years the decision was taken to attribute all coke, which is consumed in the production of iron and steel, to the energy sector as fuel consumption. When this production was discontinued and a new electric arc furnace started production in 1988, the only source of process emissions in this category was production of steel from scrap iron in the EAF. We assumed that energy source in this type of industry is only electricity and emissions from coke and other material are all process emissions. The consequence is, that all coke consumption for the years 1986–1987 is allocated to the energy sector, whereas for the period 1988–2010 is all coke consumption included in the industrial processes sector.

Data on the amount and carbon content of input and output material were obtained from three iron and steel producers. In our case, input materials were mostly coke (including FAT coke), graphite electrodes and scrap iron. For allocation plan purposes more detailed data were available from 1999 on, which enabled us to determine our own emission factor. Average EF for the period 1999–2004 has been 47 kg CO<sub>2</sub>/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 2005–2010 we have used precise and verified data obtained from EU ETS. Figure 4.9.2 shows CO<sub>2</sub> emissions contributed by different input material and steel produced for 2005–2010.



**Figure 4.9.2: CO<sub>2</sub> emissions contributed by different input material and steel produced for 2005–2010.**

### 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 Ferrous Production

Key sector - Base year: no

Key sector - Year 2010: no

#### 4.10.1 Source category description

Ferrous alloys 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. Ferrous alloy production involves a metallurgical reduction process which results in significant carbon dioxide emissions.

In ferrous alloy 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.

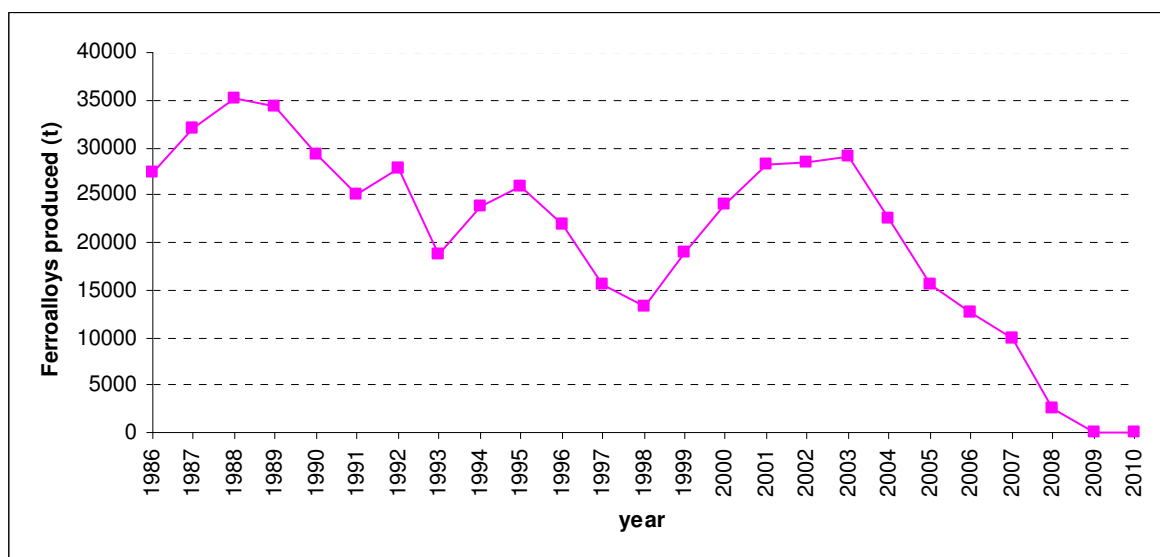


Figure 4.10.1: Ferrous alloys production in ton/year.

#### 4.10.2 Methodological issues

##### CARBON DIOXIDE EMISSIONS

CO<sub>2</sub> emissions have been calculated from the consumption of fuels, while data on ferrous alloys 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<sub>2</sub> 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 2010. 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<sub>2</sub> 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<sub>2</sub> 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**

	<b>KS</b>	<b>Gas</b>	<b>Contribution to Level %</b>	<b>Contribution to Trend %</b>	<b>Rank KS level</b>
<b>1986</b>	Level	PFC	0.88		19
<b>2010</b>	Trend	PFC	0.04	2.42	51

#### **4.11.1      Source category description**

Aluminium is produced in two phases. Firstly, alumina (Al<sub>2</sub>O<sub>3</sub>) 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<sub>2</sub>, 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<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> emission factors.**

Technology	Unit	Emission factors
Electrolysis unit A, Soderberg, HSS	kg CF <sub>4</sub> /t	0.61
	kg C <sub>2</sub> F <sub>6</sub> /t	0.061
Electrolysis unit B, Soderberg, HSS, until 1987	kg CF <sub>4</sub> /t	0.61
	kg C <sub>2</sub> F <sub>6</sub> /t	0.061
Electrolysis unit B, reconstruction to PB, 1988	kg CF <sub>4</sub> /t	0.40
	kg C <sub>2</sub> F <sub>6</sub> /t	0.04
Electrolysis unit C, Pechiney, PFPB, until 2004	kg CF <sub>4</sub> /t	0.035
	kg C <sub>2</sub> F <sub>6</sub> /t	0.0035

PF - Point Feeding,  
PB - PreBaked anod,  
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 40,000 t of aluminium was built and its electrolysis technology was taken from Aluminium Pechiney. Simultaneously, reduction cells in electrolysis unit B were reconstructed to use prebaked anodes.

In 2002 upgrading the aluminium production that includes the construction of the second half of the electrolysis unit C with an annual production capacity of 40,000 t of aluminium was carried out. Due to the high costs for electricity used a plant had to wind up production in pot B in the end of 2007. 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 was halved compared to 2008. In 2010 production of aluminium has been slightly increased, but it is still far from pre-crises values. It amounted to 40177 t. Significant drop in aluminium production occurred due to world economical crisis.

#### 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<sub>2</sub> emissions from primary aluminium production are most precisely estimated from the consumption of anodes. Their consumption in 2010 amounted to 403 kg/ton Al. The emission factor is 3.6 t CO<sub>2</sub>/ton anodes. The significant decline of CO<sub>2</sub> emissions in 2009 is due to smaller aluminium production. Slightly higher emissions of CO<sub>2</sub> are observed in 2010, but they are still far from pre-crises values.

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

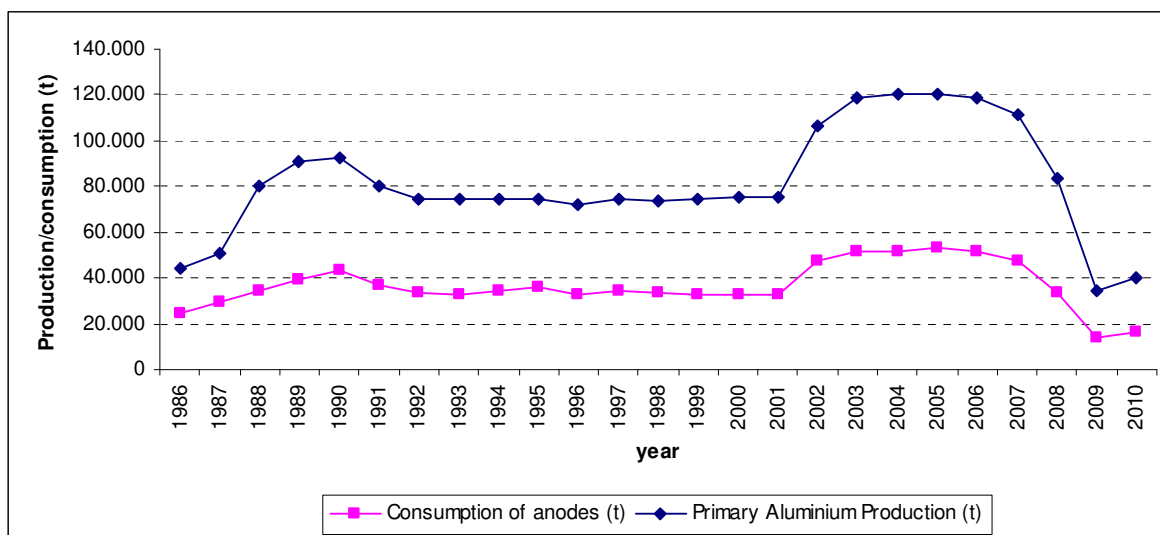
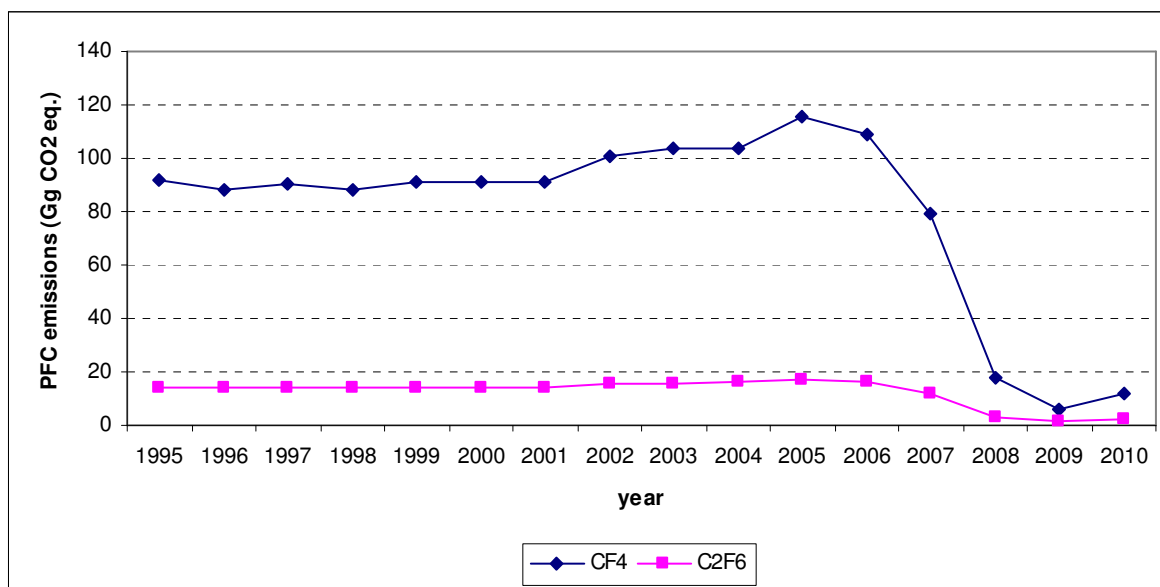


Figure 4.11.1: Primary aluminium production in ton/year and a consumption of anodes in ton/year.

##### PFC EMISSIONS

Data on emission calculations of tetrafluoromethane and hexafluoroethane 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<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> emission factors from 1995 to 2010. The CF<sub>4</sub> emission factor has fallen from the base

year 1995 till now from 0.191 kg CF<sub>4</sub>/ton Al to 0.044 kg CF<sub>4</sub>/ton Al and C<sub>2</sub>F<sub>6</sub> emission factor from 0.021kg C<sub>2</sub>F<sub>6</sub>/ton Al in the base year to 0.0057 kg C<sub>2</sub>F<sub>6</sub>/ton Al in 2010.



**Figure 4.11.2: Emissions of CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> 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 2005 -2010. Annually determined emission factors have been used. Pechiney overvoltage method was used for emissions calculation of 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 CO<sub>2</sub> 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 2010: no

### 4.12.1 Source category description

This chapter comprises CO<sub>2</sub> 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

To improve transparency CO<sub>2</sub> emission 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. EF for anode burn-off is a plant specific. Data on amount of anode burn-off and emissions of CO<sub>2</sub> are provided by the producer expert service. CO<sub>2</sub> 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). CO<sub>2</sub> EF for 2010 is 3.35 t CO<sub>2</sub>/ t anode burn-off.

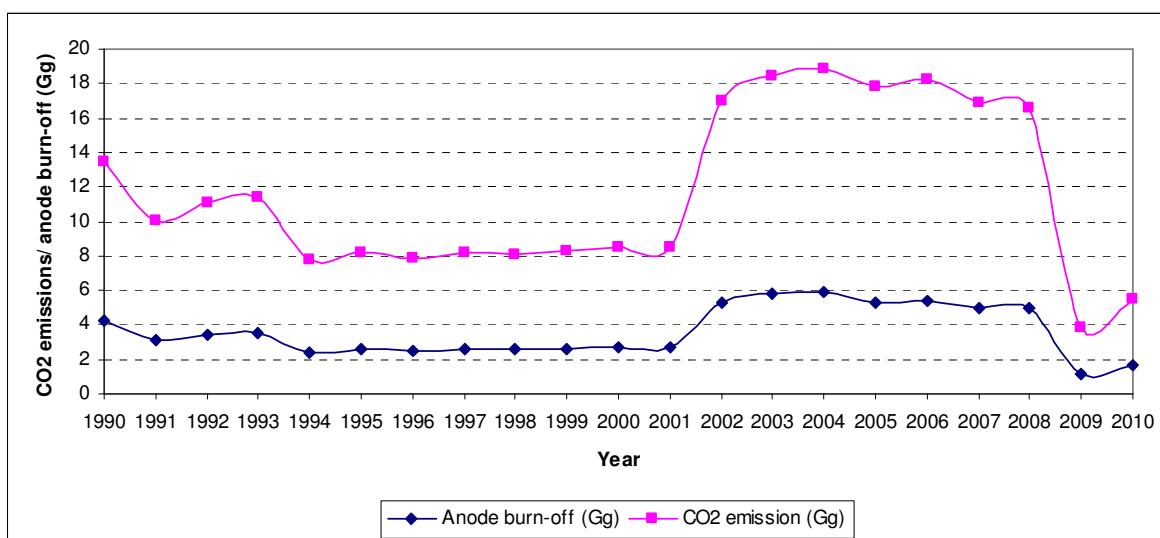


Figure 4.12.3: CO<sub>2</sub> emissions from anode burn-off in the process of anode production.

### 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

Recalculation of CO<sub>2</sub> emissions for the period 2005-2009 have been performed due to more precise data on amount of anode burn-off obtained from aluminium producer.

#### 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 Environmental Agency of Republic of Slovenia. 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 12 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.

In the case of CO<sub>2</sub> emissions from aluminium production thorough examination of data was performed. To improve transparency emissions from anode burn-off have been reported separately under Other 2.C.5.

### 4.14 Emissions Related to Consumption of Halocarbons and Sulphur Hexafluoride

Refrigeration and AC Equipment	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
1986	no	HFC	NO		NO
2010	Level, Trend	HFC	0.57	1.65	22

Other categories:      Key sector - Base year:      no  
                                  Key sector - Year 2010:      no

#### 4.14.1 Source category description

This category includes HFC and SF<sub>6</sub> 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
<b>Refrigeration and AC equipment</b>		
- 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
<b>Foam blowing</b>		
- hard foam	1995-2010	HFC-134a
- soft foam	1995-2010	HFC-134a
<b>Fire extinguishers</b>	1997-2010	HFC-227ea
<b>Aerosols and meter dose inhalers</b>	2003-2010	HFC-134a
<b>Electrical equipment</b>	1986-2010	SF <sub>6</sub>
<b>Noise insulation windows</b>	1995-1997	SF <sub>6</sub>

The year 1995 was chosen as base year for HFC, PFC and SF<sub>6</sub> emissions. Actual as well as potential emissions have been calculated.

#### HFC

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<sub>2</sub> etc.) were available.

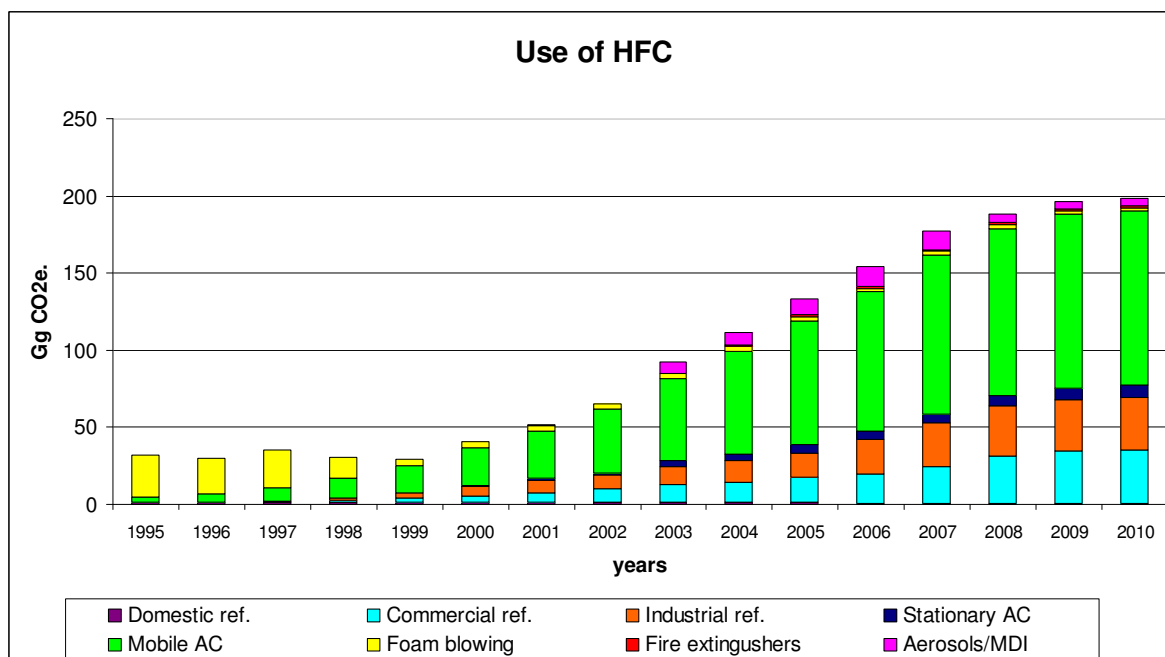
The Slovenian chemical industry does not produce HFCs and therefore these substances are imported. Major users generally import them on their own, lesser users buy them from distributors.

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<sub>6</sub> 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 1<sup>st</sup> 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<sub>2</sub> 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 precharged 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<sub>6</sub>

SF<sub>6</sub> 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<sub>6</sub> 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<sub>6</sub> as insulating gas has increased strongly. This type of equipment is not produced in Slovenia and there is no export of SF<sub>6</sub> 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<sub>6</sub> 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 SF<sub>6</sub> have been calculated using the following equation:

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

where:

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

$E_{\text{assembly, } t}$  = Emissions during system manufacture/assembly in year t

$E_{\text{charge, } t}$  = The amount of F-gas charged into new systems in year t

k = Production/assembly losses (%)

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

$E_{\text{operation, } t}$  = Amount of F-gas emitted during system operation in year t

$E_{\text{stock, } t}$  = 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)

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

$E_{\text{disposal, } t}$  = Amount of F-gas emitted at disposal in year t

$E_{\text{consumption (t-n)}}$  = 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 1998-2010 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 based on the amounts filled into new manufactured products.

### **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 isobutane 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 (isobutane) 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.

**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 <sub>2</sub> eq)
<b>Domestic refrigeration</b> Range from GPG 2000	1 0.2 - 1	0.5 0.1 - 0.5		0.63
<b>Commercial refrigeration</b> <b>Stand alone</b> Range from GPG 2000 Range from 2006 Guidelines	3 0.5 - 3	5 1 - 10 1 - 15		34.73
<b>Medium and large</b> Range from GPG 2000 Range from 2006 Guidelines	3 0.5 - 3	20 10-30 10-35		
<b>Industrial refrigeration</b> Range from GPG 2000	3 0.5 - 3	16 7 - 25		34.00
<b>Stationary Air Conditioning</b> Range from GPG 2000 Range from 2006 Guidelines	0.6 0.2 - 1	1-10 1 - 5 1 -10		8.03
<b>Mobile Air Conditioning</b> Range from GPG 2000	0.5 0.5	15 10 - 20	0.75	112.98

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.

## 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 CO<sub>2</sub> 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<sub>2</sub>, 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 assumed 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 1<sup>st</sup> 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.

Our Health insurance companies are collecting data on medicine sold in Slovenia and are willing to provide them on request. What we need is the list of MDI filled with HFC-134a and amount of it. So far we were not able to get such information.

### 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

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



As production of SF<sub>6</sub> in Slovenia doesn't exist and until now no equipment including SF<sub>6</sub> 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<sub>6</sub> used to fill new equipment.

Equipment use emissions are determined by the amount of SF<sub>6</sub> used to service equipment. SF<sub>6</sub> which has been recovered from equipment before servicing and returned after servicing is not included in the estimate.

Upon ERT recommendation the SF<sub>6</sub> 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.

**Table 4.14.3: HFC emissions: SF<sub>6</sub> 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 <sub>6</sub> emissions	kg	428.5	431.1	482.1	658.5	789.3	697.8	666.1	692.2
Total SF <sub>6</sub> emissions	Gg CO <sub>2</sub> eq	10.2	10.3	11.5	15.7	18.9	16.7	15.9	16.5

## 2.F.8 Other

Upon ERT recommendation emissions of SF<sub>6</sub> 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<sub>6</sub> for soundproof windows in Slovenia. According to the Regulation on certain fluorinated greenhouse gases the placing on the market of double glazed windows filled with SF<sub>6</sub> 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**

In the response to the "Saturday paper" in 2011 the whole sector has been improved using the data from the database on use of F-gases, data from service companies and a custom data. The new estimates have been prepared in relatively short time period of 6 weeks and the calculations did not undergo all necessary QC checks.

During the preparation of 2012 submission all regular QA/QC activities have been performed and the following two errors have been found: in the industrial refrigeration and in the stationary AC, HFC emissions have been calculated using wrong value for annual leakage rate of 20% instead of 16% and 3%, respectively. Errors have been corrected for the period 1997-2009. In the same time the database has been updated with improve data on HFC consumption and a new disaggregation of data between industrial and commercial refrigeration as well as AC has been done. Due to updated data the emissions from commercial and industrial refrigeration as well from stationary AC have been recalculated.

Recalculations have also occurred in the category related to the consumption of SF<sub>6</sub>. In 2011 data about SF<sub>6</sub> used in electrical equipment has been updated and emissions for 2005-2009 have been recalculated accordingly.

#### **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 CO<sub>2</sub> 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
<b>TOTAL</b>	<b>515.90</b>	<b>116.14</b>	<b>126.28</b>	<b>64.83</b>

	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
<b>TOTAL</b>	<b>1989.5</b>	<b>116.14</b>	<b>131.2</b>	<b>87.65</b>

	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
<b>TOTAL</b>	<b>280.30</b>	<b>116.14</b>	<b>129.55</b>	<b>200.81</b>

	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
<b>TOTAL</b>	<b>369.60</b>	<b>116.14</b>	<b>75.42</b>	<b>137.53</b>

## 5 SOLVENT AND OTHER PRODUCT USE (CRF sector 3)

### 5.1 Overview

Solvents and related compounds are important for greenhouse gas and other emission inventories 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<sub>2</sub>. No other GHGs are emitted in significant amounts from the use of solvents and related compounds, which 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<sub>2</sub>O 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<sub>2</sub>O.

### 5.2 Other products use

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CH <sub>4</sub>	0.26		36
2010	Trend	CH <sub>4</sub>	0.09	0.49	42

#### N<sub>2</sub>O EMISSIONS

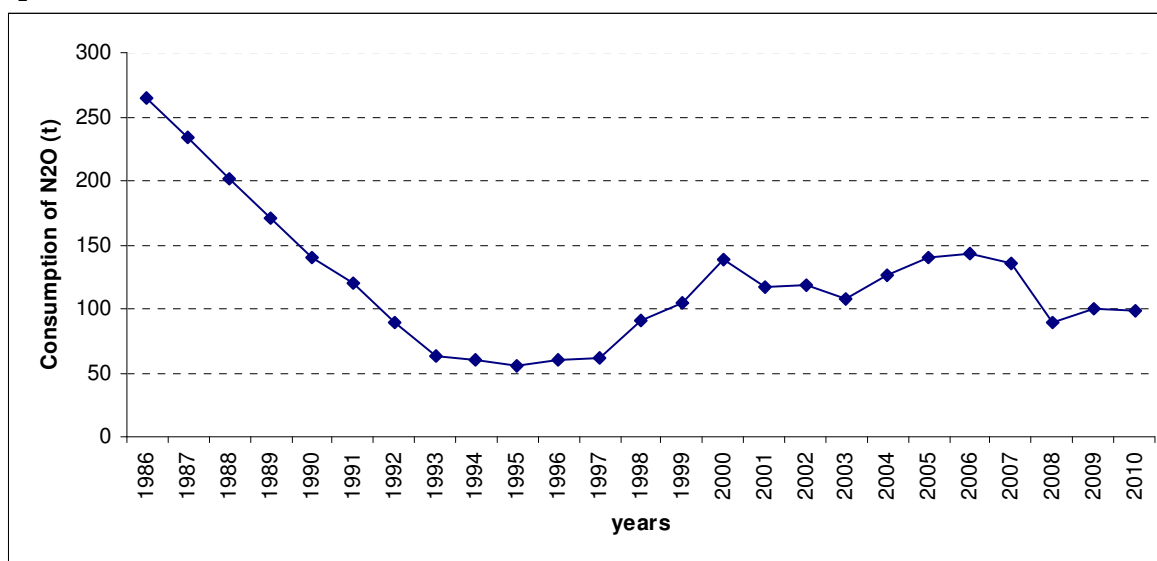


Figure 5.2.1: Consumption of N<sub>2</sub>O.

This chapter presents N<sub>2</sub>O emissions arising from use of N<sub>2</sub>O in the health service, and to a lesser extent also in food industry. Emissions of N<sub>2</sub>O for the year 1986 and the period 1993 to 1998 have been estimated in the research project done by the Chamber of Commerce and Industry of Slovenia. Data required for emission calculation from 1999 onwards have been obtained from the Statistical Office of the Republic of Slovenia. Consumption of N<sub>2</sub>O has been calculated from data on import and export. Since 1999, there is no N<sub>2</sub>O production in Slovenia. N<sub>2</sub>O emissions are reported under 3.D.1. Use of N<sub>2</sub>O 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 recalculation 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<sub>4</sub> emissions from enteric fermentation and manure management as well as N<sub>2</sub>O emissions from manure management and emissions from agricultural soils (direct and indirect emissions and emissions from grazing animals).

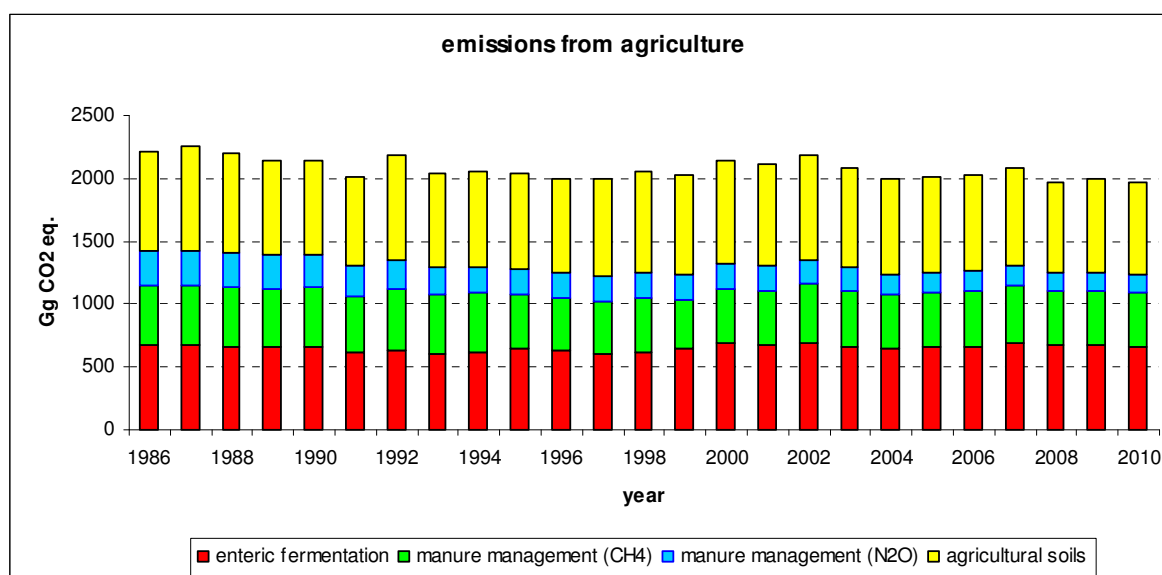


Figure 6.0.1: CH<sub>4</sub> and N<sub>2</sub>O emissions from agriculture activities in Gg CO<sub>2</sub> eq.

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<sub>4</sub> Emissions from Enteric Fermentation

dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH <sub>4</sub>	1.22		15
2010	Level, Trend	CH <sub>4</sub>	0.71	1.48	19

non-dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH <sub>4</sub>	0.84		22
2010	Level, Trend	CH <sub>4</sub>	1.16	0.93	10

**Swine, goats, horses, sheep** Key sector - Base year: no  
Key sector - Year 2010: no

### 6.1.1 Source category description

CH<sub>4</sub> 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.

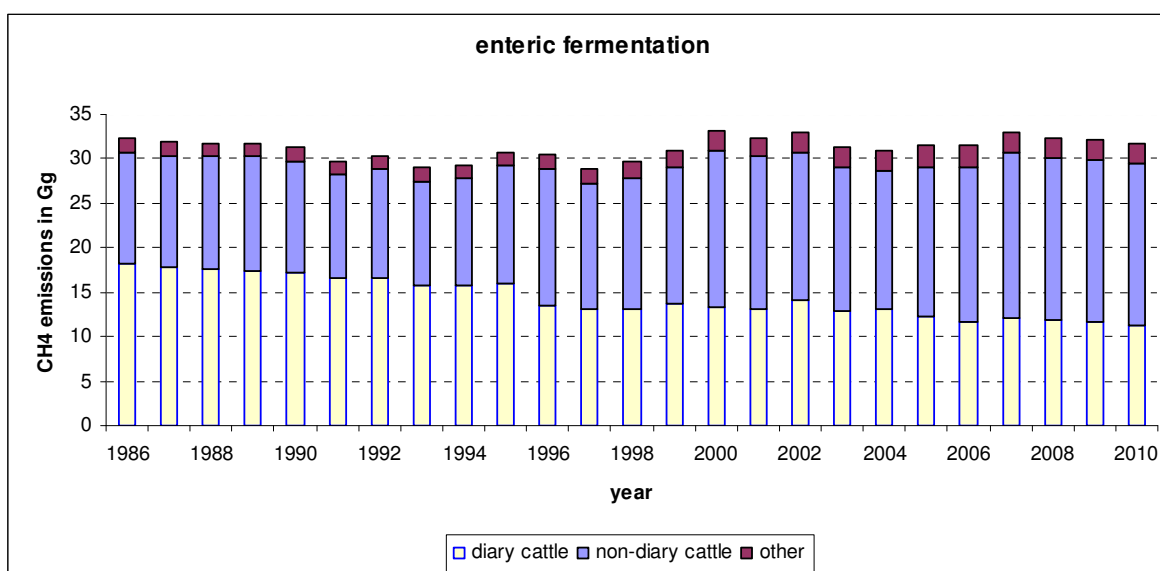


Figure 6.1.1: CH<sub>4</sub> emissions from enteric fermentation in Gg.

CH<sub>4</sub> 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<sub>4</sub> emissions from enteric fermentation while non-dairy cattle represent about 53% of total CH<sub>4</sub> from enteric fermentation. Jointly, cattle are responsible for almost 87% of total CH<sub>4</sub> 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<sub>4</sub> 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).

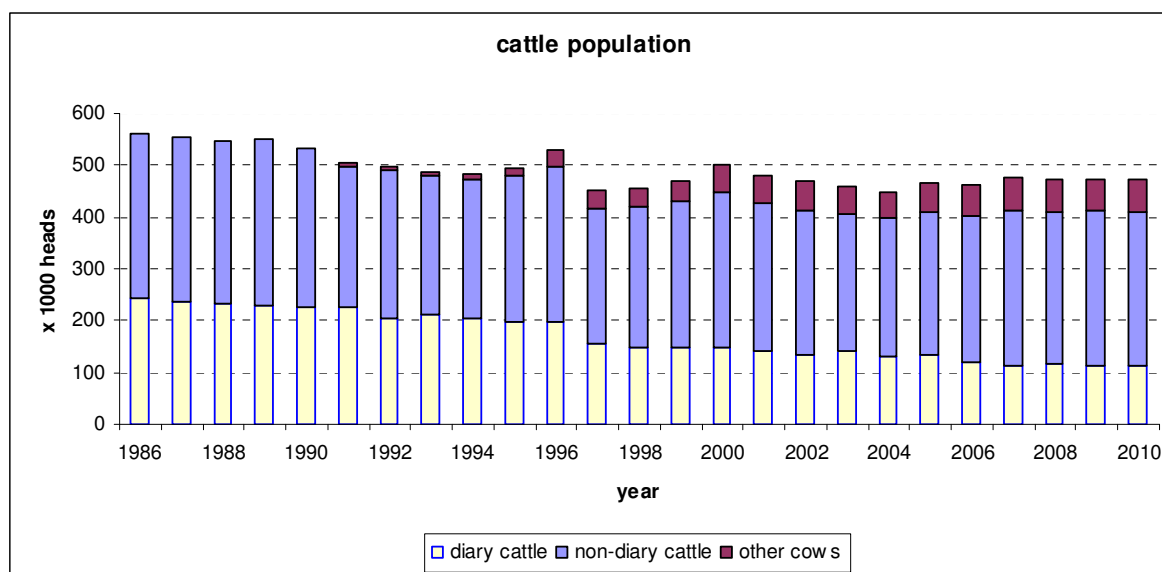
The detailed data about cattle are available in the Annex 3 to the NIR. In the category dairy cattle only dairy cows over 2 years have been included while non-dairy cattle consists of all other cattle groups. In the IPCC category non-dairy cattle the suckler-cows (named also other cows over 2 years) 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
<b>Dairy cattle</b>	<b>dairy cows over 2 years</b>
<b>Non-dairy cattle</b>	<b>all other cattle</b>
other cows (suckler-cows)	other cows over 2 years
other non-dairy cattle	<p><b>YOUNG CATTLE – under 1 year</b>  calves for slaughter- young bulls  calves for slaughter - young heifers  calves for fattening - young bulls  calves for fattening - young heifers</p> <p><b>YOUNG CATTLE – 1 -2 years</b>  breeding heifers in calf  other breeding heifers  heifers for fattening  bulls, oxen</p> <p><b>CATTLE – over 2 years</b>  breeding heifers in calf  other breeding heifers  heifers for fattening  bulls for breeding  bulls and oxen for fattening</p>

**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, dairy and non-dairy 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.

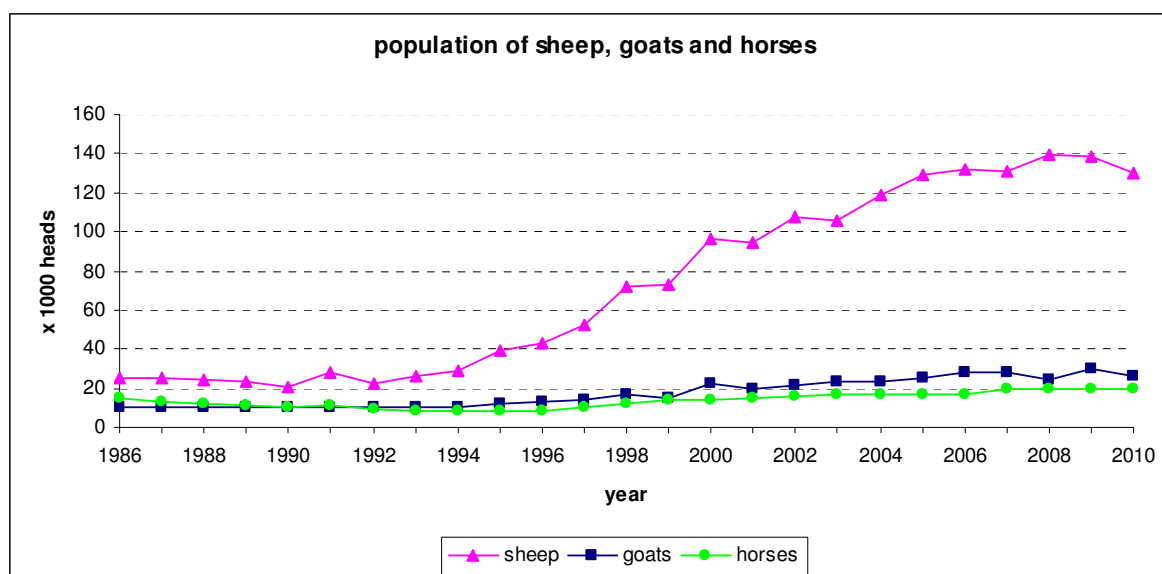


Figure 6.1.3: Number of sheep, goats and horses in thousands.

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  $W = 418.8 + 0.0313 \times M$  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 Spiekens (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:

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

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):

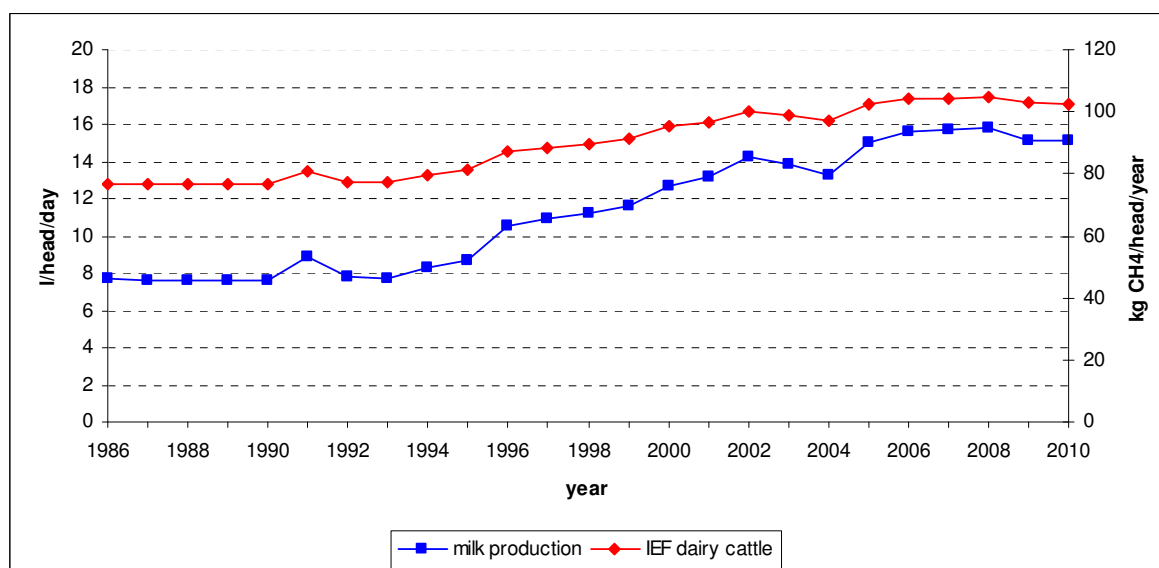
Emissions (kg/animal/year) = GE (MJ/year)  $\times$   $Y_m \div 55.65$  MJ/ kg of methane

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
<b>Milk yield kg/head/year</b>	2817	2763	2772	2795	2775	3252	2835	2800	3014
<b>EF kg/head/year</b>	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
<b>Milk yield kg/head/year</b>	3831	3975	4091	4252	4625	4807	5198	5062	3831
<b>EF kg/head/year</b>	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		
<b>Milk yield kg/head/year</b>	4853	5479	5708	5726	5764	5531	5517		
<b>EF kg/head/year</b>	97.4	102.6	104.0	104.4	104.8	102.8	102.6		

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 CH<sub>4</sub>/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 102.8 kg/head/year seems 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

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

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:

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

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

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  $\frac{1}{2}$  of the category of calves of up to 6 months and after 2000, only  $\frac{3}{4}$  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		
Other cows	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		
Non-dairy c.	49.4	50.6	51.1	50.9	50.9	50.5	50.8		

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 population of swine (Figure 6.1.5) 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 2000-2010.

Based on data from the Statistical Office of the Republic of Slovenia (SY) on total weight gain, herd size in commercial pig farms and private sector as well as estimated average weight gains in commercial conditions (Šalehar et al., 1998) it is estimated that the weight gain in swine on small scale family farms does not differ significantly from weight gains in market oriented family farm production (approximately 600 g/day). Consequently, in estimating emissions, only the difference in the mass at the time of slaughter is taken into account. For swine on commercial pig farms and market oriented family farms, the

emission factor suggested by IPCC has been taken into account - 1.5 kg methane per head annually, while for swine on small scale family farms, the emission factor of 2.33 kg of methane per head annually has been taken into account (estimated on the basis of body mass differences) (Verbič, Sušin, Podgoršek 1999, p. 6).

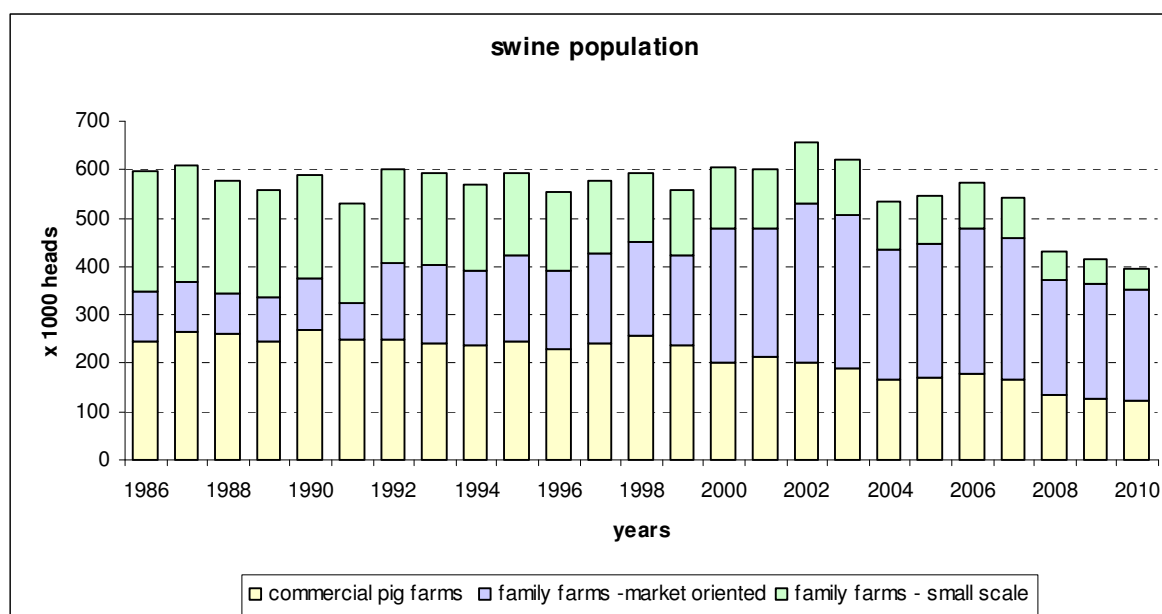


Figure 6.1.5: Number of swine in thousands.

Higher emission factor for swine on small scale family farms is based on higher body mass in comparison to pigs on commercial pig farms. There are no exact data on slaughter weight of pigs belonging to this category; however, it was estimated to be 170 kg. The value is considerably higher than for pigs from commercial farms (110 kg). About 15 to 20 % of total pigs were reared on small scale family farms during the period 2000-2010 and as a result, the average emission factor for swine was higher than the IPCC default value (1.5 kg CH<sub>4</sub>/head/year).

Table 6.1.3: EFs for swine.

EF kg/head/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
swine	1.84	1.83	1.83	1.83	1.80	1.82	1.77	1.76	1.76
EF kg/head/year	1995	1996	1997	1998	1999	2000	2001	2002	2003
swine	1.74	1.74	1.72	1.70	1.70	1.67	1.67	1.66	1.65
EF kg/head/year	2004	2005	2006	2007	2008	2009	2010		
swine	1.65	1.65	1.64	1.63	1.62	1.61	1.59		

### 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**

No recalculations have been performed for this category.

#### **6.1.5 Future improvements**

No improvement is planned for the future.

## 6.2 CH<sub>4</sub> Emissions from Manure Management

dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH <sub>4</sub>	0.48		26
2010	Level	CH <sub>4</sub>	0.40	0.25	26

non-dairy cattle	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CH <sub>4</sub>	0.21		38
2010	Level, Trend	CH <sub>4</sub>	0.51	0.86	23

swine	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CH <sub>4</sub>	0.74		24
2010	Trend	CH <sub>4</sub>	0.36	1.09	29

goats, horses, sheep, poultry

Key sector - Base year: no

Key sector - Year 2010: no

### 6.2.1 Source category description

In storing solid and/or liquid manure, both methane and N<sub>2</sub>O 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<sub>2</sub>O prevails in storage of solid manure.

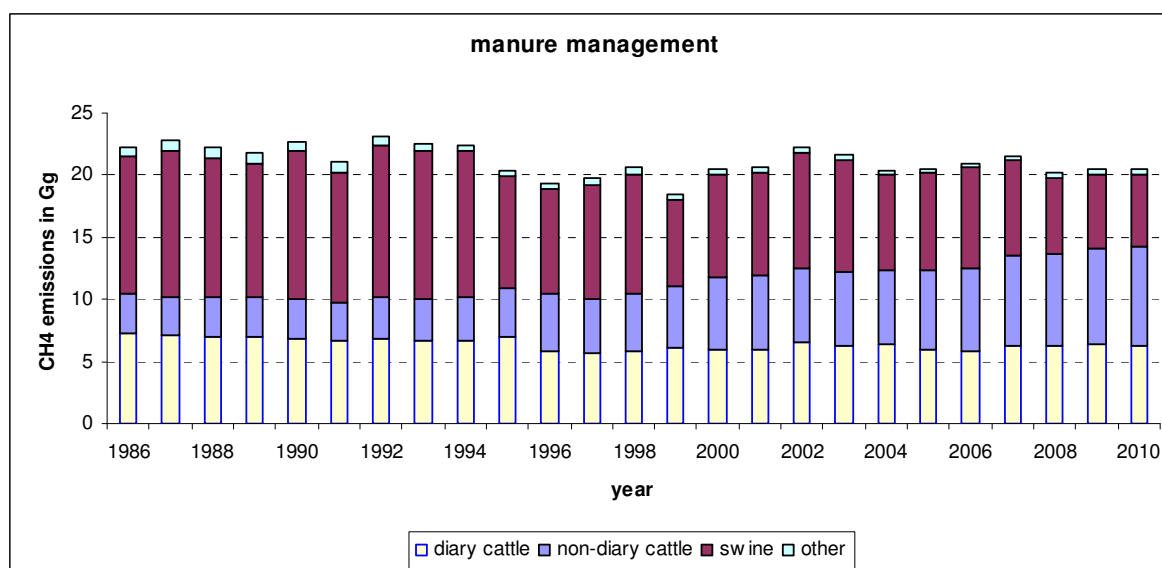
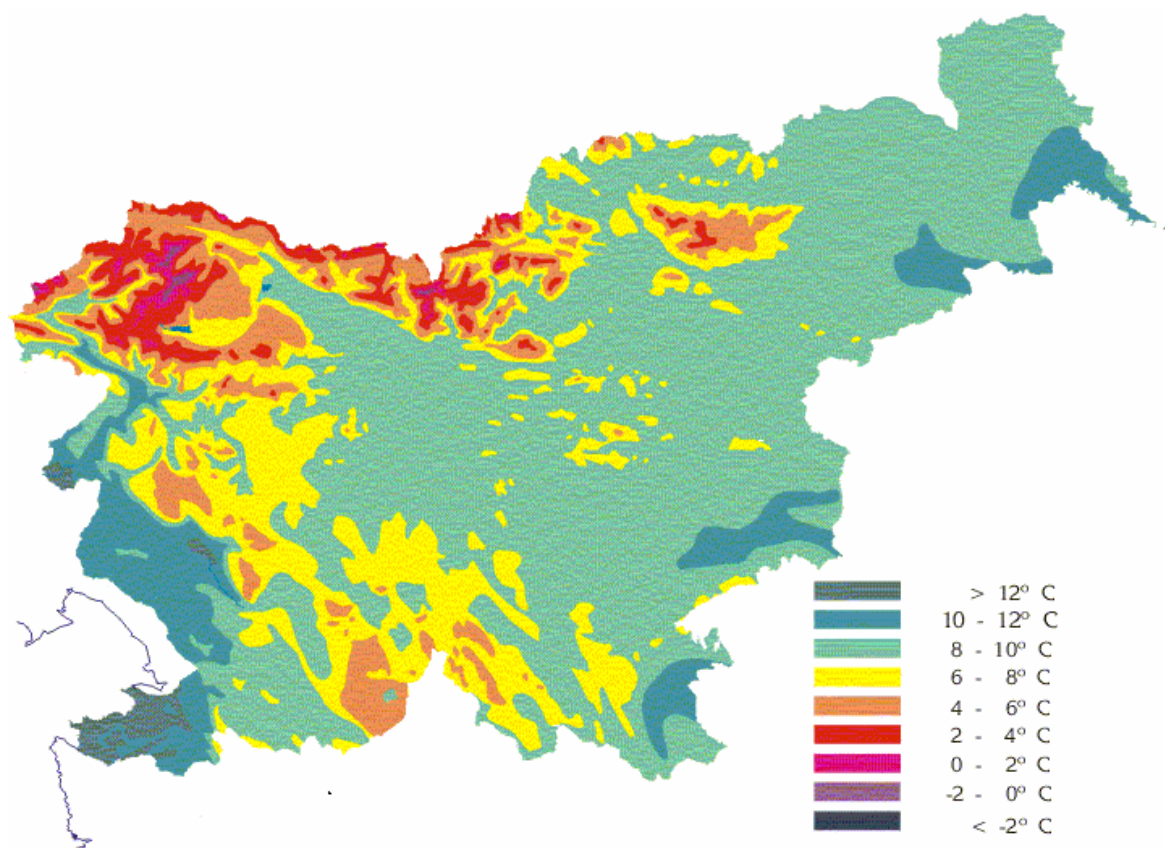


Figure 6.2.1: CH<sub>4</sub> emissions from manure management in Gg.



**Figure 6.2.2: The average yearly temperature in Slovenia.**

([http://www.arso.gov.si/podro~cja/vreme\\_in\\_podnebie/napovedi\\_in\\_podatki/temperaturna\\_karta.html](http://www.arso.gov.si/podro~cja/vreme_in_podnebie/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 below 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).

$$VS \text{ (kg/day)} = \text{gross energy intake (MJ/day)} \times (1 \text{ kg}/18.45 \text{ MJ}) \times (1 - \text{DE\%/100}) \times (1 - \text{ash\%/100})$$

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 ( $E_{\text{M MANURE}}$ ) was estimated according to the equation:

$$E_{\text{M MANURE}} = VS \text{ (kg/day)} \times 365 \text{ days/year} \times B_0 \text{ (m}^3\text{/kg VS)} \times 0.67 \text{ kg/m}^3 \times \text{MCF}$$

As for the methane producing capacity of manure  $B_0$  for dairy cows, the value of 0.24 m<sup>3</sup>/kg VS was considered, for other bovine animals it was 0.17 m<sup>3</sup>/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 and 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 CH<sub>4</sub> 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		
Dairy cattle	48.1	49.7	51.4	53.2	54.9	55.9	57.4		
Non-dairy c.	18.5	19.0	19.8	20.3	21.0	21.5	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 lower (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		
MCF 39%	48.1	49.7	51.4	53.2	54.9	55.9	57.4		
MCF 20%	25.3	26.1	27.0	27.9	28.7	29.2	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

Annual emissions of methane ( $E_{\text{M MANURE}}$ ) have been estimated according to the IPCC method. Quantities of excreted volatile solids (VS) have been calculated for commercial pig farms and market oriented family farms, considering that each swine daily excretes 0.5 kg of VS (IPCC, 1996). For small scale family farm production, considering the higher body weight, 0.775 kg VS/day has been taken into account. For the methane-producing capacity of manure  $B_0$ , the value for swine (0.45 m<sup>3</sup>/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  $K_{\text{F MANURE}}$  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 decreased to 0.213.

**Table 6.2.3: EFs for swine.**

EF kg/head/year	1986	1987	1988	1989	1990	1991	1992	1993	1994
swine	18.6	19.3	19.4	19.3	20.1	19.9	20.3	20.3	20.5
EF kg/head/year	1995	1996	1997	1998	1999	2000	2001	2002	2003
swine	15.4	15.3	15.8	16.2	12.4	13.8	13.7	14.3	14.4
EF kg/head/year	2004	2005	2006	2007	2008	2009	2010		
swine	14.4	14.4	14.0	14.0	13.9	14.3	14.6		

#### 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.

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.

**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.

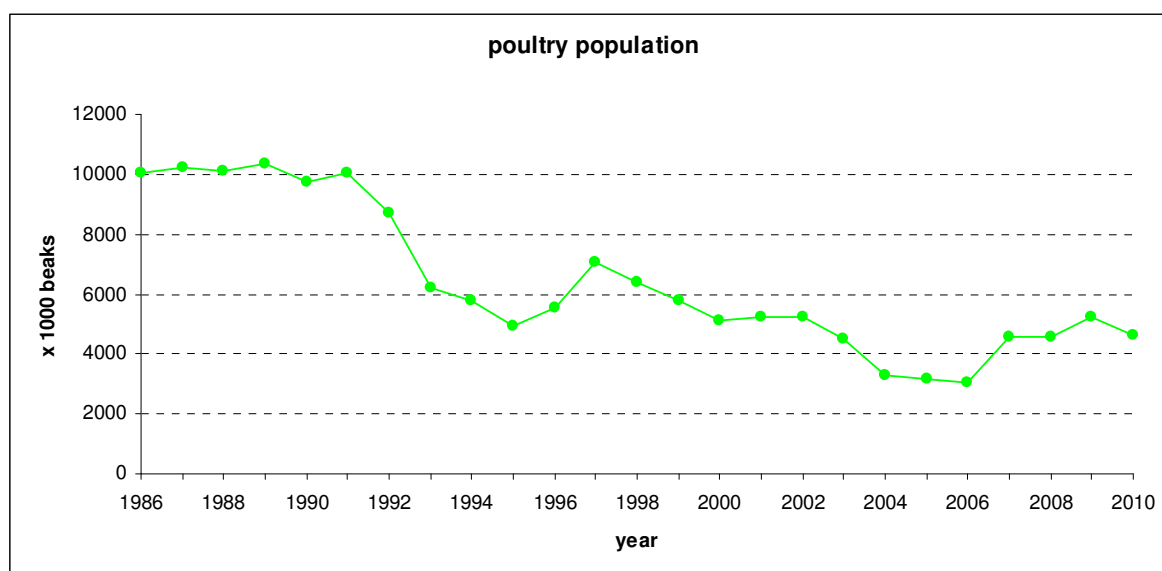


Figure 6.2.3: Number of poultry in thousands.

**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 EF 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**

A small correction for VS for non-dairy cattle has influenced that CH<sub>4</sub> EF has changed from 7.75 to 7.74 kt CH<sub>4</sub>/head/year in 2009.

**6.2.5 Future improvements**

No improvement is planned for this sector.

### 6.3 N<sub>2</sub>O Emissions from Manure Management

Solid storage and dry lot	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	N <sub>2</sub> O	0.85		21
2010	Level, Trend	N <sub>2</sub> O	0.39	1.33	27

**Liquid systems, Anaerobic lagoons, other systems:** Key sector - Base year: no  
2010: 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.

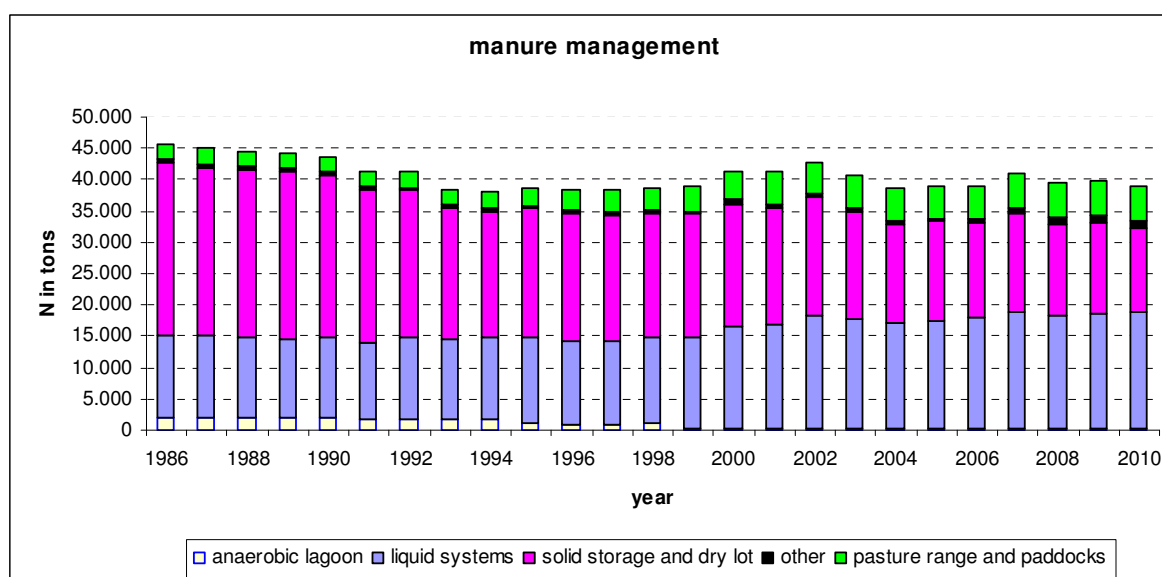


Figure 6.3.1: Nitrogen excretion per different AWMS in tons.

#### 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
<b>Nex kg/head/year</b>	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
<b>Nex kg/head/year</b>	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		
<b>Nex kg/head/year</b>	103.5	110.0	112.4	112.6	113.0	110.6	110.4		

**Table 6.3.2: Nitrogen excretion rates for non-dairy cows.**

	1986	1987	1988	1989	1990	1991	1992	1993	1994
<b>Nex kg/head/year</b>	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
<b>Nex kg/head/year</b>	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		
<b>Nex kg/head/year</b>	41.5	42.4	42.6	42.3	42.5	42.3	42.6		

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<sub>3</sub> 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-diary 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
<b>non-dairy cattle (total)</b>	<b>359,775</b>			<b>40.4</b>

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
<b>non-dairy cattle (total)</b>	<b>360,684</b>			<b>40.6</b>

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 ( $0.5 \cdot 20$  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 then 6 months.

**Table 6.3.4: Nex for swine in various countries in 2009.**

2009	Nex
Croatia	20
Germany	12.14
<b>Slovenia</b>	<b>11.92</b>
Italy	11.78
Austria	9.57
Hungary	8.07
<b>Slovenia (IPCC, 2006)</b>	<b>11.15</b>

Following recommendation from 2011 review Nex used in Slovenia have been compared to the value used in neighbouring countries and other European countries with similar management practice. The comparison have been made with 2009 data. The N excretions 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  $N_2O-N$  /kg N? IPCC default value is equal to 0.005 kg  $N_2O-N$  /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  $N_2O-N$ /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. For battery-cage system for layers 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).

### 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

No recalculations have been performed for this category.

### 6.3.5 Future improvements

No improvement is planned for this sector.

## 6.4 Emissions from Agricultural Soils

Three sources of N<sub>2</sub>O are distinguished in the IPCC methodology: direct emissions from agricultural soil, direct soil emissions from animal production (grazing animals) and N<sub>2</sub>O emissions indirectly induced by agricultural activities.

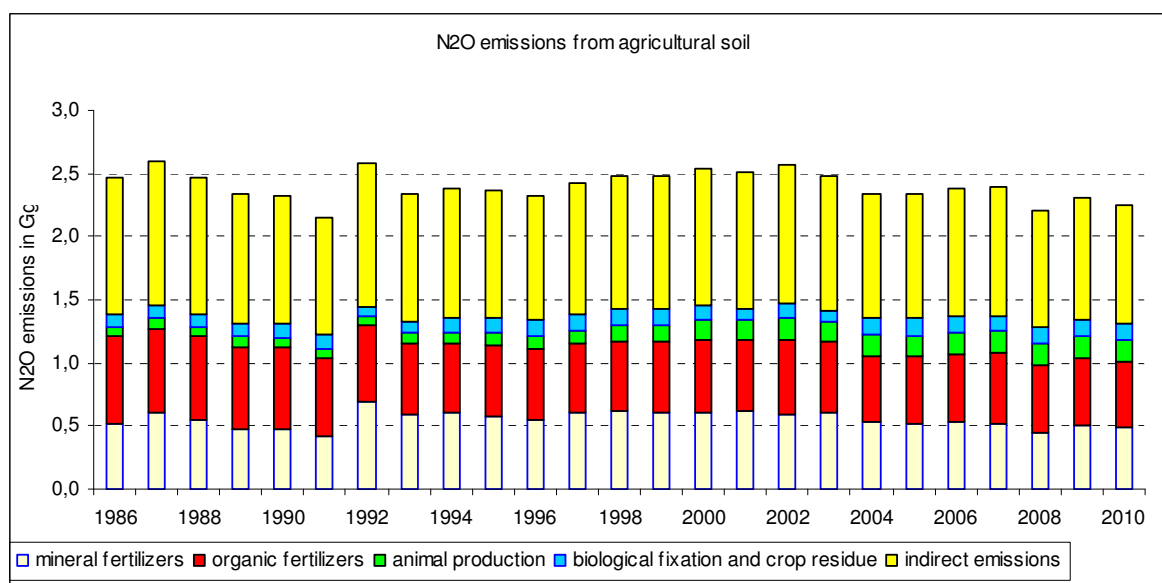


Figure 6.4.0: N<sub>2</sub>O emissions from agricultural soil in Gg.

### 6.4.1 Direct N<sub>2</sub>O Emissions from Agricultural Soil

direct soil emissions	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	N <sub>2</sub> O	1.38		13
2010	Level, Trend	N <sub>2</sub> O	1.14	0.69	11

#### 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):

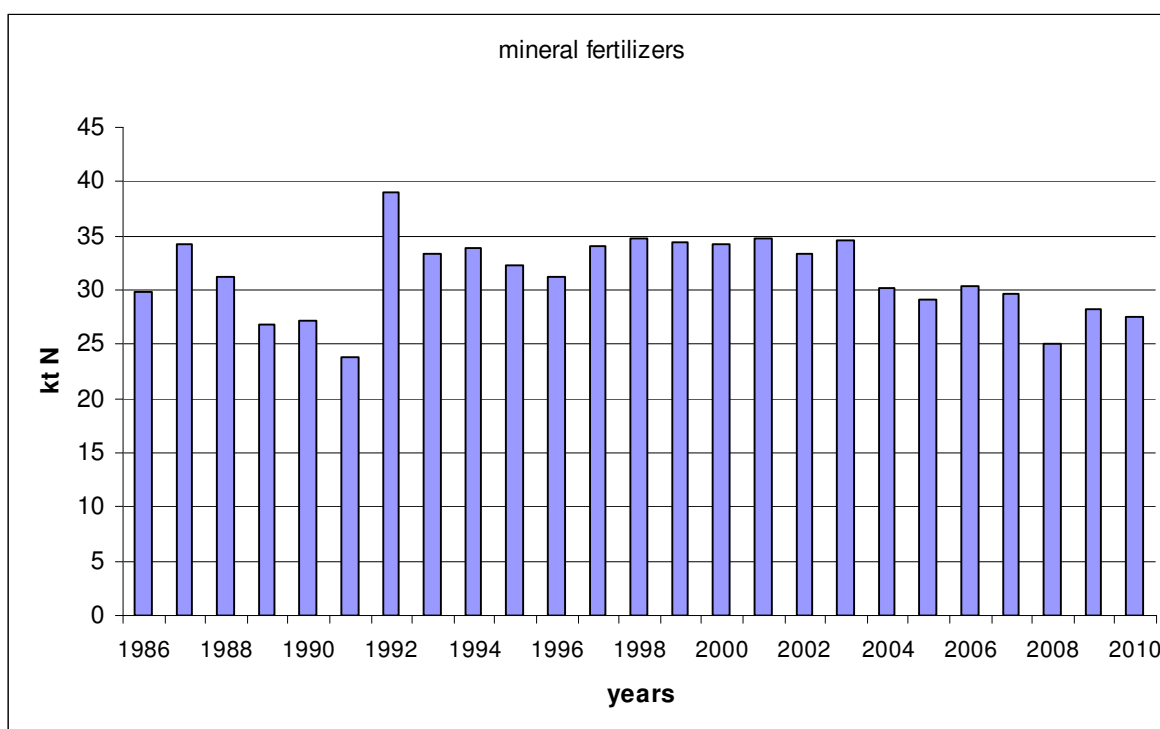
- Mineral fertilizers
- Organic fertilizers (solid and liquid manure) from animal husbandry
- Biological fixation of nitrogen
- Crop residue
- Cultivation of high-organic content (peat) soil
- Sewage sludge

### 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<sub>x</sub> (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<sub>2</sub>O-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<sub>2</sub>O 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<sub>x</sub>. 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<sub>2</sub>O-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<sub>2</sub>O-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<sub>2</sub>O-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<sub>2</sub>O emissions in CO<sub>2</sub> eq.**

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Area (ha)	7405	7338	7270	7203	7136	7069	7001	6934	6867
CO <sub>2</sub> 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
CO <sub>2</sub> 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		
CO <sub>2</sub> in Gg eq.	26.80	26.91	26.83	26.75	26.77	26.83	26.86		

**Table 6.4.4: Utilized area of organic soil according national class ID**

Code	Utilized area (ha)	2005	2006	2007	2008	2009	2010
1100	Arable land	3232	2735	2239	2233	2248	2259
1180	Other permanent crops on arable land	0	0	0	0	1	1
1190	Greenhouses	0	0	1	0	0	0
1211	Vineyards	0	1	2	0	0	0
1221	Intensive orchards	0	8	15	18	18	18
1222	Extensive orchard	7	9	10	10	10	10
1240	Other permanent crop	16	9	1	0	0	0
1300	Meadows and pastures	763	589	416	185	190	279
1321	Swampy meadows and pastures	2294	2912	3530	3775	3795	3717
1410	Overgrown areas	112	165	218	223	221	217
1420	Forest plantation	127	69	10	10	10	10
1500	Mixed land use area	354	338	323	319	310	306
1600	Uncultivated agriculture land	0	49	98	94	80	71
1800	Forest trees on agricultural land	0	1	2	2	2	2
2000	Forest	788	860	933	926	920	920
3000	Built-up areas and related surfaces	364	382	399	398	395	398
4100	Swamps	58	53	49	48	45	45
4210	Reeds	11	12	13	13	13	13
4220	Other marshy areas	55	45	35	34	34	26
7000	Waters	110	100	91	92	91	90
<b>Total</b>	<b>Use of histosols (all uses)</b>	<b>8291</b>	<b>8337</b>	<b>8383</b>	<b>8379</b>	<b>8383</b>	<b>8383</b>
<b>Total</b>	<b>Agricultural use of hist. (1100-1800)</b>	<b>6906</b>	<b>6885</b>	<b>6864</b>	<b>6868</b>	<b>6884</b>	<b>6891</b>
<b>Total</b>	<b>Cultivated histosols (1100 - 1240)</b>	<b>3255</b>	<b>2762</b>	<b>2268</b>	<b>2262</b>	<b>2277</b>	<b>2289</b>



Detailed data about use of agricultural area for 2005-2010 are in the table 6.4.4. The data for 2006 have been interpolated. For N<sub>2</sub>O 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<sub>2</sub>O 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<sub>2</sub>O emissions from sewage sludge was 0.09 Gg CO<sub>2</sub> 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<sub>3</sub> and NO<sub>x</sub> according to the equation below:

$$F_{SS} = N_{SS} * (1 - \text{Frac}_{SS})$$

Where:

$F_{SS}$  = annual amount of sewage sludge nitrogen applies to soils adjusted to account for the amount that volatilises as NH<sub>3</sub> and NO<sub>x</sub>

$N_{SS}$  = annual amount of sewage sludge nitrogen

$\text{Frac}_{SS}$  = fraction of sewage sludge nitrogen that volatilises as NH<sub>3</sub> and NO<sub>x</sub>

For the calculation of NH<sub>3</sub> volatilisation the CORINAIR default emission factor for slurry spreading (0.15 kg NH<sub>3</sub>-N per kg sewage sludge N) was applied (EEA 2007) while for NO<sub>x</sub>-N losses the conservative emission factor of 1% of sewage sludge nitrogen (Freibauer and Kaltschmitt, 2001) has been used.  $\text{Frac}_{SS}$  used is therefore 0.16. All these values have been taken from Austrian GHG inventory submission 2010.

The direct N<sub>2</sub>O emissions are calculated according equation:

$$N_2O = F_{SS} * EF_{DIR} * 44/28$$

For  $EF_{DIR}$  IPCC default value of 0.0125 kg N<sub>2</sub>O-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 <sub>ss</sub>	Sewage sludge applied kg N	EF kg N <sub>2</sub> O - N/kg N	Emissions kg N <sub>2</sub> O	Emissions Gg CO <sub>2</sub> 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	439.050	17,123	0.16	14,383	0.0125	283	0.088
2004	79,620	3,105	0.16	2,608	0.0125	51	0.016
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

#### 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 amount of sewage sludge applied to the agricultural soils have been updated for 2003, 2004 and for the period 2007 to 2009 and direct N<sub>2</sub>O emissions from the sewage sludge application have been recalculated accordingly

In 2009 also area of cultivated histosols has changed.

#### 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 2010: 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<sub>2</sub>O Emissions from Manure Management). IPCC methodology (1996) suggests using the same emission factor (0.02 kg N<sub>2</sub>O-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<sub>2</sub>O emissions from Agricultural Soil

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
<b>Base Year</b>	Level	N <sub>2</sub> O	1.06		17
<b>2010</b>	Level, Trend	N <sub>2</sub> O	0.88	0.53	16

#### 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<sub>x</sub>)
- 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<sub>3</sub>) and nitrogen oxides (NO<sub>x</sub>)

In fertilizing agricultural soils with nitrogen fertilizers, some N volatilises in form of ammonia and nitrogen oxides (NO<sub>x</sub>). 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  $\text{N}_2\text{O}$ . Emissions are attributed to the place of origin of ammonia and  $\text{NO}_x$ , not to the place where N is re-deposited, causing  $\text{N}_2\text{O}$  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  $\text{N}_2\text{O}$ -N/kg  $\text{NH}_3$  and  $\text{NO}_x$ -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  $\text{N}_2\text{O}$ -N/kg  $\text{NH}_3$ -N and  $\text{NO}_x$ -N (IPCC, 1996).

#### Emissions from sewage sludge:

Emissions have been calculated according to the methodology described in IPCC GPG 2000.

$\text{N}_2\text{O}$  emissions from atmospheric deposition of  $\text{NO}_x$  and  $\text{NH}_3$  are calculated according the equation bellow:

$$\text{N}_2\text{O} = \text{N}_{\text{SS}} * \text{Frac}_{\text{SS}} * \text{EF}_{\text{AD}} * 44/28$$

Where  $\text{EF}_{\text{AD}}$  is IPCC default 0.01 kg  $\text{N}_2\text{O}$  -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  $\text{N}_2\text{O}$ -N is emitted (IPCC, 1996). The applied emission factor is a sum of partial factors (denitrification in soil or in groundwater 15 g  $\text{N}_2\text{O}$ -N/kg N, denitrification in river sediments 2.5 g  $\text{N}_2\text{O}$ -N/kg N, nitrification in rivers 5 g  $\text{N}_2\text{O}$ -N/kg N, nitrification in estuaries 2.5 g  $\text{N}_2\text{O}$ -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<sub>2</sub>O-N/kg of leached/run-off N).

Nitrogen leaching and runoff into groundwater, surface waters, and watercourses due to sewage sludge:

Emissions of N<sub>2</sub>O 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<sub>LEACH</sub> is IPCC default 0.3 kg N/kg N input to the soils and EF<sub>LEACH</sub> is IPCC default 0.025 kg N<sub>2</sub>O-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 amount of sewage sludge applied to the agricultural soils in 1986-1999 have been included in the inventory for the first time while for the years 2003, 2004 and for the period 2007 to 2009 the updated values have been used. This recalculation has 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<sub>4</sub> – Country specific CH<sub>4</sub> EF for cattle and swine has been compared with IPCC default
- Manure management – CH<sub>4</sub> - Country specific CH<sub>4</sub> EFs for cattle and swine has been compared with IPCC default and with EFs used in other European countries with similar climate
- Manure management – N<sub>2</sub>O – 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 <sub>2</sub>	29.10		1
2010	Level, Trend	CO <sub>2</sub>	32.63	10,28	1

Land converted to Cropland	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	3.44		7
2010	Level, Trend	CO <sub>2</sub>	3.61	0.49	4

Land converted to Settlements	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	1.49		11
2010	Level, Trend	CO <sub>2</sub>	1.82	0.97	8

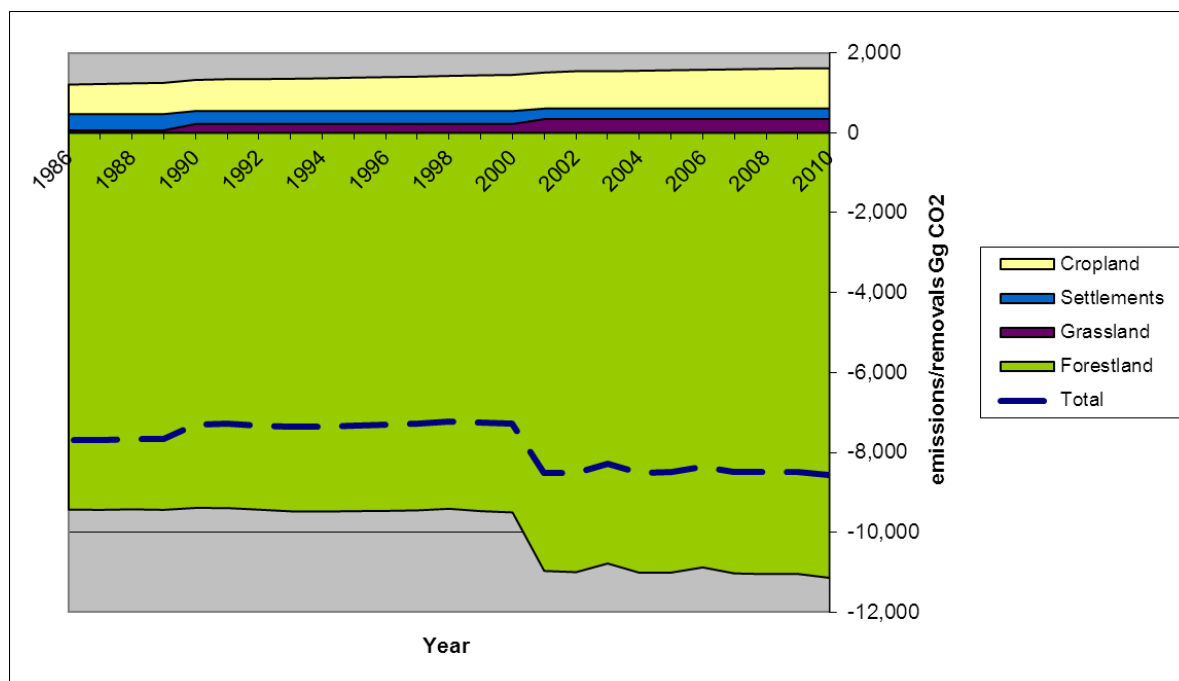
Cropland Remaining Cropland	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	0.39		28
2010	Level, Trend	CO <sub>2</sub>	1.24	2.44	9

Land converted to Grassland	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CO <sub>2</sub>	0.20		39
2010	Level, Trend	CO <sub>2</sub>	1.03	2.39	15

Land converted to Forest Land	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	Level	CO <sub>2</sub>	0.85		20
2010	Level	CO <sub>2</sub>	0.81	0.13	17

## 7.1 Overview of sector

The Land Use, Land-Use Change and Forestry (LULUCF) sector in 2010 as a whole acted as a CO<sub>2</sub> sink of –8,757.95 Gg CO<sub>2</sub> because total emissions arising from the sector were smaller than the total removals.



**Figure 7.1.1: Net emissions and removals in the LULUCF sector in 1986-2010 by land-use category, Gg CO<sub>2</sub>.**

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<sub>2</sub>O emissions from N fertilization, N<sub>2</sub>O emissions from drainage of soils, N<sub>2</sub>O emissions from disturbance associated with land-use conversion to cropland, CO<sub>2</sub> emissions from agricultural lime application, and non-CO<sub>2</sub> 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.

Land uses in reporting year are presented in Table 7.1.1.



**Table 7.1.1: Land use by categories in year 2010.**

Area	kha	%
Forests	1,244.268	61.4
Cropland	222.700	11.0
Grassland	407.817	20.1
Wetlands	13.440	0.7
Settlements	112.836	5.6
Other land	26.240	1.3
Sum	2,027.300	100.0

Table 7.1.2 summarizes the CO<sub>2</sub> emissions and removals in consequence of carbon losses and gains for the years 1986 – 2010. The total net removals of CO<sub>2</sub> from LULUCF sector from 1986 to 2010 vary between -7,215.1 Gg (1998) and -8,575.9 Gg (2010). The main sink category in LULUCF in Slovenia is forest land remaining forest land.

**Table 7.1.2: Emissions and removals from sector 5 LULUCF by sub categories in Gg CO<sub>2</sub>**

	Total	Forestland	Cropland	Grassland	Wetland	Settlements	Other land
year	Gg CO <sub>2</sub> /yr	Gg CO <sub>2</sub> /yr	Gg CO <sub>2</sub> /yr	Gg CO <sub>2</sub> /yr	Gg CO <sub>2</sub> /yr	Gg CO <sub>2</sub> /yr	Gg CO <sub>2</sub> /yr
2010	-8,575.946	-11,138.328	1,612.649	343.038	NE,NO	606.695	NA,NO
2009	-8,477.231	-11,039.613	1,612.649	343.038	NE,NO	606.695	NA,NO
2008	-8,492.442	-11,043.132	1,600.957	343.038	NE,NO	606.695	NA,NO
2007	-8,489.025	-11,027.510	1,588.752	343.038	NE,NO	606.695	NA,NO
2006	-8,349.067	-10,875.788	1,576.988	343.038	NE,NO	606.695	NA,NO
2005	-8,490.502	-11,006.733	1,566.498	343.038	NE,NO	606.695	NA,NO
2004	-8,507.001	-11,009.662	1,552.927	343.038	NE,NO	606.695	NA,NO
2003	-8,288.390	-10,778.966	1,540.843	343.038	NE,NO	606.695	NA,NO
2002	-8,504.088	-10,995.364	1,541.542	343.038	NE,NO	606.695	NA,NO
2001	-8,506.877	-10,965.219	1,508.609	343.038	NE,NO	606.695	NA,NO
2000	-7,280.714	-9,500.637	1,450.998	222.213	NE,NO	546.712	NA,NO
1999	-7,259.739	-9,468.012	1,439.348	222.213	NE,NO	546.712	NA,NO
1998	-7,215.097	-9,409.167	1,425.145	222.213	NE,NO	546.712	NA,NO
1997	-7,275.193	-9,449.242	1,405.125	222.213	NE,NO	546.712	NA,NO
1996	-7,298.452	-9,461.707	1,394.331	222.213	NE,NO	546.712	NA,NO
1995	-7,318.100	-9,467.814	1,380.790	222.213	NE,NO	546.712	NA,NO
1994	-7,347.139	-9,479.847	1,363.783	222.213	NE,NO	546.712	NA,NO
1993	-7,352.261	-9,473.518	1,352.333	222.213	NE,NO	546.712	NA,NO
1992	-7,318.355	-9,430.693	1,343.414	222.213	NE,NO	546.712	NA,NO
1991	-7,279.474	-9,391.337	1,342.939	222.213	NE,NO	546.712	NA,NO
1990	-7,295.184	-9,387.883	1,323.774	222.213	NE,NO	546.712	NA,NO
1989	-7,652.228	-9,435.576	1,250.660	64.347	NE,NO	468.340	NA,NO
1988	-7,653.245	-9,423.298	1,237.366	64.347	NE,NO	468.340	NA,NO
1987	-7,680.288	-9,435.543	1,222.567	64.347	NE,NO	468.340	NA,NO
1986	-7,689.869	-9,429.214	1,206.658	64.347	NE,NO	468.340	NA,NO

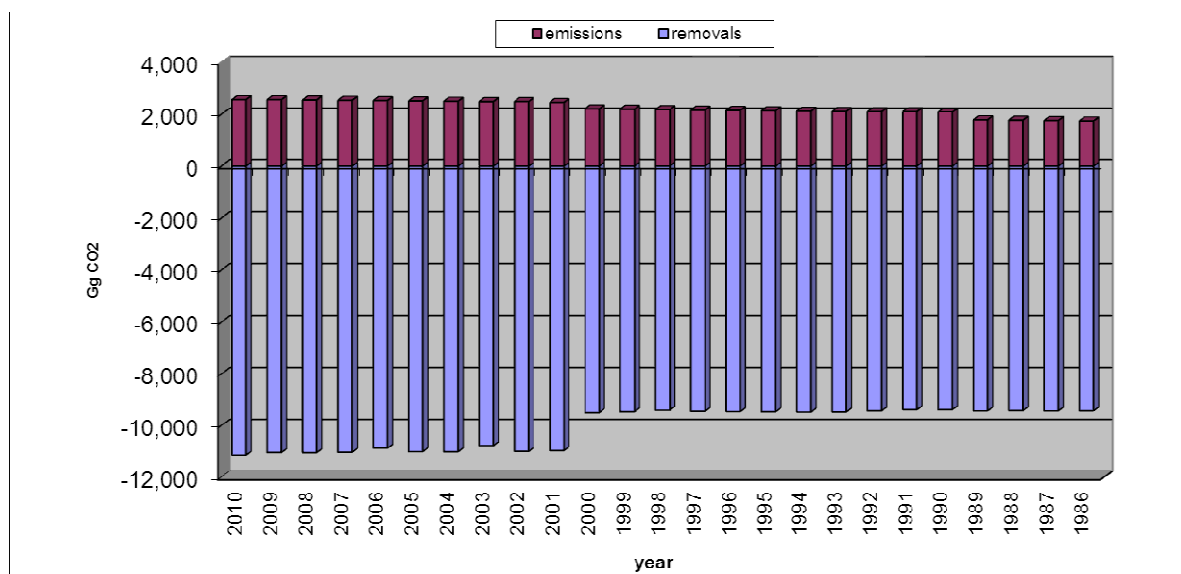


Figure 7.1.2: LULUCF sector emissions and removals from 1986 to 2010.

## 7.2 Methodological issues for LULUCF in Slovenia

### 7.2.1 Land use and land use change in time period 1986 -2010

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 cover changes: the one published in the year 2002 (reflecting the land use / land cover situation from the year 1998), and the other published in 2008 (reflecting the situation in the year 2007). This is the first Slovenian database, where directly comparable data could be used for estimation of land use cover 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.

**Table 7.2.1: References to sources of information (GFRA 2010)**

References to sources of information	Variable(s)	Year(s)	Additional comments
Cadastre of Actual Agricultural Land Use. Ministry of Agriculture, Forestry and Food (MAFF) 2002 and 2008.	Land use / Land cover	1998, 2007	Land use photo interpreted in scale 1:5,000 from aerial imagery acquired in years 1994 to 2001; 1998 is the average year; covers also all the forested and urban areas.

The ALUM 2002 and 2008 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). In 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>

**Currently used land use change matrix is under revision (internal and external). Discrepancies in areas were noticed during preparation of NIR and by ERT during centralized review. Results of the revision will be implemented in 2013 submission.**

Definitions about specific land use from GPG 2003 for Slovenia are described below.

Definition of forest: Land spanning more than 0,5 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 0.25 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.

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 fallows ground. There are temporary meadows, uncultivated agricultural land 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, riparian overgrowths and forest hedges (by watercourses, field hedges...) and forest trees on agricultural land.

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 mountain 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

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 m<sup>2</sup>), waste and other opened areas. This is all land that is not classified in other land use definitions.

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 7.2.2, 7.2.3, and Table 7.2.5).

**Table 7.2.2: 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

**Table 7.2.3: Categories in ALUM in 2008**

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

**Table 7.2.4: Uncertainties for ALUM database.**

	% errors in land use
ALUM 2002 (agricultural land use map)	4,68
ALUM 2007	4,68

**Table 7.2.5: Categories from ALUM 2002 and 2008 delivered in six main categories from GPG IPCC 2003.**

Main category in IPCC	Sub category in IPCC	National class ID	remarks
Cropland 5.B			
	annual	1100	Arable land
		1130	Temporary meadows
		1160	Hop fields
		1190	Green houses
	perennial	1180	Other permanent crops on arable land
		1211	Vineyards
		1212	Nursery
		1221	Intensive orchards
		1222	Extensive orchards
		1230	Olive groves
		1240	Other permanent crops
		1420	Forest plantation
1800	Forest trees on agricultural land		
Grassland 5.C			
		1300	Meadows and pastures
		1321	Swampy meadows and pastures
		1330	Alpine meadows
		1500	Mixed land use (arable land and forest, small areas)
		1600	Uncultivated agriculture land
Forest 5.A			
		2000	Forest
		1410	Overgrown areas
Wetlands 5.D			
		4100	Swamps
		4210	Reeds
		4220	Other marshy areas
		7000	Waters (inland water bodies)
Settlements 5.E			
		3000	Built-up areas and related surfaces
Other land 5.F			
		6000	Open areas with little or no vegetation
		5000	Dried open areas with special vegetation

The cropland is separated on two subcategories: annual and perennial cropland.

### 7.2.1.1 Land use change matrix

The land areas in the period 1986-2010 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) and presented land use situation in 1998. The method was repeated in 2007. With these two maps of land use we could find out the land use changes between period 1998 and 2007. 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 1998 the down dating method was used. For land use changes in years 2008, 2009 and 2010 it is presumed that the changes stay the same as in years before.

**Table 7.2.6: The average annual land use change matrix for IPCC land use categories.**

ha / year	Forest land	Cropland perenial	Cropland annual	Grassland	Wetlands	Settlemets	Other land	Total
Forest land		754	86	1,982	82	984	199	4,086
Cropland perenial	807		195	1,271	50	402	1	2,726
Cropland annual	299	396		4,560	34	560	0	5,849
Grassland	3,083	1,651	1,967		111	1,146	6	7,964
Wetlands	74	42	9	203		72	15	414
Settlemets	221	401	70	1,163	31		3	1,888
Other land	362	56	1	647	10	11		1,087
Total	4,845	3,299	2,328	9,825	319	3,174	225	24,015

Currently used land use change matrix is under revision (internal and external). Discrepancies in areas were noticed during preparation of NIR and by ERT during centralized review. Results of the revision will be implemented in 2013 submission.

Land use areas for each land use were calculated using following equation.

$$Area_{LU, yearofinventory} = Area_{LU, previousinventoryyear} + Area_{landconvertedtoLU} - Area_{LUconvertedtootherlandcategory}$$

(Equation 1)

$Area_{LU, yearofinventory}$  - 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]  
 $Area_{LU, convertedtootherlandcategory}$  - area of selected land use category converted to other land use category [ha]

The final areas of individual land use were corrected with total area of Slovenia. Areas from basic year to 2010 are in Table 7.2.7. The results were compared with a spatial sampling



approach method (Kobler 2008) and the results were very similar. A spatial sampling method is described in Slovenian National Inventory Report 2008, Chapter 7.2.).

**Table 7.2.7: Areas for land uses from 1986 to 2010.**

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
2010	2,027.300	1,244.268	222.700	407.817	13.440	112.836	26.240
2009	2,027.300	1,243.426	228.183	403.542	13.544	111.407	27.198
2008	2,027.300	1,242.583	233.667	399.267	13.648	109.978	28.156
2007	2,027.300	1,241.741	239.151	394.992	13.752	108.550	29.114
2006	2,027.300	1,240.898	244.635	390.717	13.856	107.121	30.072
2005	2,027.300	1,240.056	250.119	386.441	13.961	105.693	31.030
2004	2,027.300	1,239.214	255.603	382.166	14.065	104.264	31.988
2003	2,027.300	1,238.371	261.087	377.891	14.169	102.835	32.946
2002	2,027.300	1,237.529	266.571	373.616	14.273	101.407	33.905
2001	2,027.300	1,236.687	272.055	369.341	14.377	99.978	34.863
2000	2,027.300	1,235.844	277.539	365.065	14.481	98.550	35.821
1999	2,027.300	1,235.002	283.022	360.790	14.586	97.121	36.779
1998	2,027.300	1,234.159	288.506	356.515	14.690	95.693	37.737
1997	2,027.300	1,233.317	293.990	352.240	14.794	94.264	38.695
1996	2,027.300	1,232.475	299.474	347.964	14.898	92.835	39.653
1995	2,027.300	1,231.632	304.958	343.689	15.002	91.407	40.611
1994	2,027.300	1,230.790	310.442	339.414	15.107	89.978	41.569
1993	2,027.300	1,229.948	315.926	335.139	15.211	88.550	42.527
1992	2,027.300	1,229.105	321.410	330.864	15.315	87.121	43.486
1991	2,027.300	1,228.263	326.894	326.588	15.419	85.692	44.444
1990	2,027.300	1,227.420	332.378	322.313	15.523	84.264	45.402
1989	2,027.300	1,226.578	337.861	318.038	15.627	82.835	46.360
1988	2,027.300	1,225.736	343.345	313.763	15.732	81.407	47.318
1987	2,027.300	1,224.893	348.829	309.488	15.836	79.978	48.276
1986	2,027.300	1,224.051	354.313	305.212	15.940	78.549	49.234

## 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 physical and chemical properties, but no data of soil bulk density, so pedotransfer functions were used.

### LITTER

The separate estimate of carbon stock in  $O_i$ ,  $O_f$  and  $O_h$  sub horizon was provided, due to fact that each organic subhorizon were sampled within an area of  $25 \times 25$  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:

$$C_{pool} = \sum_{i=1}^k (\%C_{org,i} \cdot M_{105^\circ C,i} / 100) \quad (\text{Equation 2})$$

$C_{pool}$  - carbon stock [ $Gg \text{ ha}^{-1}$ ]  
 $C_{org}$  - the organic carbon content and clay content (both in %)  
 $M_{105^\circ C,i}$  - quantity [ $Gg \text{ ha}^{-1}$ ] of dry soil in sub horizon  $i$   
 $k$  - number of soil horizon in soil profile

**Table 7.2.8: Average carbon stock in litter (from 8x8km grid survey)**

	average carbon stock [ $t \text{ ha}^{-1}$ ]	n
$O_i$ horizon	$1.44 \pm 0.15$	143
$O_{fh}$ horizon	$8.85 \pm 1.42$	145
<b>litter (<math>O_i + O_{fh}</math>)</b>	<b><math>10.41 \pm 1.50</math></b>	<b>143</b>

### SOILS

Carbon stock in mineral part of soil (SOM) was calculated from the following equation 2.

$$C_{pool} = \sum_{i=1}^k (\%C_{org,i} \cdot d_i \cdot \rho_i \cdot 100) \quad (\text{Equation 3})$$

$C_{pool}$  - carbon stock [ $Gg \text{ ha}^{-1}$ ]  
 $D_i$  - thickness [ $m$ ] of soil horizon  $i$   
 $\rho_i$  - soil bulk density [ $g \text{ cm}^{-3}$ ]  
 $k$  - 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.

$$\rho_i = \begin{cases} 1/(0,625 + 0,05 \cdot \%C_{org} + 0,0015 \cdot \%clay) \rightarrow \text{if } \%C_{org} \leq 5\% \\ 1,55 - 0,0814 \cdot \%C_{org} \rightarrow \text{if } 5\% < \%C_{org} \leq 15\% \\ 0,725 - 0,337 \cdot \log_{10} \%C_{org} \rightarrow \text{if } \%C_{org} \geq 15\% \end{cases} \quad (\text{Equation 4})$$

$\rho_i$  - 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 7.2.9: Average carbon stock (SOC) on 30 cm depth in mineral part of soil.**

Land use	Average carbon stock [t ha <sup>-1</sup> ]	n
Cropland annual	100	187
Cropland perennial	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 7.2.10: Average carbon stock in mineral soils for forest land (from 8x8km grid survey)**

	average carbon stock [t ha <sup>-1</sup> ]	n
M <sub>10</sub> horizon	35.25 ± 2.06	141
M <sub>40</sub> horizon	68.32 ± 6.22	136
<b>Mineral soils</b>	<b>103.31 ± 7.90</b>	<b>136</b>

Recalculations will be made in 2013 submission.

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<sub>2</sub> 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<sub>2</sub> emissions from biomass burning are reported.

Area of forest land in Slovenia is 1,243,426 ha and covers 61.3 % 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<sup>2</sup>). 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 7.3.1: Activity data for forest land (1986 – 2010) 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
2010	1,244.268	1,239.423	4.845	1.106	3.083	0.074	0.221	0.362
2009	1,243.426	1,238.581	4.845	1.106	3.083	0.074	0.221	0.362
2008	1,242.583	1,237.739	4.845	1.106	3.083	0.074	0.221	0.362
2007	1,241.741	1,236.896	4.845	1.106	3.083	0.074	0.221	0.362
2006	1,240.898	1,236.054	4.845	1.106	3.083	0.074	0.221	0.362
2005	1,240.056	1,235.212	4.845	1.106	3.083	0.074	0.221	0.362
2004	1,239.214	1,234.369	4.845	1.106	3.083	0.074	0.221	0.362
2003	1,238.371	1,233.527	4.845	1.106	3.083	0.074	0.221	0.362
2002	1,237.529	1,232.684	4.845	1.106	3.083	0.074	0.221	0.362
2001	1,236.687	1,231.842	4.845	1.106	3.083	0.074	0.221	0.362
2000*	1,235.844	1,231.000	4.845	1.106	3.083	0.074	0.221	0.362
1999	1,235.002	1,230.157	4.845	1.106	3.083	0.074	0.221	0.362
1998	1,234.159	1,229.315	4.845	1.106	3.083	0.074	0.221	0.362
1997	1,233.317	1,228.473	4.845	1.106	3.083	0.074	0.221	0.362
1996	1,232.475	1,227.630	4.845	1.106	3.083	0.074	0.221	0.362
1995	1,231.632	1,226.788	4.845	1.106	3.083	0.074	0.221	0.362
1994	1,230.790	1,225.945	4.845	1.106	3.083	0.074	0.221	0.362
1993	1,229.948	1,225.103	4.845	1.106	3.083	0.074	0.221	0.362
1992	1,229.105	1,224.261	4.845	1.106	3.083	0.074	0.221	0.362
1991	1,228.263	1,223.418	4.845	1.106	3.083	0.074	0.221	0.362
1990	1,227.420	1,222.576	4.845	1.106	3.083	0.074	0.221	0.362
1989	1,226.578	1,221.734	4.845	1.106	3.083	0.074	0.221	0.362
1988	1,225.736	1,220.891	4.845	1.106	3.083	0.074	0.221	0.362
1987	1,224.893	1,220.049	4.845	1.106	3.083	0.074	0.221	0.362
1986	1,224.051	1,219.206	4.845	1.106	3.083	0.074	0.221	0.362

Table 7.3.2: Emissions/removals from forestland (1986 – 2010) in Gg CO<sub>2</sub>

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 <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>
2010	-11,138.328	-10,869.439	-268.889	-227.155	-34.269	NE	NO	-7.466
2009	-11,039.613	-10,770.724	-268.889	-227.155	-34.269	NE	NO	-7.466
2008	-11,043.132	-10,774.243	-268.889	-227.155	-34.269	NE	NO	-7.466
2007*	-11,027.510	-10,758.620	-268.889	-227.155	-34.269	NE	NO	-7.466
2006	-10,875.788	-10,606.899	-268.889	-227.155	-34.269	NE	NO	-7.466
2005	-11,006.733	-10,737.843	-268.889	-227.155	-34.269	NE	NO	-7.466
2004	-11,009.662	-10,740.772	-268.889	-227.155	-34.269	NE	NO	-7.466
2003	-10,778.966	-10,510.077	-268.889	-227.155	-34.269	NE	NO	-7.466
2002	-10,995.364	-10,726.474	-268.889	-227.155	-34.269	NE	NO	-7.466
2001	-10,965.219	-10,696.330	-268.889	-227.155	-34.269	NE	NO	-7.466
2000*	-9,500.637	-9,231.747	-268.889	-227.155	-34.269	NE	NO	-7.466
1999	-9,468.012	-9,199.123	-268.889	-227.155	-34.269	NE	NO	-7.466
1998	-9,409.167	-9,140.277	-268.889	-227.155	-34.269	NE	NO	-7.466
1997	-9,449.242	-9,180.353	-268.889	-227.155	-34.269	NE	NO	-7.466
1996	-9,461.707	-9,192.817	-268.889	-227.155	-34.269	NE	NO	-7.466
1995	-9,467.814	-9,198.925	-268.889	-227.155	-34.269	NE	NO	-7.466
1994	-9,479.847	-9,210.957	-268.889	-227.155	-34.269	NE	NO	-7.466
1993	-9,473.518	-9,204.628	-268.889	-227.155	-34.269	NE	NO	-7.466
1992	-9,430.693	-9,161.804	-268.889	-227.155	-34.269	NE	NO	-7.466
1991	-9,391.337	-9,122.448	-268.889	-227.155	-34.269	NE	NO	-7.466
1990	-9,387.883	-9,118.994	-268.889	-227.155	-34.269	NE	NO	-7.466
1989	-9,435.576	-9,166.686	-268.889	-227.155	-34.269	NE	NO	-7.466
1988	-9,423.298	-9,154.409	-268.889	-227.155	-34.269	NE	NO	-7.466
1987	-9,435.543	-9,166.654	-268.889	-227.155	-34.269	NE	NO	-7.466
1986	-9,429.214	-9,160.325	-268.889	-227.155	-34.269	NE	NO	-7.466

\* Inventory year

Removals CO<sub>2</sub> in category forest land range from –9,429.2 Gg CO<sub>2</sub> (1986) to – 11,138.3 Gg CO<sub>2</sub> (2010).

Forest land remaining forest land (CO<sub>2</sub>) and Land converted to forest land (CO<sub>2</sub>) were identified as key source categories. Concerning the CH<sub>4</sub> or N<sub>2</sub>O 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 2010 the annual removals were between -9,122.4 Gg CO<sub>2</sub> (1991) and -10,869.4 Gg CO<sub>2</sub> (2010).

#### **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-LULUCF was used:

$$\Delta C = \frac{(C_{t_2} - C_{t_1})}{t_2 - t_1} * A \quad \text{(Equation 5)}$$

$\Delta C$  – living biomass [t CO<sub>2</sub>]

$A$  – 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<sub>2j</sub>), 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.

$$C = (GS_j * WD_j * BEF_{2j}) * (1 + R_j) * CF \quad \text{(Equation 6)}$$

$GS$  – 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. 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<sup>3</sup>/ha (confidence interval: 269.37 – 297.01 m<sup>3</sup>/ha) and in year 2007 was 326.43 m<sup>3</sup>/ha (confidence interval: 312.30 – 340.57 m<sup>3</sup>/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 losses 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 2010, the following methodology was applied:

- the initial growing stock volume is from NFI 2000 and NFI 2007;
- the growing stock between these years were interpolated;
- the growing stock from 2000 to year 1986 was extrapolated;
- the growing stock for 2008, 2009 and 2010 remains the same as in 2007 (326.43 m<sup>3</sup>/ha).

Next NFI is planned for 2012. When data from NFI\_2012 will be available, recalculations of growing stock for years 2008 – 2012 will be made.

**Table 7.3.3: Growing stock in Slovenian forests from 1986 to 2010.**

Year	Growing stock	Year	Growing stock
	[m <sup>3</sup> /ha]		[m <sup>3</sup> /ha]
2010	326.4	1997	264.7
2009	326.4	1996	258.5
2008	326.4	1995	252.3
2007*	326.4	1994	246.1
2006	320.3	1993	240.0
2005	314.1	1992	233.8
2004	307.9	1991	227.6
2003	301.7	1990	221.4
2002	295.5	1989	215.2
2001*	289.4	1988	209.1
2000	283.2	1987	202.9
1999	277.0	1986	197.0
1998	270.8	* Inventory year	

**Table 7.3.4: Growing stock composition (in percent) by tree species in inventory years.**

% of growing stock		year	
Scientific name	Common name	2000	2007
<i>Picea abies</i>	Spruce	33.39	30.94
<i>Fagus sylvatica</i>	Beech	31.65	31.02
<i>Abies alba</i>	Fir	9.27	8.20
<i>Quercus petraea</i>	Oak	5.09	5.75
<i>Pinus sylvestris</i>	Scots Pine	4.09	4.12
<i>Acer pseudoplatanus</i>	Maple	3.24	3.22
<i>Carpinus betulus</i>	Hornbeam	1.62	2.30
<i>Castanea sativa</i>	Chestnut	1.52	1.89
<i>Pinus nigra</i>	Black Pine	1.16	1.57
<i>Ostrya carpinifolia</i>	Hop Hornbeam	0.82	1.25
Remaining		8.15	9.75
<b>TOTAL</b>		<b>100.00</b>	<b>100.00</b>



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* ( $WD = 0.584 \text{ t/m}^3$ ) and *Alnus glutinosa* ( $WD = 0.445 \text{ t/m}^3$ ). 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 ( $CF = 0.5 \text{ t C/t d.m.}$ ).

**Table 7.3.5: Parameters ( $WD$ ,  $BEF_2$ ,  $R$ ,  $CF$  and ) used for selected tree species.**

Common name	WD	BEF2	R	CF
	[t/m <sup>3</sup> ]	[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 accordance with equation 3.2.10. from GPG- LULUCF.

$$\Delta C_{FF_{DOM}} = \Delta C_{FF_{DW}} + \Delta C_{FF_{LT}} \quad \text{(Equation 7)}$$

$\Delta C_{FF_{DOM}}$  – annual change in carbon stocks in dead organic matter [t C yr<sup>-1</sup>]

$\Delta C_{FF_{DW}}$  – change in carbon stocks in dead wood [t C yr<sup>-1</sup>]

$\Delta C_{FF_{LT}}$  – change in carbon stocks in litter [t C yr<sup>-1</sup>]

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-LULUCF was used.

$$\Delta C_{FF}(DW) = \left[ A * \frac{(B_{t2} - B_{t1})}{T} \right] * CF \quad \text{(Equation 8)}$$

$\Delta C_{FF}(DW)$  – annual change in carbon stocks in dead wood [t yr<sup>-1</sup>]

$A$  – 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<sup>3</sup>/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<sup>3</sup>/ha) and for year 1990 was 5.83 t d.m./ha (12.60 m<sup>3</sup>/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 that 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.

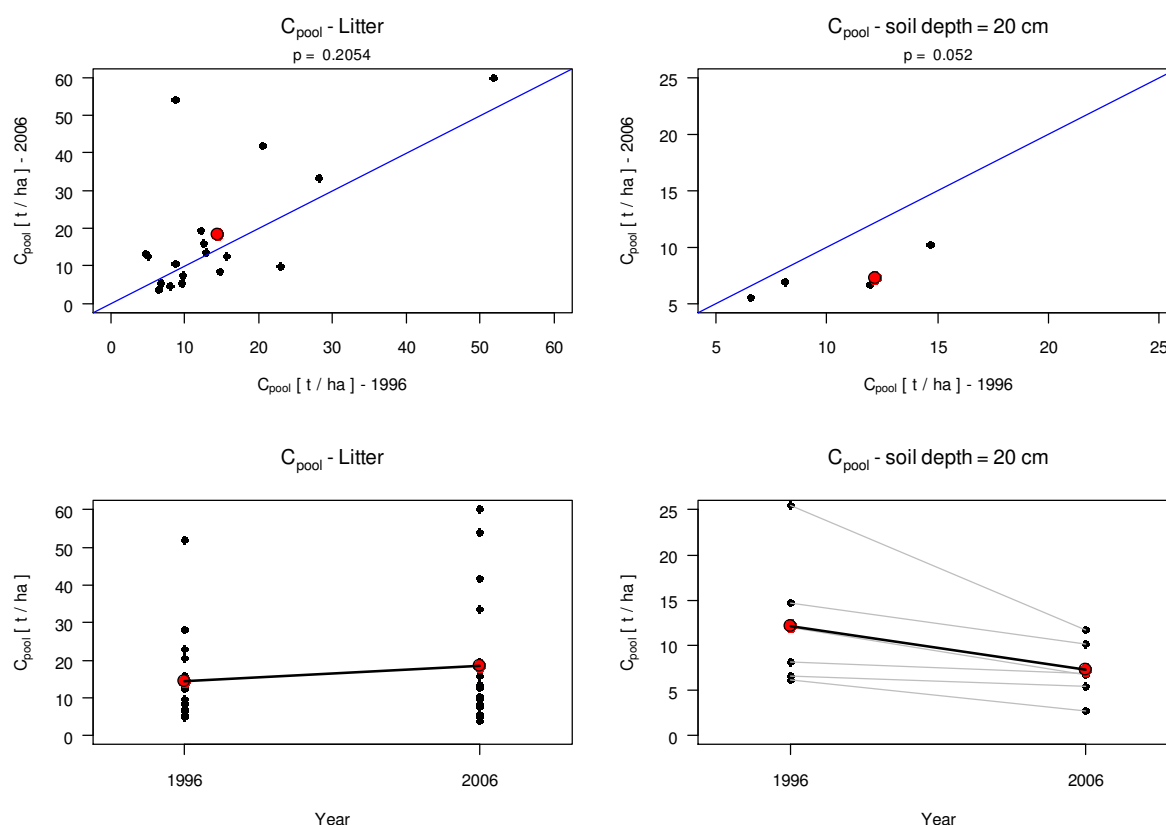
### **Carbon stock changes in soils**

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 ( $\varnothing = 7$  cm) at fixed depth (0–5, 5–10 and 10–20 cm) and for organic layer within  $25 \times 25$  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 7.3.1: 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<sub>2</sub> greenhouse gas emission

#### **N<sub>2</sub>O 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.

$L_{fire}[tGHG] = A * B * C * D * 10^{-6}$ <p> <i>A</i> – area burnt [ha]  <i>B</i> – mass of available fuel [kg d.m. ha<sup>-1</sup>]  <i>C</i> – combustion efficiency (Table 3A.1.12 in IPCC GPG – LULUCF 2003)  <i>D</i> – emission factor (Table 3A.1.16 in IPCC GPG – LULUCF 2003) </p>	(Equation 9)
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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 7.3.6: Emission factors used from Table 3A.1.16 (GPG- LULUCF)**

Gas		Emission factor (D)
		[g / kg d.m.]
CO <sub>2</sub>	carbon dioxide	1580
CO	carbon oxide	130
CH <sub>4</sub>	methane	9
NO <sub>x</sub>	nitrogen oxide	0.7
N <sub>2</sub> O	nitrous oxide	0.11
NMHC	non methane hydrocarbons	10

Mass of available fuel (B) was calculated from average growing stock for each year. 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 emissions shown in Table 7.3.7 were calculated.

**Table 7.3.7: Productive forest land affected by wildfires and resulting GHG emissions 1986-2010.**

Year	Area	Mass of available fuel	CO <sub>2</sub>	CO	CH <sub>4</sub>	NO <sub>x</sub>	N <sub>2</sub> O	NMHC
	ha	t/ha	t	t	t	t	t	t
2010	52.06	183.62	8,307.02	683.49	47.32	3.68	0.58	52.58
2009	114.73	183.62	18,307.05	1,506.28	104.28	8.11	1.27	115.87
2008	46.69	183.62	7,450.15	612.99	42.44	3.30	0.52	47.15
2007	98.61	183.62	15,734.84	1,294.64	89.63	6.97	1.10	99.59
2006	1,022.81	180.15	160,118.73	13,174.33	912.07	70.94	11.15	1,013.41
2005	142.23	176.67	21,836.49	1,796.67	124.39	9.67	1.52	138.21
2004	76.87	173.20	11,569.66	951.93	65.90	5.13	0.81	73.23
2003	1,592.84	169.72	234,927.17	19,329.45	1,338.19	104.08	16.36	1,486.88
2002	77.47	166.25	11,192.06	920.87	63.75	4.96	0.78	70.84
2001	240.36	162.77	33,998.83	2,797.37	193.66	15.06	2.37	215.18
2000	124.14	159.30	17,184.66	1,413.93	97.89	7.61	1.20	108.76
1999	321.10	155.82	43,480.19	3,577.48	247.67	19.26	3.03	275.19
1998	725.10	152.35	95,996.43	7,898.44	546.82	42.53	6.68	607.57
1997	383.33	148.87	49,591.82	4,080.34	282.49	21.97	3.45	313.87
1996	243.75	145.40	30,798.19	2,534.03	175.43	13.64	2.14	194.93
1995	148.88	141.92	18,361.67	1,510.77	104.59	8.13	1.28	116.21
1994	NA	138.45	NA	NA	NA	NA	NA	NA
1993	NA	134.97	NA	NA	NA	NA	NA	NA
1992	319.37	131.50	36,495.51	3,002.80	207.89	16.17	2.54	230.98
1991	624.90	128.03	69,522.57	5,720.21	396.01	30.80	4.84	440.02
1990	615.77	124.55	66,647.49	5,483.65	379.64	29.53	4.64	421.82
1989	120.00	121.08	12,625.78	1,038.83	71.92	5.59	0.88	79.91
1988	181.75	117.60	18,574.00	1,528.24	105.80	8.23	1.29	117.56
1987	NA	114.13	NA	NA	NA	NA	NA	NA
1986	NA	110.65	NA	NA	NA	NA	NA	NA

All data related to burned areas are based on databases of Slovenia Forest Service (SFS). The areas are identified 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.

Calculations of emissions from biomass burning were rechecked and recalculated. Areas of burned forests in previous reports included whole burned areas (forest land and other land uses, e.g. grassland), not only forestland. Recalculations were made.

### 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 4,845 ha. 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 high (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<sup>3</sup>/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).

$$\Delta C_{LF\ growth} = A * G_{total} * CF \quad \text{(Equation 10)}$$

$A$  – 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<sup>-1</sup> yr<sup>-1</sup>]

$CF$  – carbon fraction of dry matter (default = 0.5 t C / t d.m.)

$$G_{total} = G_W * (1 + R)$$

$G_W$  – average annual aboveground biomass increment [t d. m. ha<sup>-1</sup> yr<sup>-1</sup>]

$R$  – root shoot ratio appropriate to increments

$$G_W = I_v * WD * BEF_1$$

$I_v$  – average annual net increment [m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup>]

$WD$  – basic wood density [t d.m. m<sup>-3</sup>]

$BEF_1$  – 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<sup>-3</sup>) and for broadleaves ( $WD = 0.580$  t d.m. m<sup>-3</sup>).

Average annual increment ( $I_v$ ) on areas converted to forestland was 2.16 m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup> (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 7.3.8: Factors for calculation of CO<sub>2</sub> accumulation in land converted to forest land.**

	$I_v$	WD	R	BEF <sub>1</sub>
	[m <sup>3</sup> ha <sup>-1</sup> yr <sup>-1</sup> ]	[t d.m. m <sup>-3</sup> ]	[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 from 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).

$$\Delta C_{LF \text{ mineral}} = \frac{[(SOC_{ExtForest} - SOC_{non-forestland}) * A_{ExtForest}]}{T_{ExtForest}} \quad \text{(Equation 11)}$$

$\Delta C_{LF \text{ mineral}}$  – annual change in carbon stock in mineral soils [t C yr<sup>-1</sup>]

$SOC_{ExtForest}$  – stable soil organic carbon stocks of the new, extensively managed forest [t C ha<sup>-1</sup>]

$SOC_{non-forestland}$  – soil organic carbon stocks of the non-forest land prior to its conversion [t C ha<sup>-1</sup>]

$A_{ExtForest}$  – land area [ha]

$T_{ExtForest}$  – time [default 20 years]

$$SOC_{ExtForest} = SOC_{ref} * f_{forest\ type} * f_{man\ intensity} * f_{dist\ regime}$$

$SOC_{ref}$  –  $SOC_{30}$  – Slovenian national value for organic carbon stock in mineral soil for forest land [t C ha<sup>-1</sup>]

$f_{forest\ type}$  – adjustment factor for a forest 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  $SOC_{ref}$  ( $SOC_{30} = 105 \text{ t C ha}^{-1}$ ) was determined from national soil profiles data and it is presented in Table 7.2.9. Also values for soil organic stock of previous land uses ( $SOC_{non-forestland}$ : grassland =  $107 \text{ t C ha}^{-1}$ , cropland perennial =  $68 \text{ t C ha}^{-1}$ , cropland annual =  $100 \text{ t C ha}^{-1}$ ), are presented in Table 7.2.9. and used in calculations. According to spontaneously expansion of forest on converted areas, with

minimum human intervention, values for adjustment factors ( $f_{\text{forest type}} = f_{\text{man intensity}} = f_{\text{dist regime}} = 1.00$ ) 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 7.3.9.

**Table 7.3.9: Indicators from NFI 2007**

Carbon stock	326.40 m³/ha	± 4.30 %
Living trees growing stock	8.65 m³/ha	± 6.50 %
Dead wood	18.64 m³/ha	± 16.60 %
Soil and litter	see chapter 7.2.2	

Estimated uncertainty in land managed factors	± 12 % (GPG-LULUCF table 3.3.4)
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### 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 8x8 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 and recalculated. Areas of burned forests in previous reports included whole burned areas (forest land and other land uses, e.g. grassland), not only forestland. Recalculations were made.

### **7.3.6 Source specific planned improvements**

Currently used land use change matrix is under revision (internal and external). Discrepancies in areas were noticed during preparation of NIR and by ERT during centralized review. Also from different national data on land use areas in 2010, a change in land use changes was noticed (e.g. area of forestland is smaller than previous years, natural afforestation of abandoned agricultural land has slowly stopped). Results of the revision will be implemented in 2013 submission and all the recalculations will be made.

## 7.4 Cropland (5B)

### 7.4.1 Source category description

Cropland category includes CO<sub>2</sub> 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<sub>2</sub> emissions from agricultural lime application and N<sub>2</sub>O emissions associated with land conversion to cropland.

Cropland covers 222,700 ha and that represents 11.0 % of country total area. Cropland land use is separated in two subcategories: annual cropland (arable land, temporary meadows, hop fields, green houses) and perennial cropland (other permanent crops on arable land, vineyards, nursery, intensive orchards, extensive orchards, olive groves, other permanent crops, forest plantation, forest trees on agricultural land).

**Table 7.4.1: Activity data for cropland (1986 – 2010) in kha**

Year	5.B. Total Cropland	5.B. Organic soil	5.B.1. Cropland remaining Cropland	5.B .2. Land converted to Cropland <sup>(12)</sup>	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	222.700	6.884	210.762	5.037	0.840	3.618	0.051	0.471	0.057
2009	228.183	6.884	216.262	5.037	0.840	3.618	0.051	0.471	0.057
2008	233.667	6.868	221.762	5.037	0.840	3.618	0.051	0.471	0.057
2007	239.151	6.864	227.251	5.037	0.840	3.618	0.051	0.471	0.057
2006	244.635	6.885	232.714	5.037	0.840	3.618	0.051	0.471	0.057
2005	250.119	6.906	238.176	5.037	0.840	3.618	0.051	0.471	0.057
2004	255.603	6.876	243.690	5.037	0.840	3.618	0.051	0.471	0.057
2003	261.087	6.846	249.204	5.037	0.840	3.618	0.051	0.471	0.057
2002	266.571	6.816	254.718	5.037	0.840	3.618	0.051	0.471	0.057
2001	272.055	6.786	260.232	5.037	0.840	3.618	0.051	0.471	0.057
2000	277.539	6.755	265.747	5.037	0.840	3.618	0.051	0.471	0.057
1999	283.022	6.725	271.261	5.037	0.840	3.618	0.051	0.471	0.057
1998	288.506	6.695	276.775	5.037	0.840	3.618	0.051	0.471	0.057
1997	293.990	6.665	282.289	5.037	0.840	3.618	0.051	0.471	0.057
1996	299.474	6.732	287.706	5.037	0.840	3.618	0.051	0.471	0.057
1995	304.958	6.800	293.121	5.037	0.840	3.618	0.051	0.471	0.057
1994	310.442	6.867	298.538	5.037	0.840	3.618	0.051	0.471	0.057
1993	315.926	6.934	303.955	5.037	0.840	3.618	0.051	0.471	0.057
1992	321.410	7.001	309.372	5.037	0.840	3.618	0.051	0.471	0.057
1991	326.894	7.069	314.788	5.037	0.840	3.618	0.051	0.471	0.057
1990	332.378	7.136	320.205	5.037	0.840	3.618	0.051	0.471	0.057
1989	337.861	7.203	325.622	5.037	0.840	3.618	0.051	0.471	0.057
1988	343.345	7.270	331.039	5.037	0.840	3.618	0.051	0.471	0.057
1987	348.829	7.338	336.455	5.037	0.840	3.618	0.051	0.471	0.057
1986	354.313	7.405	341.872	5.037	0.840	3.618	0.051	0.471	0.057

Table 7.4.2: Emission from cropland (1986 – 2010) in Gg CO<sub>2</sub>

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 <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>
2010	1,612.649	411.873	1,200.776	538.826	661.950	NO	NO	NO
2009	1,612.649	411.873	1,200.776	538.826	661.950	NO	NO	NO
2008	1,600.957	400.181	1,200.776	538.826	661.950	NO	NO	NO
2007	1,588.752	387.975	1,200.776	538.826	661.950	NO	NO	NO
2006	1,576.988	376.212	1,200.776	538.826	661.950	NO	NO	NO
2005	1,566.498	365.722	1,200.776	538.826	661.950	NO	NO	NO
2004	1,552.927	352.151	1,200.776	538.826	661.950	NO	NO	NO
2003	1,540.843	340.066	1,200.776	538.826	661.950	NO	NO	NO
2002	1,541.542	340.766	1,200.776	538.826	661.950	NO	NO	NO
2001	1,508.609	307.833	1,200.776	538.826	661.950	NO	NO	NO
2000	1,450.998	301.420	1,149.578	487.628	661.950	NO	NO	NO
1999	1,439.348	289.770	1,149.578	487.628	661.950	NO	NO	NO
1998	1,425.145	275.567	1,149.578	487.628	661.950	NO	NO	NO
1997	1,405.125	255.547	1,149.578	487.628	661.950	NO	NO	NO
1996	1,394.331	244.752	1,149.578	487.628	661.950	NO	NO	NO
1995	1,380.790	231.212	1,149.578	487.628	661.950	NO	NO	NO
1994	1,363.783	214.205	1,149.578	487.628	661.950	NO	NO	NO
1993	1,352.333	202.755	1,149.578	487.628	661.950	NO	NO	NO
1992	1,343.414	193.835	1,149.578	487.628	661.950	NO	NO	NO
1991	1,342.939	193.361	1,149.578	487.628	661.950	NO	NO	NO
1990	1,323.774	174.196	1,149.578	487.628	661.950	NO	NO	NO
1989	1,250.660	167.975	1,082.685	420.735	661.950	NO	NO	NO
1988	1,237.366	154.681	1,082.685	420.735	661.950	NO	NO	NO
1987	1,222.567	139.882	1,082.685	420.735	661.950	NO	NO	NO
1986	1,206.658	123.973	1,082.685	420.735	661.950	NO	NO	NO

Emissions CO<sub>2</sub> in category cropland range from 1,206.7 Gg CO<sub>2</sub> (1986) to 1,612.7 Gg CO<sub>2</sub> (2009, 2010).

Cropland remaining cropland (CO<sub>2</sub>) and Land converted to cropland (CO<sub>2</sub>) were identified as key source categories. Concerning the N<sub>2</sub>O emissions, land converted to cropland have not resulted as a key source category.

## 7.4.2 Methodological issues

### 7.4.2.1 Cropland remaining cropland

#### 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)

$$\text{Annual change in biomass} = (\text{area of perennial cropland} * \text{biomass accumulation rate}) - (\text{area of perennial cropland before 30 years} * 0,033 * \text{biomass carbon loss})$$

**Table 7.4.3: 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 ( $2.1 \text{ t C ha}^{-1} \text{ yr}^{-1}$ ) in perennial vegetation and biomass carbon loss ( $63.0 \text{ t C ha}^{-1}$ ) 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.

### Perennial 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 perennial cropland converted to annual cropland the Tier 1/Tier 2 method was applied and equation 3.3.8 (GPG-LULUCF) was used.

$$\text{Annual change in biomass} = \text{annual area of converted land} * (L_{\text{conversion}} + \Delta C_{\text{growth}}) \quad (\text{Equation 13})$$

$$L_{\text{conversion}} = C_{\text{after}} - C_{\text{before}}$$

$C_{\text{after}}$  – carbon after conversion is 0

$C_{\text{before}}$  – IPCC default value for carbon stock in wood biomass before is  $63.0 \text{ t C ha}^{-1}$

$\Delta C_{\text{growth}}$  – IPCC default value for annual crops carbon accumulation rate  $5.0 \text{ t C ha}^{-1}$

Value for the annual crops carbon accumulation rate ( $\Delta C_{\text{growth}} = 5.0 \text{ t C ha}^{-1} \text{ yr}^{-1}$ ) was adopted from Table 3.3.8 (GPG-LULUCF) and value for carbon stock in wood biomass before conversion ( $C_{\text{before}} = 63.0 \text{ t C ha}^{-1}$ ) 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 perennial cropland the Tier 1/Tier 2 method was applied and equation 3.3.8 (GPG-LULUCF) was used.

$$\text{Annual change in biomass} = \text{annual area of converted land} * (L_{\text{conversion}} + \Delta C_{\text{growth}}) \quad (\text{Equation 14})$$

$$L_{\text{conversion}} = C_{\text{after}} - C_{\text{before}}$$

$C_{\text{after}}$  – carbon after conversion is 0

$C_{\text{before}}$  – IPCC default value for carbon stock in biomass before is  $5.0 \text{ t C ha}^{-1}$

$\Delta C_{\text{growth}}$  – IPCC default value for perennial crops carbon accumulation rate  $2.1 \text{ t C ha}^{-1}$

Value for the perennial crops carbon accumulation rate ( $\Delta C_{\text{growth}} = 2.1 \text{ t C ha}^{-1} \text{ yr}^{-1}$ ) was adopted from Table 3.3.8 (GPG-LULUCF) and value for carbon stock in annual crops biomass before conversion ( $C_{\text{before}} = 5.0 \text{ t C ha}^{-1}$ ) 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.

$$\Delta C_{CC \text{ mineral}} = \frac{[SOC_0 - SOC_{0-T}] * A}{T} \quad (\text{Equation 15})$$

$\Delta C_{CC \text{ mineral}}$  – annual change in carbon stock in mineral soils [ $\text{t C yr}^{-1}$ ]  
 $SOC_0$  – soil organic carbon stock in the inventory year [ $\text{t C ha}^{-1}$ ]  
 $SOC_{0-T}$  – soil organic carbon stock  $T$  years prior to the inventory [ $\text{t C ha}^{-1}$ ]  
 $T$  – 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:  $SOC_{30} = 100 \text{ t/ha}$ ; cropland perennial:  $SOC_{30} = 68 \text{ t/ha}$ ) are presented in Table 7.2.9.

#### **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:

$$\Delta C = \sum (A * EF) \quad (\text{Equation 16})$$

$A$  – land area of organic soils  
 $EF$  – emission factor for climate type ( $10 \text{ t ha}^{-1}$ )

Emission factor ( $EF = 10 \text{ t ha}^{-1}$ ) 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.

$$\Delta C_{\text{lime}} = M_{\text{limestone}} * EF_{\text{limestone}} + M_{\text{dolomite}} * EF_{\text{dolomite}} \quad (\text{Equation 17})$$

$\Delta C_{\text{lime}}$  – annual C emissions from agricultural lime application [t C yr<sup>-1</sup>]  
 $M$  – the annual amount of calcic limestone or dolomite [t yr<sup>-1</sup>]  
 $EF$  – 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<sub>3</sub>) or dolomite (CaMg(CO<sub>3</sub>)<sub>2</sub>) 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 5,037 ha. 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. Due to necessary assurance for Slovenian land area consistency through whole time series, also conversions from wetland, settlements, other land to cropland are included in land use change matrix.

The average annual area converted from forest land to cropland is 840 ha (to cropland annual: 86 ha; to cropland perennial: 754 ha). The average annual area converted from grassland to cropland is 3,618 ha (to cropland annual: 1,967 ha; to cropland perennial: 1,651 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 methodology and equation 3.3.8 (GPG-LULUCF) were used.

$$\text{Annual change in biomass} = \text{annual area of converted land} * (L_{\text{conversion}} + \Delta C_{\text{growth}}) \quad (\text{Equation 18})$$

$$L_{\text{conversion}} = C_{\text{after}} - C_{\text{before}}$$

$\Delta C_{\text{growth}}$  – IPCC default value for carbon accumulation rate  
 accumulation rates: annual crops is 5.0 t C ha<sup>-1</sup>, perennial crops is 2.1 t C ha<sup>-1</sup>  
 $C_{\text{after}}$  – carbon after conversion is 0  
 $C_{\text{before}}$  – growing stock (forest land), biomass carbon stocks (grassland)

Values for the perennial crops carbon accumulation rate ( $\Delta C_{\text{growth}} = 2.1 \text{ t C ha}^{-1}$ ) and for the annual crops accumulation rate ( $\Delta C_{\text{growth}} = 5.0 \text{ t C ha}^{-1}$ ) were adopted from Table 3.3.8 (GPG-LULUCF). The growing stock in forest land ( $C_{\text{before}}$ ) is represented in Table 7.3.3. Value for grassland biomass carbon stocks ( $C_{\text{before}} = 13.5 \text{ t C ha}^{-1}$ , 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.

$$\Delta C_{LC_{DOM}} = \Delta C_{LC_{DW}} + \Delta C_{LC_{LT}} \quad \text{(Equation 19)}$$

$\Delta C_{LC_{DOM}}$  – annual change in carbon stocks in dead organic matter [t C yr<sup>-1</sup>]

$\Delta C_{LC_{DW}}$  – change in carbon stocks in dead wood [t C yr<sup>-1</sup>]

$\Delta C_{LC_{LT}}$  – change in carbon stocks in litter [t C yr<sup>-1</sup>]

For calculations of annual change in carbon stocks in dead wood the following equation was used:

$$\Delta C_{LC_{DW}} = \text{annual area of converted land} * L_{\text{conversion}} \quad \text{(Equation 20)}$$

$$L_{\text{conversion}} = C_{\text{after}} - C_{\text{before}}$$

$C_{\text{after}}$  – carbon after conversion is 0  
 $C_{\text{before}}$  – carbon stock in dead wood [t C ha<sup>-1</sup>]

Values for carbon stock in dead wood ( $C_{\text{before}}$ ) 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:

$$\Delta C_{LC_{LT}} = \text{annual area of converted land} * L_{\text{conversion}}$$

$$L_{\text{conversion}} = C_{\text{after}} - C_{\text{before}}$$

$C_{\text{after}}$  – carbon after conversion is 0  
 $C_{\text{before}}$  – carbon stock in litter [t C ha<sup>-1</sup>]

Value for carbon stock in litter ( $C_{\text{before}} = 5.6 \text{ t C ha}^{-1}$ ) 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.

$$\Delta C_{LC \text{ mineral}} = \frac{[SOC_0 - SOC_{0-T}] * A}{T} \quad \text{(Equation 21)}$$



$\Delta C_{LC\text{ mineral}}$  – annual change in carbon stock in mineral soils [t C yr<sup>-1</sup>]  
 $SOC_0$  – soil organic carbon stock in the inventory year [t C ha<sup>-1</sup>]  
 $SOC_{0-T}$  – soil organic carbon stock  $T$  years prior to the inventory [t C ha<sup>-1</sup>]  
 $T$  – 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<sup>-1</sup> for annual cropland;  $SOC_{30} = 68$  t C ha<sup>-1</sup> for perennial 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<sup>-1</sup>, forest land = 105 t C ha<sup>-1</sup>,) 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

### **N<sub>2</sub>O emissions in soils of land converted to cropland**

For calculations of N<sub>2</sub>O emissions 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<sub>2</sub>O-N<sub>conv</sub>** – N<sub>2</sub>O emissions as a result of the disturbance associated with land-use conversion of forest land, grassland, or other land to cropland, [kg N<sub>2</sub>O-N yr<sup>-1</sup>]

**N<sub>net-min</sub>** – N released annually by net soil organic matter mineralisation as a result of the disturbance, [kg N yr<sup>-1</sup>]

**EF<sub>1</sub>** – 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<sub>2</sub>O-N/kg N]. (The default value is 0.0125 kg N<sub>2</sub>O-N/kg N)

$$N_{net-min} = \Delta C_{LC\text{ mineral}} * 1 / C : N_{ratio}$$

(Equation 23)

$$N_{net-min} = \Delta C_{LC\ min\ eral} * 1 / C : N_{ratio} \quad \text{(Equation 24)}$$

$N_{net-min}$  – annual N released by net soil organic matter mineralisation as a result of the disturbance, [kg N yr<sup>-1</sup>]

$\Delta C_{LC\ mineral}$  – annual carbon stock change in soils (land converted to cropland) [kg C yr<sup>-1</sup>]

C:N ratio – the ratio by mass of C to N in the soil organic matter (SOM), [kg C (kg N)<sup>-1</sup>]

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 ( $\Delta C_{LC\ mineral}$ ) were taken from calculations of carbon stock changes in soils for land (forest land and grassland) converted to cropland. For emission factor (EF<sub>1</sub>), the default value (0.0125 kg N<sub>2</sub>O-N/kg N) was used.

The average annual emissions of N<sub>2</sub>O from land converted to cropland were 0.271 Gg N<sub>2</sub>O.

**Table 7.4.4: Areas of grassland and forestland converted to cropland (annual, perennial) and N<sub>2</sub>O emissions.**

	from forest land		from grassland		sum	
	ha	t N <sub>2</sub> O-N / yr	ha	t N <sub>2</sub> O-N / yr	ha	t N <sub>2</sub> O-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
to cropland	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 Grassland	± 75 %; ± 95 % (GPG-LULUCF table 3.4.2; 3.4.3)
previous land use 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

No recalculations were made for this category.

### 7.4.6 Source-specific planned improvements

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.

## 7.5 Grassland (5C)

### 7.5.1 Source category description

Grassland category includes CO<sub>2</sub> 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<sub>2</sub> emissions from agricultural lime application are included in cropland category.

Table 7.5.1: Activity data for grassland in 1986 – 2010 in ha.

Year	5.C. Total Grassland	5.C. Organic soil	5.C.1. Grassland remaining Grassland	5.C.2. Land converted to Grassland <sup>(12)</sup>	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
2010	407.817	IE	397.992	9.825	1.982	5.831	0.203	1.163	0.647
2009	403.542	IE	393.717	9.825	1.982	5.831	0.203	1.163	0.647
2008	399.267	IE	389.442	9.825	1.982	5.831	0.203	1.163	0.647
2007	394.992	IE	385.167	9.825	1.982	5.831	0.203	1.163	0.647
2006	390.717	IE	380.892	9.825	1.982	5.831	0.203	1.163	0.647
2005	386.441	IE	376.616	9.825	1.982	5.831	0.203	1.163	0.647
2004	382.166	IE	372.341	9.825	1.982	5.831	0.203	1.163	0.647
2003	377.891	IE	368.066	9.825	1.982	5.831	0.203	1.163	0.647
2002	373.616	IE	363.791	9.825	1.982	5.831	0.203	1.163	0.647
2001	369.341	IE	359.515	9.825	1.982	5.831	0.203	1.163	0.647
2000	365.065	IE	355.240	9.825	1.982	5.831	0.203	1.163	0.647
1999	360.790	IE	350.965	9.825	1.982	5.831	0.203	1.163	0.647
1998	356.515	IE	346.690	9.825	1.982	5.831	0.203	1.163	0.647
1997	352.240	IE	342.415	9.825	1.982	5.831	0.203	1.163	0.647
1996	347.964	IE	338.139	9.825	1.982	5.831	0.203	1.163	0.647
1995	343.689	IE	333.864	9.825	1.982	5.831	0.203	1.163	0.647
1994	339.414	IE	329.589	9.825	1.982	5.831	0.203	1.163	0.647
1993	335.139	IE	325.314	9.825	1.982	5.831	0.203	1.163	0.647
1992	330.864	IE	321.039	9.825	1.982	5.831	0.203	1.163	0.647
1991	326.588	IE	316.763	9.825	1.982	5.831	0.203	1.163	0.647
1990	322.313	IE	312.488	9.825	1.982	5.831	0.203	1.163	0.647
1989	318.038	IE	308.213	9.825	1.982	5.831	0.203	1.163	0.647
1988	313.763	IE	303.938	9.825	1.982	5.831	0.203	1.163	0.647
1987	309.488	IE	299.662	9.825	1.982	5.831	0.203	1.163	0.647
1986	305.212	IE	295.387	9.825	1.982	5.831	0.203	1.163	0.647

Grassland covers 407,817 ha and that represents 20.1 % 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.

Area of organic soils in grassland is included in area of organic soils in cropland.

**Table 7.5.2: Emission from grassland (1986 – 2010) in Gg CO<sub>2</sub>**

Year	5.C. Total Grassland	5.C.1. Grassland remaining Grassland	5.C.2. Land converted to Grassland <sup>(12)</sup>	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 <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>
2010	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2009	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2008	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2007	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2006	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2005	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2004	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2003	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2002	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2001	343.038	NE. IE	343.038	829.769	-527.419	NE	NO	NE
2000	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1999	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1998	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1997	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1996	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1995	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1994	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1993	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1992	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1991	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1990	222.213	NE. IE	222.213	708.944	-527.419	NE	NO	NE
1989	64.347	NE. IE	64.347	551.079	-527.419	NE	NO	NE
1988	64.347	NE. IE	64.347	551.079	-527.419	NE	NO	NE
1987	64.347	NE. IE	64.347	551.079	-527.419	NE	NO	NE
1986	64.347	NE. IE	64.347	551.079	-527.419	NE	NO	NE

Emissions from organic soils in grassland remaining grassland are included in emissions from organic soils in cropland.

CO<sub>2</sub> emissions in category grassland range from 64.3 Gg CO<sub>2</sub> (1986) to 343.0 Gg CO<sub>2</sub> (2010).

Land converted to grassland (CO<sub>2</sub>) was identified as key source category. Grassland remaining grassland (CO<sub>2</sub>) 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 rationale is that in grassland where management practices are static, biomass carbon stock will be in an approximate steady-state where carbon accumulation through 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.

$$\Delta C_{GGsoils} = \Delta C_{GGmineral} - \Delta C_{GGorganic} - \Delta C_{GGliming} \quad (\text{Equation 25})$$

$\Delta C_{GGsoils}$  - annual change in carbon stocks in soil [t C yr<sup>-1</sup>]

$\Delta C_{GGmineral}$  - annual change in carbon stocks in mineral soils [t C yr<sup>-1</sup>]

$\Delta C_{GGorganic}$  - annual changes in carbon stocks in organic soils [t C yr<sup>-1</sup>]

$\Delta C_{GGliming}$  - annual C emissions from lime application to grassland [t C yr<sup>-1</sup>]

#### **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 management 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**

Area of organic soils and emissions are presented together for cropland and grassland (in section cropland).

#### **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 perennial: 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 methodology and equation 3.4.13 (GPG-LULUCF) were used.

<p style="text-align: right;">(Equation 26)</p> <p><i>Annual change in biomass = annual area of converted land * (<math>L_{conversion} + \Delta C_{growth}</math>)</i></p> <p><math>L_{conversion} = C_{after} - C_{before}</math></p> <p><math>\Delta C_{growth}</math> – default value for carbon accumulation rate (<math>1.7 \text{ t d.m. ha}^{-1}</math>, <math>0.85 \text{ t C ha}^{-1}</math>)</p> <p><math>C_{after}</math> – carbon after conversion is 0</p> <p><math>C_{before}</math> – carbon stock (forest land), biomass carbon stocks (cropland)</p>
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Values for the carbon accumulation rate ( $\Delta C_{growth} = 0.85 \text{ t C ha}^{-1}$ ;  $1.7 \text{ t d.m. ha}^{-1} * 0.5$ ) were adopted from Table 3.4.2 (GPG-LULUCF). The carbon stock in forest land ( $C_{before}$ ) is represented in Table 7.3.3. Value for cropland biomass carbon stocks ( $C_{before} = 63.0 \text{ t C ha}^{-1}$ , 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.

$$\Delta C_{LG_{DOM}} = \Delta C_{LG_{DW}} + \Delta C_{LG_{LT}} \quad \text{(Equation 27)}$$

$\Delta C_{LG_{DOM}}$  – annual change in carbon stocks in dead organic matter [ $\text{t C yr}^{-1}$ ]

$\Delta C_{LG_{DW}}$  – change in carbon stocks in dead wood [ $\text{t C yr}^{-1}$ ]

$\Delta C_{LG_{LT}}$  – change in carbon stocks in litter [ $\text{t C yr}^{-1}$ ]

For calculations of annual change in carbon stocks in dead wood the following equation was used:

(Equation 28)

$$\Delta C_{LG_{DW}} = \text{annual area of converted land} * L_{\text{conversion}}$$

$$L_{\text{conversion}} = C_{\text{after}} - C_{\text{before}}$$

$C_{\text{after}}$  – carbon after conversion is 0

$C_{\text{before}}$  – carbon stock in dead wood [ $\text{t C ha}^{-1}$ ]

Values for carbon stock in dead wood ( $C_{\text{before}}$ ) 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:

$$\Delta C_{LG_{LT}} = \text{annual area of converted land} * L_{\text{conversion}}$$

$$L_{\text{conversion}} = C_{\text{after}} - C_{\text{before}}$$

$C_{\text{after}}$  – carbon after conversion is 0

$C_{\text{before}}$  – carbon stock in litter [ $\text{t C ha}^{-1}$ ]

Value for carbon stock in litter ( $C_{\text{before}} = 5.6 \text{ t C ha}^{-1}$ ) 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.

$$\Delta C_{LG_{\text{mineral}}} = \frac{[SOC_0 - SOC_{0-T}] * A}{T} \quad (\text{Equation 29})$$

$\Delta C_{LG_{\text{mineral}}}$  – annual change in carbon stock in mineral soils [ $\text{t C yr}^{-1}$ ]

$SOC_0$  – soil organic carbon stock in the inventory year [ $\text{t C ha}^{-1}$ ]

$SOC_{0-T}$  – soil organic carbon stock  $T$  years prior to the inventory [ $\text{t C ha}^{-1}$ ]

$T$  – 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  $SOC_0$  ( $SOC_{30} = 107 \text{ t C ha}^{-1}$  for grassland) was determined from national soil profiles data. Also values for soil organic stock of previous land uses ( $SOC_{0-T} = 100 \text{ t C ha}^{-1}$  for annual cropland;  $SOC_{30} = 68 \text{ t C ha}^{-1}$  for perennial cropland,  $SOC_{0-T} = 105 \text{ t C ha}^{-1}$  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 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 grassland remaining grassland		
Uncertainty in biomass accumulation rates		$\pm 75\%$ (GPG-LULUCF table 3.4.2)
Uncertainty from land converted to grassland		
Carbon stocks in previous land use	Cropland	$\pm 75\%$ (GPG-LULUCF table 3.3.2)
	Forestland	
Uncertainty total non woody biomass		$\pm 75\%$ (GPG-LULUCF table 3.4.9)
Estimated uncertainty in land managed factors		$\pm 12\%$ (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

No recalculations in this chapter were made.

### 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 do not occur in Slovenia.

Wetland covers 13,544 ha and that represents 0.7 % of country total area. Wetland land use includes: swamps, reeds, other marshy areas and waters (inland water bodies).

**Table 7.6.1: Activity data of wetland 1986 – 2010 in ha**

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 wetland	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
2010	13.440	13.121	0.319	0.082	0.084	0.111	0.031	0.010
2009	13.544	13.225	0.319	0.082	0.084	0.111	0.031	0.010
2008	13.648	13.329	0.319	0.082	0.084	0.111	0.031	0.010
2007	13.752	13.433	0.319	0.082	0.084	0.111	0.031	0.010
2006	13.856	13.537	0.319	0.082	0.084	0.111	0.031	0.010
2005	13.961	13.641	0.319	0.082	0.084	0.111	0.031	0.010
2004	14.065	13.746	0.319	0.082	0.084	0.111	0.031	0.010
2003	14.169	13.850	0.319	0.082	0.084	0.111	0.031	0.010
2002	14.273	13.954	0.319	0.082	0.084	0.111	0.031	0.010
2001	14.377	14.058	0.319	0.082	0.084	0.111	0.031	0.010
2000	14.481	14.162	0.319	0.082	0.084	0.111	0.031	0.010
1999	14.586	14.266	0.319	0.082	0.084	0.111	0.031	0.010
1998	14.690	14.371	0.319	0.082	0.084	0.111	0.031	0.010
1997	14.794	14.475	0.319	0.082	0.084	0.111	0.031	0.010
1996	14.898	14.579	0.319	0.082	0.084	0.111	0.031	0.010
1995	15.002	14.683	0.319	0.082	0.084	0.111	0.031	0.010
1994	15.107	14.787	0.319	0.082	0.084	0.111	0.031	0.010
1993	15.211	14.892	0.319	0.082	0.084	0.111	0.031	0.010
1992	15.315	14.996	0.319	0.082	0.084	0.111	0.031	0.010
1991	15.419	15.100	0.319	0.082	0.084	0.111	0.031	0.010
1990	15.523	15.204	0.319	0.082	0.084	0.111	0.031	0.010
1989	15.627	15.308	0.319	0.082	0.084	0.111	0.031	0.010
1988	15.732	15.412	0.319	0.082	0.084	0.111	0.031	0.010
1987	15.836	15.517	0.319	0.082	0.084	0.111	0.031	0.010
1986	15.940	15.621	0.319	0.082	0.084	0.111	0.031	0.010

Table 7.6.2: Emission from wetlands (1986 – 2010) in Gg CO<sub>2</sub>

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 <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>
2010	NE, NO	NE	NO	NO	NO	NO	NO	NO
2009	NE, NO	NE	NO	NO	NO	NO	NO	NO
2008	NE, NO	NE	NO	NO	NO	NO	NO	NO
2007	NE, NO	NE	NO	NO	NO	NO	NO	NO
2006	NE, NO	NE	NO	NO	NO	NO	NO	NO
2005	NE, NO	NE	NO	NO	NO	NO	NO	NO
2004	NE, NO	NE	NO	NO	NO	NO	NO	NO
2003	NE, NO	NE	NO	NO	NO	NO	NO	NO
2002	NE, NO	NE	NO	NO	NO	NO	NO	NO
2001	NE, NO	NE	NO	NO	NO	NO	NO	NO
2000	NE, NO	NE	NO	NO	NO	NO	NO	NO
1999	NE, NO	NE	NO	NO	NO	NO	NO	NO
1998	NE, NO	NE	NO	NO	NO	NO	NO	NO
1997	NE, NO	NE	NO	NO	NO	NO	NO	NO
1996	NE, NO	NE	NO	NO	NO	NO	NO	NO
1995	NE, NO	NE	NO	NO	NO	NO	NO	NO
1994	NE, NO	NE	NO	NO	NO	NO	NO	NO
1993	NE, NO	NE	NO	NO	NO	NO	NO	NO
1992	NE, NO	NE	NO	NO	NO	NO	NO	NO
1991	NE, NO	NE	NO	NO	NO	NO	NO	NO
1990	NE, NO	NE	NO	NO	NO	NO	NO	NO
1989	NE, NO	NE	NO	NO	NO	NO	NO	NO
1988	NE, NO	NE	NO	NO	NO	NO	NO	NO
1987	NE, NO	NE	NO	NO	NO	NO	NO	NO
1986	NE, NO	NE	NO	NO	NO	NO	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.

#### **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.

Settlements cover 112,836 ha and that represents 5.6 % of country total area. Settlements land use includes: built-areas and related surfaces.

**Table 7.7.1: Activity data of settlements in ha (1986-2010)**

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
2010	112.836	109.661	3.174	0.984	0.962	1.146	0.072	0.011
2009	111.407	108.233	3.174	0.984	0.962	1.146	0.072	0.011
2008	109.978	106.804	3.174	0.984	0.962	1.146	0.072	0.011
2007	108.550	105.376	3.174	0.984	0.962	1.146	0.072	0.011
2006	107.121	103.947	3.174	0.984	0.962	1.146	0.072	0.011
2005	105.693	102.518	3.174	0.984	0.962	1.146	0.072	0.011
2004	104.264	101.090	3.174	0.984	0.962	1.146	0.072	0.011
2003	102.835	99.661	3.174	0.984	0.962	1.146	0.072	0.011
2002	101.407	98.233	3.174	0.984	0.962	1.146	0.072	0.011
2001	99.978	96.804	3.174	0.984	0.962	1.146	0.072	0.011
2000	98.550	95.376	3.174	0.984	0.962	1.146	0.072	0.011
1999	97.121	93.947	3.174	0.984	0.962	1.146	0.072	0.011
1998	95.693	92.518	3.174	0.984	0.962	1.146	0.072	0.011
1997	94.264	91.090	3.174	0.984	0.962	1.146	0.072	0.011
1996	92.835	89.661	3.174	0.984	0.962	1.146	0.072	0.011
1995	91.407	88.233	3.174	0.984	0.962	1.146	0.072	0.011
1994	89.978	86.804	3.174	0.984	0.962	1.146	0.072	0.011
1993	88.550	85.375	3.174	0.984	0.962	1.146	0.072	0.011
1992	87.121	83.947	3.174	0.984	0.962	1.146	0.072	0.011
1991	85.692	82.518	3.174	0.984	0.962	1.146	0.072	0.011
1990	84.264	81.090	3.174	0.984	0.962	1.146	0.072	0.011
1989	82.835	79.661	3.174	0.984	0.962	1.146	0.072	0.011
1988	81.407	78.233	3.174	0.984	0.962	1.146	0.072	0.011
1987	79.978	76.804	3.174	0.984	0.962	1.146	0.072	0.011
1986	78.549	75.375	3.174	0.984	0.962	1.146	0.072	0.011

**Table 7.7.2: Emissions from settlements (1986–2010) in Gg CO<sub>2</sub>**

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 <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>
2010	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2009	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2008	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2007	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2006	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2005	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2004	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2003	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2002	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2001	606.695	NE	606.695	444.578	133.754	28.363	NO	NO
2000	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1999	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1998	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1997	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1996	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1995	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1994	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1993	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1992	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1991	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1990	546.712	NE	546.712	384.595	133.754	28.363	NO	NO
1989	468.340	NE	468.340	306.224	133.754	28.363	NO	NO
1988	468.340	NE	468.340	306.224	133.754	28.363	NO	NO
1987	468.340	NE	468.340	306.224	133.754	28.363	NO	NO
1986	468.340	NE	468.340	306.224	133.754	28.363	NO	NO

CO<sub>2</sub> emissions in category settlements range from 468.3 Gg CO<sub>2</sub> (1986) to 606.7 Gg CO<sub>2</sub> (2010). Land converted to settlements (CO<sub>2</sub>) 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<sub>2</sub> 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 cover 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 perennial 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.

$\Delta C_{FSLB} = A * (C_{after} - C_{before})$ <p style="text-align: right;"><b>(Equation 30)</b></p>
<p><i><math>\Delta C_{FSLB}</math> – annual change in carbon stocks in living biomass due to conversion of forest land to settlements [t C yr<sup>-1</sup>]</i></p> <p><i>A – area of land annually converted [ha yr<sup>-1</sup>]</i></p> <p><i>C<sub>after</sub> – carbon stocks in living biomass immediately following conversion to settlements [t C ha<sup>-1</sup>]</i></p> <p><i>C<sub>before</sub> – carbon stocks in living biomass immediately before conversion to settlements [t C ha<sup>-1</sup>]</i></p>

### 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 planned 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.

Other land covers 26,240 ha and that represents 1.3 % of country total area. Other land includes: open areas with little or no vegetation and dried open areas with special vegetation.

**Table 7.8.1: Activity data of other land in ha (1986-2010)**

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 <sup>1</sup>	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
2010	26.240	26.015	0.225	0.199	0.001	0.006	0.015	0.003
2009	27.198	26.973	0.225	0.199	0.001	0.006	0.015	0.003
2008	28.156	27.931	0.225	0.199	0.001	0.006	0.015	0.003
2007	29.114	28.889	0.225	0.199	0.001	0.006	0.015	0.003
2006	30.072	29.847	0.225	0.199	0.001	0.006	0.015	0.003
2005	31.030	30.806	0.225	0.199	0.001	0.006	0.015	0.003
2004	31.988	31.764	0.225	0.199	0.001	0.006	0.015	0.003
2003	32.946	32.722	0.225	0.199	0.001	0.006	0.015	0.003
2002	33.905	33.680	0.225	0.199	0.001	0.006	0.015	0.003
2001	34.863	34.638	0.225	0.199	0.001	0.006	0.015	0.003
2000	35.821	35.596	0.225	0.199	0.001	0.006	0.015	0.003
1999	36.779	36.554	0.225	0.199	0.001	0.006	0.015	0.003
1998	37.737	37.512	0.225	0.199	0.001	0.006	0.015	0.003
1997	38.695	38.470	0.225	0.199	0.001	0.006	0.015	0.003
1996	39.653	39.428	0.225	0.199	0.001	0.006	0.015	0.003
1995	40.611	40.386	0.225	0.199	0.001	0.006	0.015	0.003
1994	41.569	41.345	0.225	0.199	0.001	0.006	0.015	0.003
1993	42.527	42.303	0.225	0.199	0.001	0.006	0.015	0.003
1992	43.486	43.261	0.225	0.199	0.001	0.006	0.015	0.003
1991	44.444	44.219	0.225	0.199	0.001	0.006	0.015	0.003
1990	45.402	45.177	0.225	0.199	0.001	0.006	0.015	0.003
1989	46.360	46.135	0.225	0.199	0.001	0.006	0.015	0.003
1988	47.318	47.093	0.225	0.199	0.001	0.006	0.015	0.003
1987	48.276	48.051	0.225	0.199	0.001	0.006	0.015	0.003
1986	49.234	49.009	0.225	0.199	0.001	0.006	0.015	0.003

Table 7.8.2: Emissions from other land (1986–2010) in Gg CO<sub>2</sub>

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 <sup>1</sup>	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 <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>
2010	NE, NO	NE	NO	NO	NO	NO	NO	NO
2009	NE, NO	NE	NO	NO	NO	NO	NO	NO
2008	NE, NO	NE	NO	NO	NO	NO	NO	NO
2007	NE, NO	NE	NO	NO	NO	NO	NO	NO
2006	NE, NO	NE	NO	NO	NO	NO	NO	NO
2005	NE, NO	NE	NO	NO	NO	NO	NO	NO
2004	NE, NO	NE	NO	NO	NO	NO	NO	NO
2003	NE, NO	NE	NO	NO	NO	NO	NO	NO
2002	NE, NO	NE	NO	NO	NO	NO	NO	NO
2001	NE, NO	NE	NO	NO	NO	NO	NO	NO
2000	NE, NO	NE	NO	NO	NO	NO	NO	NO
1999	NE, NO	NE	NO	NO	NO	NO	NO	NO
1998	NE, NO	NE	NO	NO	NO	NO	NO	NO
1997	NE, NO	NE	NO	NO	NO	NO	NO	NO
1996	NE, NO	NE	NO	NO	NO	NO	NO	NO
1995	NE, NO	NE	NO	NO	NO	NO	NO	NO
1994	NE, NO	NE	NO	NO	NO	NO	NO	NO
1993	NE, NO	NE	NO	NO	NO	NO	NO	NO
1992	NE, NO	NE	NO	NO	NO	NO	NO	NO
1991	NE, NO	NE	NO	NO	NO	NO	NO	NO
1990	NE, NO	NE	NO	NO	NO	NO	NO	NO
1989	NE, NO	NE	NO	NO	NO	NO	NO	NO
1988	NE, NO	NE	NO	NO	NO	NO	NO	NO
1987	NE, NO	NE	NO	NO	NO	NO	NO	NO
1986	NE, NO	NE	NO	NO	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<sub>2</sub> 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 no conversions from other land uses to other land. Due to necessary assurance for Slovenian land area consistency through whole time series, also conversions from forest land, cropland, grassland, settlements and wetlands to other land are included in land use change matrix.

#### **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<sub>4</sub> emissions resulting from solid waste disposal on land, GHG emissions from waste incineration and CH<sub>4</sub> emissions from treatment of liquid wastes. This section also includes estimates of emission of N<sub>2</sub>O from municipal sewage.

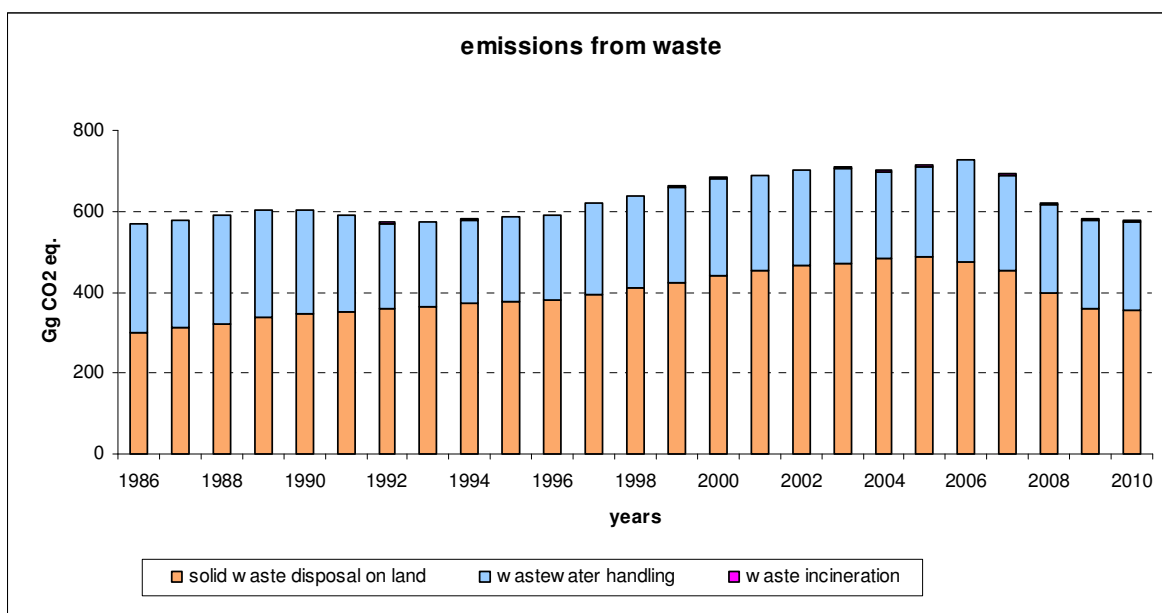


Figure 8.0.1: Emissions from solid waste disposal on land and from wastewater handling in Gg CO<sub>2</sub> eq.. Emissions from waste incineration are very small and therefore not visible on the figure.

### 8.1 CH<sub>4</sub> Emissions from Solid Waste Disposal sites

	KS	Gas	Contribution to Level%	Contribution to Trend%	Rank KS level
Base Year	Level	CH <sub>4</sub>	0.95		18
2010	Level	CH <sub>4</sub>	1.07	0.35	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 transposed. 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.

The Operational Programme is project oriented, focusing on goals:

- 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.

Also measures for achieving the listed goals are part of the Operational Programme:

- 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):

$$\text{CH}_4 \text{ generated in year } t \text{ (Gg/yr)} = \sum_x [(A \cdot k \cdot \text{MSW}(x) \cdot L_0(x)) \cdot e^{-k(t-x)}] \quad (1)$$

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)

$\text{MSW}(x)$  = total municipal solid waste landfilled (Gg/yr)

$L_0$  = methane generation potential (Gg  $\text{CH}_4$ /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:

$$Lo = MCF \cdot DOC \cdot DOC_F \cdot F \cdot 16/12$$

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):

$$CH_4 \text{ emitted} = (CH_4 \text{ generated} - R) \cdot (1 - OX)$$

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 biodegradable 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.**

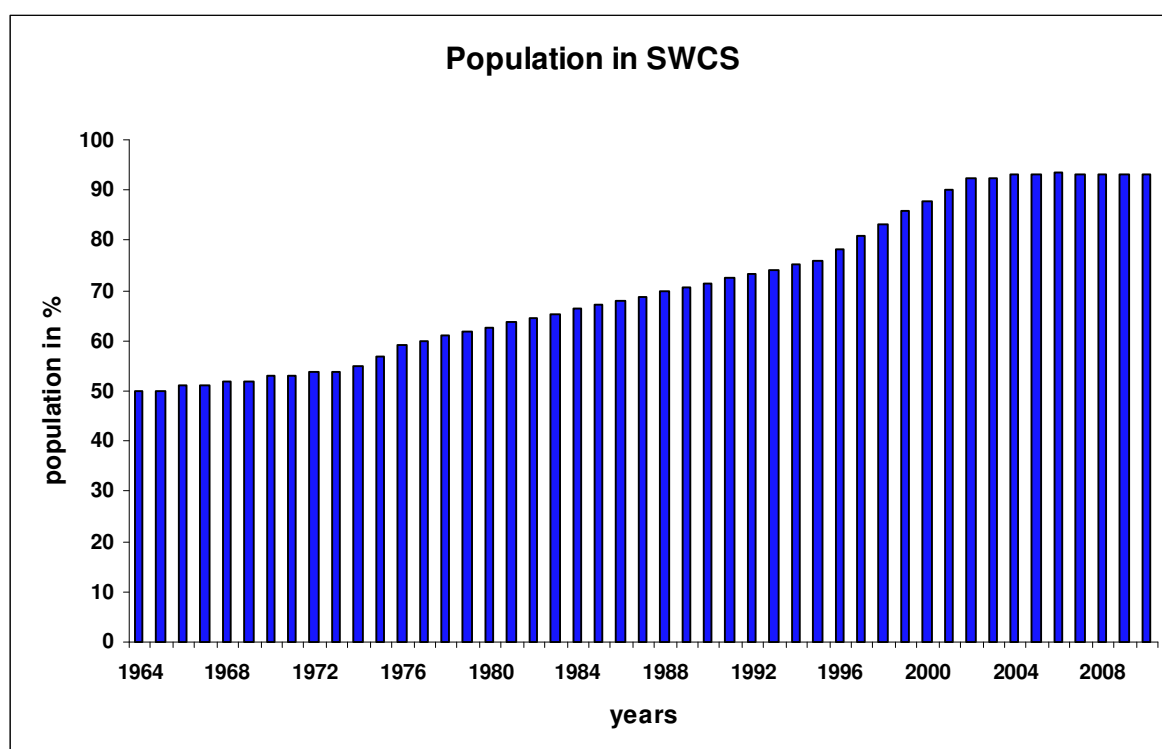
year	Urban population	Coverage in %	Waste disposal rate in kg/per./y.	Municipal solid waste (t)
1995	1,510,504	76.0	468	707,000
1996	1,561,674	78.4	464	725,000
1997	1,606,565	80.9	462	743,000
1998	1,651,310	83.3	461	761,000
1999	1,702,019	85.7	458	780,000
2000	1,749,847	87.9	457	800,000

The amount of waste in the period 2001 - 2010

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 Environmental Agency of the Republic of Slovenia, 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

**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
other operations of disposal	%	0.2	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
waste incineration	%	0	0	0	0.1	0.8	0	0	0	0
other operations of recovery	%	0.7	0.9	0.2	0.4	0.5	0.2	0.3	0.1	0.1
waste use as a fuel	%	0.6	0.2	1.8	0.3	0	0	1.2	1.4	1.7
recovery	%	1	1.6	14.1	16	11.5	31.0	31.3	35.0	35.2

**Table 8.1.5: Quantities of landfilled waste in the period 1964 - 2010.**

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			



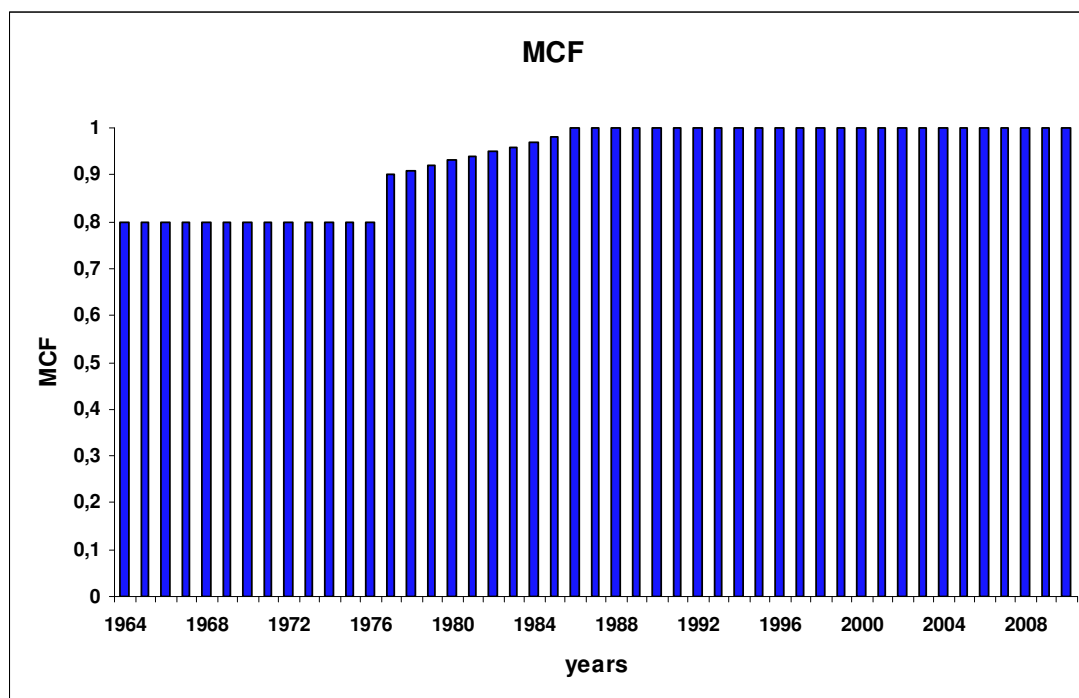
The quantities of municipal waste have marked a slight decrease in recent years. There are several possible explanations for this, one of them being that the quantities in previous years have mostly been arrived at by estimation, whereas in the last three years we had at our disposal very accurate data 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<sub>4</sub> 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.

$$\text{DOC} = (0.4 \cdot A) + (0.17 \cdot B) + (0.15 \cdot C) + (0.3 \cdot D)$$

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

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.

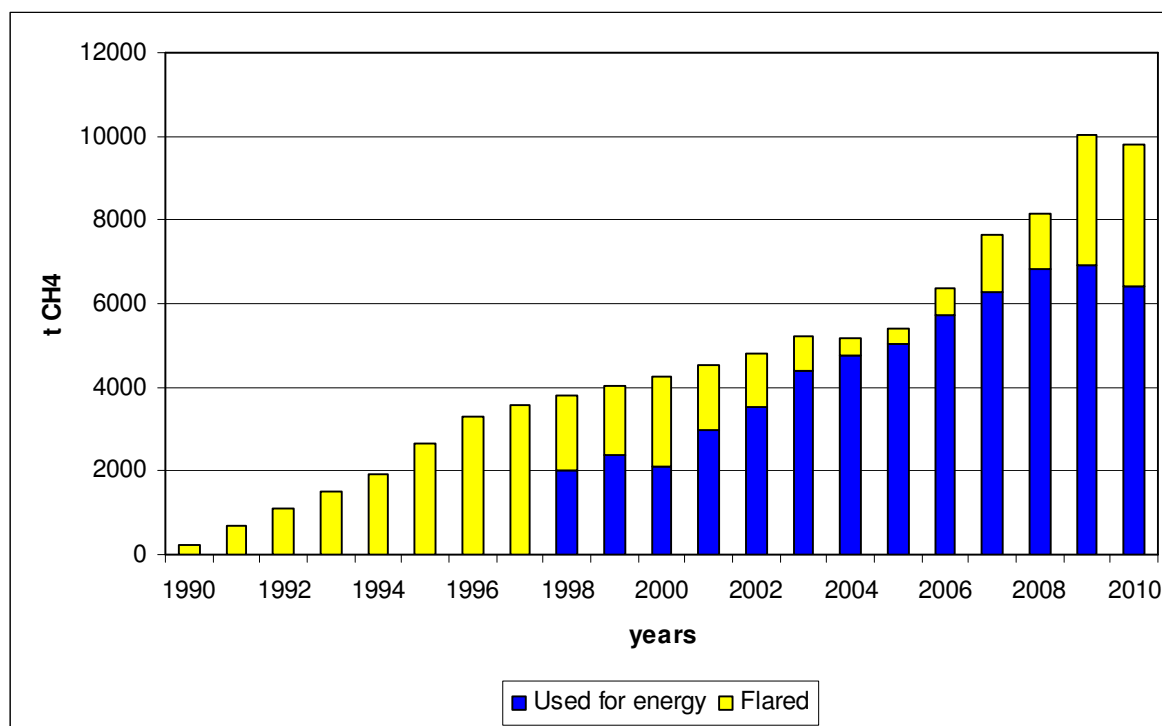
$CH_4$  recovery (R) is the amount of  $CH_4$  generated at SWDS that is recovered and combusted (e.g. flared or used for energy). The amount of methane that is recovered and flared or oxidised in gas engines is subtracted from the annual methane emissions

**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
Recovery	t $CH_4$	5422	6366	7633	8165	10011	9816
Recovery	TJ	273	321	385	411	505	495
used for electricity	TJ	253	288	317	343	349	324
Difference - flared	TJ	20	33	68	68	156	171
flared	t $CH_4$	402	651	1344	1359	3087	3396

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<sub>4</sub> from SWDS that is oxidised in the soil or other material covering the waste. The amount of CH<sub>4</sub> that oxidises turns primarily to CO<sub>2</sub>. If the OX is zero, no oxidation takes place, and if OX is 1 then 100% of CH<sub>4</sub> 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.

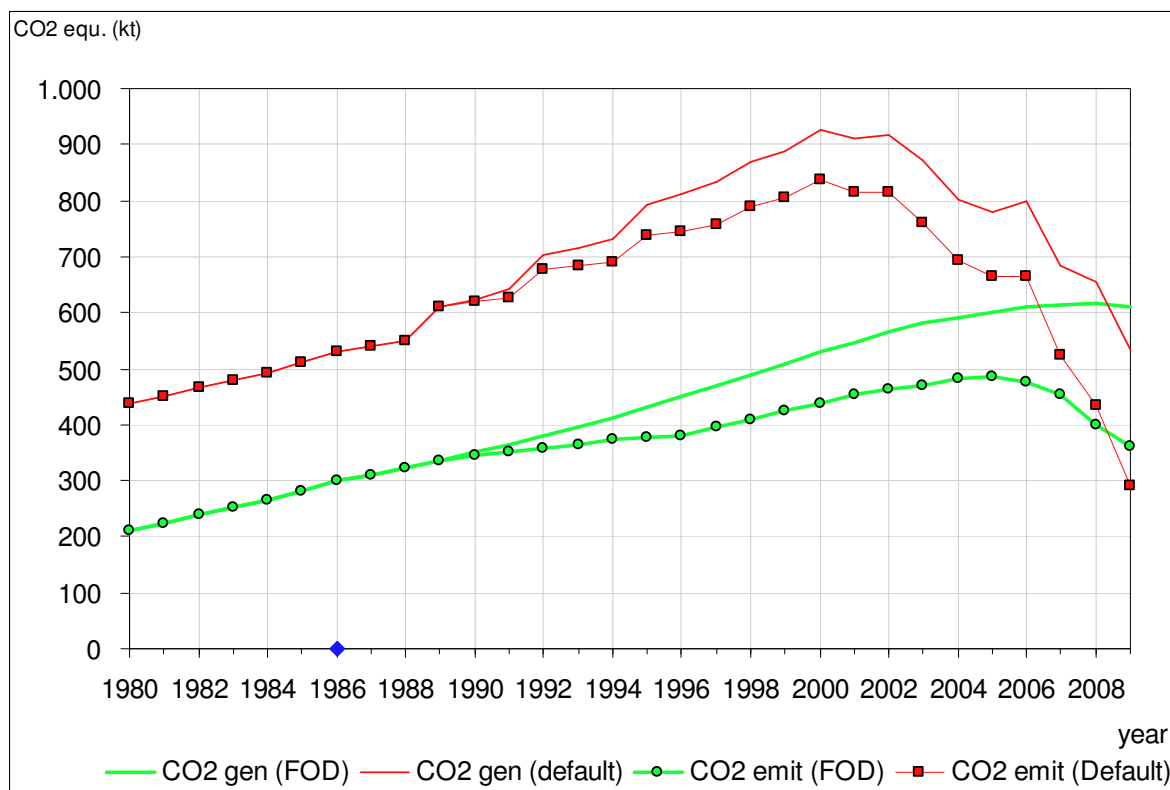


Figure 8.1.4: Methane emissions from SWDS in Gg CO<sub>2</sub>.

#### 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

Dom. & Comm.	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
Base Year	no	CH <sub>4</sub>	0.36		30
2010	Level	CH <sub>4</sub>	0.43	0.21	25

### 8.2.1 Source category description

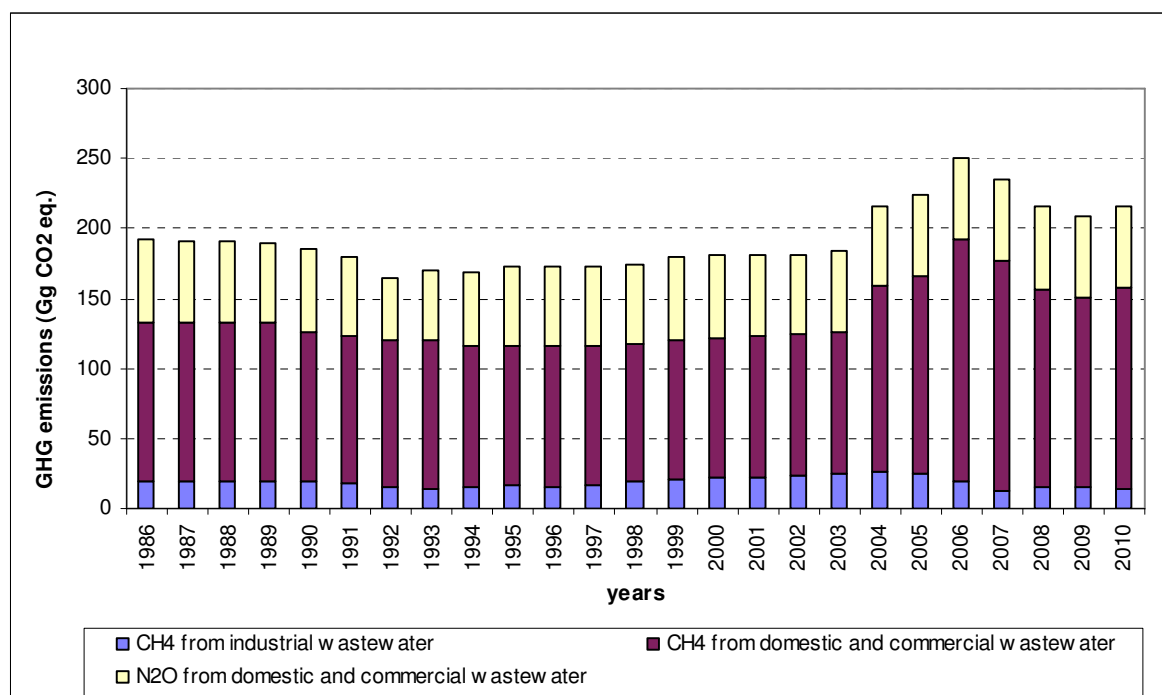


Figure 8.2.1: Emissions of methane and nitrous oxide from wastewater handling.

Wastewater can 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), sewerage 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<sub>4</sub> and N<sub>2</sub>O emissions from domestic and industrial wastewater treatment for the period 1986-2010. Emissions in Figure 8.2.1 are expressed in Gg CO<sub>2</sub> equivalent. Conversion factors of 21 for CH<sub>4</sub> and 310 for N<sub>2</sub>O were used in the calculations. Referring to the third IPCC assessment report, 1 g CH<sub>4</sub> and 1 g N<sub>2</sub>O have the greenhouse effect of 21 and 310 g CO<sub>2</sub>, 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
	CH <sub>4</sub> emissions (Gg)	CH <sub>4</sub> emissions (Gg)	N <sub>2</sub> O emissions (Gg)	CH <sub>4</sub> emissions (in Gg CO <sub>2</sub> eq.)	CH <sub>4</sub> emissions (in Gg CO <sub>2</sub> eq.)	N <sub>2</sub> O emissions (in Gg CO <sub>2</sub> 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	6.38	0.18	25.7	133.9	56.5
2005	1.16	6.73	0.19	24.5	141.4	58.0
2006	0.95	8.20	0.19	19.9	172.2	57.9
2007	0.61	7.82	0.19	12.7	164.3	58.4
2008	0.74	6.72	0.19	15.6	141.2	58.6
2009	0.70	6.45	0.19	14.8	135.5	59.0
2010	0.64	6.84	0.19	13.4	143.7	59.1

## 8.2.2 Methodological issues

### Domestic and Commercial Wastewater

#### CH<sub>4</sub> EMISSIONS

IPCC methodology has been used in calculating the emission of methane from domestic wastewater handling.

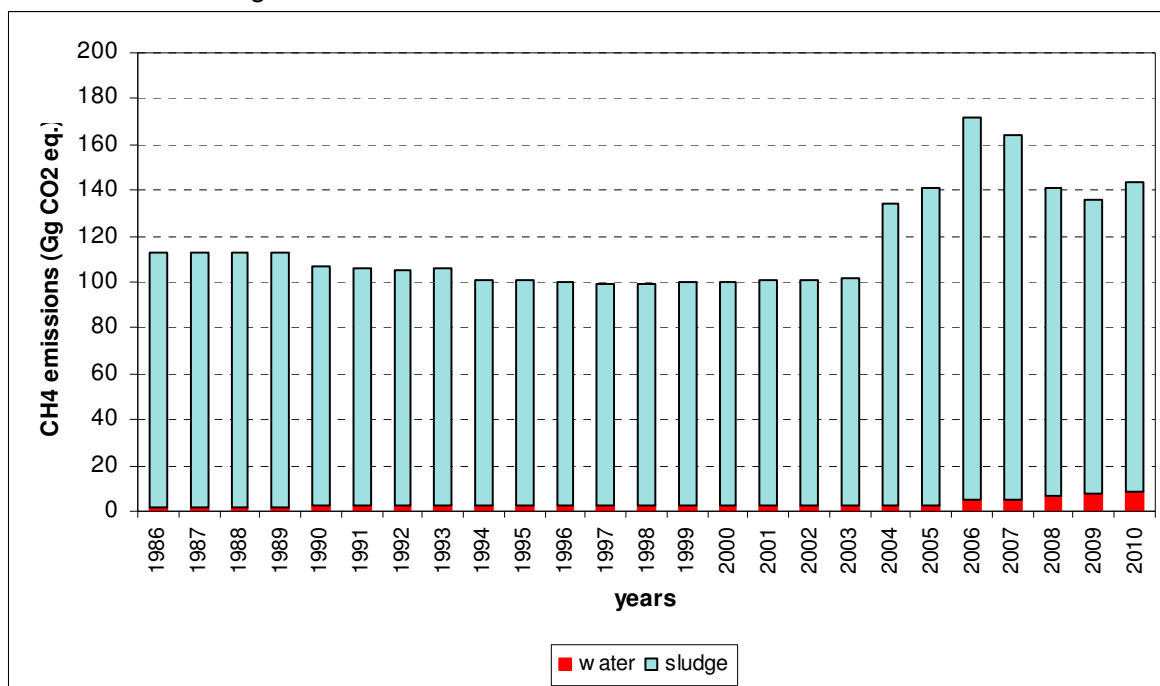


Figure 8.2.2: CH<sub>4</sub> emissions from domestic and commercial wastewater treatment .

As a first step, it is necessary to determine the quantity of total organic decomposable matter in the wastewater ( $TOW_{DOM}$ ) and sludge ( $TOS_{DOM}$ ).

$$TOW_{DOM} = P * D_{DOM} * (1 - DS_{DOM})$$

$$TOS_{DOM} = P * D_{DOM} * DS_{DOM}$$

P – Population (in 1000 persons),

$D_{DOM}$  – Degradable organic component in wastewater per 1000 persons annually,

$DS_{DOM}$  = Fraction of degradable organic component removed as sludge.

Secondly, the emission factor for wastewater and sludge is estimated. Emission factor in kg CH<sub>4</sub>/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,

$WS_{ix}$  = Fraction of wastewater from source i treated in system x,

$MCF_{ix}$  = Methane conversion factor for an individual type of wastewater handling system,

$SS_{jy}$  = Fraction of sludge from source j treated in system y,

$MCF_{jy}$  = Methane conversion factor for sludge handling.



Total emissions of methane from wastewater and sludge handling are:

$$WM = \sum_i (TOW_i * EF_i - MR_i)$$

$$SM = \sum_j (TOW_j * EF_j - MR_j)$$

$MR_{ij}$  - 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<sub>4</sub> emissions (in Gg CO<sub>2</sub> eq.) from domestic wastewater treatment for the period 1986-2010 are shown in Figure 8.2.2. Referring to the third IPCC assessment report, 1 g CH<sub>4</sub> has the greenhouse effect of 21 g CO<sub>2</sub>.

### 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 2010, 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<sub>4</sub> 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.

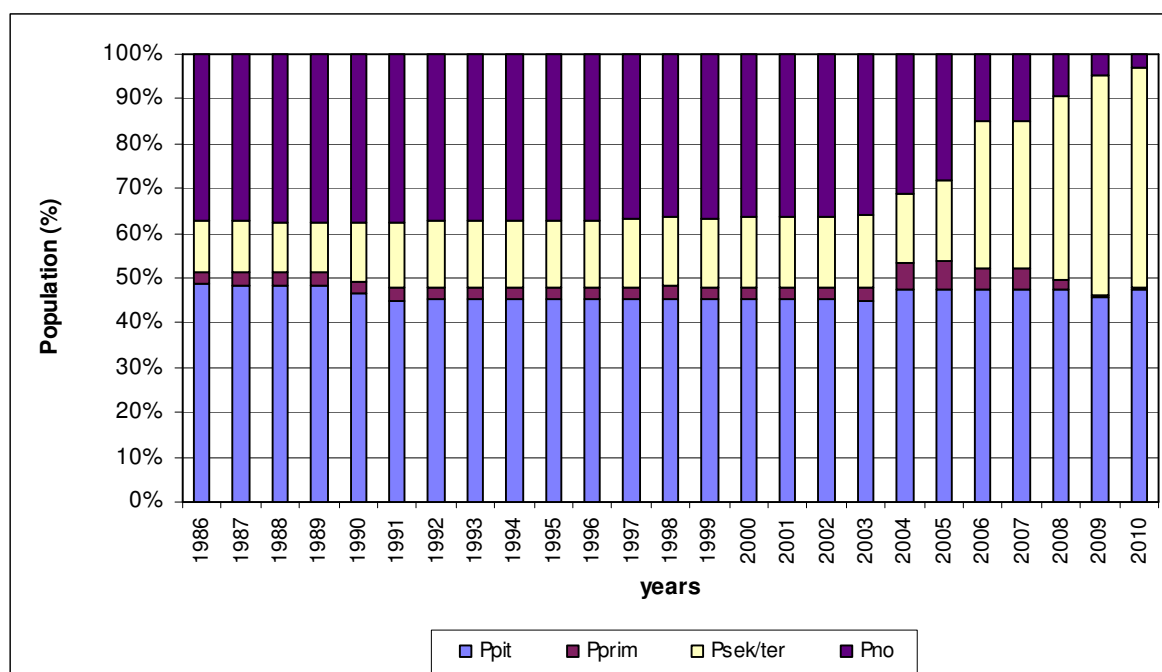


Figure 8.2.3: Fraction of inhabitants included into various types of domestic wastewater treatment (septic tanks (pit), primary treatment, secondary/tertiary treatment and no treatment).

The fraction of inhabitants according to various types of domestic wastewater treatment is shown in figure 8.2.3. Data are taken from SORS and the database on municipal wastewater treatment plants collected by the Environmental Agency of the Republic of Slovenia.

Degradable organic component:

In biochemical oxygen demand per person is overall default 60 g BOD/person/day or 21900 kg BOD/1000 person/year.

Fraction of degradable organic component removed as sludge:

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 IPCC Guidelines provide only one default value of  $B_0$  that had to be applied to both COD and BOD. This is not consistent with the observed differences between BOD and COD levels in raw sewage where COD (mg/l) is 2 to 2.5 higher than BOD (mg/l). Thus, it is good practice to use a default value of 0.25 kg  $CH_4$ /kg COD or a default value of 0.6 kg  $CH_4$ /kg BOD. In our case we use  $B_0$  as 0.6 kg  $CH_4$ /kg BOD.

Methane conversion factor:

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. In our estimate approximately 39% of sludge from wastewater treatment plants was disposed on solid waste disposal sites, while 61% was treated in digestion plants.

Methane recovery

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 2006-2010 were obtained from SORS. Data on recovery for previous years were collected in the frame of research project. 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	CH <sub>4</sub> Recovery (Gg)	Year	CH <sub>4</sub> Recovery (Gg)	Year	CH <sub>4</sub> Recovery (Gg)	Year	CH <sub>4</sub> 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		
1991	0.475	1998	0.828	2005	0.828		
1992	0.517	1999	0.828	2006	0.933		

**N<sub>2</sub>O EMISSIONS**

IPCC methodology for calculation of N<sub>2</sub>O 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<sub>2</sub>O-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<sub>2</sub>O formation can substantially contribute to the GHGs emissions, which is due to a very high global warming potential of N<sub>2</sub>O. Referring to the third IPCC assessment report, 1 g N<sub>2</sub>O has the greenhouse effect of 310 g CO<sub>2</sub> (Table 8.2.3).

**Table 8.2.3: Population, protein consumption and N<sub>2</sub>O emissions in the period 1986-2010.**

Year	Population	Protein in (kg/person/year)	N <sub>2</sub> O emissions (Gg)	N <sub>2</sub> O emissions (in Gg CO <sub>2</sub> 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	37.0	0.189	58.59
2009	2046976	37.0	0.190	59.01
2010	2050189	37.0	0.191	59.10

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 2008, 2009 and 2010, data for the year 2007 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<sub>2</sub>O is presented. Applied methodology is taken from Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, 6.28.

The emissions of N<sub>2</sub>O from human sewage are calculated as follows:

$$N_2O = Protein * Frac_{NPR} * EF * NR_{people}$$

N<sub>2</sub>O — emissions of N<sub>2</sub>O from human sewage (kg N<sub>2</sub>O-N/year)

Protein — annual consumption of protein per capita (kg/person/year)

NR<sub>people</sub> — number of people in country (population)

EF — emissions factor (kg N<sub>2</sub>O-N/kg sewage-N produced)

Frac<sub>NPR</sub> — fraction of nitrogen in protein

### Industrial Wastewater

	KS	Gas	Contribution to Level %	Contribution to Trend %	Rank KS level
<b>Base Year</b>	no	CH <sub>4</sub>	0.31		33
<b>2010</b>	Trend	CH <sub>4</sub>	0.05	0.73	49

### CH<sub>4</sub> 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<sub>4</sub> emissions (in Gg CO<sub>2</sub> eq.) from industrial wastewater treatment for the period 1986-2010 are shown in Figure 8.2.4. Referring to the third IPCC assessment report, 1 g CH<sub>4</sub> has the greenhouse effect of 21 g CO<sub>2</sub>

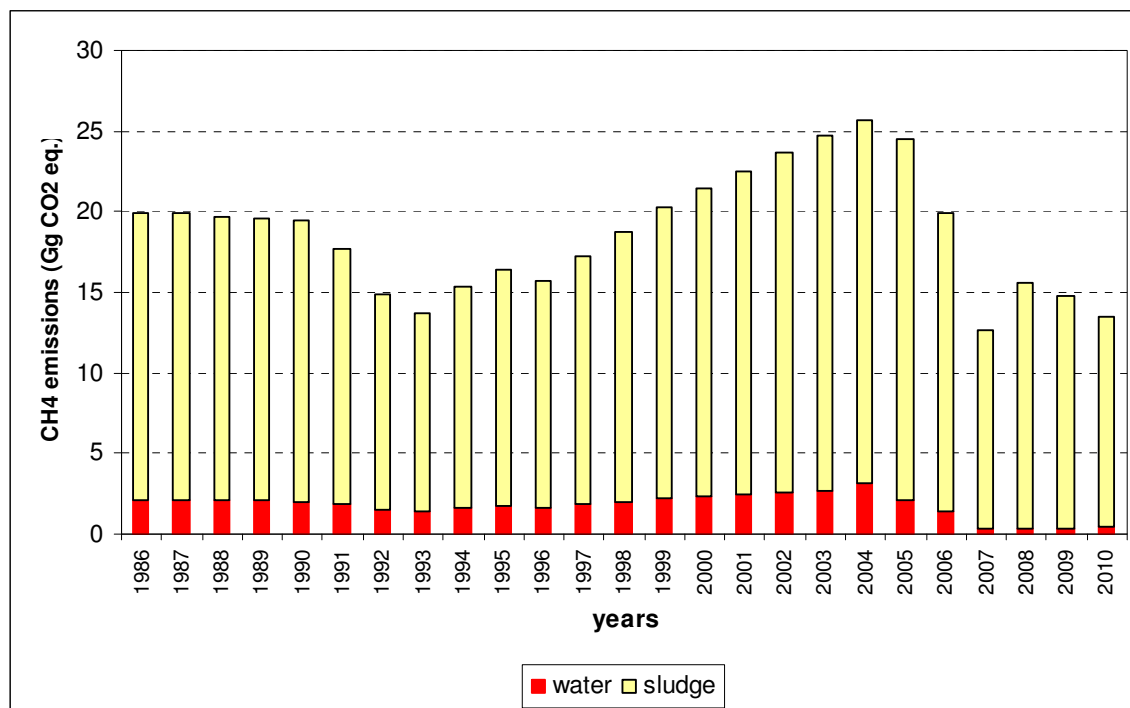


Figure 8.2.4: CH<sub>4</sub> emissions from industrial wastewater treatment.

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 meat processing and pharmaceutical industry, 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 2010 with regard to various industries are presented in Table 8.2.4.

**Table 8.2.4: Methane emissions in 2010 with regard to various industries.**

Industry Type	CH <sub>4</sub> from water (Gg)	CH <sub>4</sub> from sludge (Gg)	CH <sub>4</sub> total (Gg)	Share (%)
Production of leather	0.00028	0.00002	0.00030	0.0
Production of soft drinks and alcohol beverage	0.07093	0.00264	0.07356	11.5
Production of meat	0.07610	0.00191	0.07802	12.2
Production of pulp and paper	0.36679	0.00486	0.37165	58.1
Production of milk	0.03461	0.00025	0.03485	5.4
Production of food	0.00503	0.00000	0.00503	0.8
Production of pharmaceutical products	0.06534	0.01087	0.07621	11.9
<b>Total</b>	<b>0.61907</b>	<b>0.02055</b>	<b>0.63962</b>	<b>100.0</b>

Following the ERT recommendation Slovenia reviewed the data for the period 1986-2003 and recalculated them using a surrogate method, as outlined in chapter 7 of the IPCC good practice guidance, to ensure a consistent time series.

Prior recalculation considerable inter-annual changes between the years 2003 and 2004 were observed due to the different methodologies applied for the period 1986-2003 and 2004-2009. For the period 1986-2003 calculation of TOW<sub>ind</sub> and TOS<sub>ind</sub> were performed applying SORS data on production of individual industry in tonnes and default quantity of wastewater per unit of product. For the period 2004-2010 precise data on direct quantity of wastewater were used for calculation of TOW<sub>ind</sub> and TOS<sub>ind</sub>. Since actual monitored volumes of wastewater are not available before the year 2004, estimation of actual volumes for the years 1986-2003 were performed. Estimation performed is 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 a way that we multiplied these ratios for the year 2004 with data on annual production of individual industry. We decided to chose ratios for the year 2004, since this year most closely represents situation in previous years (Table 8.2.5).

**Table 8.2.5: 2004 data used for estimation of actual volumes for the years 1986-2003.**

2004	Production of individual industry (t)	Actual volumes of wastewater (m3)	Ratio: actual volumes/ production (m3/t)
Production of pulp and paper	1077866	27672000	25.6
Production of leather	12484	274700	22.0
Production of soft drinks and alcohol beverage	405017	1970685	4.86
Production of food	59665	136139	2.28
Production of milk	368751	1133979	3.07
Production of meat	186476	662367	3.55

Table 8.2.6: 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

Calculation of methane emissions for the whole period 1986-2010 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 2004-2010 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. 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. For the period 1986-2003 values of quantity of waste water were estimated as described in previous paragraph. Other parameters needed for emission calculation were adopted from 2004 data.

Following the ERT recommendation to enhance transparency activity data on industrial wastewater has been included. Data on amount of wastewater output for individual industries for the whole period 1986-2010 are presented in Table 8.2.6.

#### 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 disposed on solid waste disposal sites. Conditions at solid waste disposal sites (access of atmospheric oxygen, lower temperature, stabilised sludge) do not allow extensive conversion of organic component into methane. 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.

#### 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 8.2.7. 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.

**Table 8.2.7: 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

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 2010 are specified in Table 8.2.8. Specified values have been used in subsequent calculations.

**Table 8.2.8: 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 <sup>3</sup> 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<sub>4</sub> emissions from domestic waste water treatment were recalculated for the year 2009 due to new data available on inhabitants included into secondary/tertiary treatment.

Following the ERT recommendation to ensure a consistent time series recalculations of CH<sub>4</sub> emissions from industrial waste water for the period 1986-2003 were performed. Estimated actual volumes of waste water were used for emission calculation for the period 1986-2003 instead of previously used data on production of individual industry and default quantity of wastewater per unit of product.

CH<sub>4</sub> emissions from industrial waste water treatment were recalculated for the year 2009. Quantity of wastewater from pharmaceutical industry was changed due to new data obtained for 2009.

### 8.2.4 Future improvements

No improvements are planned for this category.



### 8.3 Waste incineration

Key source - base year: NO

Key source - 2010: no

#### 8.3.1 Source category description

To reduce the number of the not estimated sources to the extend 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 CO<sub>2</sub> eq. in 2010).

#### 8.3.2 Methodological issues

##### Activity data

Amount on waste which was incinerated in Slovenia have been obtained from Environmental Agency of the Republic of Slovenia. 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 - 2010.**

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

### 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 - 2010.**

	unit	biogenic waste	municipal solid waste	clinical waste	hazardous waste
CO <sub>2</sub>	t / t waste	1.289	0.55733	0.836	1.64175
CH <sub>4</sub>	t / t waste	NA	NA	NA	NA
N <sub>2</sub> O	t / t waste	0.0004	0.00015	NA	NA

CO<sub>2</sub> 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)

$$\text{CO}_2 \text{ EF (t/t waste)} = (29.9 * 12 * 0.98 * 44/12) / 1000$$

CO<sub>2</sub> 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:

$$\text{CO}_2 \text{ EF (t/t waste)} = \text{C Content of waste (\%)} * \text{Fossil C of Total C} * \text{Combustion efficiency} * 44/12$$

**Table 8.3.3: Parameters for calculation of CO<sub>2</sub> 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 N<sub>2</sub>O 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.

CH<sub>4</sub> from solid wastes

Uncertainty of activity data amounts to 30%.

Uncertainty of emission factor amounts to 40%

CH<sub>4</sub> from domestic waters:

Uncertainty of activity data amounts to 10%.

Uncertainty of emission factor amounts to 100%.

N<sub>2</sub>O from domestic waters:

Uncertainty of activity data amounts to 15%.

Uncertainty of emission factor amounts to 250%.

CH<sub>4</sub> 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 CO<sub>2</sub> EF: 97% (IPCC Guidelines)

Uncertainty of N<sub>2</sub>O 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 handling is also very urgent. It would be conducted in 2011 if expert or institution will be found with adequate knowledge from this field.

## **9 OTHER**

No emissions have been reported under other.

## 10 RECALCULATIONS AND IMPROVEMENTS

Most recalculation which have been performed for 2011 submission have followed recommendations from the draft review report of our 2010 submission. Due to the very long review process the draft review report have been received in the middle of January and very short time was available to the March submission to made all necessary improvements.

For this reason we have focused more on improvements of calculations while improvements of transparency of the NIR are planned to be done for April submission. Table 10.3.1 provides an overview of the actions taken to improve the NIR and the inventory in response to the comments made by UNFCCC Expert Review Teams.

### 10.1 Justifications of recalculations and implication for emission levels

Not all necessary recalculations have been performed for the March submission 2012. We are still waiting on the draft report from UNFCCC review process 2011 to perform more improvements, mostly related to the LULUCF sector.

Recalculations occurred for the whole period 1986-2009. The impact of recalculations on total GHG emissions is presented in the Table 10.0.1 and more details are available in the sectoral tables.

**Table 10.0.1: Total changes due to recalculation with respect to the previous submission.**

	1986	1990	1995	2000	2005	2006	2007	2008	2009
1. Energy	41.46	32.04	1.38	3.84	15.05	17.39	19.64	18.22	8.32
2. Industrial Processes	28.34	25.72	37.20	47.36	30.62	38.76	46.10	46.32	34.60
3. Solvents									
4. Agriculture	0.75	0.75	0.75				0.00	0.00	-0.31
5. LULUCF	81.19	71.98	64.25	57.39	55.36	4.73	75.76	75.21	67.43
6. Waste	-76.2	-70.8	-35.32	-60.08					-9.11
<b>Total w/o LULUCF</b>	<b>-5.65</b>	<b>-12.33</b>	<b>4.00</b>	<b>-8.87</b>	<b>45.67</b>	<b>56.16</b>	<b>65.75</b>	<b>64.54</b>	<b>33.50</b>
<b>Total with LULUCF</b>	<b>75.53</b>	<b>59.65</b>	<b>68.25</b>	<b>48.52</b>	<b>101.04</b>	<b>60.89</b>	<b>141.51</b>	<b>139.75</b>	<b>100.93</b>
<b>Total in % w/o LULUCF</b>	<b>-0.03</b>	<b>-0.07</b>	<b>0.02</b>	<b>-0.05</b>	<b>0.22</b>	<b>0.27</b>	<b>0.32</b>	<b>0.30</b>	<b>0.17</b>
<b>Total in % with LULUCF</b>	<b>0.60</b>	<b>0.53</b>	<b>0.61</b>	<b>0.42</b>	<b>0.85</b>	<b>0.49</b>	<b>1.15</b>	<b>1.07</b>	<b>0.91</b>

### 10.1.1 Energy

#### 1.A.1.a Energy Industries / Public electricity and heat production

In the previous submission emission factor for the MSW has been used to calculate CO<sub>2</sub> and N<sub>2</sub>O emissions from non-biogenic part of waste incinerated in the Slovenian only waste incineration thermal power plant. From additional information on waste type it shows up that most of the waste is plastics and that the CO<sub>2</sub> EF for MSW is not appropriate. Instead of 0.55 t CO<sub>2</sub>/t waste the emission factor 20 t C/TJ has been used (73.3 t CO<sub>2</sub>/TJ). Since

the plastic does not contain any nitrogen, there are no N<sub>2</sub>O emissions associated with combusting plastic. Therefore N<sub>2</sub>O emissions are zero and notation key NO has been used. Recalculations have occurred to the 2009 only as this is year when the incineration plant has started to work.

#### 1.A.2.f Manufacturing industry and construction / Other

Due to the use of updated value on biogas used in the other industry, emissions in 2009 has been recalculated.

#### 1.A.4.b Other Sectors / Residential and Commercial

In 2011 the SORS settled the results from the questioner about energy and fuel use in residential sector, carried out under the project, which was financially supported by Eurostat. One of the result was improved data on biomass consumption in this sector. The new data is available for 2009 and 2010 only. It shows out that amount of wooden biomass in tonnes, which was used in previous reports was quite good estimates but the NCV was to low. In 2009 we have used NCV of 12.17 TJ/kt while NCV from the new SORS data is 14.71 MJ/kt. To reach this value the fuel wood have to be dried inside what was not the case in the past. For this reason we have interpolated NCV value back to the year 2000.

Recalculations occurred also due to the use of small amount of brown coal for which we believed it is not used in the residential sector since 2005.

Small changes occurred also in the commercial sector in 2009 due to the correction of data for LPG consumption and flaring of methane from SWDS.

#### 1.A.5.b Other Mobile

Emissions from the Army have been estimated for the period 1986-2007, excluded from international bunkers and reported under 1.A.5.b Other/Mobile.

#### 1.B.2 Oil and natural gas

Fugitive emissions from distribution of natural gas have been recalculated for the period 2006-2008 due to the very small correction of EF used for low pressure PVC pipelines.

**Table 10.1.1: Changes due to recalculation with respect to the previous submission in Energy sector in Gg CO<sub>2</sub> eq.**

Energy	1986	1990	1995	2000	2005	2006	2007	2008	2009
A. Fuel Combustion	41.46	32.04	1.38	3.84	15.05	17.38	19.91	18.85	8.32
1. Energy Industries									5.76
2. Manufacturing Ind.									-0.02
3. Transport									
4. Other Sectors				0.76	11.72	14.05	16.43	18.85	2.58
5. Other	41.46	32.04	1.38	3.08	3.33	3.33	3.49		
B. Fugitive Emissions						0.01	-0.27	-0.63	
1. Solid Fuels									
2. Oil and Natural Gas						0.01	-0.27	-0.63	
<b>Total in Gg CO<sub>2</sub> eq</b>	<b>41.46</b>	<b>32.04</b>	<b>1.38</b>	<b>3.84</b>	<b>15.05</b>	<b>17.39</b>	<b>19.64</b>	<b>18.22</b>	<b>8.32</b>
<b>Total of Energy in %</b>	<b>0.26</b>	<b>0.22</b>	<b>0.01</b>	<b>0.03</b>	<b>0.09</b>	<b>0.11</b>	<b>0.12</b>	<b>0.10</b>	<b>0.05</b>

## 10.1.2 Industrial processes

### 2.A.3 Limestone and dolomite use

During detailed assessment of data regarding limestone and dolomite used activity data was slightly increased since in the manufacturing of dyes and pigments the acidic liquid wastes have been neutralized using lime flour. Furthermore some consumption of calcium carbonate was observed in the manufacturing of other non-metallic mineral products. The amount of  $\text{CaCO}_3$  used and associated  $\text{CO}_2$  emissions have been added for the whole period 1986-2009. The second source is limestone and dolomite used for mineral wool production.

### 2.C.5 Aluminium - Anode burn-off

From the same source (EU-ETS) more precise data have been obtained on anode burned-off from Slovenian only aluminium producer and associated  $\text{CO}_2$  emissions have been recalculated for the period 2005 to 2009.

### 2.F Consumption of HFC

The large recalculations have occurred also in the Consumption of Halocarbons and  $\text{SF}_6$  sector. In the response to the "Saturday paper" in 2011 the whole sector has been improved using the data from the database on use of F-gases. data from service companies and a custom data. The new estimates have been prepared in relatively short time period of 6 weeks and the calculations did not undergo all necessary QC checks.

During the preparation of 2012 submission all regular QA/QC activities have been performed and the following two errors have been found: in the industrial refrigeration and in the stationary AC. HFC emissions have been calculated using wrong value for annual leakage rate of 20% instead of 16% and 3%, respectively. Errors have been corrected for the period 1997-2009. In the same time the database has been updated with improve data on HFC consumption and a new disaggregation of data between industrial and commercial refrigeration as well as AC has been done.

Recalculations have also occurred in the category related to the consumption of  $\text{SF}_6$ . In 2011 data about  $\text{SF}_6$  used in electrical equipment has been updated and emissions for 2005-2009 have been recalculated accordingly.

**Table 10.1.2: Changes due to recalculation with respect to the previous submission in Industrial processes sector in Gg  $\text{CO}_2$  eq.**

<b>2. Industrial Processes</b>	<b>1986</b>	<b>1990</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
A. Mineral Products	28.34	25.72	37.20	46.48	47.21	54.05	57.66	54.92	54.22
B. Chemical Industry									
C. Metal Production					-0.73	-1.33	-0.69	-1.42	-0.30
F. Consumption of HFC and $\text{SF}_6$				0.88	-14.99	13.96	-10.87	-7.17	-19.32
<b>Total in Gg <math>\text{CO}_2</math> eq</b>	<b>28.34</b>	<b>25.72</b>	<b>37.20</b>	<b>47.36</b>	<b>30.62</b>	<b>38.76</b>	<b>46.10</b>	<b>46.32</b>	<b>34.60</b>
<b>Total of IP sector in %</b>	<b>2.15</b>	<b>1.95</b>	<b>3.71</b>	<b>3.51</b>	<b>2.23</b>	<b>2.71</b>	<b>3.19</b>	<b>3.49</b>	<b>3.56</b>

### 10.1.3 Agriculture

Very minor recalculations have occurred in the agriculture sector for the period 1986-2009.

#### 4.B Manure management / Non-dairy cattle

The wrong value for volatile solids in 2009 for non-dairy cows has been corrected what has influence on CH<sub>4</sub> EF

#### 4.D Agricultural Soils

The amount of sewage sludge applied to the agricultural soils have been estimated for the period 1986-1999 and updated for 2003, 2004 and for the period 2007 to 2009 and direct and indirect N<sub>2</sub>O emissions from the sewage sludge application have been recalculated accordingly.

In 2009 also area of cultivated histosols has changed.

**Table 10.1.3: Changes due to recalculation with respect to the previous submission in agriculture sector in Gg CO<sub>2</sub> eq.**

<b>4. Agriculture</b>	<b>1986</b>	<b>1990</b>	<b>1995</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
A. Enteric Fermentation						
B. Manure Management						-0.31
D. Agricultural Soils	0.75	0.75	0.75	0.00007	0.00007	0.0002
<b>Total in Gg CO<sub>2</sub> eq</b>	<b>0.75</b>	<b>0.75</b>	<b>0.75</b>	<b>0.00007</b>	<b>0.00007</b>	<b>-0.31</b>
<b>Total of agriculture sector in %</b>	<b>0.34</b>	<b>0.35</b>	<b>0.36</b>	<b>0.000</b>	<b>0.000</b>	<b>-0.015</b>

### 10.1.4 LULUCF

In LULUCF sector the recalculations have been performed for 1986-2009 due to the updated values on forest wild fires and corrected errors in calculation of N<sub>2</sub>O emissions from disturbances associated with land use conversion (Forest land and Grassland converted to Cropland). More comprehensive improvements are expected for the next submission.

**Table 10.1.4: Changes due to recalculation with respect to the previous submission in LULUCF sector in Gg CO<sub>2</sub> eq.**

<b>5. LULUCF</b>	<b>1986</b>	<b>1990</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
A. Forest Land		-9.21	-16.94	-23.79	-25.82	-76.46	-5.43	-5.98	-13.75
B. Cropland	81.19	81.19	81.19	81.19	81.19	81.19	81.19	81.19	81.19
C. Grassland									
E. Settlements									
<b>Total in Gg CO<sub>2</sub> eq</b>	<b>81.19</b>	<b>71.98</b>	<b>64.25</b>	<b>57.39</b>	<b>55.36</b>	<b>4.73</b>	<b>75.76</b>	<b>75.21</b>	<b>67.43</b>
<b>Total of LULUCF in %</b>	<b>1.07</b>	<b>1.00</b>	<b>0.89</b>	<b>0.80</b>	<b>0.66</b>	<b>0.06</b>	<b>0.90</b>	<b>0.89</b>	<b>0.80</b>

### 10.1.5 Waste

CH<sub>4</sub> emissions from domestic waste water treatment were recalculated for the year 2009 due to new data obtained on inhabitants included into secondary/tertiary treatment.

CH<sub>4</sub> emissions from industrial waste water treatment were recalculated for the year 2009. Quantity of wastewater from pharmaceutical industry was changed due to new data obtained for 2009.

Following the ERT recommendation to ensure a consistent time series recalculations of CH<sub>4</sub> emissions from industrial waste water for the period 1986-2003 were performed. Estimated actual volumes of waste water were used for emission calculation for the period 1986-2003 instead of previously used data on production of individual industry and default quantity of wastewater per unit of product.

**Table 10.1.5: Changes due to recalculation with respect to the previous submission in LULUCF sector in Gg CO<sub>2</sub> eq.**

6. Waste	1986	1990	1995	2000	2005	2006	2007	2008	2009
A. SWD on Land									
B. WW Handling	-76.20	-70.83	-35.32	-60.08					-9.11
C. Incineration									
D. Other									
<b>Total in Gg CO<sub>2</sub> eq</b>	-76.20	-70.83	-35.32	-60.08					-9.11
<b>Total of Waste in %</b>	-15.53	-13.31	-6.43	-9.65					-1.58

## 10.2 Response to the UNFCCC Review Process

There has been one review of the Slovenian GHG inventory since the publication of the 2011 NIR.

The UNFCCC conducted a Centralised Review of the 2011 greenhouse gas inventory submission in accordance with decision 22/CMP.1. This review took place from 29 August to 3 September 2011 in Bonn, Germany. We have received the draft ARR on March 13 what was extremely late but we have managed to consider the majority of recommendations for the April submission, except for LULUCF for which we are planning improvements for the submission 2013.

**Table 10.2.1: Responses to the UNFCCC Review conducted in 2011**



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Category		para	Comment from RR	Slovenia's response	Where in the NIR
<b>I. OVERVIEW</b>					
<b>1. Annual submission and other sources of information</b>					
Annual submission		2011, para 6	The ERT recommends that Slovenia take measures in order to ensure that it submit its next inventory by 15 April 2012, including both the CRF tables and a NIR.	Due to the technical problems the submission was made on Monday, 18 April, instead of Friday, 15 April. It was an exceptional case and we believe it will not repeat any more.	NA
Completeness of inventory		2011, para 11	The same as para 33 and para 68	Resolved.	See relevant chapters in the NIR
<b>2. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management</b>					
Inventory preparation	Uncertainties	2011, para 18	The same as para 94	Will be implemented for the submission 2013.	
Inventory preparation	Verification and QA/QC approaches	2011, para 21	The ERT recommends that Slovenia update, on an annual basis, the information on QA/QC procedures, including a follow-up of the planned activities reported in previous submissions and the new activities, together with a schedule for their implementation.	The information have been updated in the submission 2012	NIR 2012, chapter 1.6, page 25
Inventory preparation	Verification and QA/QC approaches	2011, para 22	The ERT reiterates the recommendation in the previous review report that Slovenia improve the information on how the category-specific QC checks are implemented.	Description of category-specific checks are in the relevant chapters.	See relevant chapters in the NIR
Inventory preparation	Verification and QA/QC approaches	2011, para 23	The ERT recommends that the Party improve its QC procedures in order to minimize inconsistencies between NIR and CRF tables and ensure that the text included in the NIR reflects the information related to the current submission.	NIR has been checked and errors have been corrected for the submission 2012	NIR 2012
Inventory preparation	Transparency	2011, para 24	The ERT recommends that the Party continue to improve the transparency of the information provided in its next annual submission. Details are in sectoral descriptions.	See para 41, 42, 44, 59, 60, 67, 78, 80, 81, 82, 89, and 92	See relevant chapters in the NIR
Inventory management	Transparency	2011, para 25	The ERT recommends that Slovenia include detailed information on how internal documentation is archived in its next annual submission.	Information is provided in the submission 2012	NIR 2012, chapter 1.6, page 24

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Inventory management	Transparency	2011, para 26	The ERT recommends that Slovenia provide information on progress to convert all hard copy documentation into an electronic format in its next NIR.	All relevant hard copies have been transformed in the electronic format.	NIR 2012, chapter 1.6, page 24
3. Follow-up to previous reviews					
		2011, para 27	Some of the recommendations from the previous review report have not yet been implemented. <ul style="list-style-type: none"> <li>- new data in residential sector</li> <li>- revision of EFs used for HFC</li> <li>- revision of HFC emissions</li> </ul>	All recommendations have been implemented and descriptions are provided under relevant chapters.	See relevant chapters in the NIR
4. Areas for further improvement					
	Identified by the Party	2011, para 28	(a) The performance of a peer review for selected sectors; (b) The use of new data for fuel use in the residential sector following the results of a data survey; (c) The investigation of the availability of more accurate data for consumption of halocarbons, in order to improve the accuracy of the emission estimates; (d) The estimation of uncertainties for the KP-LULUCF categories.	Recommendation described under a, b and c have been implemented in the submission 2012 while recommendation under (d) will be implemented in the submission 2013.	See relevant chapters in the NIR
	Identified by ERT	2011, para 29, 30, 123	The ERT identifies the following cross-cutting issues for improvement: (a) The maintenance of time-series consistency when performing recalculations due to methodological improvements; (b) The improvement of QC procedures in order to minimize inconsistencies in the CRF tables and the NIR, and between them; (c) The further improvement of the transparency	All improvements have been done for the submission 2012	See relevant chapters in the NIR
<b>B. ENERGY</b>					
1. Sector overview		2011, para 33	The ERT recommends that Slovenia investigate the differences between IEA data and CRF reporting (RA), review its use of the notation keys and improve the completeness and time-series consistency of its reporting.	Data in Reference approach have been updated in the extend possible.	CRF Table, 1.A(b) and NIR 2012, chapter 3.1.1, pages 37-38

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1. Sector overview		2011, para 34	The ERT recommends that Slovenia investigate the discrepancies and correct the errors in the NIR and in the CRF, and make additional efforts to improve the accuracy of the data and the transparency of the information provided in the NIR and in the CRF tables in its next annual submission.	All errors have been corrected in the submission 2012	NIR 2012, chapter 3
1. Sector overview		2010, para 33 2011, para 35	The ERT recommends that Slovenia provide further information on this survey and on the new EF for natural gas for the years 1997-2009 and make the relevant recalculations in its next annual submission. The ERT also recommends that the Party develop country-specific CO <sub>2</sub> EFs for fuels which have a significant share in the fuel mix for each key category.	The possibilities for CS EF will be checked and EF will be provided for the submission 2013 if relevant.	
1. Sector overview		2010, para 40, 2011, para 36	The ERT still recommends that the Party make additional efforts to reallocate emissions from Army under other (mobile) for the entire time series and report in its next annual submission.	Emissions from Army have been estimated for the entire time series.	CRF Tables 1.A and NIR 2012, chapters 3.1.2, pages 38-39 and chapter 3.2.8, page 97
2. Reference and sectoral approach		2011, para 37	The ERT recommends that Slovenia report the reference approach in accordance with the Revised 1996 IPCC Guidelines in its next annual submission.	The missing fuels have been included in the Reference approach	CRF Table, 1.A(b) and NIR 2012, chapter 3.1.1, pages 37-38
2. Reference and sectoral approach		2011, para 38	The ERT recommends that Slovenia also investigate the discrepancies regarding natural gas imports and stock changes and improve the completeness and time-series consistency of the reporting in its next annual submission.	Data on EB for natural gas have been corrected.	CRF Table, 1.A(b) and NIR 2012, chapter 3.1.1, pages 37-38
2. Reference and sectoral approach		2011, para 39	The ERT recommends that Slovenia improve its QC checks of discrepancies with energy balance, elaborate on the reasons for the discrepancies and make the necessary corrections and reallocations in its next annual submission.	The data have been checked but not corrected because Statistical Yearbook is not a relevant source of data.	NA

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2. Reference and sectoral approach	Feedstock and non-energy use of fuels	2011, para 40	The ERT recommends that the Party exclude all fuels used as feedstock and for non-energy purposes from the energy sector and report, in CRF tables 1.A(b) and 1.A(d), all feedstock and non-energy use of fuels (as identified in the national energy balance), the associated CO <sub>2</sub> emissions and the category/sector under which they are allocated in the inventory.	All fuel used as a feedstock have been included in the relevant tables.	CRF Table 1.A(d),
3. Non-key categories	Stationary combustion: liquid fuels- CH <sub>4</sub>	2011, para 41	The ERT recommends that Slovenia provide more information on why it considers CS CH <sub>4</sub> EF of LPG to be more appropriate to the national circumstances in its next NIR, in order to improve the transparency of its reporting.	Information have been included in the submission 2012	NIR 2012, chapter 3.2.2, pages 45-46
3. Non-key categories	Stationary combustion: biomass- CH <sub>4</sub> and N <sub>2</sub> O	2011, para 42	The ERT recommends that Slovenia report additional information on the AD and EFs for all categories of biomass, in order to improve the transparency of its reporting.	Additional information and AD have been included in the NIR	NIR 2012, chapter 3.2.4.1 , pages 50-51, chapter 3.2.5, page 65 and Annex 2 to the NIR
3. Non-key categories	Stationary combustion: biomass- CH <sub>4</sub> and N <sub>2</sub> O	2011, para 43	The ERT recommends that the Party investigate why gaseous biomass is not reported in the RA and review its use of the notation keys.	Gaseous biomass have been included in the RA for the submission 2012	CRF Table, 1.A(b) and NIR 2012, chapter 3.1.1, pages 37-38
3. Non-key categories	Stationary combustion: other fuels- CO <sub>2</sub>	2011, para 44	The ERT recommends that the Party include information about other fuel used under public electricity and heat production in its next NIR.	Information have been included in the submission 2012	NIR 2012, chapter 3.2.4, page 51
3. Non-key categories	Civil aviation: Liquid fuels – CO <sub>2</sub> , CH <sub>4</sub> , and N <sub>2</sub> O	2011, para 45	The ERT recommends that the Party use the notation key IE. (included elsewhere) (i.e. included under other mobile), rather than the notation key NO in CRF table 1.A.(a) and make this correction in its next annual submission.	Notation key has been changed	CRF Table 1.A (a)
<b>C. INDUSTRIAL PROCESSES AND SOLVENT AND OTHER PRODUCT USE</b>					
2. Key categories	Limestone and dolomite use	2011, para 51	The ERT recommends that Slovenia estimate CO <sub>2</sub> emissions from limestone and dolomite used in bricks and ceramics production for the complete time series and transparently document the methodologies, EFs and AD used for the calculations in its next annual submission.	Estimation of CO <sub>2</sub> emissions from limestone and dolomite used in bricks and ceramics production were performed. Description was included in the NIR.	CRF Table 2(l)s1 and NIR 2012, Chapter 4.3.2, pages 122-123

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2. Key categories	Consumption of halocarbons and SF6 – HFCs and SF6	2010, para 56, 2011, para 52	As already noted in the previous review report, some of the EFs may be too high, and the ERT reiterates the recommendation that Slovenia review the EFs used, in particular for domestic refrigeration, stationary air-conditioning and mobile air-conditioning, and justify or recalculate them as appropriate.	All emissions of F-gases have been recalculated using the data from database. The EF used have been checked and corrected where needed.	CRF tables 2.F NIR 2012, chapter 4.14, pages 137-147
2. Key categories	Consumption of halocarbons and SF6 – HFCs and SF6	2011, para 54	The ERT recommends that Slovenia continue to use data on blends containing F-gases from the recently established F-gas database or other relevant data sources to estimate HFC emissions in its future annual submissions and transparently document the methodologies, EFs and AD used in its NIR.	All emissions of F-gases have been recalculated using the data from database. The EF used have been checked and corrected where needed.	CRF tables 2.F NIR 2012, chapter 4.14, pages 137-147
2. Key categories	Consumption of halocarbons and SF6 – HFCs and SF6	2010, para 57, 2011, para 56	The ERT recommends that Slovenia transparently document the methodologies, EFs and AD used for the calculations of HFC emissions from foam blowing in its next annual submission.	All emissions of F-gases have been recalculated using the data from database. The EF used have been checked and corrected where needed.	CRF tables 2.F NIR 2012, chapter 4.14, pages 137-147
2. Key categories	Consumption of halocarbons and SF6 – HFCs and SF6	2010, para 57, 2011, para 57	The ERT recommends that Slovenia transparently document the methodologies, EFs and AD used for the calculations of HFC emissions from fire extinguishers in its next annual submission.	All emissions of F-gases have been recalculated using the data from database. The EF used have been checked and corrected where needed.	CRF tables 2.F NIR 2012, chapter 4.14, pages 137-147
2. Key categories	Consumption of halocarbons and SF6 – HFCs and SF6	2011, para 58	The ERT recommends that Slovenia collect national data on the use of aerosols/metered dose inhalers containing HFCs for its next annual submission and transparently document the methodologies, EFs and AD used for the calculations.	We will try to collect this data for the next submission.	
2. Key categories	Consumption of halocarbons and SF6 – HFCs and SF6	2011, para 59	The ERT recommends that Slovenia transparently describe the methodologies, EFs and AD used for the calculations of SF6 emissions from electrical equipment in its next annual submission.	Description have been improved	NIR 2012, chapter 4.14, pages 137-147
3. Non-key categories	Glass production - CO2	2011, para 60	The ERT recommends that Slovenia provide further details on the EFs, AD and methods used to calculate CO2 emissions from glass production for the whole time series and how it has ensured time-series consistency in its next NIR, in order to enhance transparency.	Description of methods, EF and AD used for CO2 emissions calculation for the whole time series was included in the NIR.	NIR 2012, Chapter 4.5.2, page 125
D. AGRICULTURE					

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B. Key categories	Manure management – N2O	2011, para 67	The ERT recommends that Slovenia include additional supporting data, such as a comparison to the Nex rates from swine in other countries with similar management practices, to verify the use of the country-specific Nex rates for swine.	Verification have been done.	NIR 2012, Chapter 6.3, pages 170-171
B. Key categories	Agricultural soil emissions - N2O	2011, para 68	The ERT reiterates the recommendation from the previous review report that, for the years prior to 2000, the Party use methods to estimate the AD on sewage sludge use, such as those outlined in the IPCC good practice guidance, in order to ensure time-series consistency.	Data about sewage sludge deposited on the agricultural land have been estimated for the years prior 2000.	CRF Tables 4.D. NIR 2012, Chapter 6.4, pages 177-178
<b>E. LULUCF</b>					
1. Sector overview		2011, para 71	The ERT reiterates the previous recommendation that the Party provide information on »non-existing small area of land converted to and from WL, ST, and OL in the documentation boxes of the relevant CRF tables, including a cross reference to the detailed explanation in the NIR for the cases in which AD exist but the corresponding emissions are not estimated.	Will be included in 2013 submission	
1. Sector overview		2011, para 72	Net CO2 emissions and removals from forest land, cropland, grassland and settlements show large fluctuations between 2000 and 2001. The ERT recommends that Slovenia investigate the fluctuations and report corrected values, or provide a clear explanation of the fluctuations in the next annual submission.	Will be included in 2013 submission	
1. Sector overview		2011, para 73	The ERT reiterates the previous recommendation that the Party improve its QC procedures by reviewing the NIR and the CRF tables prior to their submission and that it correct any identified errors in its next annual submission.	Will be included in 2013 submission	
1. Sector overview		2010, para 77 2011, para 74	The ERT <b>strongly</b> reiterates the recommendation from the previous review report that the Party provide more information on ALUMs, including information on data processing and analysis, and an assessment of their accuracy in the next annual submission.	Partly implemented in the 2012 submission	NIR 2012, Chapter 7.2.1, pages 187-191

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2. Key categories	Forest land remaining forest land - CO2	2011, para 75	The ERT recommends that the Party report the carbon stock changes in dead wood for the years 2007-2012 applying equation 3.2.12 of the IPCC good practice guidance for LULUCF using data from the 2012 NFI in the NIR of the 2014 submission, provide information on the availability of data from the 2012 NFI in its next annual submission, and explore more accurate methodologies for the estimation of the carbon stock changes in dead wood for the years prior to 2007.	Will be included in 2013 submission	
2. Key categories	Land converted to forest land - CO2	2011, para 76	As land converted to forest land is a key category, the ERT recommends that Slovenia report the emissions and removals using a higher-tier method.	Will be included in 2013 submission	
2. Key categories	Land converted to forest land - CO2	2011, para 77	The ERT recommends that Slovenia set the Party's definition of organic soils in reference to page G.14 (annex A) of the IPCC good practice guidance for LULUCF and report the carbon stock changes in organic soils in the next annual submission.	Will be included in 2013 submission	
2. Key categories	Cropland remaining cropland - CO2	2011, para 78	The ERT reiterates the recommendation of the previous review report that Slovenia report the areas of perennial and annual crops and the associated carbon stock changes as separate subcategories in CRF table 5.B, in order to increase transparency.	Will be included in 2013 submission	
2. Key categories	Land converted to Cropland - CO2	2011, para 79	The ERT reiterates the recommendation from the previous review report that Slovenia correct these errors and improve its QC procedures for its next annual submission.	Will be included in 2013 submission	
2. Key categories	Grassland - CO2	2011, para 80	The ERT recommends that Slovenia, in its next annual submission, provide information on the area and carbon stock changes of organic soils in land converted to grassland, and clear information on the estimated carbon stock changes in organic soils in grassland remaining grassland in the NIR and the related CRF documentation box.	Will be included in 2013 submission	
2. Key categories	Land converted to settlements - CO2	2011, para 81	The ERT recommends that Slovenia provide information on the carbon stocks in living biomass immediately before conversion to settlements (Cbefore) in its next annual submission.	Will be included in 2013 submission	

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3. Non-key categories	N2O emissions from disturbance associated with land-use conversion to cropland . N2O	2011, para 82	The ERT recommends that Slovenia correct these inconsistencies in NIR and in CRF tables and provide further information on the choice of the C:N ratio in its next annual submission.	Will be included in 2013 submission	
VI. WASTE					
2. Key categories	Solid waste disposal on land – CH4	2011, para 86	The ERT recommends that the Party report oxidation factor using the figure "0" instead of the notation key "NO".	Oxidation factors for the period 1986-2007 have been reported as "0" instead of "NO".	CRF 2012, Table 6.A,C
2. Key categories	Wastewater handling – CH4	2010, para 92, 2011, para 88	The ERT reiterates the recommendation from the previous review report that Slovenia review the data for the period 1986-2003 and recalculate them, if necessary, using methods such as the surrogate method, as outlined in chapter 7 of the IPCC good practice guidance, to ensure a consistent time series.	Data for the period 1986-2003 were reviewed and emissions were recalculated using a surrogate method. Recalculation was described in the NIR.	CRF Table 6.Bs1 and NIR 2012, Chapter 8.2.2, pages 246-250
3. Non-key categories	Waste incineration - CO2	2011, para 89	The ERT reiterates the recommendation of the previous review report that the Party increase the transparency of its reporting by including more information on the method applied and data used in the relevant section of the NIR.	Method and EF used have been included in the 2012 submission.	NIR 2012, Chapter 8.3, page 258
G. SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL					
1. information and activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol					
Overview		2011, para 92	The Party has not provided detailed information on whether the system covers the whole deforested land area for the entire time series. The ERT recommends that Slovenia provide this information in its next annual submission.	Will be included in 2013 submission	
Overview		2011, para 94	The ERT reiterates the recommendation from the previous review report that the Party report information on uncertainty in the next annual submission.	Will be included in 2013 submission	
Overview		2011, para 95	The ERT recommends that the Party harmonize the discrepancy of the estimated area between the Convention and the Kyoto Protocol in its next annual submission.	Will be included in 2013 submission	



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Activities under Article 3, paragraph 3, of the Kyoto Protocol	Deforestation – CO2	2011, para 99	The ERT recommends that Slovenia investigate the difference in net CO2 emissions in all carbon pools between 2008 and 2009 and report the revised values in the next annual submission, if appropriate.	Will be included in 2013 submission	
Activities under Article 3, paragraph 3, of the Kyoto Protocol	Deforestation - CO2	2011, para 100	The ERT recommends that the Party report the deforested area as NA in CRF table KP(K-I)A.2.1 in its next annual submission.	Will be included in 2013 submission	
Activities under Article 3, paragraph 3, of the Kyoto Protocol	Deforestation – CO2	2011, para 101	The ERT reiterates the previous recommendation that Slovenia check the AD and EFs used and revise the estimates of net carbon stock changes and report thereon in its next annual submission, if appropriate.	Will be included in 2013 submission	
Activities under Article 3, paragraph 4, of the Kyoto Protocol	Forest management - CO2	2011, para 103	The ERT strongly recommends that Slovenia estimate and report the carbon stock changes in litter and mineral soils on areas under forest management in the next annual submission, or provide verifiable information, as required in paragraph 6(e) of the annex to decision 15/CMP.1, which demonstrates that these pools are not net sources in line with section 4.2.3.1 of the IPCC good practice guidance for LULUCF.	Will be included in 2013 submission	
5. Minimizing of adverse impacts in accordance with Article 3, paragraph 14 of the Kyoto Protocol					
		2011, para 111	The ERT recommends that Slovenia include more information in the next annual submission on the most relevant actions taken and their potential adverse impacts. The ERT also recommends that the Party, in its next annual submission, report any change(s) in its information provided under Article 3, paragraph 14, in accordance with chapter I.H of the annex to decision 15/CMP.1.	Included in the 2012 submission	NIR 2012, Chapter 3.13, page 292

## Legend:

Included in this submission
Partly included in this submission
Planned to be included in the next submission

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
<b>Total (Net Emissions)</b>			
<b>1. Energy</b>			
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			
<b>2. Industrial Processes</b>			
A. Mineral Products			
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6	√	√	HFC from 2.F.1-4, NIR p.135-145
G. Other			
<b>3. Solvent and Other Product Use</b>			
<b>4. Agriculture</b>			
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			
<b>5. Land Use, Land-Use Change and Forestry</b>			
A. Forest Land			
B. Cropland			
C. Grassland			
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			
<b>6. Waste</b>			
A. Solid Waste Disposal on Land			
B. Waste-water Handling			
C. Waste Incineration			
D. Other			
<b>7. Other (as specified in Summary 1.A)</b>			
<b>Memo Items:</b>			
<b>International Bunkers</b>			
Aviation			
Marine			
<b>Multilateral Operations</b>			
<b>CO2 Emissions from Biomass</b>			
<b>NIR Chapter</b>	<b>DESCRIPTION</b>		<b>REFERENCE</b>
	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
<b>Chapter 1.2 Institutional arrangements</b>			
<b>Chapter 1.6 QA/QC plan</b>			

## PART II: SUPPLEMENTARI INFORMATION UNDER ARTICLE 7, PARAGRAPH 1

### 11 KP-LULUCF

#### 11.1 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 2010 were 359.43 Gg CO<sub>2</sub> eq. The area subjected to D was 6.051 kha at the end of the third year of the commitment period.

Removals from Article 3.4 activity (FM) in 2010 were -10,307.99 Gg CO<sub>2</sub> eq.. The area subjected to FM was 1,185,169 ha at the end of the third year of the commitment period.

**Table 11.1.1: Emissions from activities under Article 3.3 (Deforestation) in 1990 - 2010, Gg CO<sub>2</sub>.**

	Annual area	Total area	Living biomass	DOM	Soils	Total	N <sub>2</sub> O
	kha	kha	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	kg N <sub>2</sub> O-N / yr
2010	0.724	6.051	300.17	27.33	25.79	356.86	10.34
2009	0.676	5.327	280.27	25.52	24.08	329.87	9.66
2008	0.309	4.652	127.00	11.55	8.73	147.28	3.47
2007	0.163	4.343	67.15	6.04	1.32	74.50	0.52
2006	0.240	4.180	97.63	8.80	0.31	106.74	0.12
2005	0.114	3.939	45.23	4.13	0.52	49.88	0.21
2004	0.211	3.825	81.72	7.54	0.96	90.23	0.38
2003	0.182	3.614	67.67	6.34	4.69	78.69	1.66
2002	0.279	3.432	75.14	7.05	0.51	82.71	0.18
2001	0.241	3.154	115.24	11.12	14.92	141.28	5.29
2000	0.190	2.913	65.98	6.49	3.70	76.17	1.47
1999	0.312	2.723	105.59	10.51	3.02	119.11	1.20
1998	0.228	2.411	75.16	7.62	3.25	86.04	1.30
1997	0.280	2.183	90.87	9.29	3.09	103.26	1.23
1996	0.248	1.903	78.02	8.14	3.83	89.99	1.53
1995	0.255	1.655	78.94	8.31	3.08	90.34	1.23
1994	0.399	1.400	121.09	12.90	4.11	138.10	1.64
1993	0.100	1.001	29.11	3.20	2.07	34.37	0.82
1992	0.100	0.901	28.41	3.17	2.07	33.65	0.82
1991	0.100	0.802	27.72	3.14	2.07	32.93	0.82
1990	0.702	0.702	193.34	21.92	7.41	222.68	2.95

**Table 11.1.2: Emissions and removals from activities under Article 3.4 (Forest management) in 1990 - 2010, Gg CO<sub>2</sub>.**

	Area	Living biomass	DOM	Soils	Biomass burning	Total
	kha	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>	Gg CO <sub>2</sub>
2010	1,185.2	-9,851.70	-465.75	NA	8.31	-10,309.14
2009	1,186.1	-9,859.89	-466.14	NA	18.31	-10,307.72
2008	1,185.1	-9,854.96	-465.91	NA	7.45	-10,313.42
2007	1,183.3	-9,840.43	-465.22	NA	15.73	-10,289.92
2006	1,173.8	-9,761.56	-461.49	NA	160.12	-10,062.93
2005	1,169.2	-9,723.93	-459.71	NA	21.84	-10,161.80
2004	1,163.8	-9,678.34	-457.56	NA	11.57	-10,124.33
2003	1,157.8	-9,628.77	-455.21	NA	234.93	-9,849.05
2002	1,149.6	-9,559.84	-451.95	NA	11.19	-10,000.60
2001	1,142.9	-9,503.90	-449.31	NA	34.00	-9,919.21
2000	1,134.2	-8,211.19	-309.23	NA	17.18	-8,503.24
1999	1,115.7	-8,075.87	-304.14	NA	43.48	-8,336.53
1998	1,111.0	-8,042.77	-302.89	NA	96.00	-8,249.66
1997	1,109.7	-8,033.01	-302.52	NA	49.59	-8,285.94
1996	1,098.8	-7,954.57	-299.57	NA	30.80	-8,223.34
1995	1,097.9	-7,947.89	-299.32	NA	18.36	-8,228.85
1994	1,094.2	-7,919.85	-298.26	NA	NA	-8,218.11
1993	1,089.9	-7,890.89	-297.17	NA	NA	-8,188.06
1992	1,085.6	-7,859.75	-296.00	NA	36.50	-8,119.25
1991	1,081.3	-7,828.61	-294.83	NA	69.52	-8,053.92
1990	1,077.0	-7,793.11	-293.49	NA	66.65	-8,019.95

### 11.1.1 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 11.1.3: 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<sub>2</sub> sinks under Articles 3.3 and 3.4.

### **11.1.2 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 fulfilling the definition of forest (**Napaka! Vira sklicevanja ni bilo mogoče najti.**11.0.2), 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.

### **11.1.3 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.

### **11.1.4 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 11.2.1: Land transition matrix for 2008.**

To current inventory year (2008)  From previous inventory year (2007)		Article 3.3 activities		Article 3.4 activities				Other	Total area at the beginning of the current inventory year
		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		4.34						4.34
Article 3.4 activities	Forest Management (if elected)		0.31	1,182.78					1,183.09
	Cropland Management (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation (if elected)	NA			NA	NA	NA		NA
Other		NA	NA	2.37	NA	NA	NA	837.50	839.87
Total area at the end of the current inventory year		0.00	4.65	1,185.15	NA	NA	NA	837.50	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.

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**Table 11.2.2: Land transition matrix for 2009.**

To current inventory year (2009)  From previous inventory year (2008)		Article 3.3 activities		Article 3.4 activities				Other	Total area at the beginning of the current inventory year
		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		4.65						4.65
Article 3.4 activities	Forest Management (if elected)		0.68	1,184.47					1,185.15
	Cropland Management (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation (if elected)	NA			NA	NA	NA		NA
Other		NA	NA	1.63	NA	NA	NA	835.87	837.50
Total area at the end of the current inventory year		0.00	5.33	1,186.10	NA	NA	NA	835.87	2,027.30

**Table 11.2.3: Land transition matrix for 2010.**

To current inventory year (2010)  From previous inventory year (2009)		Article 3.3 activities		Article 3.4 activities				Other	Total area at the beginning of the current inventory year
		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		5.33						5.33
Article 3.4 activities	Forest Management (if elected)		0.72	1,188.17					1,185.89
	Cropland Management (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation (if elected)	NA			NA	NA	NA		NA
Other		NA	NA	1.63	NA	NA	NA	836.08	836.08
Total area at the end of the current inventory year		0.00	6.05	1,185.17	NA	NA	NA	836.08	2,027.30

### **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 georeferenced 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<sub>2</sub>O 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<sub>2</sub>O 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 that 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 explanation about calculations are described in chapter 7.3.2 (7.3.2.1 Forest land remaining forest land and 7.3.2.2 Non-CO2 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**

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.

**Table 11.3.1: 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 <sub>2</sub> O	N <sub>2</sub> O	N <sub>2</sub> O
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

### 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 uncertainties for Article 3.3 activities have not been estimated separately.

#### **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, 2009, and 2010 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 – 2010.

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 totally damaged, the legislation on prevention of insect and fungus disturbances binds owners to remove the rest of the damaged trees. After that, the reestablishment work should be started immediately if possible. That areas remain registered 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 and in 2010. The net emissions from carbon stock changes were 144.93 Gg CO<sub>2</sub> eq. (in 2008), 316.71 Gg CO<sub>2</sub> eq. (in 2009) and 359.43 Gg CO<sub>2</sub> eq. (2010).

## **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 and in 2010. The net removals from carbon stock changes were -10,312.37 Gg CO<sub>2</sub> eq. (in 2008), -10,305.14 Gg CO<sub>2</sub> eq. (in 2009) and -10,307.99 Gg CO<sub>2</sub> eq. (in 2010).

## **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<sub>2</sub> emissions from deforestation (conversion to grassland). CO<sub>2</sub> 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 2011 (SEF\_SI\_2012\_1\_10-41-43 9-1-2012.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 2011 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)	<p>The Standard Electronic Format report for 2011 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.</p> <p>SEF_SI_2012_1_10-41-43 9-1-2012.xls</p> <p>The contents of the SEF report (R1) can also be found in Annex 6 of this document.</p>

### 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	<p>No discrepant transactions occurred in 2011.</p> <p>Refer to Separate Electronic Attachment "SIAR Reports 2012-SI v 1.0.xls" Worksheet R2.</p>
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	<p>No CDM notifications occurred in 2011.</p> <p>Refer to Separate Electronic Attachment "SIAR Reports 2012-SI v 1.0.xls" Worksheet R3.</p>

Annual Submission Item	Report
15/CMP.1 annex I.E paragraph 15: List of non-replacements	No non-replacements occurred in 2011.  Refer to Separate Electronic Attachment "SIAR Reports 2012-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 2011.  Refer to Separate Electronic Attachment "SIAR Reports 2012-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 2011.

## 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: <a href="http://rte.arso.gov.si/Default.aspx?Module=/PublicReportsA">http://rte.arso.gov.si/Default.aspx?Module=/PublicReportsA</a>  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-gases), 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 <sub>2</sub> eq.)
Emissions (without F-gasses and LUCF) in 1986	20,027.878
Emissions of F-gasses in 1995	326.164
<b>TOTAL Base Year Emission</b>	<b>20,354.042</b>
Kyoto target	-8%
Annual average emissions (2008-2012)	18,725.719
<b>Estimated assigned amount</b>	<b>93,628.593</b>

Slovenia's AA= 20,354.042 x 0.92 x 5 = **93,628.593 Gg CO<sub>2</sub> equivalent**

Slovenia's CPR = 93,628.593 x 0.90 = **84,265.734 Gg CO<sub>2</sub> 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

**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 Slovenian Environment Agency Vojkova 1b, SI-1000 Ljubljana Email: misa.bizjak@gov.si Telephone: +386 14784087 Fax: +386 14784051.
15/CMP.1 annex II.E paragraph 32.(b)  Change of cooperation arrangement	No change of cooperation arrangement occurred during the reported period.

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Reporting Item	Report
<p>15/CMP.1 annex II.E paragraph 32.(c)</p> <p>Change to database or the capacity of national registry</p>	<p>The Greta software upgrade occurred in January 2011. Greta Version 5.1.24 was released into production on 10<sup>th</sup> of February 2011.</p> <p><u>Database and Application Backup</u>  <i>There were no change to the database and application backup in 2011.</i></p> <p><u>Disaster Recovery Plan</u>  <i>There was no change to the Disaster Recovery Plan in 2011.</i></p> <p><u>Test Plan and Test Report</u>  <i>There was no change to the Test Plan and Test Report in 2011.</i></p>
<p>15/CMP.1 annex II.E paragraph 32.(d)</p> <p>Change of conformance to technical standards</p>	<p>No change in the registry's conformance to technical standards occurred for the reported period.</p>
<p>15/CMP.1 Annex II.E Paragraph 32.(e)</p> <p>Change of discrepancies procedures</p>	<p>No change of discrepancies procedures occurred during the reported period.</p>
<p>15/CMP.1 annex II.E paragraph 32.(f)</p> <p>Change of security</p>	<p>Slovenian registry performed the two-man rule (Method 2). From February 2011, it became mandatory for all accounts to have an additional authorised representative to authorise transactions.</p> <p>Independent Security Assessment was performed in January / February 2011. The testing was based on standard content of penetration testing, including security risks listed by OWASP and other high risk threats.</p> <p>In relation to the software. A number of security improvements were made in Greta Version 5.1.24, these include also removal of phishing by URL redirection and recommendations regarding configuration settings.</p>

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Reporting Item	Report
<p>15/CMP.1 annex II.E paragraph 32.(g)</p> <p>Change of list of publicly available information</p>	<p>Publicly accessible information is provided with specific reference to paragraphs 44-48 in the annex to decision 13/CMP.1.</p> <p>Public available information could be accessed via registry website, URL:  <a href="http://rte.arso.gov.si/Default.aspx?Module=/PublicReportsA">http://rte.arso.gov.si/Default.aspx?Module=/PublicReportsA</a></p> <p>According to the Commission Regulation No 920/2010 and security reasons representative name and contact information held as confidential.</p> <p>After 20<sup>th</sup> of June 2012, public available information would be accessed via registry website, URL, :  <a href="http://www.arso.gov.si/">http://www.arso.gov.si/</a> with selection "Register emisijskih kuponov"</p>
<p>15/CMP.1 annex II.E paragraph 32.(h)</p> <p>Change of Internet address</p>	<p>No change of the registry Internet address occurred during the reporting period.</p>
<p>15/CMP.1 annex II.E paragraph 32.(i)</p> <p>Change of data integrity measures</p>	<p>No change of data integrity measures occurred during the reporting period.</p>
<p>15/CMP.1 annex II.E paragraph 32.(j)</p> <p>Change of test results</p>	<p>Slovenian registry used Greta software v4.1.16 and v5.1.24 in reported period.</p> <p>Slovenian registry has performed testing of new Greta software v5.1.24 in December 2010 and January 2011. Slovenia passed the official test with the CITL on 10th of January 2011. The official EU ETS Testing Plan is submitted in Annex 6.</p>
<p>The previous Annual Review recommendations (FCCC/ARR/2011/SVN)</p>	<p>No recommendations from the 2011 Annual Review</p>

### **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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