



REPUBLIC OF SLOVENIA
MINISTRY FOR AGRICULTURE AND ENVIRONMENT
SLOVENIAN ENVIRONMENT AGENCY

SLOVENIA'S NATIONAL INVENTORY REPORT 2014



EMISSION INVENTORIES 1986-2012 - SUBMITTED UNDER THE UNITED NATIONS
FRAMEWORK CONVENTION ON CLIMATE CHANGE AND THE KYOTO PROTOCOL

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PREFACE

Slovenian Environment Agency (SEA) is in accordance with the Slovenian legislation charged with both the overall coordinating of activities that are necessary for the development of emission inventories and 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 1986-2012 and additional information as support of this submission in the following annexes:

Annex 1: Detailed information on key category analyze including Table 7.A1 and A2 of the IPCC good practice guidance

Annex 2: Detailed methodology and data for estimating CO₂ emissions from fossil fuel combustion

Annex 3: Other detailed descriptions for agriculture and LULUCF sector

Annex 4: CO₂ reference approach and comparison with sectoral approach and relevant information on the national energy balance

Annex 5: Assessment of completeness

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

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

Annex 8: QA/QC

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PART 1: NATIONAL INVENTORY 1986-2012

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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." 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..." The Republic of Slovenia views this report as an opportunity to fulfil these commitments.

This report summarizes the latest information on Slovenian anthropogenic greenhouse gas emission trends from 1986 through 2012. 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 for standard methodology for monitoring emissions of greenhouse gases was expressed; it 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 (CO₂), methane (CH₄), nitrous oxide (N₂O), nitrogen oxides (NO_x), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). The methodology was adopted in Paris in March 1991 at the Fifth Session of the Intergovernmental Panel on Climate Change (IPCC) and it became the starting point for individual states in creating their national inventories of greenhouse gases.

The methodology for the calculation of greenhouse gases has been developing all the time and is a project under development even today. 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 emissions of direct greenhouse gases that have been encompassed by the Kyoto Protocol (CF₄, C₂F₆, PFCs, HFCs and SF₆). 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 (CO₂), methane (CH₄), nitrous oxide (N₂O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF₆), as well as estimates for indirect GHGs, including carbon monoxide (CO), nitrogen oxides (NO_x), and non-methane volatile organic compounds (NMVOC). Data are also reported for sulphur oxides (SO_x).

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 CO₂ and therefore GWP-weighted emissions are measured in Gg of CO₂ equivalents (Tg CO₂ eq.).

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

Gas	GWP
Carbon dioxide (CO ₂)	1
Methane (CH ₄)*	21
Nitrous oxide (N ₂ 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 ₄	6,500
C ₂ F ₆	9,200
C ₄ F ₁₀	7,000
C ₆ F ₁₄	7,400
SF ₆	23,900

Source: IPCC (1996)

* The methane GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapour. The indirect effect due to the production of CO₂ is not included. Global warming potentials are not provided for CO, NO_x, NMVOCs, SO₂ 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).

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 in Table 1.1.1.

1.2 Description of the Institutional Arrangement for Inventory Preparation

In Slovenia, the institution responsible for GHG inventories is the Slovenian Environment Agency (SEA). In accordance with its tasks and obligations to international institutions, the SEA 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"> • Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy Balances, annual energy statistics • Slovenian Environment Agency: ETS data
	CRF 1A2 - Manufacturing Industries and Construction	<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy Balances, annual energy statistics • Slovenian Environment Agency: ETS data
	CRF 1A3 – Transport	<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy balances • Ministry of Infrastructure and Spatial Planning, Directorate for National Roads (DRSC) • Ministry of the Interior (vehicle stock)
	CRF 1A4 – Other Sectors	<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia:
CRF 1 B – Fugitive Emissions from Fuels		<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia: • Energy Agency of the Republic of Slovenia
CRF 2 – Industrial Processes	CRF 2A – Mineral Products	<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia: • Slovenian Environment Agency
	CRF 2B – Chemical Industry	<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia:
	CRF 2C – Metal Production	<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia: • Slovenian Environment Agency
	CRF 2D – Other Production	<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia: • Slovenian Environment Agency
	CRF 2F – Consumption of Halocarbons and SF ₆	<ul style="list-style-type: none"> • Slovenian Environment Agency
CRF 3 – Solvent and Other Product Use		<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia • Slovenian Environment Agency
CRF 4 – Agriculture		<ul style="list-style-type: none"> • Statistical Office of the Republic of Slovenia • Agricultural Institute of Slovenia
CRF 5 – Land Use, Land Use Change, and Forestry		<ul style="list-style-type: none"> • Slovenian Forestry Institute
CRF 6 – Waste	CRF 6A – Solid Waste Disposal on Land	<ul style="list-style-type: none"> • Slovenian Environment Agency
	CRF 6B – Wastewater Handling	<ul style="list-style-type: none"> • Slovenian Environment Agency • Statistical Office of the Republic of Slovenia

The chief sources of data are the Statistical Office of the Republic of Slovenia (SORS) and the Ministry of Agriculture and the Environment; however, the Slovenian Environmental Agency obtains much of its data through other activities 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 SEA has decided to implement a unified system of data collection for the purposes of making inventories, as well as secure reliable financing in accordance with the annual program of its work. The ability to fulfil its obligations with regard to reporting was also improved by the participation of Slovenian Environmental Agency in the GEF project "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.

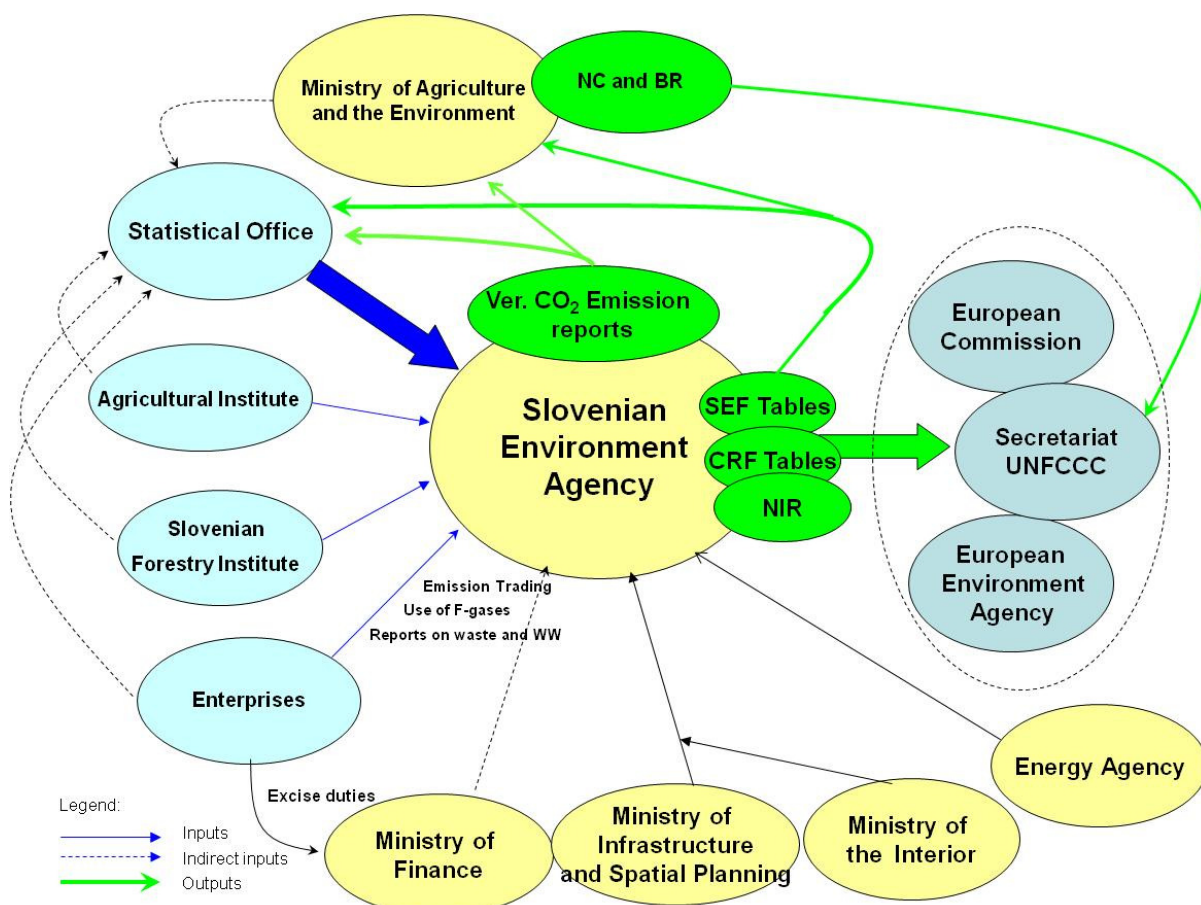


Figure 1.3.1: Data flow in the Slovenian Inventory System

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 SORS, 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 found.

The year 2003 saw the end of the process of harmonisation of data collection among the Directorate of Energy, Ministry of Agriculture and the Environment, and the Statistical Office of the Republic of Slovenia. An end was put to previous parallel double collecting of data. The competence of collecting data has, by law, passed to the SORS, 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 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. In 2014 the new agreement has been signed which consists more data sets and updated time lines.

Experts from the Slovenian Forestry Institute and the Agricultural Institute of Slovenia work on GHG inventories according to the standing rules of institutes (ordinance). Financing is assured by governmental institutions according to the yearly work plan. All data from external institutions are submitted to the Slovenian Environmental Agency, where they are archived. The detailed process from gathering data to emissions calculation and reporting is described in the Manual of Procedures, which was prepared in 2005 and further updated in 2009. The QA/QC plan as part of the Manual was developed and mostly implemented in 2009. In 2014 a new QA/QC Plan has been developed and fully implemented while a new Manual of procedures which will include new methodologies described in the 2006 IPCC Guidelines is still under preparation.

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 SEA 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 SORS, which makes them available in its publications and submits them to EUROSTAT and the IEA.

In 2006 we have started to develop a joint database for GHGs and other pollutants: ISEE – Information system for emission inventories. In broad terms the application has been completed and operational since 2011, but it is still necessary to conduct regular maintenance and improvements. The database contains activity data, emission factors and other parameters together with a description of sources from 1980 on for other pollutants, and from 1986 on for GHG emissions. It contains equations necessary for calculation of emissions and enables a direct bulk import into the CRF Reporter.

1.4 Brief General Description of Methodologies and Data Sources

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

In energy sector, national/plant specific CO₂ emission factors were used for assessment of emissions from solid fuels, petroleum coke and natural gas (Tier 2/3), while default IPCC emission factors were mainly used for other fuels. The quantities of fuels and consumed fuel energy values were taken from the SORS. Additional data on the energy use of some types of waste (waste tyres, oils and solvents) were acquired from the 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 Institutional and commercial sector. GHG emissions in road transport were determined with the COPERT 4 model using default EFs from the model.

Emission factors for fugitive emissions of CO₂ and CH₄ in mining activities were determined on the basis of measurements of methane concentrations in ventilation shafts in mines and estimated quantities of released methane and, not very common, also a considerable amount of CO₂. The CH₄ emission factor that was determined in this manner was lower than the default IPCC emission factor. CO₂ 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 CH₄ 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, material and pressure, applying specific losses per unit of length, as presented in the scientific literature (Reichert, 2000); this appears to be a sensible solution considering the level of maintenance and low average age of the distribution network.

Until 1997 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 SORS partly changed the method 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 EU-ETS. Since 2005, data from verified reports have mostly been used while in some cases (aluminium and ferroalloy production) the plant data had to be obtained. In determining actual emissions caused by the use of HFCs, data were obtained from companies that use or sell these materials; also data on the export and import of refrigerators were acquired. For SF₆ 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 N₂O, which arises from evaporation during the use of N₂O, mostly for anaesthesia.

In agriculture, methane emissions from enteric fermentation and manure management in bovine animals were determined using Tier 2 approach and the Tier 1 approach was used for other animals that represent a smaller fraction in methane emissions. Input data for N₂O emissions from manure handling and from direct and indirect emissions from fertilisation with animal fertilisers were obtained in the process of estimating methane emissions. For N₂O emissions, default IPCC factors were used.

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

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

Emissions and removals from the LULUCF sector have been calculated for all six types of land use — Forest land, Cropland, Grassland, Wetlands, Settlements and Other land - and are based on the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003) completed by country-specific methodologies. 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 N₂O emissions from N fertilization, N₂O emissions from drainage of soils, N₂O emissions from disturbance associated with land-use conversion to cropland, CO₂ emissions from agricultural lime application, and non-CO₂ emissions from biomass burning. 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.

Methane emissions from solid waste handling were determined by the FOD method, which takes into account the time dynamics of methane release. Emissions of CH₄ and N₂O from wastewater as well as GHG emissions from waste incineration were calculated using the default method.

1.5 Brief Description of Key Categories

The analysis of key source categories was performed on the basis of sectoral distribution and use of the Tier 1 approach. This approach was used both for the base year and for the year 2012. A level assessment was undertaken for 1986 and 2012, and a trend assessment was performed for 2012. The KCA has been performed with and without LULUCF sector. Following recommendation from the ERT the key category analysis includes a disaggregation of CO₂ emissions from stationary and mobile combustion by fuel type. Due to the new methodology some differences in results of KC analyses have occurred related to the last reporting. The main difference is that much more KC have been determined as key according to the level (Table 1.5.1 KC 2012: 32, 24, 35, 26) and trend (Table 1.5.1 KC 2012: 37, 46, 83). In the Energy sector some big KC are now disaggregated to 2 or 3 key categories. Due to the recalculations performed in LULUCF sector CO₂ emissions from wetlands is not a key source any more.

On the basis of the Tier 1 KCA including LULUCF, 36 categories were selected as keys, representing 95.3% of emissions in 2012 according to the level assessment, and 14 were chosen as key categories according to the trend assessment only. As many as 29 categories are key sources according to level and trend key source analysis. The most of the 36 key categories are from Energy sector: 14 categories are CO₂ emissions from fuel combustion, one is CH₄ emissions from fuel combustion, and one is CH₄ emissions from Coal mining and handling, their contribution to the level amounts to 52.6 %. The second most important sector is LULUCF with 7 key source categories and contribution of 32.2% to the level. Eight KC are in the Agriculture sector; 5 are related to methane emissions and 3 to N₂O emissions. Their contribution to the total is only 6.3%. 3 KCs are in the industrial processes and only 1 in the Waste sector together they contribute 4.2% of GHG emissions.

On the basis of the Tier 1 analysis excluding LULUCF, 34 categories were selected as keys, representing 95.2% of emissions in 2012 according to the level assessment, and 12 were chosen as key categories according to the trend assessment only. As many as 27 categories are key sources according to level and trend key source analysis. The most of the 34 key categories (18) are from Energy sector: 15 categories are CO₂ emissions from fuel combustion, one is CH₄ emissions from fuel combustion, and two are CO₂ and CH₄

emissions from Coal mining and handling their contribution to the level amounts to 79.3%. The second most representative sector is Agriculture sector with 8 KC; 5 are related to methane emissions and 3 to N₂O emissions. Their contribution to the total is only 9.3%. 5 KCs are in the industrial processes, one is in the Solvents, and 2 are in the Waste sector; together they contribute 7.3% of GHG emissions.

In 2010 a Tier 2 key categories analysis has been done for level assessment only and as much as 27 categories have been determined as keys. Mainly due to the large uncertainty, the most KC were in Agriculture sector (9), following by LULUCF (5), Road transport (4), Waste (3), Fuel combustion in Residential sector (2), Fugitive emissions from solid fuels (2), Consumption of HFCs (1) and Electricity and heat production (1). Following the recommendation from ICR 2013, the qualitative analysis has also been performed but no additional categories have been identified as keys.

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 CO₂ emissions from deforestation (conversion to grassland, to cropland to settlements and to other land) and CO₂ removals due to forest management also represent a key category.

Following recommendation from the UNFCCC review in 2013, the qualitative approach has been also used to determine key source categories but no additional categories have been found to be keys. For determination the following criteria has been included:

- Mitigation techniques and technologies
- High expected emission growth
- High uncertainty
- Unexpected low or high emissions

On the following pages Tier 1 key categories estimates are presented with and without LULUCF. The KCs are indicated with red numbers for KC according to the level assessment of emissions in 1986, with blue ones according to the level assessment of emissions in 2012 and with green ones for KC according to the trend.

Table 1.5.1: IPCC Key Source Categories for 2012, Tier 1 with LULUCF.

KS 1986	KS 2012		CRF Category	Subcategory	GHG	1986	2012	rel. 1986	rel. 2012	rel. trend	KS trend
2	1	5	LULUCF/ A. Forest land	1. Forest Land remaining Forest Land	CO ₂	2786	5900	0.1075	0.2104	0.1758	2
1	2	1A	1.a. Public Electricity and Heat Production	Solid Fuels	CO ₂	6155	5590	0.2375	0.1994	0.0650	3
10	3	1A	3.b. Road Transportation	Diesel Oil	CO ₂	633	4018	0.0244	0.1434	0.2032	1
3	4	1A	3.b. Road Transportation	Gasoline	CO ₂	1272	1622	0.0491	0.0579	0.0150	14
7	5	5	LULUCF/ C Grassland	2. Land converted to Grassland	CO ₂	758	958	0.0292	0.0342	0.0084	28
5	6	5	LULUCF/ A. Forest land	2. Land converted to Forest Land	CO ₂	838	838	0.0323	0.0299	0.0042	38
9	7	5	LULUCF/ E. Settlements	2. Land converted to Settlements	CO ₂	638	701	0.0246	0.0250	0.0006	
23	8	1A	4.b. Residential	Liquid Fuels	CO ₂	292	660	0.0113	0.0235	0.0210	7
13	9	1A	2.f. Other	Gaseous Fuels	CO ₂	463	444	0.0179	0.0158	0.0035	42
44	10	1A	4.a. Commercial/Institutional	Liquid Fuels	CO ₂	95	382	0.0037	0.0136	0.0170	10
27	11	4	A. Enteric Fermentation	1. Non-Dairy Cattle	CH ₄	263	368	0.0101	0.0131	0.0051	35
14	12	4	D. Agricultural Soils	1. Direct Soil Emissions	N ₂ O	435	363	0.0168	0.0129	0.0066	33
21	13	6	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	CH ₄	299	359	0.0115	0.0128	0.0022	
45	14	1A	1.a. Public Electricity and Heat Production	Gaseous Fuels	CO ₂	94	333	0.0036	0.0119	0.0141	15
11	15	2	Industrial Processes	1. Cement Production	CO ₂	515	326	0.0199	0.0116	0.0141	16
28	16	5	LULUCF/ B. Cropland	2. Land converted to Cropland	CO ₂	253	283	0.0098	0.0101	0.0006	
20	17	4	D. Agricultural Soils	3. Indirect Emissions	N ₂ O	335	280	0.0129	0.0100	0.0050	36
78	18	1A	4.b. Residential	Gaseous Fuels	CO ₂	14	270	0.0005	0.0096	0.0155	12
4	19	1A	2.f. Other	Liquid Fuels	CO ₂	955	247	0.0369	0.0088	0.0479	5
16	20	4	A. Enteric Fermentation	1. Dairy Cattle	CH ₄	384	242	0.0148	0.0086	0.0106	21
17	21	1B	Fugitive Emissions	a. Coal Mining and Handling	CH ₄	359	241	0.0138	0.0086	0.0090	25
	22	2	Industrial Processes	1. Refrigeration and AC Equipment	HFC		211	0.0000	0.0075	0.0129	17
15	23	1A	4.c. Agriculture/Forestry	Liquid Fuels	CO ₂	428	209	0.0165	0.0075	0.0155	13
22	24	1A	2.d. Pulp, Paper and Print	Gaseous Fuels	CO ₂	292	205	0.0113	0.0073	0.0068	30
30	25	5	LULUCF/ B. Cropland	1. Cropland remaining Cropland	CO ₂	225	185	0.0087	0.0066	0.0035	41
36	26	5	LULUCF/ F. Other Land	2. Land converted to Other Land	CO ₂	151	172	0.0058	0.0061	0.0005	
19	27	1A	2.a. Iron and Steel	Gaseous Fuels	CO ₂	344	166	0.0133	0.0059	0.0125	18
49	28	4	B. Manure Management	1. Non-Dairy Cattle	CH ₄	66	160	0.0025	0.0057	0.0054	34
55	29	2	Industrial Processes	3. Limestone and Dolomite Use	CO ₂	47	160	0.0018	0.0057	0.0066	32
35	30	4	B. Manure Management	1. Dairy Cattle	CH ₄	152	135	0.0059	0.0048	0.0018	
26	31	4	B. Manure Management	13. Solid Storage and Dry Lot	N ₂ O	267	127	0.0103	0.0045	0.0099	23
40	32	1A	4. Other Sectors	b. Residential	CH ₄	135	127	0.0052	0.0045	0.0011	

33	33	1A	2.d. Pulp, Paper and Print	Solid Fuels	CO ₂	219	126	0.0084	0.0045	0.0067	31
46	34	2	Industrial Processes	3. Aluminium Production	CO ₂	89	122	0.0034	0.0043	0.0015	
18	35	1A	2.f. Other	Solid Fuels	CO ₂	345	89	0.0133	0.0032	0.0173	8
29	36	4	B. Manure Management	8. Swine	CH ₄	228	88	0.0088	0.0031	0.0097	24
41	37	1B	Fugitive Emissions	a. Coal Mining and Handling	CO ₂	120	79	0.0046	0.0028	0.0031	43
32	38	2	Industrial Processes	2. Lime Production	CO ₂	220	74	0.0085	0.0026	0.0100	22
47	39	3	Solvent and Other Product Use	D. 1. Use of N ₂ O for Anaesthesia	N ₂ O	82	61	0.0032	0.0022	0.0017	
43	41	1A	2.b. Non-Ferrous Metals	Gaseous Fuels	CO ₂	110	60	0.0042	0.0021	0.0036	40
42	46	6	B. Waste Water Handling	2. Domestic and Commercial Waste Water	CH ₄	117	51	0.0045	0.0018	0.0046	37
31	51	1A	2.e. Food Processing, Beverages and Tobacco	Liquid Fuels	CO ₂	220	33	0.0085	0.0012	0.0125	19
37	54	1A	2.b. Non-Ferrous Metals	Liquid Fuels	CO ₂	142	27	0.0055	0.0009	0.0077	29
25	56	2	Industrial Processes	3. Aluminium Production	PFC	276	26	0.0107	0.0009	0.0166	11
24	58	1A	1. a. Public Electricity and Heat Production	Liquid Fuels	CO ₂	285	25	0.0110	0.0009	0.0173	9
8	60	1A	2.a. Iron and Steel	Solid Fuels	CO ₂	658	24	0.0254	0.0009	0.0419	6
38	77	1A	2.a. Iron and Steel	Liquid Fuels	CO ₂	139	7	0.0054	0.0002	0.0088	27
39	78	1A	2.d. Pulp, Paper and Print	Liquid Fuels	CO ₂	139	6	0.0053	0.0002	0.0088	26
34	80	1A	2.b. Non-Ferrous Metals	Solid Fuels	CO ₂	188	5	0.0073	0.0002	0.0121	20
52	83	1A	1.c. Manufacture of Solid Fuels and Other EI	Gaseous Fuels	CO ₂	59	4	0.0023	0.0001	0.0036	39
6	91	1A	4.b. Residential	Solid Fuels	CO ₂	794	2	0.0306	0.0001	0.0522	4
12		1A	4.a. Commercial/Institutional	Solid Fuels	CO ₂	497		0.0192			

Table 1.5.2: IPCC KS Categories for 2012, Tier 1 without LULUCF.

KS 1986	KS 2012		CRF Category	Subcategory	GHG	1986	2012	rel. 1986	rel. 2012	rel. trend	KS trend
1	1	1A	1.a. Public Electricity and Heat Production	Solid Fuels	CO ₂	6155	5590	0.3048	0.2956	0.0172	14
6	2	1A	3.b. Road Transportation	Diesel Oil	CO ₂	633	4018	0.0313	0.2125	0.2993	1
2	3	1A	3.b. Road Transportation	Gasoline	CO ₂	1272	1622	0.0630	0.0858	0.0372	5
19	4	1A	4.b. Residential	Liquid Fuels	CO ₂	292	660	0.0144	0.0349	0.0337	6
9	5	1A	2.f. Other	Gaseous Fuels	CO ₂	463	444	0.0229	0.0235	0.0007	
37	6	1A	4.a. Commercial/Institutional	Liquid Fuels	CO ₂	95	382	0.0047	0.0202	0.0256	7
23	7	4	A. Enteric Fermentation	1. Non-Dairy Cattle	CH ₄	263	368	0.0130	0.0194	0.0105	25
10	8	4	D. Agricultural Soils	1. Direct Soil Emissions	N ₂ O	435	363	0.0216	0.0192	0.0041	36
17	9	6	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	CH ₄	299	359	0.0148	0.0190	0.0068	32
38	10	1A	1. a. Public Electricity and Heat Production	Gaseous Fuels	CO ₂	94	333	0.0047	0.0176	0.0214	9
7	11	2	Industrial Processes	1. Cement Production	CO ₂	515	326	0.0255	0.0172	0.0138	18
16	12	4	D. Agricultural Soils	3. Indirect Emissions	N ₂ O	335	280	0.0166	0.0148	0.0030	
70	13	1A	4.b. Residential	Gaseous Fuels	CO ₂	14	270	0.0007	0.0143	0.0224	8
3	14	1A	2.f. Other	Liquid Fuels	CO ₂	955	247	0.0473	0.0130	0.0569	3
12	15	4	A. Enteric Fermentation	1. Dairy Cattle	CH ₄	384	242	0.0190	0.0128	0.0104	26
13	16	1B	Fugitive Emissions	a. Coal Mining and Handling	CH ₄	359	241	0.0178	0.0127	0.0085	30
	17	2	Industrial Processes	1. Refrigeration and AC Equipment	HFC		211	0.0000	0.0112	0.0185	13
11	18	1A	4.c. Agriculture/Forestry	Liquid Fuels	CO ₂	428	209	0.0212	0.0111	0.0169	15
18	19	1A	2.d. Pulp, Paper and Print	Gaseous Fuels	CO ₂	292	205	0.0145	0.0109	0.0061	33
15	20	1A	2.a. Iron and Steel	Gaseous Fuels	CO ₂	344	166	0.0170	0.0088	0.0137	19
42	21	4	B. Manure Management	1. Non-Dairy Cattle	CH ₄	66	160	0.0033	0.0085	0.0086	29
48	22	2	Industrial Processes	3. Limestone and Dolomite Use	CO ₂	47	160	0.0023	0.0085	0.0101	27
29	23	4	B. Manure Management	1. Dairy Cattle	CH ₄	152	135	0.0075	0.0071	0.0008	
22	24	4	B. Manure Management	13. Solid Storage and Dry Lot	N ₂ O	267	127	0.0132	0.0067	0.0109	23
33	25	1A	4. Other Sectors	b. Residential	CH ₄	135	127	0.0067	0.0067	0.0000	
27	26	1A	2.d. Pulp, Paper and Print	Solid Fuels	CO ₂	219	126	0.0108	0.0067	0.0069	31

39	27	2	Industrial Processes	3. Aluminium Production	CO ₂	89	122	0.0044	0.0064	0.0033	41
14	28	1A	2.f. Other	Solid Fuels	CO ₂	345	89	0.0171	0.0047	0.0206	11
24	29	4	B. Manure Management	8. Swine	CH ₄	228	88	0.0113	0.0046	0.0111	21
34	30	1B	Fugitive Emissions	a. Coal Mining and Handling	CO ₂	120	79	0.0060	0.0042	0.0030	
26	31	2	Industrial Processes	2. Lime Production	CO ₂	220	74	0.0109	0.0039	0.0116	20
40	32	3	Solvent and Other Product Use	D. 1. Use of N ₂ O for Anaesthesia	N ₂ O	82	61	0.0041	0.0032	0.0014	
44	33	6	B. Waste Water Handling	2. Domestic and Commercial Waste Water	N ₂ O	59	60	0.0029	0.0032	0.0004	
36	34	1A	2.b. Non-Ferrous Metals	Gaseous Fuels	CO ₂	110	60	0.0054	0.0032	0.0038	37
67	35	1A	2.c. Chemicals	Gaseous Fuels	CO ₂	16	57	0.0008	0.0030	0.0036	39
71	37	1A	2.e. Food Processing, Beverages and Tobacco	Gaseous Fuels	CO ₂	12	55	0.0006	0.0029	0.0038	38
35	38	6	B. Waste Water Handling	2. Domestic and Commercial Waste Water	CH ₄	117	51	0.0058	0.0027	0.0051	34
41	42	1A	3. Transport	c. Railways	CO ₂	68	37	0.0034	0.0020	0.0023	
25	43	1A	2.e. Food Processing, Beverages and Tobacco	Liquid Fuels	CO ₂	220	33	0.0109	0.0017	0.0152	16
30	46	1A	2.b. Non-Ferrous Metals	Liquid Fuels	CO ₂	142	27	0.0070	0.0014	0.0094	28
21	48	2	Industrial Processes	3. Aluminium Production	PFC	276	26	0.0137	0.0014	0.0205	12
20	50	1A	1.a. Public Electricity and Heat Production	Liquid Fuels	CO ₂	285	25	0.0141	0.0013	0.0213	10
5	52	1A	2.a. Iron and Steel	Solid Fuels	CO ₂	658	24	0.0326	0.0013	0.0520	4
43	54	1A	2.c. Chemicals	Liquid Fuels	CO ₂	61	21	0.0030	0.0011	0.0031	
31	67	1A	2.a. Iron and Steel	Liquid Fuels	CO ₂	139	7	0.0069	0.0004	0.0109	24
32	68	1A	2.d. Pulp, Paper and Print	Liquid Fuels	CO ₂	139	6	0.0069	0.0003	0.0109	22
28	70	1A	2.b. Non-Ferrous Metals	Solid Fuels	CO ₂	188	5	0.0093	0.0003	0.0150	17
4	80	1A	4.b. Residential	Solid Fuels	CO ₂	794	2	0.0393	0.0001	0.0651	2
49	86	2	Industrial Processes	4. Carbide Production	CO ₂	45	1	0.0022	0.0001	0.0036	40
8	121	1A	4.a. Commercial/Institutional	Solid Fuels	CO ₂	497		0.0246			

Key category analysis as a base for prioritizing improvements in GHG inventory

Key source categories have received special considerations in terms of improvements and QA/QC. On Tables 1.5.3, 1.5.4 and 1.5.5 the methodologies used to calculate emissions from key categories are presented.

Table 1.5.3: Methodologies used for key categories in 2012 (Level, LULUCF included)

KS 2012 - Level		CRF Category	Subcategory	GHG	Methodology	EF and other parameters
1	5	LULUCF/ A. Forest land	1. Forest Land remaining Forest Land	CO ₂	Tier 3	D and CS
2	1A	1.a. Public Electricity and Heat Production	Solid Fuels	CO ₂	Tier 3	PS
3	1A	3.b. Road Transportation	Diesel Oil	CO ₂	Model	Model
4	1A	3.b. Road Transportation	Gasoline	CO ₂	Model	Model
5	5	LULUCF/ C Grassland	2. Land converted to Grassland	CO ₂	Tier 1 and 2	D and CS
6	5	LULUCF/ A. Forest land	2. Land converted to Forest Land	CO ₂	Tier 1 and 2	D and CS
7	5	LULUCF/ E. Settlements	2. Land converted to Settlements	CO ₂	Tier 1 and 2	D and CS
8	1A	4.b. Residential	Liquid Fuels	CO ₂	Tier 1	D
9	1A	2.f. Other	Gaseous Fuels	CO ₂	Tier 2	CS
10	1A	4.a. Commercial/Institutional	Liquid Fuels	CO ₂	Tier 1	D
11	4	A. Enteric Fermentation	1. Non-Dairy Cattle	CH ₄	Tier 2	CS
12	4	D. Agricultural Soils	1. Direct Soil Emissions	N ₂ O	Tier 1a, 1b	D
13	6	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	CH ₄	Tier 2	D and CS
14	1A	1.a. Public Electricity and Heat Production	Gaseous Fuels	CO ₂	Tier 2	CS
15	2	Industrial Processes	1. Cement Production	CO ₂	Tier 3	PS
16	5	LULUCF/ B. Cropland	2. Land converted to Cropland	CO ₂	Tier 1 and 2	D and CS
17	4	D. Agricultural Soils	3. Indirect Emissions	N ₂ O	Tier 1a, 1b	D
18	1A	4.b. Residential	Gaseous Fuels	CO ₂	Tier 2	CS
19	1A	2.f. Other	Liquid Fuels	CO ₂	Tier 1	D
20	4	A. Enteric Fermentation	1. Dairy Cattle	CH ₄	Tier 2	CS
21	1B	Fugitive Emissions	a. Coal Mining and Handling	CH ₄	Tier 3	PS
22	2	Industrial Processes	1. Refrigeration and AC Equipment	HFC	Tier 2	D and CS
23	1A	4.c. Agriculture/Forestry	Liquid Fuels	CO ₂	Tier 1	D
24	1A	2.d. Pulp, Paper and Print	Gaseous Fuels	CO ₂	Tier 2	CS
25	5	LULUCF/ B. Cropland	1. Cropland remaining Cropland	CO ₂	Tier 1 and 2	D and CS
26	5	LULUCF/ F. Other Land	2. Land converted to Other Land	CO ₂	Tier 1 and 2	D and CS
27	1A	2.a. Iron and Steel	Gaseous Fuels	CO ₂	Tier 2	CS
28	4	B. Manure Management	1. Non-Dairy Cattle	CH ₄	Tier 2	CS
29	2	Industrial Processes	3. Limestone and Dolomite Use	CO ₂	Tier 1	D
30	4	B. Manure Management	1. Dairy Cattle	CH ₄	Tier 2	CS
31	4	B. Manure Management	13. Solid Storage and Dry Lot	N ₂ O	Tier 1	D and CS
32	1A	4. Other Sectors	b. Residential	CH ₄	Tier 1	D
33	1A	2.d. Pulp, Paper and Print	Solid Fuels	CO ₂	Tier 3	PS
34	2	Industrial Processes	3. Aluminium Production	CO ₂	Tier 3	PS
35	1A	2.f. Other	Solid Fuels	CO ₂	Tier 3	PS
36	4	B. Manure Management	8. Swine	CH ₄	Tier 2	D and CS

According to both analyses (Tier 1 and Tier 2), the most important key categories are from LULUCF sector. For 2012 submission the LULUCF sector was highly improved using the newest data from 2012 forest inventory and with additional support from experts from JRC and from EU support project. Although we are planning to continue our efforts to establish improved land use change matrix as one of major challenges for the future. Furthermore, it is of priority importance for Slovenia to improve the methodology of land area presentation, particularly to harmonize the areas of forest management and deforestation activities between the reportings under the Convention and KP.

Table 1.5.4: Methodologies used for key categories in 2012 (Level, LULUCF excluded)

Level		CRF Category	Subcategory	GHG	Methodology	EF and other parameters
37	1B	Fugitive Emissions	a. Coal Mining and Handling	CO ₂	Tier 3	PS
38	2	Industrial Processes	2. Lime Production	CO ₂	Tier 3	PS
41	1A	2.b. Non-Ferrous Metals	Gaseous Fuels	CO ₂	Tier 2	CS
46	6	B. Waste Water Handling	2. Domestic and Commercial WW	CH ₄	Tier 1	D and CS
51	1A	2.e. Food Proc., Beverages and Tobacco	Liquid Fuels	CO ₂	Tier 1	D
54	1A	2.b. Non-Ferrous Metals	Liquid Fuels	CO ₂	Tier 1	D
56	2	Industrial Processes	3. Aluminium Production	PFC	Tier 3	PS
58	1A	1. a. Public Electricity and Heat Production	Liquid Fuels	CO ₂	Tier 1	D
60	1A	2.a. Iron and Steel	Solid Fuels	CO ₂	Tier 3	PS
77	1A	2.a. Iron and Steel	Liquid Fuels	CO ₂	Tier 1	D
78	1A	2.d. Pulp, Paper and Print	Liquid Fuels	CO ₂	Tier 1	D
80	1A	2.b. Non-Ferrous Metals	Solid Fuels	CO ₂	Tier 3	PS
83	1A	1.c. Manuf. of Solid Fuels and Other EI	Gaseous Fuels	CO ₂	Tier 2	CS
91	1A	4.b. Residential	Solid Fuels	CO ₂	Tier 1	D

Table 1.5.5: Methodologies used for key categories in 2012 (only trend, LULUCF included)

KC		CRF Category/ Level	Subcategory	GHG	Methodology	EF
level	3	Solvent and Other Product Use	D. 1. Use of N ₂ O for Anaesthesia	N ₂ O	Tier 1	D
trend	1A	2.b. Non-Ferrous Metals	Gaseous Fuels	CO ₂	Tier 2	CS
trend	1A	2.c. Chemicals	Gaseous Fuels	CO ₂	Tier 2	CS
trend	1A	2.e. Food Proc., Beverages and Tobacco	Gaseous Fuels	CO ₂	Tier 2	CS

The Energy and Industrial processes sectors have already largely improved with inclusion of big emitters in EU-ETS. The use of default EFs for liquid fuel - mostly fuel oil represents the main deficiency. Due to the unavailability of resources needed to develop CS EF, the verification of default EFs for some liquid fuels have been made and the final results are presented in the NIR of May resubmission. This includes the verification of EFs for diesel and gasoline from Copert model and combustion of Fuel oil in the residential sector.

The Agriculture sector has also improved in the past and the new improvements which are planned for the next submission are related to the implementation of 2006 IPCC Guidelines. We will also try to obtain additional data to improve estimates of manure allocation. Unfortunately, methodologies for calculation of emissions from agricultural soils are not planned for further improvement. It has been assessed that resources (financial and personal) for determination of CS EFs in this category are unreasonably high for the expected results.

We are planning to improve HFC emissions from Refrigeration and AC with regular updates of the data on stock. This can be regarded as an ongoing process and will probably lead to an improvement of the inventory.

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.

During the in-country review in 2013, the ERT found that, due to the very limited resources and support available, a coordinated and systematic QA/QC was not appropriate. Although no important errors have been found in emission calculations, the insufficient application of QA/QC procedures in the preparation of NIR does affect the transparency of the submission significantly.

In the Potential Problems and Further Questions by ERT formulated in the course of the 2013 review of the greenhouse gas inventories of Slovenia submitted in 2013, ERT recommends Slovenia to provide ERT with evidence that the National System will:

- a) As a matter of priority, allocate additional resources to support the work of the GHG inventory team;
- b) Develop a QA/QC plan in accordance with the IPCC good practice guidance, which will allow solving the above mentioned issues before the next annual submission (2014).

In response the Minister has secured the additional administrative resources to carry out the necessary QA/QC activities. He has nominated QA/QC manager as well as a control team of experts with the following main tasks:

- Develop a QA/QC plan in accordance with the IPCC good practice guidance;
- Develop an inventory improvement plan;
- Implement general inventory QC procedures (Tier 1) in accordance with the QA/QC plan following the IPCC good practice guidance;
- Collaboration of other members of the team with the inventory experts and QA/QC manager when necessary;
- Regular partial review of QA/QC by sector, scheduled by the team;
- Preparation of expert framework for elaboration of emission inventories for land use.

Not all necessary QA/QC activities have been performed for the April submission. For this reason we have continue with the QC activities and resubmitted the NIR on 27 May.

The most important improvement for the 2014 submission is that QA/QC team has been established and that a new QA/QC plan has been developed and all QC activities were fully implemented. A special attention of QC have been dedicated to the NIR, which have been checked many times by different experts and also by proof-reader. The samples of documentation on the checks performed are in the Annex 8 to the NIR.

Quality Control (QC)

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

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

The final part of this system is incorporated in an Oracle database (ISEE – "Emission inventory" information system). 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 the late 2009, the first two stages of development of ISEE were finished, while the bulk importing into CRF Reporter was finished in 2011. ISEE enables and ensures that all necessary built-in QA/QC checks have been performed before data and emission estimates are entered in the reporting format tables. It also keeps a record of all changes made to data in the database.

As all calculations are performed in the database with software generated for this purpose, no human errors are expected. But for QA/QC purpose all emissions are also calculated in the old way in Excel spreadsheets. Both estimates were then compared; all differences were carefully investigated and corrected.

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 resulting 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 deviations 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.

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 SORS. The role of SORS is to compare data from installations included in EU-ETS with data from their reporting system and to propose corrective measures if necessary. The outcome of data consistency checks is used as preliminary information for the Ministry of Agriculture and the Environment for performing on-site inspections. The use of (EU) ETS data is described in detail in the relevant chapter on Energy and Industrial Processes sectors.

Check of emissions estimates

For the entire period 1986–2009, GHG emissions are also calculated in the old way using Excel spreadsheets and using built-in formulas in the database. Both estimates were compared and all differences carefully investigated.

The reasons for differences were the following:

- Formulas for calculation of emissions were not correct.

- Data field was not properly labelled.
- Data relationship was not correct.
- Emissions data were not correctly aggregated from lower reporting levels to higher reporting levels.

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

QA/QC checks not performed in the database:

Uncertainty

According to the QA/QC plan checks of uncertainty were performed in 2011. The checks consisted 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 the most of 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 is presented in the tables in the NIR
- Check all EF and other parameters used in the tables in the NIR
- Check all graphs for accuracy and presence in the whole period
- Check all titles for tables and pictures
- Check that all Annexes to the NIR are included and updated

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 files 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 is archived
- Check that results of QC analysis and uncertainty estimates are archived
- Check that there is detailed internal documentation to support the estimates and enable duplication of 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.

Following recommendation from 2013 in country the instructions have been prepared to determine the form and the names of archived documents.

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 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).

In 2011, the peer review for waste sector was performed, no important errors were found.

For Agriculture and LULUCF sector it is very hard to perform a peer review as the main institutions (Slovenian Forestry Institute and Agricultural Institute of Slovenia) are already involved in the inventory preparation. Due to the lack of relevant independent expert for LULUCF sector in Slovenia, this sector has been reviewed during the two-day visit in JRC Ispra, which took place in April 2012. In the years 2013 and 2014, Slovenia has also been included in EU support project for improving LULUCF inventory.

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 have been checked.

The Statistical Office of Slovenia (SORS) is our main data provider. In 2005, the European Statistics Code of Practice was adopted, bringing considerable changes to the SORS QA/QC system. The main pillars (factors) of quality are defined and thoroughly described in the Medium-term Programme of Statistical Surveys 2013-2017

http://www.stat.si/doc/drzstat/MediumTerm_2013-2017.pdf.

The strategic directions of Quality in National Statistics are presented in detail at http://www.stat.si/eng/drz_stat_kakovost.asp.

1.6.1 Official Consideration and Approval of the Inventory

Before the inventory is reported to the EU, EEA or UNFCCC Secretariat, it goes through an approval process. The institution designated for approval is the Ministry of Agriculture and the Environment. The inventory is sent to the Ministry according to the following plan:

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

1.6.2 Public Availability of the Inventory

The inventories are publically available on the web. Every submission is accompanied with a short description in Slovenian language. The estimates are presented in a more simple way with a 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 a 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 Overall Uncertainty for Inventory Totals

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.

In the 1986, the uncertainty of the inventory was 13.33% (8.96 w/o LULUCF).

In the 2012, the uncertainty was 15.44% (6.80 w/o LULUCF). The major part to the lower uncertainty in 2012 was contributed by the energy sector, while, due to the higher amount of sinks in 2012, the total uncertainty was higher compared to 1986. Uncertainty in Industrial processes was higher than in 1986 due to the high uncertainty of F-gas estimates. Sectoral uncertainty are presented on Table 1.7.1 below while more detailed data are included in the Annex 7 to the NIR.

Table 1.7.1: Uncertainty in 1986 and 2012 by sectors.

	1986	2012
1A Energy	6.75%	2.61%
1B Fugitive	41.03%	40.74%
2&3 Processes/Solvents emissions	7.31%	14.46%
4 Agriculture	64.84%	63.18%
5 LULUCF	85.92%	42.32%
6 Waste	48.82%	49.25%
TOTAL COMBINED UNCERTAINTY	13.33%	15.44%

TOTAL trend uncertainty (2012/1986) = 2.81% (2.70% w/o LULUCF).

1.8 General Assessment of Completeness

Sources and sinks

All sources of direct GHG gases, included in the IPCC Guidelines, are covered by the 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 keysIE (included elsewhere):

There are a 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,
- All amounts of bio-diesel and bio-ethanol are reported in the road transport sector,
- N₂O emissions from Fire Extinguishers and Other use (included in anaesthesia) are included in solvent use sector,
- All GHG emissions from forest fires are reported under Forest land remaining Forest Land,
- All CO₂ emissions from 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,
- CH₄ from enteric fermentation from poultry.

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

Not estimated sources are also in the category Consumption of F-gases and SF₆ related to potential emissions only.

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 as well.

C (confidential)

Statistical low considering confidentiality is very strict in Slovenia. All data gathered by three or less reporting units is confidential. It is a 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, to a lesser extent, from energy sector are also 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

Total emissions of GHG in 2012, sinks not considered, amounted to 18,910.9 kt CO₂ eq., which represents a 6.4% decrease of emissions compared to the year 1986 and 7.1% 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 the 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 have prevailed over the decrease in other sectors which has occurred due to the policies and measures in manufacturing industry, agriculture and waste sector.

In 2009, emissions from fuel used and industrial processes emissions started to decrease due to the global financial crisis. In 2010 and 2011, emissions stayed almost the same as in 2009, while in 2012 a further decrease has been observed.

2.2 Description and Interpretation of Emission Trends by Gas

CO₂ emissions in 2012 represented 82.9% of overall emissions of greenhouse gases. CO₂ emissions excluding LULUCF followed the consumption of energy and with regard to their fraction exerted a major impact on total emissions. Compared to 1986, they decreased by 4.2% in 2012. CH₄ emissions represented 9.9% of total emissions in 2012 (10.7% in 1986) and were by 13.7% lower than in 1986. N₂O emissions represented 5.9% of total emissions and were by 20.3% lower than N₂O emissions in 1986. F-gases represent 1.4% of total emissions and some (HFCs and SF₆) have shown significant increases since 1995 (base year for F-gases), while PFC decreased drastically in 2008 and has continued to decrease in 2009 after a slow increase of emissions was observed.

Carbon dioxide – CO₂

CO₂ emissions in the period 1986–2012 arose 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 they 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 rose again, mainly as a consequence of the production of electrical energy. CO₂ emissions in 2002 thus amounted to 16.27 Mt of CO₂, which is nearly the

same as in the base year 1986. Although in 2003 CO₂ emissions decreased by 1.5% (mainly due to lower emissions from Energy Industries) 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%) began in 2004, mainly due to transport. In 2009, CO₂ emissions decreased by 10.6% due to the global financial crisis, while they stayed almost the same (0.2% increase) in 2010. In 2011, the emissions increased further by 0.3%, while they decreased by 3.1% in 2012.

In the entire period, the strongest increase in CO₂ emissions was in transport, by as much as 202%, from 2.0 Mt CO₂ eq. in 1986 to 6.2 Mt CO₂ eq. in 2008. In 2009, emissions from this sector decreased by 13.6%, in 2010 by 1.2% and were above base year emissions by 158.4%. In 2011 and 2012, emissions continued to increase by 8.2% and 1.3% comparing to previous year and were 185.0% above emissions in 1986.

The Industrial Processes sector contributed 4.8% to total CO₂ emissions in 2012, while contributions of other sectors were negligible or zero. The LULUCF sector represents sink for CO₂ emissions, in 2012 the level of sinks amounted to 4.373 Gg or 28% of CO₂ emissions.

Methane – CH₄

Agriculture represents the main source of methane emissions; in 2012, 55.7% of methane emissions arose from this sector. Between 1986 and 2012, methane emissions were slightly decreasing, from 2.165 Mt CO₂ eq. in 1986 to 1.868 Mt CO₂ eq. in 2012. CH₄ emissions diminished by 13.7.2% in spite of the increased emissions from solid waste (by 20.1%, compared to 1986). Major contribution to decrease derived from reduction of fugitive emissions from fuel and emissions from Manure management.

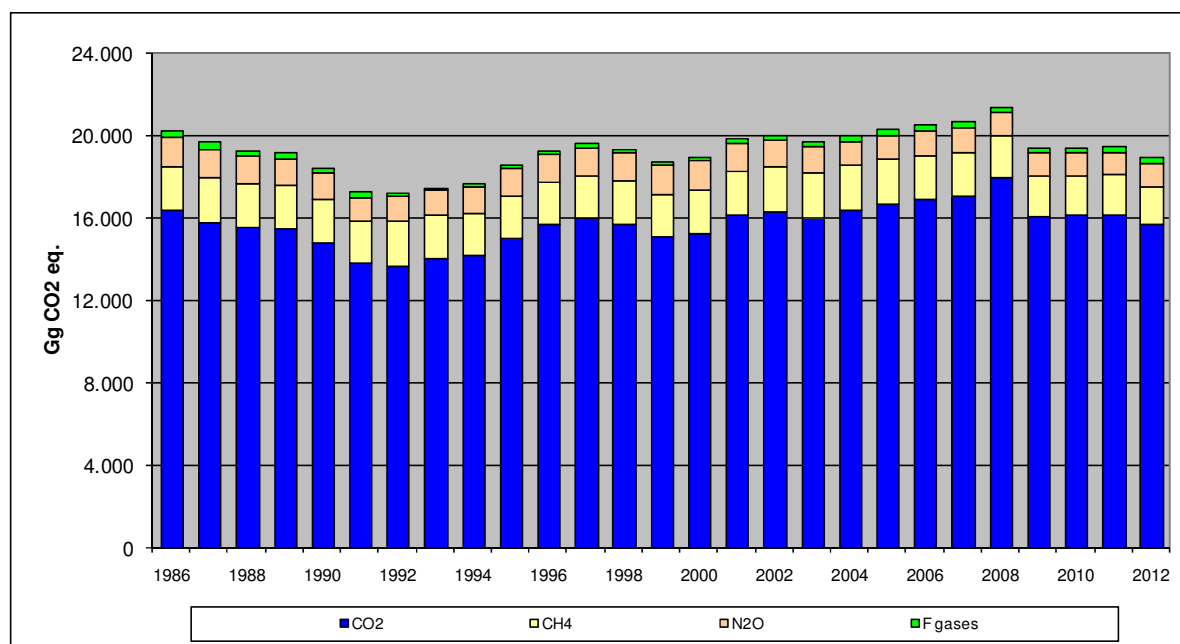


Figure 2.2.1: GHG Emissions in Slovenia by gas

Nitrous oxide – N₂O

N₂O emissions were down from 1.388 Mt CO₂ eq. in 1986 to 1.106 Mt CO₂ eq. in 2012. In Agriculture, which is the main source of N₂O emissions (75.1% in 2012), emissions diminished chiefly due to the fewer animals and less arable crop production, particularly legumes and N-fixing plants. This reduction was partly due to a changed manner of manure

storage, since the fraction of straw-based systems is diminishing on account of the increasing use of slatted floors.

Hydro-fluorocarbons – HFC

HFC emissions have grown from year to year, which is mostly the consequence of an increasing number of stationary and mobile air conditioners.

Per-fluorocarbons – PFC

The only source of PFCs in Slovenia is the primary production of aluminium. Improvement of the technology of aluminium production since 1992 has more than halved the then emissions, which diminished from 276 kt CO₂ 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 an increase of emissions by 84.1% was observed due to the increase in aluminium production and in 2011 emissions doubled because the aluminium production increased to the level before crises and stayed on the same level in 2012.

Sulphur-hexafluoride – SF₆

The main source of SF₆ emissions is high-voltage gas-insulated switchgear and circuit breakers. SF₆ emissions represent less than 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.

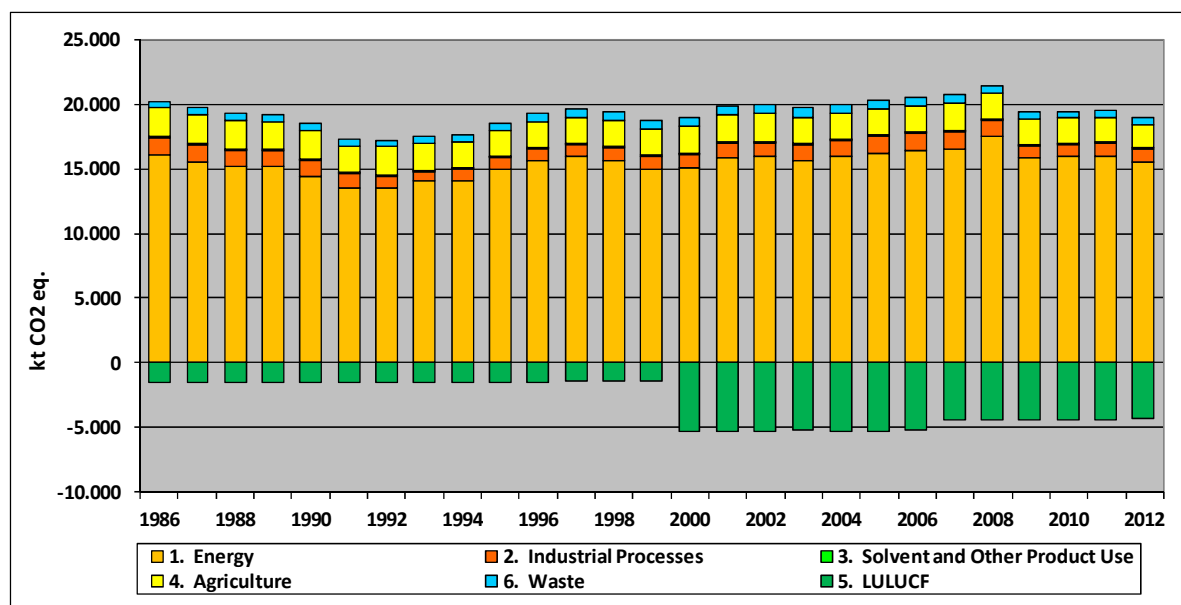


Figure 2.3.1: GHG Emissions in Slovenia by sector

By far the most important sector is Energy, which in 2012 accounted for 81.8% of total GHG emissions. In this sector emissions have decreased by 3.8%, compared to the 1986. Within this sector, in the period 1986–2012, GHG emissions from the Energy Industry, as the biggest sub-sector, decreased by 11.0%. In the most recent period, 1999–2007, steep growth (+19.6%) has been recorded due to the increased consumption of electrical energy. Undoubtedly the greatest increase in GHG emissions was observed in the transport sector,

by as much as 201.6% until 2008, due to the increase in road transportation, while emissions from other kinds of traffic slightly declined. In 2009 GHG emissions from transport decreased by 13.2% compared to 2008. The traffic emissions have further decreased by 1.2% in 2010, but increased again in 2011 by 8.2% and by 1.3% in 2012. There was an appreciable reduction of GHGs from industry between 1986 and 2000 (-52%). After 2000, a stabilisation of emissions was observed until 2008. Due to the global financial crisis, emissions from Manufacturing industry and construction decreased in 2009 by 16.8%, in 2010 by 0.9%, in 2011 by 10.3%, and in 2012 by 4% compared to the previous year.

Fugitive emissions from fuel represent only 2.2% of emissions in the sector and have decreased for 34.8% compared to emissions in 1986.

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 were 28.7% below the 1986 emissions; in the period 2010 – 2012, emissions stayed almost the same. The most important GHG of this sector was carbon dioxide, with 74.2% of emissions from this category, followed by HFCs with 21.6%, PFCs with 2.5%, and SF₆ with 1.7%. In this sector, no N₂O emissions have occurred since 2006 and no CH₄ emissions since 2011. The main source is Mineral Production, of which the production of cement and lime alone contributed almost a half of the emissions in this sector.

The Solvent and Other Product Use sector represents 0.3% of total emissions. GHG emissions have been reduced from 82 kt CO₂ eq. to 60kt CO₂ eq., only from N₂O emissions.

In Agriculture as the second most important sector, emissions in 2012 amounted to 1871 Gg CO₂ eq, which represents 9.9% of all emissions. Agriculture represents the main source of methane and N₂O emissions, namely 55.7% of all methane emissions and 75.1% of all N₂O emissions. In the agricultural sector, N₂O emissions account for 44.4% of emissions, and CH₄ emissions account for 55.5% of emissions. GHG emissions from agriculture show small oscillations for individual years, but the general trend is on the decrease. In 2012, emissions were 15.4% below the base year. The most important sub-sector represents emissions from agricultural soils, which contribute 37.1% of all emissions from agriculture, followed by emissions from enteric fermentation, with 34.7%; the rest is contributed by emissions of methane and N₂O from animal manure (28.2%).

In the LULUCF sector, the CO₂ sink was estimated at 4,356 Gg CO₂ eq in 2012, which is 3 times 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 22.6% of all methane emissions in Slovenia in 2012. The fraction of methane emissions in this sector amounts to 86.5%, while the remaining part represents N₂O (12.4%), CO₂ emissions are nearly negligible (1.1%). Solid waste handling contributes 73.5% to the total emissions from this sector, wastewater handling 25.4% and incineration of waste 1.1%.

Compared to the base year, emissions are almost the same, which is mostly due to the emissions from the solid waste disposal sites, which show an increase of 20.1%. 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 by 36.7% lower than in the base year. In the last period, a slow decreasing trend has been observed, which is mostly due to recovery of gas in wastewater treatment plants and the decrease in industrial production.

Table 2.3.1: GHG emissions and removals in Slovenia by sectors and sub-sectors 1986-2012.

TOTAL net emissions (with LULUCF) in Gg CO ₂ eq.	1986	1990	1995	2000	2005	2010	2011	2012	Change to 1986	Change to 2011
1. Energy	16,090	14,401	14,906	15,045	16,187	15,946	15,990	15,477	-3.8	-3.2
A. Fuel Combustion	15,567	13,957	14,506	14,684	15,827	15,595	15,634	15,136	-2.8	-3.2
1. Energy Industries	6,729	6,265	5,627	5,498	6,325	6,214	6,259	5,990	-11.0	-4.3
2. Man. Industries and Construction	4,404	3,119	2,615	2,269	2,486	1,900	1,704	1,637	-62.8	-4.0
3. Transport	2,025	2,730	3,824	3,862	4,428	5,265	5,699	5,773	185.0	1.3
4. Other Sectors	2,367	1,811	2,439	3,053	2,585	2,213	1,969	1,732	-26.8	-12.0
5. Other	41	32	1	3	3	3	3	3	-91.8	0.2
B. Fugitive Emissions from Fuels	523	444	400	361	360	351	356	341	-34.8	-4.2
1. Solid Fuels	479	401	358	331	337	330	335	319	-33.3	-4.7
2. Oil and Natural Gas	44	43	42	30	23	21	21	22	-50.7	3.1
2. Industrial Processes	1,317	1,318	1,002	1,063	1,373	988	1,014	1,014	-23.0	-0.1
A. Mineral Products	795	725	609	682	761	629	585	573	-27.9	-2.1
B. Chemical Industry	49	40	31	33	52	5	1	1	-97.6	-0.3
C. Metal Production	463	542	318	291	408	123	194	204	-56.0	4.8
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF ₆	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA, NO	NA, NO
F. Consumption of Halocarbons and SF ₆	10	10	44	57	152	232	233	236	2.201.0	1.0
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	82	43	17	43	43	30	49	61	-25.8	23.3
4. Agriculture	2,211	2,134	2,042	2,133	2,003	1,957	1,903	1,871	-15.4	-1.7
A. Enteric Fermentation	676	652	644	692	660	667	654	649	-4.0	-0.8
B. Manure Management	741	734	636	629	594	563	538	529	-28.7	-1.8
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	794	748	762	813	749	727	710	694	-12.6	-2.4
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

TOTAL net emissions (with LULUCF) in Gg CO ₂ eq.	1986	1990	1995	2000	2005	2010	2011	2012	Change to 1986	Change to 2011
5. Land Use, Land-Use Change and Forestry	-1,526	-1,484	-1,478	-5,353	-5,279	-4,418	-4,399	-4,356	185.48	-0.98
A. Forest Land	-3,624	-3,608	-3,635	-7,512	-7,534	-6,764	-6,760	-6,732	85.8	-0.4
B. Cropland	492	487	481	472	476	483	483	482	-2.0	-0.3
C. Grassland	771	793	820	820	885	943	954	966	25.2	1.2
D. Wetlands	46	47	48	49	52	55	56	56	22.8	1.0
E. Settlements	638	644	652	659	677	694	697	701	9.8	0.5
F. Other Land	151	153	156	159	165	170	171	172	13.8	0.6
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	495	548	581	670	707	491	506	488	-1.3	-3.5
A. Solid Waste Disposal on Land	299	345	376	439	486	356	366	359	20.1	-2.0
B. Waste-water Handling	196	202	205	228	218	130	134	124	-36.7	-7.8
C. Waste Incineration	NO	1	0	2	2	5	5	5	NA	2.9
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Memo Items:

International Bunkers	58	48	57	68	61	141	188	247	329.1	31.8
Aviation	58	48	57	68	61	74	70	67	16.3	-3.9
Marine	NA	NA	NA	NA	77	67	118	180	NA	53.0
Multilateral Operations	NA	NA	NA	1	0	0	0	0	NA	-62.7
CO₂ Emissions from Biomass	2,254	2,088	2,036	1,897	2,299	2,623	2,761	2,811	24.7	1.8
Total CO₂ Equivalent Emissions without LULUCF	20,195	18,444	18,549	18,953	20,314	19,411	19,463	18,911	-6.4	-2.8
Total CO ₂ Equivalent Emissions with LULUCF	18,669	16,960	17,070	13,600	15,035	14,993	15,064	14,555	-22.0	-3.4

2.4 Description and Interpretation of Emission Trends for Indirect GHGs and SO₂

The highest contribution to the total emission of SO₂ is that of thermal power plants and power cogeneration plants. In 1995, SO₂ 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 SO₂ took place after 2006 due to operation of wet flue gas desulphurisation in TE Trbovlje.

The biggest contribution to the overall NO_x emissions is that of mobile sources (road traffic). After 1992, NO_x emissions have begun 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_x emissions have 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 been reduced from 1986 to 2012 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_x, SO₂ and NMVOC in Slovenia excluding LULUCF (kt)

	1990	2000	2005	2010	2011	2012
NO_x	60.7	50.9	47.6	45.8	46.0	44.8
CO	335.7	212.6	177.2	151.1	158.2	157.0
NMVOC	69.2	55.2	47.4	41.5	40.7	39.2
SO₂	198.7	92.6	40.7	9.8	10.9	10.1

Table 2.4.2: Emissions of CO, NO_x, SO₂ and NMVOC in Slovenia including LULUCF (kt)

	1990	2000	2005	2010	2011	2012
NO_x	60.7	50.9	47.6	45.8	46.0	44.8
CO	337.4	213.1	177.9	151.4	159.0	160.4
NMVOC	69.3	55.3	47.5	41.5	40.8	39.5
SO₂	198.7	92.6	40.7	9.8	10.9	10.1

NMVOC and CO inventories were complemented with emissions of NMVOC and CO from the consumption of woody biomass in households in 2000. 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 was 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 over the Sector

The energy sector is the most important sector of GHG emissions in the Republic of Slovenia, since it accounts for 81.8% of overall CO₂ 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).

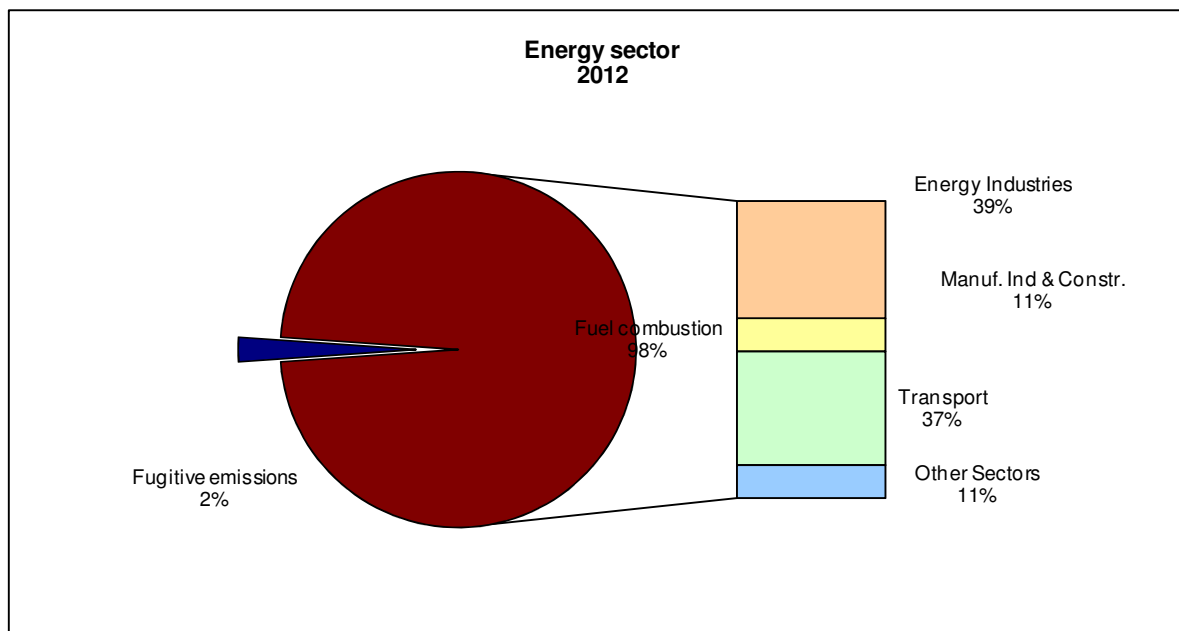


Figure 3.1.1: Emissions of GHG in Energy Sector by categories in 2012

Emissions from Energy sector are presented on the Table 3.1.1. Compared to 2011, GHG emissions from fuel combustion increased by 3.2% in 2012 and were thus 3.8% lower than in the 1986 base year.

The most important sub-sector is Energy Industries with 39.6% of emission of CO₂ eq. The most important category is Energy industries and within this category the production of electricity and heat (IPCC 1.A.1.a). Emissions from this category vary in accordance with the production of electrical energy. It has to be taken into consideration that in the Republic of Slovenia in 2012, 3.7 TWh (i.e. 26%) of electrical energy was produced in public hydroelectric power plants, 5.2 TWh (i.e. 32%) in the Krško Nuclear Power Plant, 6.1 TWh thermal power plants (i.e. 36%), while the remaining 0.9TWh (i.e. 6%) was produced by small producers (with production unit less than 10MW). The structure changes slightly from year to year, depending mostly on the changes in the hydrology of Slovenian rivers.

Almost the same importance for GHG emissions has Traffic with 38.1% of fuel combustion emissions. For traffic, virtually all emissions are accounted for by road traffic and within this category the growth of the fraction of emissions from goods transport is particularly noticeable, since the goods transport in transit through Slovenia has been, annually increasing by more than 10% since 2000. Due to the recession the emissions in 2009 decreased drastically and remained almost the same in 2010, while in 2011 the emissions increased by 8.2% compared to previous year and by 1.3% in 2012.

The highest reduction of emissions was recorded in Manufacturing Industries and Construction, which accounted for 10.9% of emissions. Emissions in this sector have, chiefly due to substitution of coal and liquid fuels, diminished by as much as 61.3% since 1986.

In the Other sector consumption, which accounts for 12.5% of emissions, Residential sector prevails.

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

Table 3.1.1: Emissions from Energy sector by sources in Gg CO₂ eq.

	1986	1990	1995	2000	2005	2010	2011	2012	Change (%)
1. Energy	16,090	14,401	14,906	15,045	16,187	15,946	15,990	15,477	-3.8
A. Fuel Combustion	15,567	13,957	14,506	14,684	15,827	15,595	15,634	15,136	-2.8
1. Energy Industries	6,729	6,265	5,627	5,498	6,325	6,214	6,259	5,990	-11.0
2. Manufac. Ind. and Constr.	4,404	3,119	2,615	2,269	2,486	1,900	1,704	1,637	-62.8
3. Transport	2,025	2,730	3,824	3,862	4,428	5,265	5,699	5,773	185.0
4. Other Sectors	2,367	1,811	2,439	3,053	2,585	2,213	1,969	1,732	-26.8
5. Other	41	32	1	3	3	3	3	3	-91.8
B. Fugitive Emissions from Fuels	523	444	400	361	360	351	356	341	-34.8
1. Solid Fuels	479	401	358	331	337	330	335	319	-33.3
2. Oil and Natural Gas	44	43	42	30	23	21	21	22	-50.7

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 diminished due to ever-smaller excavation of coal until 2000, when they were stabilized. Due to the harmonization of reporting process in EU, CO₂ emissions from flue gas desulphurisation (SO₂ scrubbing) are included in Industrial processes under Limestone and dolomite use and not under 1.B.1.c Other, as recommended in the IPCC guidance. Based on the in-country review and recommendations, Slovenia has developed country-specific emission factors for fugitive emissions from transport and distribution of natural gas.

CO₂ emissions from biomass were also computed, but were not included in the calculation; however, all other greenhouse gases (CH₄, N₂O) were included in accordance with the methodology.

3.1.1 Comparison of the Sectoral Approach with the Reference Approach

The total difference of CO₂ emissions between the sectoral approach and the reference approach in 2012 amounted to -0.10 in energy consumption (Table 3.1.2) and less than 0.15% in CO₂ emissions (Table 3.1.3). 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. In 2014, submission following the recommendation from ICR 2013 the PS and CS CO₂ EFs has been used to calculate C content in fuel in reference approach to the extent possible.

CO₂ emissions for all types of fuels according to the reference approach are presented in the table 3.1.4.

Table 3.1.2: Differences in energy consumption,% (Reference approach/National Approach)

	1986	1990	1995	2000	2005	2010	2011	2012
liquid	-2.38	2.30	1.23	-0.58	1.76	1.50	-0.32	-0.453
solid	0.24	1.76	0.32	1.18	-0.49	0.14	0.11	0.069
gaseous	4.46	-4.97	-2.65	-0.50	0.63	-0.01	0.05	-0.004
total	-0.16	0.70	0.30	-0.13	0.91	0.68	-0.06	-0.098

Table 3.1.3: Differences in CO₂ emissions, % (Reference approach/National Approach)

	1986	1990	1995	2000	2005	2010	2011	2012
liquid	-1.52	-3.33	6.96	-3.49	-0.69	0.15	-0.25	-0.521
solid	0.17	1.80	0.39	1.22	-1.15	-0.29	-0.21	0.014
gaseous	-4.15	-8.37	-0.53	0.29	0.54	-0.56	-0.04	-0.075
total	-0.86	-1.47	3.41	-1.31	-0.93	-0.62	-0.64	-0.625

Table 3.1.4: Emissions of CO₂ in Slovenia (reference approach) for the period 1986 - 2012.

Gg CO₂	1986	1990	1995	2000	2005	2010	2011	2012
Crude Oil	679	710	1609	305	NO	NO	NO	NO
Lubricants	4	5	3	9	44	20	18	33
LPG	123	97	99	230	253	239	230	228
Gasoline	1,314	1,496	2,161	2,366	2,002	1,762	1,755	1,626
Jet Kerosene, Kerosene	1	0	2	3	0	3	3	3
Gas Oil	2,145	1791	2,711	3,432	4,621	5,204	5,320	5,307
(Residual) Fuel Oil	383	641	271	270	165	29	25	25
Petroleum Coke	74	137	94	74	145	99	71	51
Other oil	NO	NO	NO	NO	9	18	13	11
Total Liquid	4,723	5,020	7,272	6,771	7,240	7,374	7,437	7,285
Sub-bituminous coal	NO	NO	475	800	1144	895	805	746
Other Bituminous Coal	123	1	2	NO	113	47	40	38
Lignite and domestic Coal	7,976	6,576	5,114	4,690	4,857	5,025	5,191	4,964
Coke Oven/Gas Coke	695	216	176	146	183	81	82	89
Anthracite	154	88	54	NO	NO	NO	NO	NO
Totals Solid	8,948	6,882	5,821	5,636	6,296	6,047	6,118	5,836
Natural gas	1,407	1,542	1,465	1,644	1,847	1,796	1,687	1,625
Total Gaseous	1,407	1,542	1,465	1,644	1,847	1,796	1,687	1,625
Fuel wood	2,021	1,872	1,819	1,959	1,796	2,308	2,093	2,258
Total Biomass	2,021	1,872	1,819	1,976	1,828	2,590	2,369	2,593
Total w/o biomass	15,079	13,445	14,558	14,051	15,384	15,217	15,241	14,746
Stored carbon (as CO₂):	150	174	284	661	800	610	408	404
Natural gas	125	131	173	258	292	190	12	10
Lubricants	15	16	10	23	39	15	23	32
Bitumen	NE	NE	NE	331	253	302	225	197
Petroleum coke	NE	NE	NE	NE	200	59	116	130
White spirit	10	10	10	3	16	16	7	8
Coke oven/Gas Coke	NO	NO	NO	NO	NO	24	22	22
Other	NO	17	91	46	NO	4	3	5

3.1.2 International Bunker Fuels

International navigation

Fuel for small boats and yachts is 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 were 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. The amount of fuel and the corresponding emissions are presented on the table 3.1.5.

Table 3.1.5: International Navigation Bunkers

	2005	2006	2007	2008	2009	2010	2011	2012
fuel in TJ	880	1206	2030	2737	1347	768	1354	2096
Gg CO₂ eq.	76	104	175	235	116	66	116	180

International aviation

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

On table 3.1.6 the fuel used in international aviation bunkers and corresponding emissions are presented.

Table 3.1.6: International Aviation Bunkers

	1986	1990	1995	2000	2005	2010	2011	2012
fuel in TJ	799	672	786	945	852	1022	967	929
Gg CO₂ eq.	58	48	57	68	61	74	70	67

Multilateral operations

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

<http://www.slovenskavojska.si/en/international-cooperation/international-operations-and-missions/>

In 2012, about 2 TJ of jet kerosene were used on international missions, which amounted to 0.2 Gg CO₂ eq. of GHG emissions.

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

Recalculation

For the period 1986-2011, CO₂ emissions from International navigation have been recalculated due to correction of CO₂ EF used (76.6 t/TJ instead of 77.6 t/TJ). In the same time, a small error has also been corrected for fuel used in 2011.

3.1.3 Feedstock and Non-Energy Use of Fuels

Natural gas

Table 3.1.7: Non-energy use of natural gas

	unit	1986	1990	1995	2000	2005	2010	2011	2012
Natural Gas	1000 m ³	67666	69524	91577	136740	164407	97004	6164	5305
Fraction of C stored		1	1	1	1	1	1	1	1
Carbon EF	t C/TJ	15,074	15,074	15,074	15,074	15,070	15,070	15,070	15,070
Stored CO ₂	Gg	125.3	131.0	172.6	257.6	292.4	190.3	3.3	2.8

Source of activity: from 1985 to 1995 Statistical office, LPI
from 1995 to 1996, Statistical office, DGP
from 1997 to 2003 LEG, Table Tg/6-3
since 2004 in SORS excel files and JQ

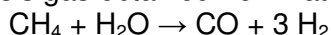


Figure 3.1.2: Methanol production in Nafta-Petrochem Lendava.

The biggest fraction of non-energy usage of fuels was the consumption of natural gas for the production of methanol, amounting to 89,475 Sm³ of natural gas in 2010, when this production stopped, and there has been no methanol production in Slovenia since 2011.

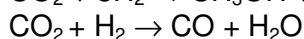
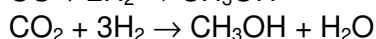
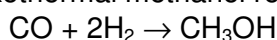
Natural gas was entirely used as the raw material for transformation into methanol. In every cycle only a fifth of it is transformed to the product, while the remaining natural gas is returned into the process. The schematic diagram of the process is shown in the Figure 3.1.3.

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.

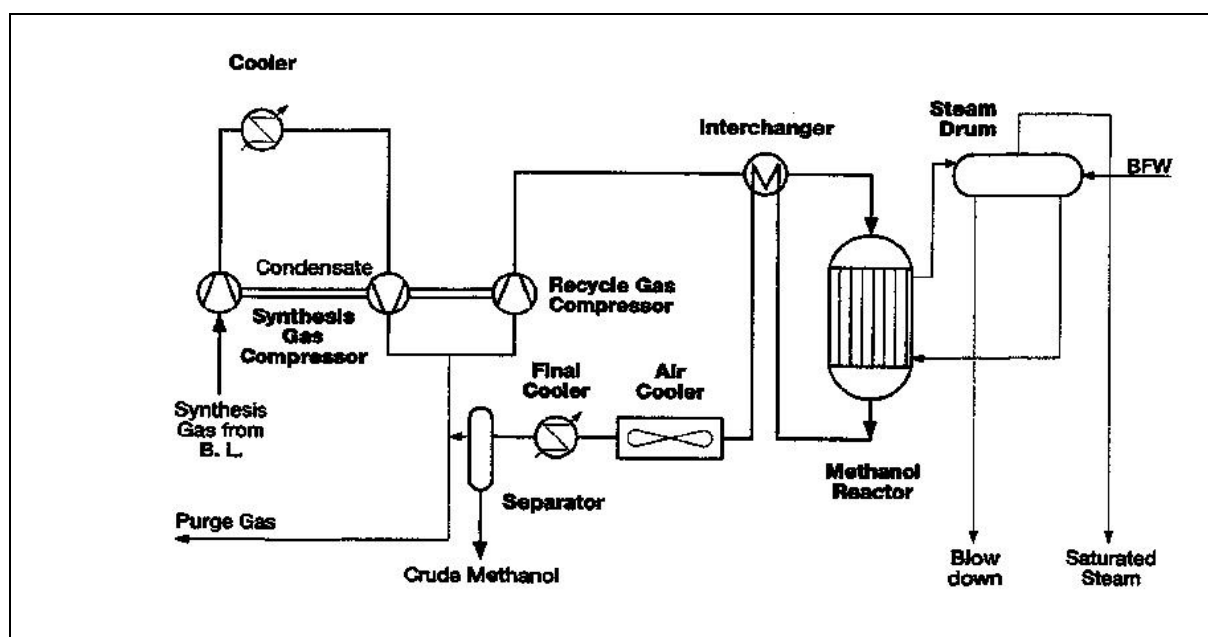


Figure 3.1.3: Schematic diagram of methanol production.

Stored CO₂ 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 amount of stored CO₂ is presented in the table 3.1.7 and the detailed data are presented in the Table 3.1.8.

Table 3.1.8: Non-energy use of natural gas for different products.

	unit	2005	2006	2007	2008	2009	2010	2011	2012
Methanol prod.	1000 Sm ³	145,903	129,384	151,556	94,437	104,487	89,475	0	0
Other org. chem.	1000 Sm ³	410	0	0	14,976	0	0	0	0
Inorganic chem.	1000 Sm ³	8,314	8,717	8,327	8,695	6,625	7,465	6,164	5,305
Rubber and Plast.	1000 Sm ³	590	819	709	38	0	64	0	0
Total	1000 Sm ³	155,217	138,920	160,592	118,146	111,112	97,004	6,164	5,305
Total	TJ	5,290	4,734	5,472	4,028	3,787	3,306	210	181

Table 3.1.9: 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: Expert judgement

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. Data and corresponding stored CO₂ are presented in the table 3.1.10.

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 SEA 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 in “1A2 Manufacturing industry and construction/other industries/Other fuel”.

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

Source of activity:

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

Emission factor:

Stored CO₂ has been calculated on the basis of the formula from IPCC guidelines, 1996, p. I.28., I. 23, I.13.

Table 3.1.10: Oil and Lubricants

	unit	2004	2005	2006	2007	2008	2009	2010	2011	2012
Oil and Lubricants	t	28623	17465	30000	22000	16000	12000	12000	13848	21104
Waste oil - combusted	t	3878	4404	4502	4281	4228	4582	6763	6109	4377
Oil and Lubricants(stored)	t	24745	13061	25498	17718	11772	7418	5228	7717	10947
NCV	TJ/kt	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Fuel stored	TJ	995	525	1025	712	473	298	210	310	440
Carbon EF	t C/TJ	20	20	20	20	20	20	20	20	20
Stored CO₂	Gg	73	39	75	52	35	22	15	23	32

Table 3.1.11: 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: Expert judgement

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 took a while that all non-energy used fuel was reported correctly. Energy and non-energy use of fuel in industry have been presented separately in statistical data since 2000.

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 disaggregated into the consumption of fuel as an additive. thus 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 production are presented in industrial processes.

There are also other uses of fuel in chemical processes not emitting any GHG, therefore no explanation is included in the CRF tables. In 2012, a small amount of fuel oil, LPG and white spirit was used, mostly for production of lacquers, paintings and other coatings. The same is valid also for bitumen which is used for road paving and for production of roofing material and during this use no GHG emissions occur.

3.1.4 CO₂ capture from flue gases and subsequent CO₂ storage

There are no plants for recovery and storage of CO₂ in Slovenia.

3.2 Fuel Combustion (CRF 1.A)

3.2.1 Sources of Activity Data

The main source of data for Fuel consumption for all sectors in the Republic of Slovenia for the period 1986-2003 is LEG – Annual Energy Statistics of the Energy Sector of the Republic of Slovenia. As LEG was not published early enough to enable us to calculate GHG inventory on time in 2005, we had received data directly from Statistical Office of the Republic of Slovenia (SORS) in electronic format before they were published for our first calculation.

After 2007, LEG is not published anymore. Since 2005 the verified reports from ETS have also been used.

In addition, SORS also provides us data in Joint questionnaires used mostly for QA/QC.

The following files with data for 2012 have been received from the SORS:

E1L-12-arso – fuel consumption in public power plants

E2L-12-arso – fuel consumption in auto producers

E2LP-12-arso – fuel consumption in cogeneration plants

E3L-12-arso – fuel consumption in public heat

epel_arso12_NACE2008.xls – fuel consumption in mining, manufacturing industry and construction

ZBIRNA E8-E12 ARSO 2011.xls – data on energy balance

Joint questionnaires:

ENERGY_NTGAS_A_SI_2012.xls – gaseous fuel

ENERGY_PETRO_A_SI_2012.xls – liquid fuel

ENERGY_RENEW_A_SI_2012.xls – other fuel

ENERGY_SOLID_A_SI_2012.xls – solid fuel

3.2.2 Country-Specific Issues

An interesting feature of inventories of greenhouse gases for Slovenia is the fact that the chosen base year 1986 goes back to the time when Slovenia was still a part of Yugoslavia. This fact notwithstanding, at that time Slovenia already 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 underwent 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 SORS changed the Unified classification of activities for the Standard classification of activities, and that caused a slight alteration of emissions within the sector Manufacturing Industries and Construction.

3.2.3 Country-specific EFs

Lignite – CO₂ EF

Table 3.2.1: National CO₂ EFs for domestic lignite from Velenje pit.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
t CO ₂ /TJ	109.95	109.25	111.89	107.76	106.98	101.84	101.06	101.48	101.69
	1995	1996	1997	1998	1999	2000	2001	2002	2003
t CO ₂ /TJ	100.99	101.85	101.82	99.54	100.21	102.56	106.71	105.44	104.90
	2004	2005	2006	2007	2008	2009	2010	2011	2012
t CO ₂ /TJ	105.85	107.94	106.32	106.15	105.64	104.76	104.52	104.48	105.18

Table 3.2.2: National CO₂ EFs for domestic lignite from Velenje pit including oxidation.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
t CO ₂ /TJ	107.76	107.07	109.65	105.61	104.83	99.76	99.07	99.44	99.78
	1995	1996	1997	1998	1999	2000	2001	2002	2003
t CO ₂ /TJ	98.97	99.81	99.78	97.55	98.08	100.51	104.58	103.33	102.80
	2004	2005	2006	2007	2008	2009	2010	2011	2012
t CO ₂ /TJ	103.74	105.78	104.19	104.03	103.52	102.67	102.43	102.39	103.08

With regard to the need to upgrade GHG emissions inventories, national CO₂ emission factors for domestic coal were developed in 2004. CO₂ 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 CO₂ EFs of coal from Trbovlje pit have been available as well as the ones 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 CO₂ EFs for domestic brown coal from Trbovlje pit.

	2005	2006	2007	2008	2009	2010	2011	2012
t CO ₂ /TJ	101.94	102.89	101.66	101.81	102.71	101.33	101.18	100.19

Table 3.2.4: National CO₂ EFs for domestic brown coal from Trbovlje pit including oxidation.

	2005	2006	2007	2008	2009	2010	2011	2012
t CO ₂ /TJ	99.90	100.83	99.63	99.77	100.65	99.30	99.16	98.18

Natural gas – CO₂ EF

We use slightly modified EF also for natural gas. CO₂ emission factors were obtained on the basis of the determined carbon contents in the fuel. Detailed results are in the study of 1998, which is available only in Slovene language (Določitev emisijskega faktorja CO₂ pri energetskezi izrabi zemeljskega plina). Because in the study of 1998 only yearly values until 1996 are available, we have used yearly values for the period 1986-1996 and 1996 value for the period 1997-2012. The value is already multiplied with default oxidation factor for gaseous fuels.

We are planning to obtain data about chemical composition of natural gas used in Slovenia from the previous report for the period after it, calculate actual values of EF and recalculate emissions back to 1997. Unfortunately, data on chemical composition are not available any more. The natural gas distributor (Geoplin Plinovodi) is not interested in such data and they believe that chemical composition is not changing a lot between the years. The main importer of natural gas is Russia, while approximately one third of natural gas comes from Algeria. CO₂ emission factors between years differ for around 0.1% and because composition data from the company are not available, we believe that cost of regular sampling and analyzing in an accredited laboratory would represent unreasonable costs.

Table 3.2.5: National CO₂ EFs for combustion of natural gas.

EF (t CO ₂ /TJ)	1986-1991	1992	1993	1994	1995	1996-2012
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 (LPG) – CH₄ EF

LPG is a flammable mixture of hydrocarbon gases (mostly propane and butane) and will evaporate at normal temperatures and pressures. It burns more 'cleanly' than heavier molecule hydrocarbons. In Reference Manual 1996, the CH₄ EF are available for natural gas and for oil, but our energy experts have considered that LPG has to have lower CH₄ EF than oil. We used value of 2 kg/TJ in energy and manufacturing industry sectors even before 2006 GL was available and this EF was also used for determination of emissions in our base year. We do not consider more appropriate only for Slovenia, we think that the default CH₄ EF from Reference Manual 1996 for LPG is too high for all countries. The 2006 GL, which we believe to be the most up to date source of EFs, confirmed our assumptions and set default CH₄ EF for LPG and for natural gas to 1 kg/TJ for combustion in all sectors.

3.2.4 Oxidation factors

For inventory purposes we have used default oxidation factors from IPCC Reference Manual 1996. They are as follows:

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

3.2.5 Energy Industries

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

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

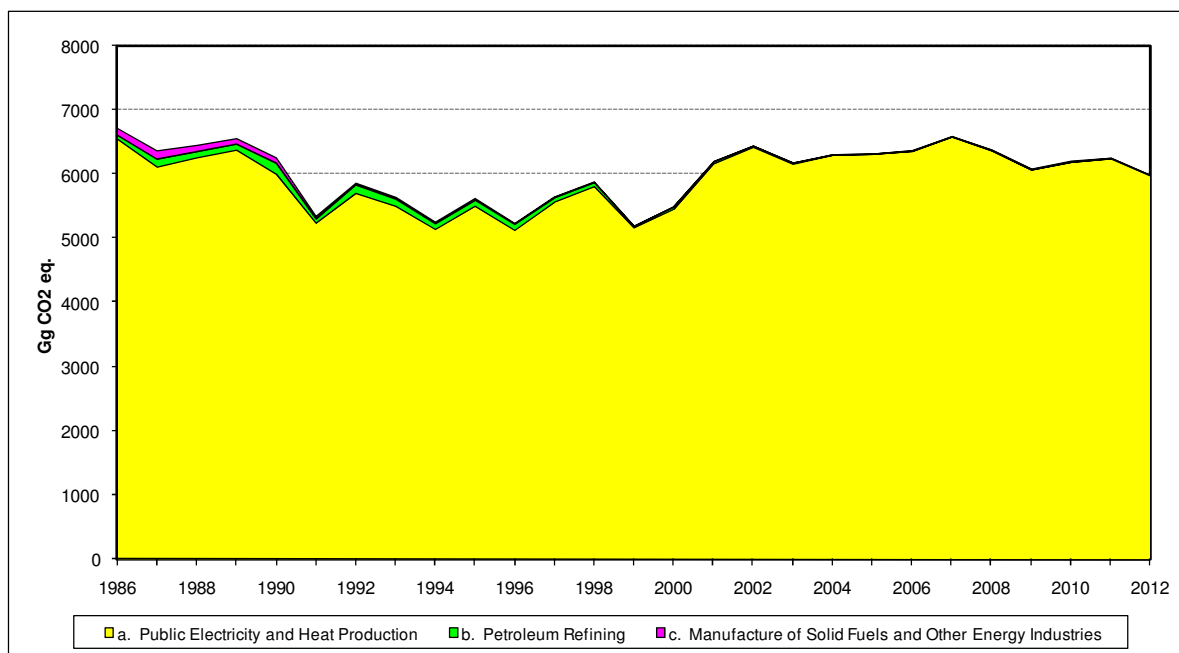


Figure 3.2.1: GHG emissions from Energy Industries

Public electricity and heat production is the most important category in this sub-sector with 97.5% share in the base year and almost 100% share in 2012. Other two categories consist mainly of fuel consumption in one refinery (closed in 2004) and in fuel consumption for coal mining activities. Emissions are presented on Figure 3.2.1 and Table 3.2.6

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

in Gg CO ₂ eq.	1986	1990	1995	2000	2005	2010	2011	2012
1. Energy Industries	6729	6265	5627	5498	6325	6214	6259	6259
a. Public Electricity and Heat Prod.	6562	6015	5513	5466	6321	6199	6254	5985
b. Petroleum Refining	62	169	92	32	0	0	0	0
c. Manufacture of Solid Fuels and ...	105	81	21	0	4	15	5	5

3.2.5.1 Public Electricity and Heat Production (CRF 1A1a)

	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	solid	Level	CO ₂	23.75		1	
	liquid	Level	CO ₂	1.10		24	
	gaseous	Level	CO ₂	0,36		45	
2012	solid	Level, Trend	CO ₂	19.94	6.05	2	3
	liquid	Trend	CO ₂	0.09	1.73	58	15
	gaseous	Level, Trend	CO ₂	1.19	1.41	14	9

In this sector, there are three big point sources in the Republic of Slovenia, which represent the backbone of electrical energy production 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, since 2008 on also wood
TET	Trbovlje	F/4 (4)	1968	125.0	Coal, mostly domestic brown coal

In addition to these three thermal power plants we also have one small plant Brestanica – TEB which uses natural gas and operates mainly as a 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:

$$\text{Emissions} = \text{Quantity of Fuel Combusted} \times \text{NCV} \times \text{EF per energy of Fuel} \times \text{OF}$$

Activity data

The main source of data for all energy industries in the Republic of Slovenia for the period 1986-2003 is LEG – Annual Energy Statistics of the Energy Sector of the Republic of Slovenia. As LEG was not published early enough to enable us to calculate GHG inventory on time in 2005, we had received data for the first inventory directly from SORS in electronic format before they were 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 clearer, the sub-sector Public Electricity and Heat Plants has in national inventories been disaggregated into:

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

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

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

Year	Lignite (Velenje)	Sub- bituminous Coal - domestic	Sub- bituminous Coal - imported	Bituminous Coal	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1986	9.390	11.880			41.820	39.740	46.000	33.500	12.170
1987	9.650	11.820			41.870	39.800	46.000	33.500	12.170
1988	9.440	12.000			41.870	39.800	46.000	34.080	12.170
1989	9.820	12.050			41.870	39.900	46.000	34.100	12.170
1990	9.810	12.760			41.870	39.800	46.000	34.100	12.170
1991	9.980	12.879			41.880	39.800	46.000	34.100	12.170
1992	10.260	12.589			41.900	39.900	46.000	34.100	12.170
1993	10.070	13.351			41.900	39.800	46.000	34.100	12.170
1994	9.960	12.666			41.900	39.860	46.000	34.100	12.170
1995	10.220	10.000	15.546		41.900	40.000	46.000	34.100	12.170
1996	9.690	11.300	16.107		41.900	40.000	46.000	34.100	12.170
1997	9.610	11.300	16.422		41.900	40.000	46.050	34.080	12.170
1998	10.010	11.230	16.924		41.900	40.000	46.050	34.080	12.170
1999	9.690	11.110	16.649		41.900	40.000	46.050	34.080	12.170
2000	10.170	11.230	16.308		41.900	40.000	46.050	34.080	12.170
2001	10.660	10.660	17.416		41.900	40.000	46.050	34.080	12.170
2002	10.350	11.220	17.927		41.900	40.000	46.050	34.080	12.170
2003	10.138	11.560	18.057		41.900	40.000	46.050	34.080	12.170
2004	10.301	11.680	18.676		41.900	40.000	46.050	34.080	12.170
2005	10.803	11.724	18.180		41.900	40.000	46.050	34.080	12.170
2006	11.132	10.880	18.874		42.600	41.420	46.050	34.080	9.764
2007	11.258	11.629	17.941		42.600	41.420	46.050	34.072	9.141
2008	10.949	10.641	17.381		42.600	41.420	46.050	34.096	11.512
2009	10.894	11.094	17.868		42.600	41.420	46.050	34.074	11.128
2010	11.097	12.815	18.050	28.271	42.600	41.420	46.050	34.080	9.871
2011	11.068	11.935	18.317	28.251	42.600	41.420	46.050	34.087	10.267
2012	10.616	11.778	18.524	26.140	42.600	41.420	46.050	34.093	10.560

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 have been 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 was taken from LEG Table Dt/1. In 1986, only data for JP Energetika, Ljubljana exist, for 1996, for instance, data already include 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), data for 1987 have been taken (the first successive year when they were available) for other fuels. 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 CO₂ EFs for coal and natural gas. A more detailed description is in chapter 3.2.3. Emission factors for all other fuels have been taken from IPCC Reference Manual 1996.

On the following Tables 3.2.9 EFs used in the period 1986-2012 are presented, while on the tables 3.2.10 to 3.2.16 country specific CO₂ EFs used in the years 2006 to 2012 for solid fuels

Table 3.2.9: EFs used for the period 1986-2012

	Unit	Lignite (Velenje)	Sub-bituminous Coal	Gas Oil	Residual Fuel Oil	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
CO ₂ EF	t/TJ	Table 3.2.1	101.2	74.0	77.4	74.0	63.0	Table 3.2.5	108.5
CO ₂ EF*OF	t/TJ	Table 3.2.2	99.2	73.3	76.6	73.3	62.4	Table 3.2.5	107.4
CH ₄ EF	t/TJ	0.001	0.001	0.003	0.003	0.003	0.002	0.001	0.03
N ₂ O EF	t/TJ	0.0014	0.0014	0.0006	0.0006	0.0006	0.0006	0.0001	0.004

Table 3.2.10: Country specific CO₂ EFs used for 2006

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal
CO ₂ EF	t/TJ	104.190	102.890	99.340
CO ₂ EF *OF	t/TJ	102.106	100.832	97.353

Table 3.2.11: Country specific CO₂ EFs used for 2007

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal
CO ₂ EF	t/TJ	106.151	101.661	100.25
CO ₂ EF *OF	t/TJ	104.028	99.628	98.245

Table 3.2.12: Country specific CO₂ EFs used for 2008

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal
CO ₂ EF	t/TJ	105.636	101.807	100.873
CO ₂ EF *OF	t/TJ	103.525	99.770	98.855

Table 3.2.13: Country specific CO₂ EFs used for 2009

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal
CO ₂ EF	t/TJ	104.761	102.707	101.015
CO ₂ EF *OF	t/TJ	102.666	100.653	98.995

Table 3.2.14: Country specific CO₂ EFs used for 2010

	Unit	Lignite (Velenje)	Brown coal (Trbovlje)	Sub-bituminous Coal	Bituminous Coal
CO ₂ EF	t/TJ	104.517	101.328	100.408	92.830
CO ₂ EF *OF	t/TJ	102.427	99.302	98.400	90.973

Table 3.2.15: Country specific CO₂ EFs used for 2011

	Unit	Lignite (Velenje and imported)	Brown coal (Trbovlje)	Sub-bituminous Coal	Bituminous Coal
CO ₂ EF	t/TJ	104.478	101.180	98.833	90.881
CO ₂ EF *OF	t/TJ	102.389	99.157	96.856	89.062

Table 3.2.16: Country specific CO₂ EFs used for 2012

	Unit	Lignite (Velenje and imported)	Brown coal (Trbovlje)	Sub-bituminous Coal	Bituminous Coal
CO ₂ EF	t/TJ	105.122	100.186	97.000	92.513
CO ₂ EF *OF	t/TJ	103.020	98.183	95.060	90.663

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

Waste Incineration

Emissions from category Other fuel have arisen from Slovenian only waste incineration thermal plant which has started to work in 2009. Data on amount of incinerated waste, NCVs and distribution between biogenic and other waste have been obtained directly from the plant. It shows up that the 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.

CO₂ emissions from combusting plastic depend on the carbon content of the plastic and the amount of carbon that is converted to CO₂ during the combustion process. There is no EF available in the 1996 and 2000 IPCC guidelines. After research done on scientific literature, which is available on the web, the emission factor of 20 t C/TJ has been used (73.3 t CO₂/TJ). It is the same as lower value for combustion of non-biomass fraction of Municipal waste in 2006 IPCC Guidelines on Table 2.2.

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

Source specific QA/QC activities

Beginning in 2005, all thermal power plants in the Republic of Slovenia have carried out regular coal sampling and determined 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, necessary for CO₂ emission trading in the period 2005-2007 on the territory of the European Union. For this reason, the country specific CO₂ EF have been also used 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 depends on total GHG emissions from the plant and typical consumption of a 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 3.2.17: Levels of pretentiousness (Tiers) for fuels used in TPP in Slovenia in 2005-2012.

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

Description of the Requests under Particular Tier

AD

Tier 1: The fuel consumption covering 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 covering 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 covering 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 covering 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.

For four thermal power plants the aggregated solid 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 as in ETS, data for GHG inventory is taken into account and notification to SORS is made to correct their data.

Recalculations

In calculation of N_2O emissions from waste an error have been found in the equation. For this reason, N_2O emissions from other fuel for the period 2009-2011 have been recalculated.

Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

3.2.5.2 Petroleum Refining (CRF 1A1b)

Key category - Base year: no
 Key category - Year 2012: NO (not occurring)

The main representative of this category was company the Nafta Lendava Refinery – Slovenian only refinery which stopped oil refining in 2002. According to the statistical methodology in the period 1986-1996, this sector also included quantities of fuels that were consumed for the production of electric energy in this sector.

Methodology

To estimate emissions from Petroleum refining, the following methodology has been adopted:

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

Activity data

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

for the period 1986-1996 under „Oil Industry”

From 1997 – 2004 under „DF–Production of coke, refined petroleum products and nuclear fuel”

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

For the period 1992 to 1994, LEG reported substantial consumption of residual fuel oil and gas oil in the category Internal Consumption and Losses (LEG Table Zb/1). These quantities were supposed to have been consumed in the Nafta Lendava Refinery; consequently, they were added to the consumption in the oil industry. For the years 1986, 1990, 1991, 1995, and 1996 in this category (Internal Consumption and Losses), the consumption of residual fuel oil and gas oil was not 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 have been subtracted within the framework of the chapter Stored Carbon in the reference approach) have not been taken into account in this sector 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 there is neither production of coke nor nuclear fuel in the Republic of Slovenia, data for the period 1997-2003 are comparable to the data from the period 1986-1996.

In 2003, the only petroleum refinery was closed and no emissions have occurred from this category since 2004. Data on fuel consumption by type and year are reported in the Annex 2 to the NIR, table 1.1.

Net calorific values

On the table 3.2.18 NCV are presented. The source for data is SORS (JQ).

Table 3.2.18: NCVs for the fuel used in energy industry.

	Fuel Oil	Residual Fuel Oil	Natural Gas
	TJ/kt	TJ/kt	MJ/Sm3
1986	41.82	39.74	33.500
1987	41.87	39.80	33,500
1988	41.87	39.80	34,080
1989	41.87	39.80	34,100
1990	41.87	39.80	34.100
1991	41.88	39.80	34.100
1992	41.90	39.90	34.100
1993	41.90	39.80	34.100
1994	41.90	39.86	34.100
1995	41.90	40.00	34.100
1996		40.00	34.100
1997		40.00	34.080
1998		40.00	34.080
1999	41.90	40.00	34.080
2000	41.90	40.00	34.080
2001	41.90	40.00	34.080
2002	41.90	40.00	
2003	41.90	40.00	
2004	41.90		

Emission factors

We have used country specific CO₂ EF for natural gas. More detailed description is in chapter 3.2.3. Emission factors for all other fuels have been taken from IPCC Reference Manual, 1996 and are presented on the Table 3.2.19.

Table 3.2.19: EFs used for all years.

	Unit	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
CO ₂ EF	t/TJ	74.0	77.4	74.0	63.0	Table 3.2.5
CO ₂ EF*OF	t/TJ	73.3	76.6	73.3	62.4	Table 3.2.5
CH ₄ EF	t/TJ	0.002	0.002	0.004	0.002	0.005
N ₂ O EF	t/TJ	0.0006	0.0006	0.03	0.0006	0.0001

Recalculations

In 2003, Nafta Lendava, which was the only Slovenian refinery, was closed, but some other activities were going on in the same company and fuel used for these activities was. reported to the Statistical office as fuel used for petroleum refinery. Following recommendation from 2012 review, emissions from 1A1b Petroleum refining have been reallocated to 1A1c Manufacturing a solid fuel and other energy industries since 2004.

Future improvements

No improvement is planned for this category.

3.2.5.3 Manufacture of Solid Fuels and Other Energy Industries (CRF 1A1c)

Key category - Base year: no
 Key category - Year 2012: gaseous fuel (Trend only, rank 39)

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

Methodology

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

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

Activity data

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

For the period 1986-1996 under „Coal-mining”

From 1997 onwards under „CA–Production of energy commodities”

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

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

In the period 2004 -2007 according to the old SKD classification the following SKD categories have been included in this CRF category:

CA10 Mining of coal and lignite
 CA11 Extraction of crude petroleum and natural gas including support activities
 DF Production of coke, refined petroleum products and nuclear fuel

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

B05 Mining of coal and lignite
 B06 Extraction of crude petroleum and natural gas
 B09.1 Support activities for petroleum and natural gas mining
 C19.1 Manufacturing of coke oven products - do not exist in Slovenia.
 C19.2 Manufacturing of refined petroleum products

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

Emission factors

Table 3.2.20: Emission factors used for all period

	Unit	Sub-bituminous Coal	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
CO ₂ EF	t/TJ	101.2	74.0	77.4	74.0	63.0	Table 3.2.5
EF*OF	t/TJ	99.2	73.3	76.6	73.3	62.4	Table 3.2.5
CH ₄ EF	t/TJ	0.010	0.002	0.002	0.002	0.004	0.005
N ₂ O EF	t/TJ	0.0014	0.0006	0.0006	0.0006	0.03	0.0001

We have used country specific CO₂ EF for natural gas. A more detailed description is in chapter 3.2.3.. Emission factors for all other fuels have been taken from IPCC Reference Manual, 1996 and are presented on the Table 3.2.20.

Net calorific values

Net calorific values have been taken from SORS and are presented in the table 3.2.21.

Table 3.2.21: NCVs for the fuel used in energy industry.

Year	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Fuel Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3
1986	11.880		41.82			46.00	33.50
1987	11.820		41.87			46.00	34.10
1988	12.000		41.87			46.00	34.10
1989	12.050		41.87			46.00	34.10
1990	12.760		41.87			46.00	34.10
1991	12.879		41.88			46.00	
1992	12.589		41.90	39.90		46.00	34.10
1993	13.351		41.90			46.00	34.10
1994	12.666		41.90			46.00	
1995		17.404	41.90			46.00	34.10
1996		16.353	41.90			46.00	
1997		17.712	41.90				
1998		20.664	41.90				
1999		20.806	41.90				
2000		20.782	41.90				
2001		20.947	41.90				
2002			41.90				
2003			41.90				
2004			41.90			46.05	
2005			42.60	41.42	42.70	46.05	
2006			41.90	40.00	42.60	46.05	34.080
2007			42.61	41.42	42.61	46.05	
2008			42.60	41.12	42.60	46.05	34.096
2009			42.60		42.60		34.080
2010			42.60		42.60		34.080
2011			42.60		42.60		34.087
2012			42.60		42.60		34.093

Recalculations

In 2003, Nafta Lendava, which was the only Slovenian refinery, was closed, but some other activities were going on in the same company and fuel used for these activities was reported to the Statistical office as fuel used for petroleum refinery. Following recommendation from 2012 review, emissions from 1A1b Petroleum refining have been reallocated to 1A1c Manufacturing a solid fuel and other energy industries since 2004. All data being rechecked, an error in NCV for natural gas for 2006 was eliminated and corresponding GHG emissions in 1A1c under gaseous fuel were recalculated.

Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

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

Iron and Steel	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	solid	Level	CO ₂	2.54		8	
	liquid	Level	CO ₂	0.54		38	
	gaseous	Level	CO ₂	1.33		19	
2012	solid	Trend	CO ₂	0.09	4.19	60	6
	liquid	Trend	CO ₂	0.02	0.88	77	27
	gaseous	Level, Trend	CO ₂	0.59	1.25	27	18

Non-ferrous Metals	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	solid	Level	CO ₂	0.73		34	
	liquid	Level	CO ₂	0.55		37	
	gaseous	Level	CO ₂	0.42		43	
2012	solid	Trend	CO ₂	0.02	1.21	80	20
	liquid	Trend	CO ₂	0.09	0.77	54	29
	gaseous	Trend	CO ₂	0.21	0.36	41	40

Pulp, Paper and Print	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	solid	Level	CO ₂	0.84		33	
	liquid	Level	CO ₂	0.53		39	
	gaseous	Level	CO ₂	1.13		22	
2012	solid	Level, Trend	CO ₂	0.45	0.67	33	31
	liquid	Trend	CO ₂	0.02	0.88	78	26
	gaseous	Level, Trend	CO ₂	0.73	0.68	24	30

Food, Bev. and Tob.	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	liquid	Level	CO ₂	0.85		31	
2012	liquid	Trend	CO ₂	0.12	1.25	51	19

Other	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	solid	Level	CO ₂	1.33		18	
	liquid	Level	CO ₂	3.69		4	
	gaseous	Level	CO ₂	1.79		13	
2012	solid	Level, Trend	CO ₂	0.32	1.73	35	8
	liquid	Level, Trend	CO ₂	0.88	4.79	19	5
	gaseous	Level, Trend	CO ₂	1.58	0.35	9	42

This chapter presents the consumption of fuels and emissions of greenhouse gases in five specific types of industry, all others are covered by other industry, which includes also fuel for construction industry. For this reason, a large number of enterprises included in "other" is the most important item for GHG emissions.

There was an appreciable reduction of GHG from industry in 1986-1997; after that, stabilisation of emission was observed until 2008, with the slight increase in the period 2004-2006. Due to the global financial crisis emissions from Manufacturing industry and construction decreased in 2009 by 16.8%, in 2010 by 0.9%, in 2011 by 10.3%, and in 2012 by 4% compared to the previous year. In the Table 3.2.22 and Figure 3.2.2 the GHG emissions from six CRF categories are presented.

Table 3.2.22: GHG emissions from Manufacturing Industries and Construction in Gg CO₂ eq.

	1986	1990	1995	2000	2005	2010	2011	2012
2. Manufacturing Ind. and Constr.	4404	3119	2615	2269	2486	1900	1704	1637
a. Iron and Steel	1147	419	232	281	208	198	195	198
b. Non-Ferrous Metals	442	435	177	63	62	89	87	92
c. Chemicals	98	208	153	169	166	116	86	79
d. Pulp, Paper and Print	652	376	688	509	571	383	351	339
e. Food Processing, Bev. and Tob.	249	219	201	181	174	112	100	88
f. Other	1816	1460	1166	1066	1305	1002	886	841

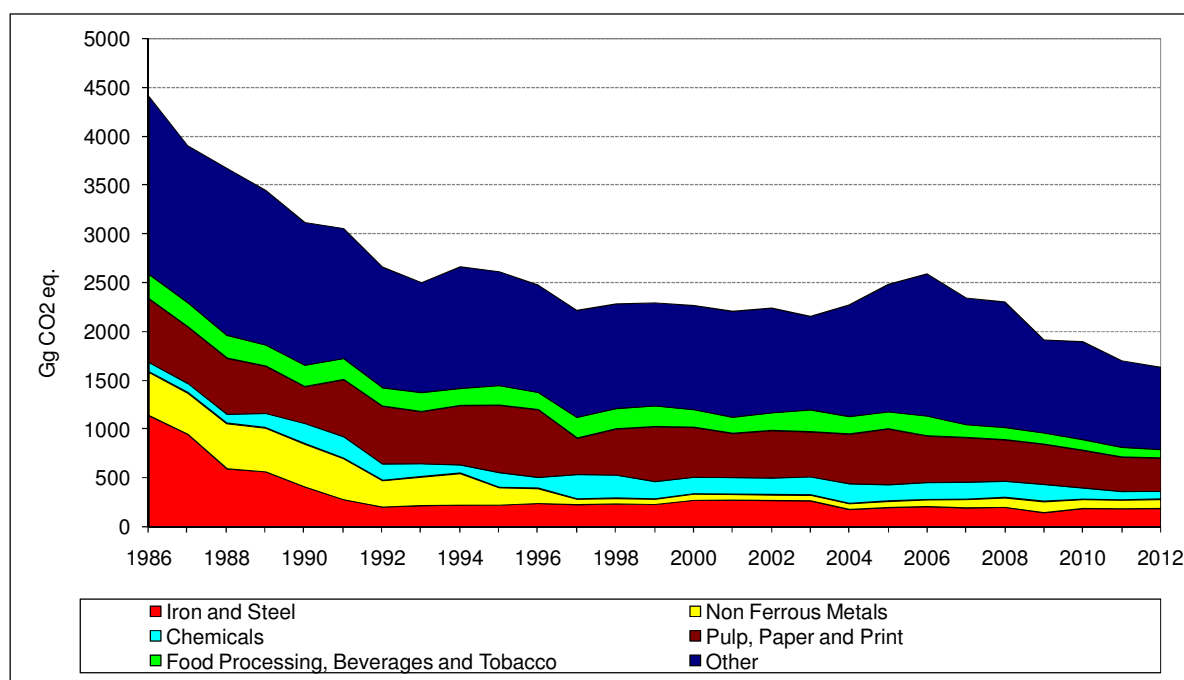


Figure 3.2.2: GHG Emissions from Manufacturing Industries and Construction

In the Figure 3.2.3 energy from different types of fuel used in the manufacturing industries and construction is presented. While use of liquid and solid fuel is decreasing, the use of natural gas stays rather constant. The use of waste fuels (other) is slowly increasing but is still almost negligible.

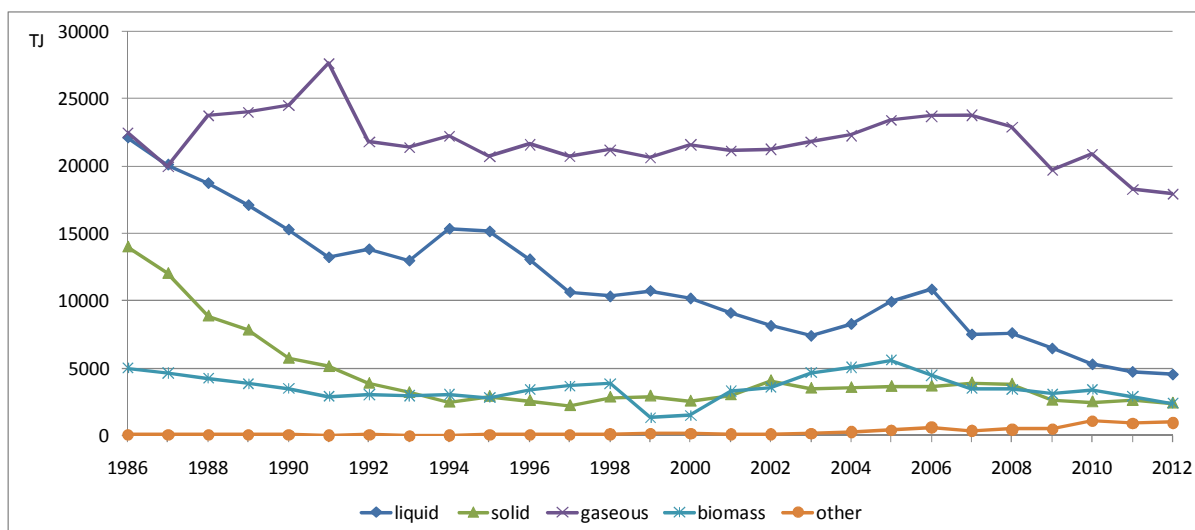


Figure 3.2.3: Energy of fuel used in manufacturing industries and construction in TJ

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

Activity data

The consumption in each category has to be determined in accordance with the classification of activities applied in IPCC guidelines. The classification applied in LEG has been taken as the basis and conversion table between LEG and CRF is presented in the table 3.2.23.

PERIOD 1986-1996

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

CRF category	LEG Classification (1986-1996)
Iron and Steel	Iron and Steel Production
Non-Ferrous Metals	Non-Ferrous Metals
Chemicals	Chemical Industry
Pulp, Paper and Print	Pulp and Paper Industry Print Industry
Food Processing, Beverages and Tobacco	Food Processing Industry Tobacco Industry
Other	Other

In this report, the group “Other” is a sum of activity data in the categories presented in the Table 3.2.24.

Table 3.2.24: Conversion table between national energy statistics (LEG) and CRF

CRF category	LEG Classification (1986-1996)
Other	Metal Industry
	Non-metal industry
	Shipbuilding
	Electrical Industry
	Construction
	Timber Industry
	Textile Industry
	Leather Industry
	Rubber Industry
	Recycling
	Other Industry

PERIOD 1997-2003

In 1997, LEG began to publish data according to the Standard Classification of Activities, which in some categories differs from the classification, which had been used until 1996. Most activities are defined in a similar manner, but this is not possible for certain activities. The table 3.2.25 shows the distribution of activities in accordance with the IPCC classification.

For consumption in individual industrial sectors there are detailed (disaggregated) data, the values of which was 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) in Slovenia. Data from basic sources hint at some relatively big changes in the consumption of fuels in some sectors.

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

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

In this report, the group “Other” is a sum of activity data in the categories presented in the Table 3.2.26.

Table 3.2.26: Conversion table between national energy statistics (LEG) and CRF

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

YEARS 2004 - 2012

We have obtained very detailed data about fuel consumption in industry in electronic format for the year 2004. 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 classification presented in the Table 3.2.27 was valid until 2007, the one in the Tables 3.2.28 and 3.2.29 has been used since 2008, when a new version of SCA classification was applied by SORS.

Table 3.2.27: Table for disaggregation of fuel in DJ sector (manufacture of basic metals and fabricated metal products)

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

Table 3.2.28: Table for disaggregation of fuel in manufacture of basic metals and fabricated metal products since 2008

SCA 2008, V2	CRF category	Description
C 24.1	Iron and Steel	Manufacture of basic iron and steel and of ferrous alloys
C 24.2	Iron and Steel	Manufacture of tubes, pipes, hollow profiles and related fittings
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 3.2.29: Conversion table between national energy statistics and CRF

CRF category	Classification SCA 2008, V2
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 26 - Production of electrical and optical equipment C 27 - Production of electrical equipment

Other	C 28 - Production of machines and devices
	C 29 – Production of vehicles
	C 30 – Production of vessels
	C 31- Production of furniture
	C 32 - Other manufacturing
	C 33 - Repair and installation of machinery and equipment
	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 of 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 period 1986 -1996, 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 SORS, 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, a half is reported as consumption in pulp and paper industry (heat), a 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 2000-2012

Recently, we have commenced to treat auto producers individually, since the SORS, 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 NIR, Table 1.2. Following the recommendation from 2011 review also data on bio fuels and other fuels have been included.

Net calorific values

Table 3.2.30 presents the net calorific values (NCV) which have been used for fuel combusted in manufacturing industries. They have been mostly 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. Since 2005, NCV from EU-ETS have been used where available (Table 3.2.31).

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

Year	Lignite (Velenje)	Sub- bituminous Coal - domestic	Sub- bituminous Coal - imported	Other Bituminous Coal	Anthracite	Coke	Petroleum coke
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt
1986	9.390	11.880		27.57	29.25	29.30	31.000
1987	9.650	11.820		27.57	29.25	29.30	31.000
1988	9.440	12.000		27.57	29.25	29.30	31.000
1989	9.820	12.050		27.57	29.25	29.30	31.000
1990	9.810	12.760		27.57	29.25	29.30	31.000
1991	9.980	12.879		25.00	29.25	29.30	31.000
1992	10.260	12.589		25.00	29.25	29.30	31.000
1993	10.070	13.351		25.00	29.25	29.30	31.000
1994	9.960	12.666		25.00	29.25	29.30	31.000
1995	10.220		17.404	25.00	29.31	29.31	31.000
1996	9.690		16.353	25.00	29.31	29.31	31.000
1997	9.610		17.712	25.00	29.31	29.31	31.000
1998	10.010		20.664	25.00	29.31	29.31	31.000
1999	9.690		20.806	25.00	29.31	29.31	31.000
2000	10.170		20.782	25.00	29.31	29.31	31.000
2001	10.660		20.947	25.00	29.31	29.31	31.000
2002	10.350		21.000	25.00	29.31	29.31	31.000
2003	10.138		21.570	25.00	29.31	29.31	31.000
2004	10.301		19.908		29.40	28.49	29.927
2005			20.381	25.15		27.90	29.927
2006			20.108	25.77		29.44	32.223
2007			20.387	24.46		29.37	31.949
2008			18.623	24.31		29.87	31.949
2009			17.972	23.896		29.67	32.498
2010			16.325	25.290		29.42	30.644
2011			15.138	25.422		29.62	31.684
2012	10.159		18.847	25.409		29.41	31.813

Year	Gas Oil	Residual Fuel Oil	Diesel	Gasoline	LPG	Natural Gas	Wood and other
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1986	41.82	39.74	42.70	43.18	46.00	33.50	12.17
1987	41.78	39.80	42.70	43.10	46.00	33.50	12.17
1988	41.71	39.80	42.70	43.10	46.00	34.08	12.17
1989	41.85	39.80	42.70	43.10	46.00	34.10	12.17
1990	41.87	39.80	42.70	43.07	46.00	34.10	12.17
1991	41.88	39.80	42.70	43.17	46.00	34.10	12.17
1992	41.90	39.90	42.70	43.10	46.00	34.10	12.17
1993	41.90	39.80	42.70	43.08	46.00	34.10	12.17
1994	41.90	39.86	42.70	43.08	46.00	34.10	12.17
1995	41.90	40.00	42.70	43.08	46.00	34.10	12.17
1996	41.90	40.00	42.70	43.08	46.00	34.10	12.17
1997	41.90	40.00	42.70	43.08	46.05	34.08	12.17
1998	41.90	40.00	42.70	43.08	46.05	34.08	12.17
1999	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2000	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2001	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2002	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2003	41.90	40.00	42.70	43.08	46.05	34.08	12.17
2004	41.90	40.00	42.70		46.05	34.08	12.17
2005	42.60	41.42	42.70		46.05	34.08	12.17
2006	42.60	41.42	42.70	43.08	46.05	34.072	12.17
2007	42.60	41.42	42.70	43.08	46.05	34.08	12.17
2008	42.60	41.42	42.70	43.85	46.05	34.096	12.17
2009	42.60	41.42	42.70	43.85	46.05	34.08	12.17
2010	42.60	41.42	42.70	43.85	46.05	34.08	10.77
2011	42.60	41.42	42.60	43.85	46.05	34.087	10.79
2012	42.60	41.42	42.60	43.85	46.05	34.093	10.41

Table 3.2.31: NCVs for the solid fuel used in manufacturing industry and construction in 2012.

Industry - 2012	Unit	Lignite	Sub-bituminous Coal - imported	Other Bituminous Coal	Coke
Iron and steel	TJ/kt				29.723
Non-Ferrous metals	TJ/kt			25.000	
Pulp. Paper and Print	TJ/kt	10.159	18.836		
Other	TJ/kt		21.000	25.492	29.300

Emission factors

Emission factors used in manufacturing industries and construction are presented in the Table 3.2.32. Until 2005, we used country specific CO₂ EF for domestic lignite and natural gas, while IPCC default values from the IPCC Reference Manual, 1996 were used for other fuels. A more detailed description on CS EF is in chapter 3.2.3.

Table 3.2.32: EFs for the fuel used in manufacturing industry and construction.

	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Other Bituminous Coal	Anthracite	Coke
CO ₂ EF	t/TJ	Table 3.2.1	101.2	101.2	94.6	98.3	108.2
CO ₂ EF*OF	t/TJ	Table 3.2.2	99.2	99.2	92.7	96.3	106.0
CH ₄ EF	t/TJ	0.010	0.010	0.010	0.010	0.010	0.010
N ₂ O EF	t/TJ	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014

	Unit	Petroleum coke	Gas Oil	Residual Fuel Oil	Diesel	Gasoline	LPG	Natural Gas	Wood and Other Biomass
CO ₂ EF	t/TJ	100.8	74.0	77.4	74.0	71.7	63.0	Table 3.2.5	108.5
CO ₂ EF*OF	t/TJ	99.80	73.3	76.6	73.3	71.0	62.4	Table 3.2.5	107.4
CH ₄ EF	t/TJ	0.0100	0.002	0.002	0.004	0.05	0.002	0.005	0.030
N ₂ O EF	t/TJ	0.0014	0.0006	0.0006	0.03	0.002	0.0006	0.0001	0.0040

Since 2005, CO₂ EF for solid fuels and petrol coke have mostly been taken from EU-ETS. CO₂ IEF which have been used in 2012 and were calculated from plant specific data and are presented in the Table 3.2.33

Table 3.2.33: Plant specific CO₂ EF (EF*OX) for solid fuel used in manufacturing industry and construction in 2012.

Industry - 2012	Unit	Lignite	Sub-bituminous Coal - imported	Other Bituminous Coal	Petroleum Coke
Pulp. Paper and Print	t/TJ	103.280	96.335		
Other	t/TJ			92.236	94.254

Detailed data for 1.A.2.f Other Industries

As already mentioned, a large number of enterprises are included in CRF category 1A2f Other and, considering its share of 51.3 per cent of emissions in 2012, this is the most important category for GHG emissions from manufacturing industries and construction. The most important industry under Other is mineral production with 46.3 per cent of emissions and all other industries included in Other (see table 3.2.29) have emitted 53.7 per cent of emissions. The biggest emitters within the mineral industries were production of cement (17.9 %) and glass production (8.8 per cent). Following the recommendation of 2012 and 2013 review, the emissions from mineral industries in 2012 are presented in the Table 3.2.34.

Table 3.2.34: CO₂ emissions in Gg eq. from industries included in "other industries" in 2012

	Cement prod.	Lime prod.	Glass prod.	Ceramic prod.	Other mineral	Total mineral	Other "other"
liquid	81	1	3	2	10	97	160
solid	25	NO	NO	NO	64	90	0
gaseous	2	26	71	20	42	161	284
other	42	NO	NO	NO	NO	42	5
biomass	0	0	NO	NO	NO	0	3
total	151	27	74	22	116	389	452
%	17.9	3.2	8.8	2.5	13.8	46.3	53.7

Waste incineration

In industry, particularly in cement industry, in addition to commonly used fuel, some waste is also incinerated because of very high temperature in the oven.

We have obtained 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 has been available since 1996 and presented on tables 3.2.35 and 3.2.38. Since 2005, all waste fuels have also been included in ETS.

Table 3.2.35: Amount of waste incinerated in cement plant.

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	t	t	t	t	t
1996	1058	0	0	1649	725
1997	1629	0	0	1390	760
1998	1526	0	0	2695	800
1999	3459	0	0	2744	835
2000	1854	0	0	4551	619
2001	2382	2124	0	2014	957
2002	1626	2214	0	3138	230
2003	2229	3319	0	4346	110
2004	3598	5225	12	6051	0
2005	4193	4496	0	10258	0
2006	4294	2177	0	10978	0
2007	4277	2535	0	8645	0
2008	4204	3074	0	12163	0
2009	4570	2280	0	11436	0
2010	4709	2071	0	18801	16509
2011	3531	1950	0	15776	17373
2012	2477	1691	0	18018	17647

Table 3.2.36: NCVs for waste incinerated in the cement plant.

	waste industrial oils	waste cooking fat	waste cooking oils	waste tyres	other waste
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt
1996	37.00			27.21	11.00
1997	37.00			27.21	11.00
1998	37.00			27.21	11.00
1999	37.00			27.21	11.00
2000	37.00			27.21	11.00
2001	37.00	39.20		27.21	11.00
2002	37.00	39.20		27.21	11.00
2003	37.00	39.20		27.21	11.00
2004	41.90	40.41	40.00	27.21	
2005	40.00	39.20		27.21	
2006	34.53	39.20		27.21	
2007	38.00	39.95		27.00	
2008	38.06	39.81		27.20	
2009	38.24	39.81		27.10	
2010	36.69	39.20		27.21	22.29
2011	36.54	39.20		27.21	19.52
2012	36.54	39.20		27.21	20.25

Table 3.2.37: EFs for waste incinerated in the cement plant in the period 1986-2009

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

Table 3.2.38: CO₂ EFs for waste incinerated in the cement plant since 2010

Year	waste industrial oils	waste cooking fat	waste tyres	other waste
	t/TJ	t/TJ	t/TJ	t/TJ
2010	70.27	70.01	54.854	60.472
2011	70.27	70.01	52.631	49.473
2012	70.27	70.01	34.305	49.473

We obtained data from pulp and paper industry about consumption of black liquor from 2004 to 2006. NCV was between 6.1 and 6.4 TJ/kt. We used the same EF for GHG calculation as for wood. From 2007, there has been no consumption of black liquor any more.

Recalculations

No recalculations have been performed for this sector.

Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

3.2.7 Transport (IPCC: I A 3)

Traffic is an important source of emissions of greenhouse gases, mostly carbon dioxide and nitrous oxide, and also an important source of emissions which cause problems in terms of air quality, such as sulphur oxides (SO_x), nitrous oxides (NO_x), carbon monoxide (CO), non volatile organic compounds (NMVOC), particulate matters (PM_{2.5} and PM₁₀) and are, consequently, indirectly responsible for the formation of ozone (O₃) in lower troposphere.

Table 3.2.39: GHG emissions from Transport in Gg CO₂ eq.

in Gg CO ₂ eq.	1986	1990	1995	2000	2005	2010	2011	2012
3. Transport	2025	2730	3824	3862	4428	5265	5699	5773
a. Civil Aviation	1	1	2	3	2	2	2	2
b. Road Transportation	1948	2656	3774	3816	4384	5217	5654	5728
c. Railways	77	73	49	43	42	42	42	42
e. NG transmission	NO	NO	NO	NO	IE	4	1	1

Undoubtedly the greatest increase in GHG emissions took place 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 slightly declined. In 2009, GHG emissions from transport decreased by 13.2% compared to 2008. The traffic emissions have further decreased by 1.2% in 2010, but increased again in 2011 by 8.2% and by 1.3% in 2012.

Clearly, the most important source is road transport, which accounts for 99% of all transport emissions (Table 3.2.39 and Figure 3.2.4)

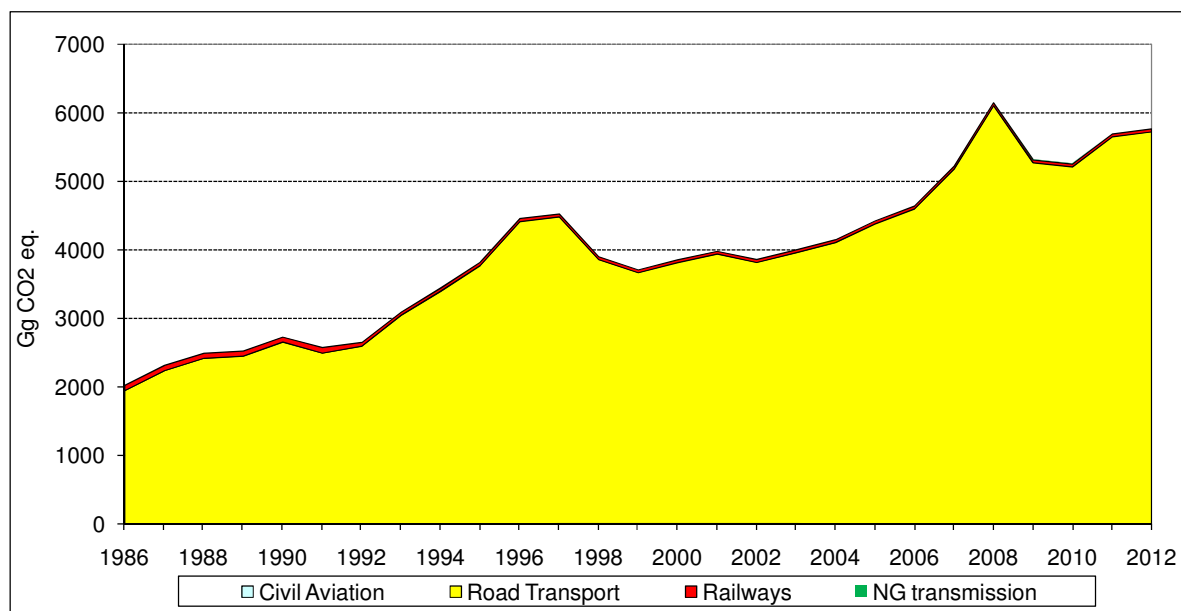


Figure 3.2.4: GHG emissions from Transport.

3.2.7.1 Road transport

	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	diesel oil	Level	CO ₂	2.44		10	
	gasoline	Level	CO ₂	4.91		3	
2012	diesel oil	Level, Trend	CO ₂	14.34	20.32	3	1
	gasoline	Level, Trend	CO ₂	05.79	1.50	4	14

Methodology

COPERT 4 (version 9.0) methodology has been used for calculation of national greenhouse gas emissions from road transport for the entire 1986-2012 period. The methodology is fully incorporated in the computer software programme COPERT 4 (version 9.0) which facilitates its application. The actual calculations have been therefore performed by using this computer software. Upgraded version of COPERT 4, this is version 9.0, has been used for the first time for this year's submission. For previous submissions version 6.1 had been used.

COPERT 4 model estimates emissions of greenhouse gas emissions (CO₂, N₂O, CH₄) as well as of all major air pollutants (CO, NO_x, NMVOC, particulate matter, NH₃, SO₂, heavy metals) produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty trucks, buses, mopeds and motorcycles). The programme also provides speciation of Polyaromatic Hydrocarbons (PAHs) and dioxins and furanes. Emissions estimated are distinguished in three sources: emissions produced during thermally stabilized engine operation (hot emissions), emissions occurring during engine start from ambient temperature (cold-start and warming-up effects) and NMVOC emissions due to fuel evaporation. The total emissions are calculated as a product of activity data provided by the user and speed-dependent emission factors calculated by the software.

The COPERT 4 methodology is also a part of the EMEP/EEA air pollutant emission inventory guidebook (formerly referred to as the EMEP CORINAIR Guidebook). The Guidebook is prepared by the UNECE/EMEP Task Force on Emission Inventories and Projections (TFEIP) and published by the European Environment Agency. It is intended to support reporting under the UNECE Convention on Long-Range Transboundary Air Pollution and the EU directive on national emission ceilings as well as under United Nations Framework Convention on Climate Change (UNFCCC). The COPERT 4 methodology is fully consistent with the Road Transport chapter of the EMEP/EEA air pollutant emission inventory guidebook 2009. The use of a software tool to calculate road transport emissions allows for a transparent and standardized, hence consistent and comparable data collecting and emissions reporting procedure, in accordance with the requirements of international conventions and protocols and EU legislation.

Applied methodology is fully described in the following literature:

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

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

Vehicle fleet

The COPERT 4 methodology requires a detailed knowledge of the structure of the vehicle fleet composition. Table 3.2.40 provides a summary of all vehicle categories and technologies covered by the applied methodology.

Table 3.2.40: 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

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

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. This matrix was prepared and suggested by researches that developed COPERT methodology. It is published on COPERT web page <http://lat.eng.auth.gr/copert/>.

The fleet composition for the years 1992–2009 was taken from the official database of registered motor and trailer vehicles in the Republic of Slovenia provided by the Ministry of the Interior. Since 2010, those data have been collected by Ministry of Infrastructure and Spatial Planning of the Republic of Slovenia. Since no database exists on licensed motor and trailer vehicles in the Republic of Slovenia for the years 1986–1991, an expert estimate has been made on the basis of the annual Statistical Yearbooks, published by SORS.

The vehicle numbers per all vehicle classes for period 1986–2012 are shown in Annex 1 (Table 1.4 : *Road transport : Fleet data (number of vehicles) 1986–2012*).

The vehicle fleet structure is presented in Figure 3.2.5. 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 2012. 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.

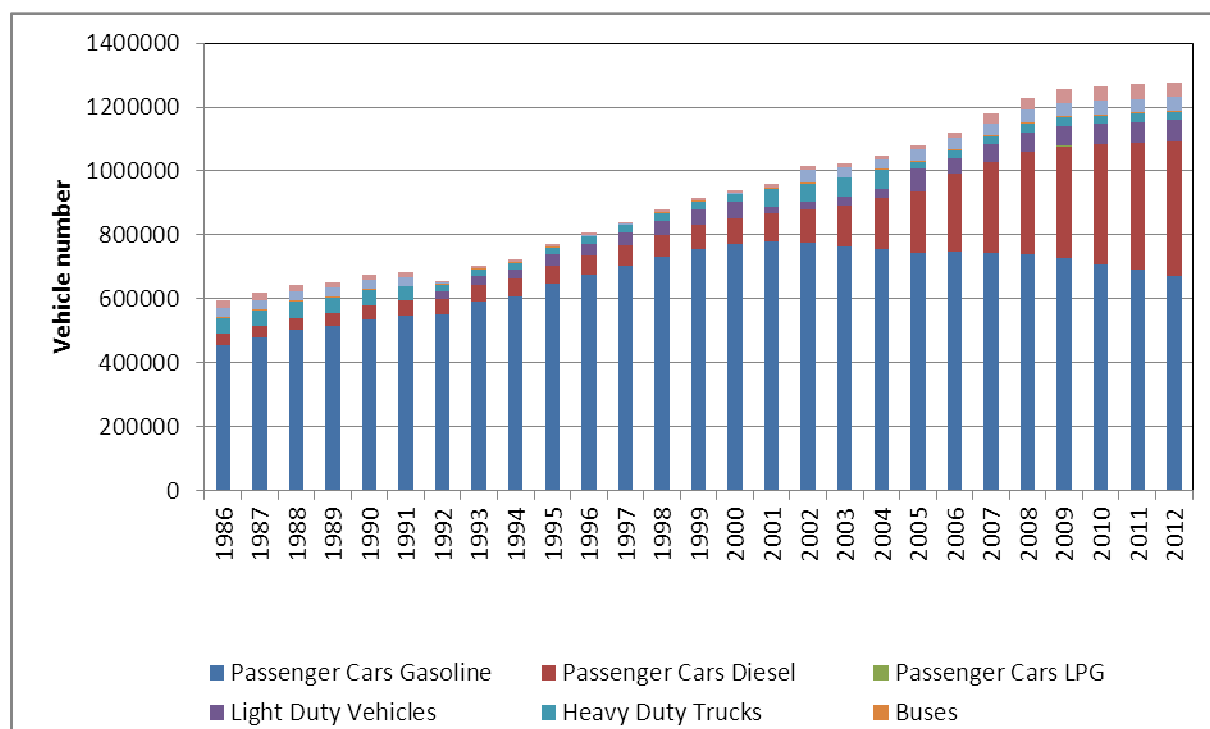


Figure 3.2.5: Vehicle fleet 1986–2012.

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 Infrastructure and Spatial Planning, Directorate of the Republic of Slovenia for Roads. Mileage data on local roads are not available; that is why estimates are made.

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

The Mf_{AC}^k , Mf_{GC}^k and Mf_{RC}^k are available for passenger cars from 1986 onwards.

The Mf_{AC}^k , Mf_{GC}^k and Mf_{RC}^k are available for buses from 1988–1990 and from 1992 on. For the year 1991 the same values were taken as for the year 1992. For the years 1986–1987 the same values were taken as for the year 1998.

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

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

Light duty vehicles and heavy duty trucks are considered together for the years 1986–1991. Mf_{AC}^k , Mf_{GC}^k and Mf_{RC}^k contain mileage for both categories of duty vehicles.

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

The values used are shown in the Annex 2 (Table 1.5: Road transport: Mileage data 1986–2012).

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 SORS on the average amount of mileage per vehicle in one year for individual vehicle subcategory for the years 1996 and 2002 is available (M^{GSm} (1996,2002), M^{GMe} (1996,2002), M^{GLa} (1996,2002), M^{DSm} (1996,2002), M^{DLa} (1996,2002) .

According to the statistical data on the amount of mileage per vehicle in one year for the years 1996 and 2002, the following mileage for individual subcategories of passenger cars has been calculated by using the trend lines for each year from 1986 to 2009. For the period 2010 – 2012 data from survey conducted by SORS in 2010 was applied. (M^{GSm} , M^{GMe} , M^{GLa} , M^{DSm} , M^{DLa}).

Light duty vehicles

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

LdV ... light duty vehicles

In estimates of average mileage from 1986 to 1991, light duty vehicles, mid-size duty vehicles as well as heavy duty vehicles have been considered together as one category. The light duty and mid-size duty vehicles were numbered among heavy duty vehicles.

The total mileage by the fleet of light duty vehicles in the highway mode of driving (Mf_H^{LdV}) and the total mileage made by the fleet of light duty vehicles on the public roads (Mf_{dc}^{LdV}) can be obtained from the statistics from 1992 on. Mileage data for local roads (M_{Rlc}^{LdV}) and mileage data for the urban mode of driving (M_U^{LdV}) are not available, so an indirect estimate was made. Mileage on public roads (M_{dc}^{LdV}) was increased by the $Corr_{U+R+H}^{LdV}$ 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.

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

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 $\text{Corr}_{U+R+H}^{HdV}$ 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 $\text{Corr}_{U+R+H}^{HdV}$ and p_R^{HdV} are the same for all years 1.5 and 0.7, respectively.

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

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:

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

$$m_R^{Ubus} = 0$$

$$m_H^{Ubus} = 0$$

$$m_U^{Cbus} = 0$$

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

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

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 (M_H^{MoT}) and the total mileage made by the fleet of motorcycles on the state roads (M_{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 was 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.

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

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:

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

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

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

Average mileage shares are the following:

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

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

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

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 1986–2012).

Fuel Consumption

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

As shown in Figure 3.2.6, the total fuel consumption in road transport began to grow markedly in the following two periods: during the years 1991–1997 due to fuel being sold to foreigners as a consequence of lower fuel prices in Slovenia, and during the years 1999–2008. During the years 2000–2008 an extensive growth in usage of diesel fuel can be observed. In 2009, a significant decline of gasoline and diesel consumption was observed. In comparison with the year 2008 consumption of gasoline dropped for 8% and diesel for 15%. In 2010 consumption of diesel was increased compared to previous year, whereas consumption of gasoline has been still on the decline. In 2012, consumption of both, diesel and gasoline, increased compared to 2010. Lower consumption of fuel in period 2009–2010 was due to the world economic crisis. In the year 2005, sale of diesel fuel exceeded the sale of gasoline. In 2012, the fuel use shares for diesel and gasoline were about 71% and 28%, respectively. The share of liquefied petroleum gas (LPG) was below 0.5%. Compressed natural gas (CNG) was reported for the first time in 2012. It is mostly used in buses. Share of CNG is only 0,03%.

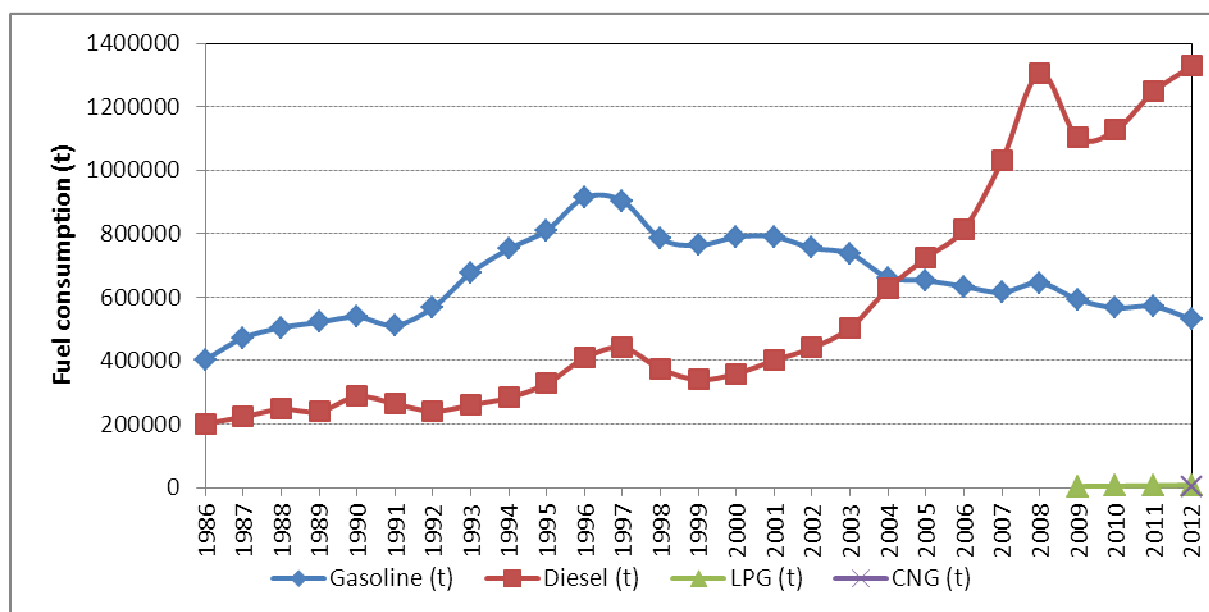


Figure 3.2.6: Fuel consumption in road transport for 1986–2012.

As shown in Figures 3.2.7 and 3.2.8, 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 fuel use for buses and light duty vehicles, has fluctuated since 1992. 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 has been 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 1986–2012).

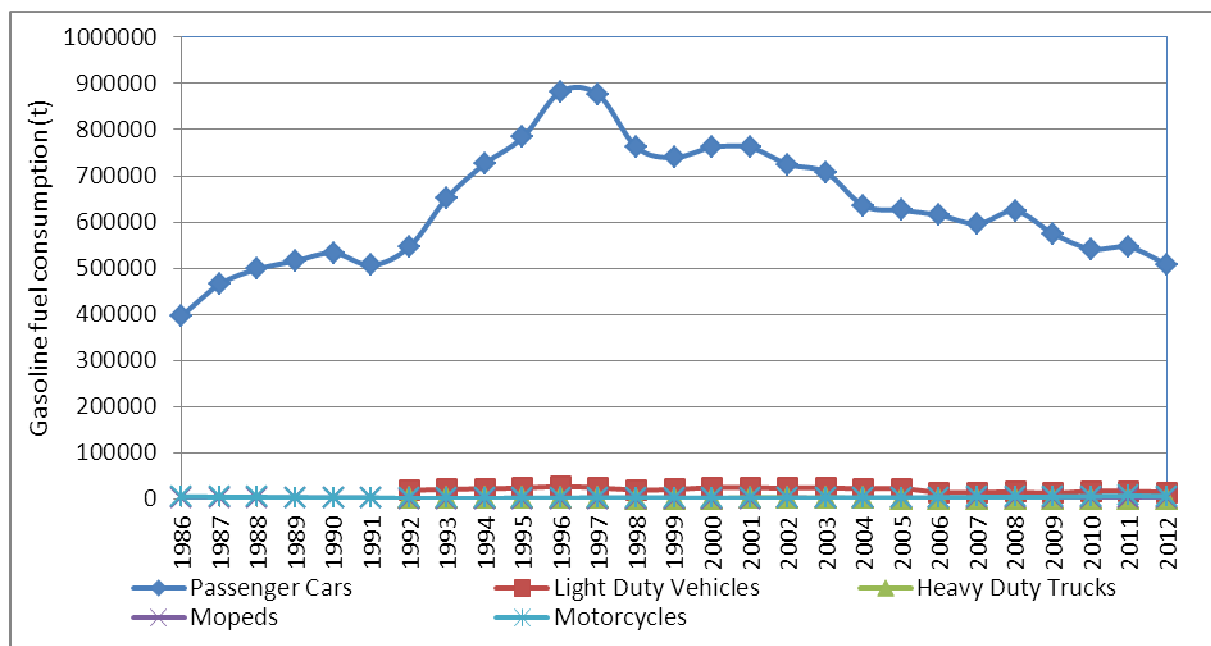


Figure 3.2.7: Gasoline fuel consumption per vehicle type for road transport 1986–2012.

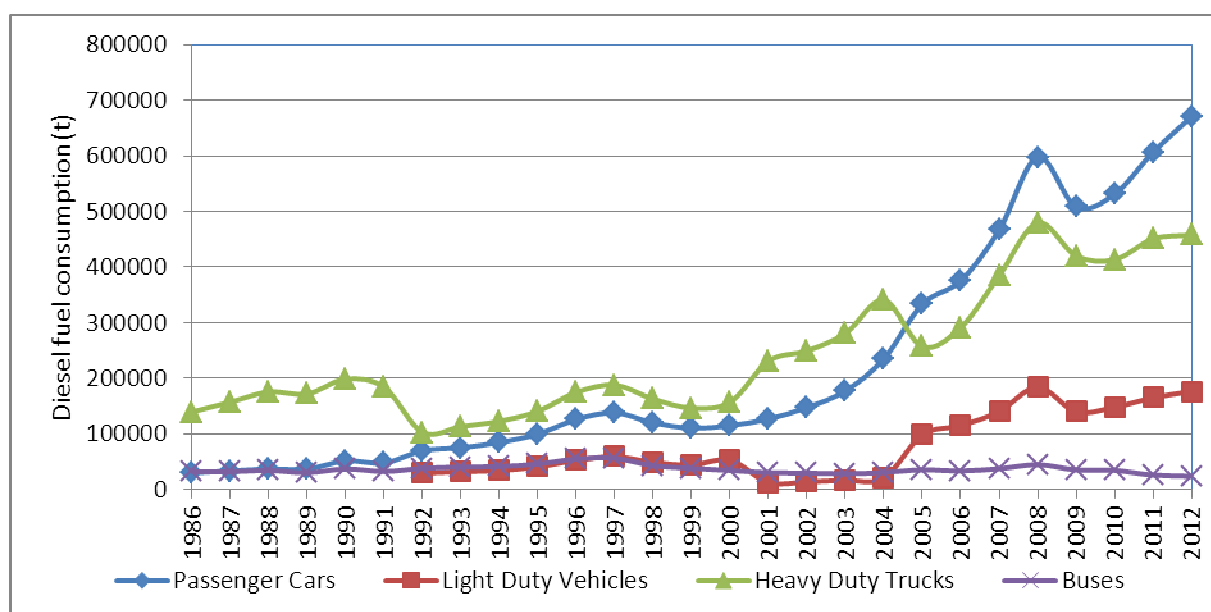


Figure 3.2.8: Diesel fuel consumption per vehicle type for road transport 1986–2012.

In 2012, fuel consumption shares for diesel passenger cars, gasoline passenger cars and diesel heavy duty trucks were about 36, 27, and 26 %, respectively (Figure 3.2.9).

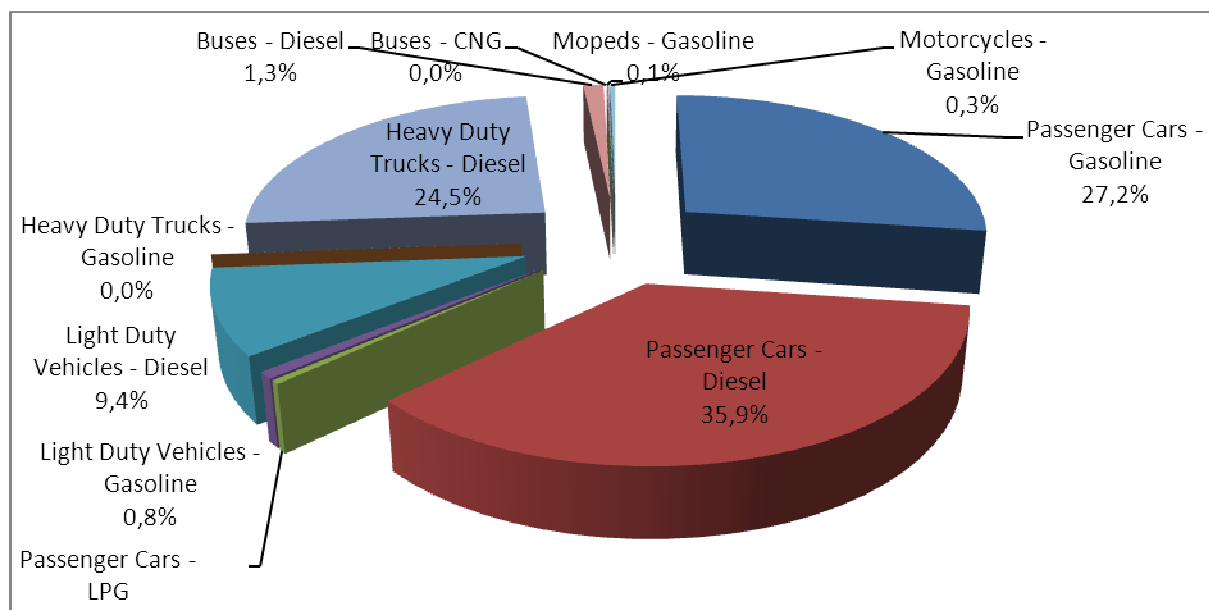


Figure 3.2.9: Fuel consumption share per vehicle type for road transport in 2012.

In addition to fossil fuels biofuels have also been used in road transportation in Slovenia. Biodiesel has been used since 2006 and bioethanol since 2008. Biodiesel in road transportation is mostly blended into fossil diesel, bioethanol into fossil gasoline. Amount of biofuel used in road transport is in steady increase also due to the national legislation on promotion of biofuel use in road transport.

Emissions from biofuels have been calculated using the COPERT 4 model as well, based on the total amount of fossil fuels and biofuels used. Owing to the reporting requirements regarding the disaggregation of fossil fuels and biofuels in the CRF tables, the emissions of CO₂, CH₄ and N₂O from biodiesel and bioethanol have been reported under 1AA3B / Biomass.

Fuel Characteristics

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

Table 3.2.41: Levels of sulphur content in gasoline and diesel fuel.

Fuel	Period	Sulphur [% wt]
Gasoline Leaded	1986-1994	0.1
	1995-2001	0.05
Gasoline Unleaded	1986-1994	0.1
	1995-2001	0.05
	2002-2004	0.015
	2005-2008	0.005
	2009-2011	0.001

Diesel	1986-1994	1
	1995	0.25
	1996-2001	0.20
	2002-2004	0.035
	2005-2008	0.005
	2009-2012	0.001

Table 3.2.42: Levels of lead content in gasoline.

Fuel	Period	Lead [g/l]
Gasoline Leaded	1986-1994	0.6
	1995	0.4
	1996-2001	0.15
Gasoline Unleaded	1986-1994	0.026
	1995-2001	0.013
	2002-2012	0.005

RVP values used were 70 kPa for winter period (1 October – 30 April) and 60 kPa for summer period (1 May – 30 September). The sulphur and lead contents were set as presented in Tables 3.2.41 and 3.2.42.

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 SEA. 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 SEA'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 CO₂, N₂O and CH₄

From 1986 to 2012 the road transport emissions of CO₂ and N₂O increased by 197 % and 133 %, respectively. The emissions of CH₄ decreased by 61 %. Due to the world economic crises and consecutively smaller fuel consumption emissions of all GHG considerably decreased in 2009. In view of difficult economic situation even slightly lower emissions of all GHG were observed in the year 2010. In the years 2011 and 2012 emissions of GHG were on the rise again and slowly approaching pre-crisis values. Referring to the third IPCC assessment report, 1 g CH₄ and 1 g N₂O have the greenhouse effect of 21 and 310 g CO₂, respectively. In spite of the relatively large CH₄ and N₂O global warming potentials, the largest contribution to the total CO₂ emission equivalents for road transport comes from CO₂ (Figure 3.2.10).

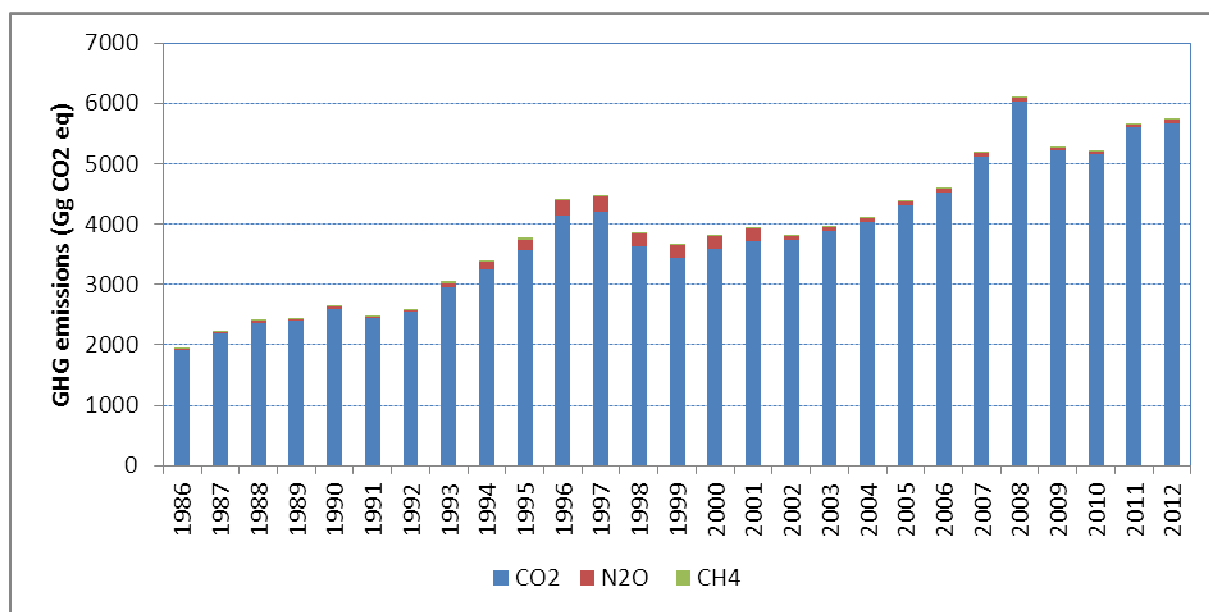


Figure 3.2.10: CO₂, N₂O and CH₄ emissions for road transport 1986–2012.

Due to the direct dependency of CO₂ emissions on fuel consumption, the total growth in CO₂ emissions reflects the trend of increased fuel consumption till 2008. In 2009 significant drop of CO₂ emissions occurred due to smaller fuel consumption. The same trend is shown for 2010, but in 2011 the trend changed. As shown in Figures 3.2.11 and 3.2.12, 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 2012, the respective emission shares were about 64, 25, 10, 1.3 and 0.4%, respectively.

CO₂ emissions of passenger cars were gradually increasing from 1991 to 1996 mainly due to fuel being sold to foreigners as a consequence of lower fuel prices in Slovenia. During the period 2000–2008, an extensive switch from petrol powered to diesel powered cars could be observed. Better energy efficiency of diesel cars and a general improvement in fuel efficiency for all new vehicles diminished a considerable increase in fuel consumption which led to slower increase of CO₂ emissions in this period.

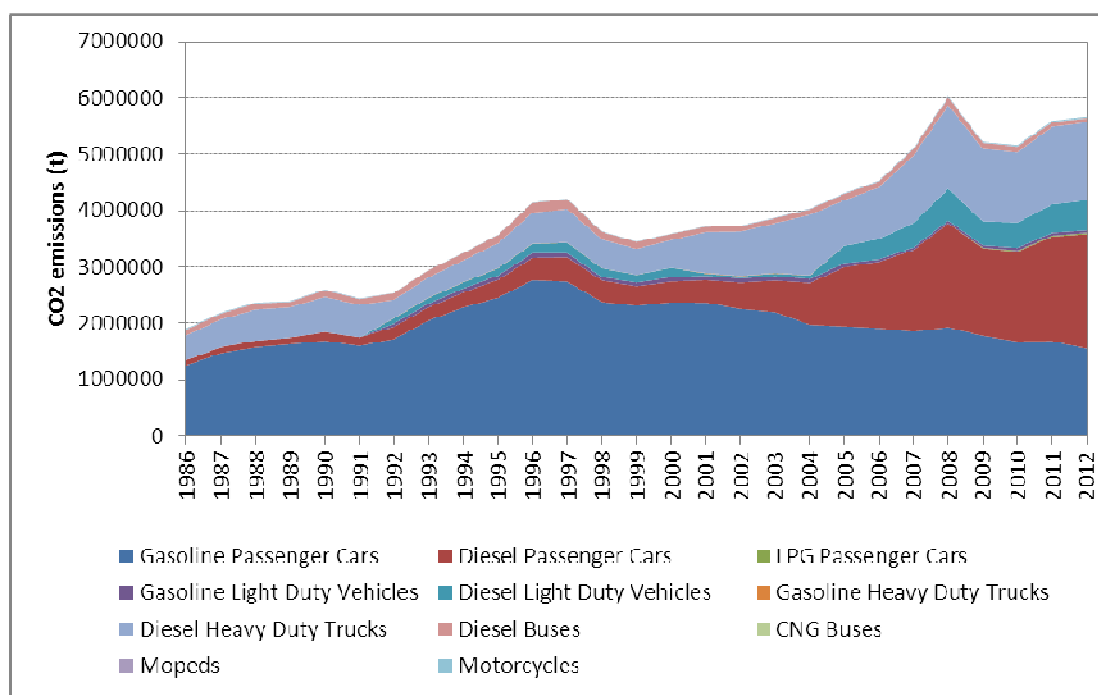


Figure 3.2.11: CO₂ emissions (t) per vehicle type for road transport 1986–2012.

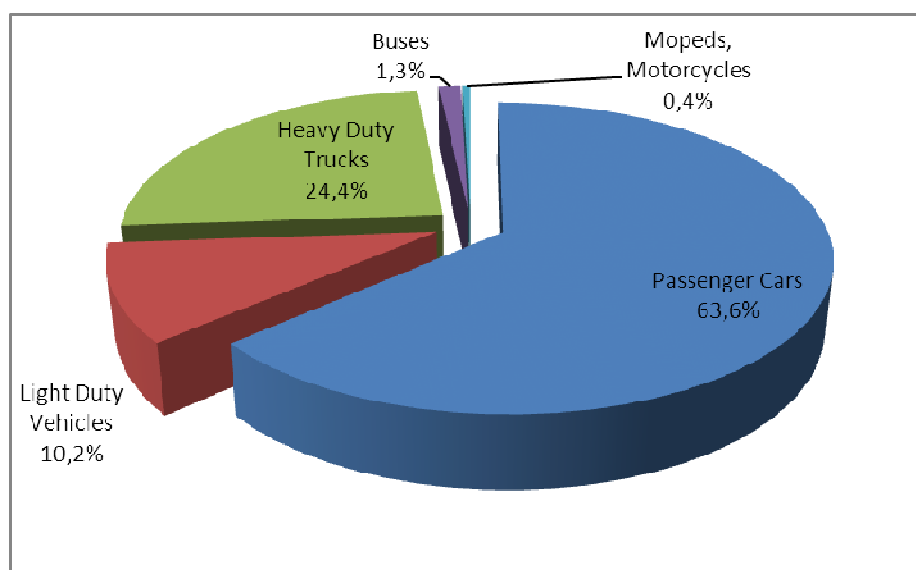


Figure 3.2.12: CO₂ emission share per vehicle type for road transport for 2012.

The fall of CO₂ 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, each vehicle category has been treated separately. The economic crisis which began in 2008 and intensified in 2009 also led to reduced emissions from diesel powered heavy duty vehicles.

N₂O emissions are not dependent only on fuel consumption but also on vehicle technology, operating characteristics, fuel characteristics, the combustion and emission control technology.

An undesirable environmental side effect of the introduction of catalyst cars is the increase in the emissions of N₂O. N₂O emissions have increased significantly from 1991 onwards, mostly due to the growing number of passenger cars with catalysts. In 2002, a huge drop of N₂O emissions occurred due to switching to lower sulphur fuel. Lower sulphur fuel helps improve catalyst performance. Sulphur content in fuel has an important impact on N₂O emissions. Sulphur content dropped between 2001 and 2002 from 0,05 % to 0,015% for gasoline and 0,2% to 0,035% for diesel.

In 2012, emission shares for passenger cars, heavy duty trucks and light duty vehicles were about 69, 21 and 9 %, of the total road transport N₂O, respectively (Figures 3.2.13 and 3.2.14).

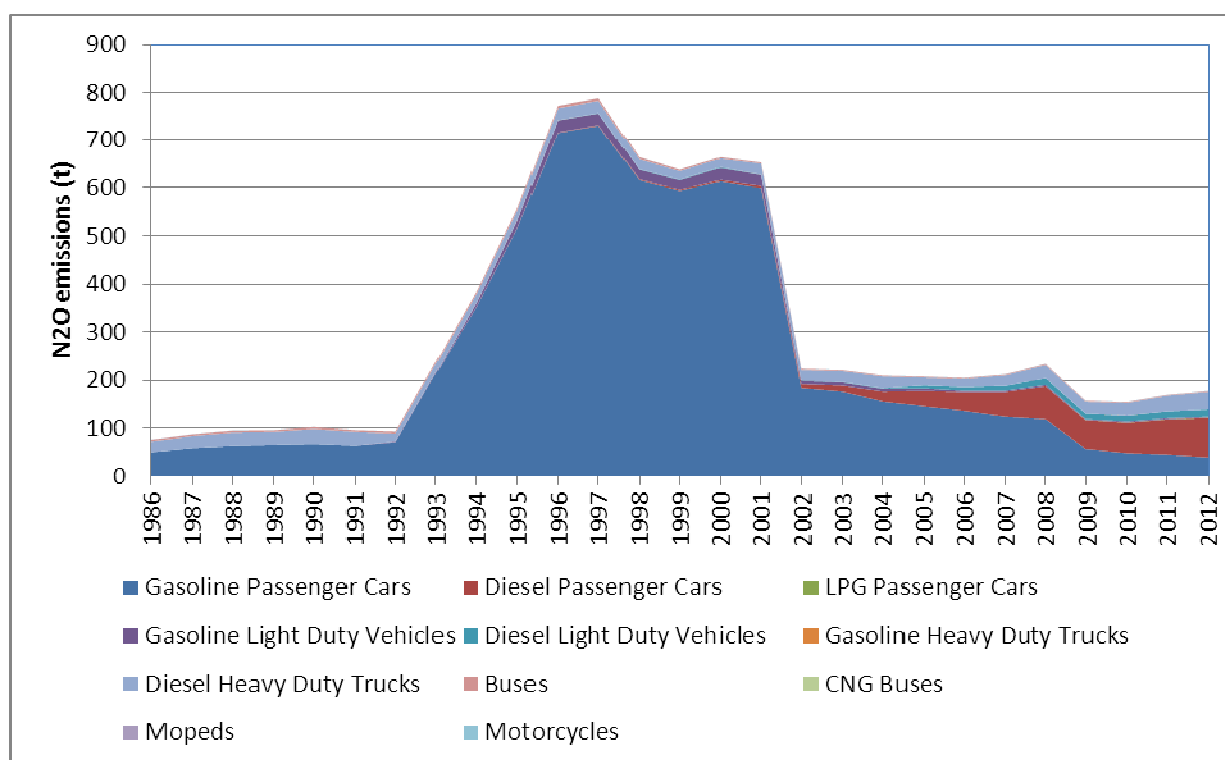


Figure 3.2.13: N₂O emissions (t) per vehicle type for road transport 1986–2012.

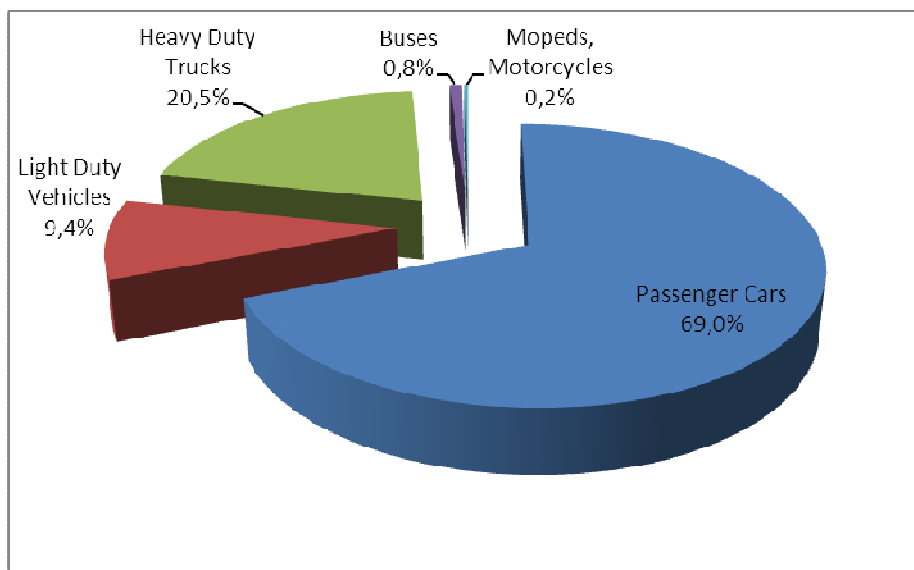


Figure 3.2.14: N₂O emission share per vehicle type for road transport for 2012.

CH₄ emissions, similarly to N₂O, do not depend only on fuel consumption but also on vehicle technology, operating characteristics, fuel characteristics, the combustion and emission control technology.

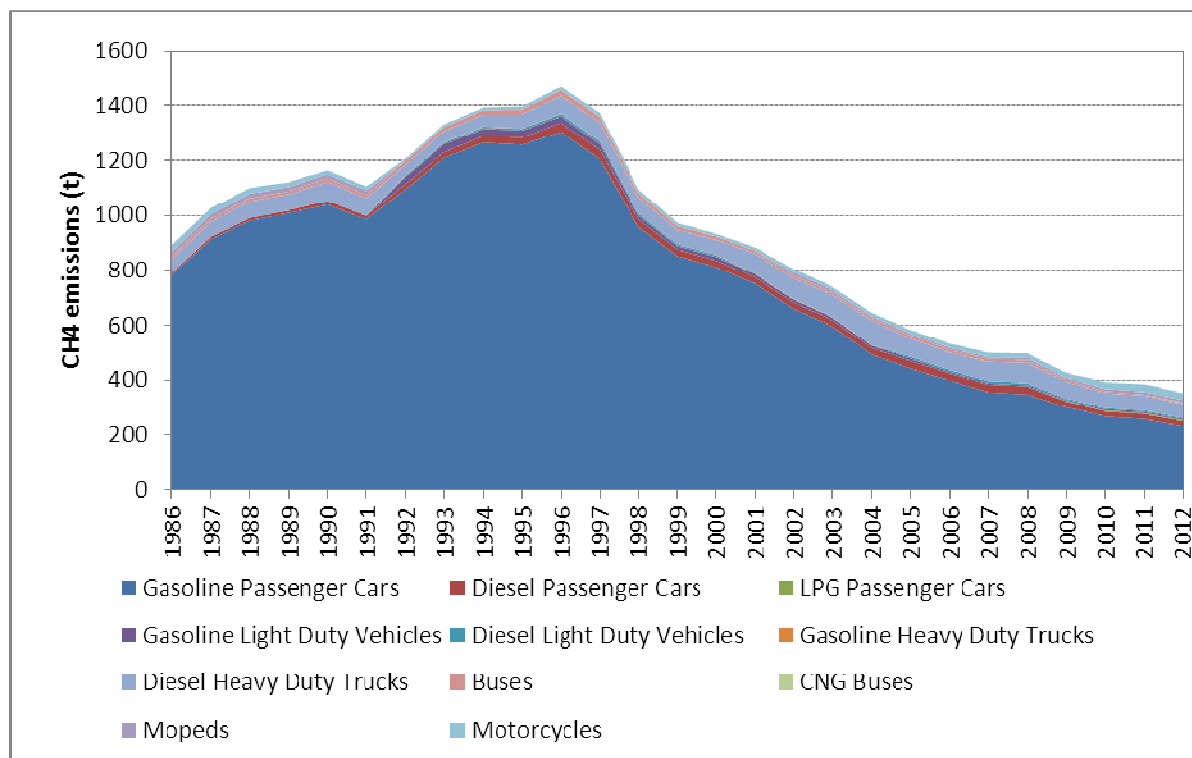


Figure 3.2.15: CH₄ emissions (t) per vehicle type for road transport 1986–2012.

The majority of CH₄ emissions from road transport come from gasoline passenger cars. The emission increase in 1991–1996 for this vehicle category is a result of bigger fuel

consumption. 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 CH₄ emission factors than conventional gasoline vehicles. The 2012 emission shares for CH₄ were about 72, 14 and 10 % for passenger cars, heavy duty trucks and 2-wheelers respectively (Figures 3.2.15 and 3.2.16).

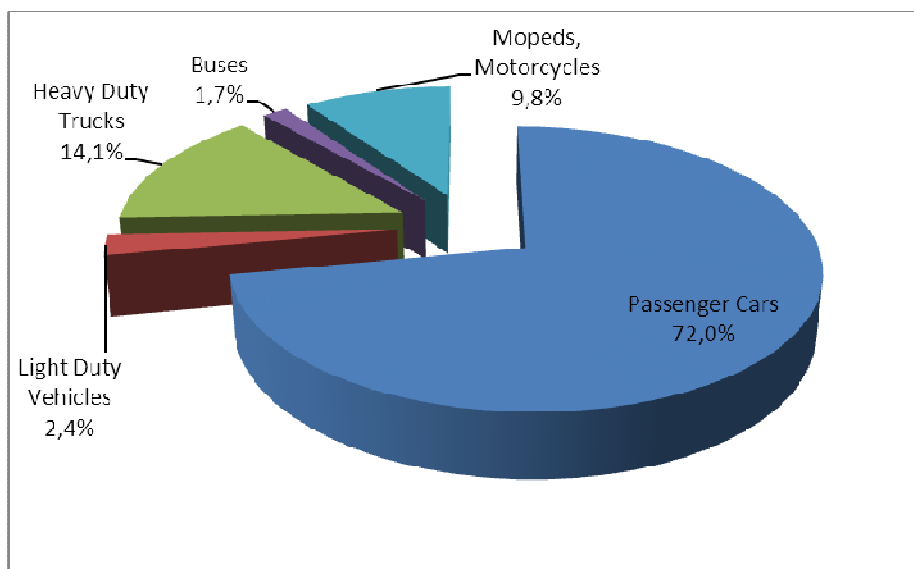


Figure 3.2.16: CH₄ emission share per vehicle type for road transport for 2012.

Uncertainties and time-series consistency

Uncertainty based on expert judgement 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.

Recalculations

No recalculations have been performed since last submission.

Planned improvements

Following recommendation of emission review team we are planning to start collecting information on characterization of the properties of gasoline and diesel used for road transportation.

3.2.7.2 Railways

Key category - Base year: no

Key category - Year 2012: no

Fuel in TJ and GHG emissions from the railways are presented on the table 3.2.43.

Table 3.2.43: GHG Emissions in the period 1986-2012.

	1986	1990	1995	2000	2005	2010	2011	2012
fuel in TJ	930	879	588	514	512	511	511	511
Gg CO₂ eq.	77	73	49	43	42	42	42	42

Methodology

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

$$\text{Quantity of Fuel used} \times \text{Net Calorific value} \times \text{EF per energy of Fuel} = \text{Emissions}$$

Activity data

The main source of emissions is 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 table 3.2.44.

Table 3.2.44: EFs for fuel used in railways.

EF	Unit	Gas Oil	Brown coal
CO₂ EF	t/TJ	74.0	101.2
EF*OF	t/TJ	73.3	99.2
CH₄ EF	t/TJ	0.004	0.01
N₂O EF	t/TJ	0.030	0.014

Recalculations

No recalculations have been performed since last submission.

Future Improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

3.2.7.3 Aviation

Key category - Base year: no

Key category - Year 2012: no

Fuel in TJ and GHG emissions from the railways are presented on the table 3.2.45.

Table 3.2.45: GHG Emissions in the period 1986-2012.

	1986	1990	1995	2000	2005	2010	2011	2012
fuel in TJ	9	15	28	40	24	23	27	24
Gg CO₂ eq.	1	1	2	3	2	2	2	2

Methodology

Most quantities of jet kerosene are consumed outside the territory of Slovenia in international transport, i.e. in the so-called international bunkers, therefore these quantities are excluded from 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 CO₂/TJ, 0.001 t CH₄/TJ and 0.002 t N₂O/TJ for aviation gasoline and for jet kerosene as well.

Recalculations

No recalculations have been performed since last submission.

Future Improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

3.2.7.4 Other Transportation

Key category - Base year: NO (not occurring)
Key category - Year 2012: no

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

Methodology

To estimate emissions the following methodology has been adopted.

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

Activity data

Statistical office has not collected data from this source and in Joint questionnaires amount of fuel under this category was reported as zero. This amount has been included under Commercial/institutional as a correction to energy balance.

We have obtained the data on natural gas used on compressor station since 2008 from the company Plinovodi which is the owner of this compressor station, while for the period 2005-2007 notation key IE has been used. There was no compression station in Slovenia before 2005.

Net calorific values

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

Emission factors

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

Recalculations

No recalculations have been performed since last submission.

Future Improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

3.2.8 Other Sectors (IPCC: I A 4)

This chapter presents 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)

GHG emissions are presented on the table 3.2.46 and on the figure 3.2.17.

Table 3.2.46: GWP of GHG emissions from Other Sectors.

in Gg CO ₂ eq.	1986	1990	1995	2000	2005	2010	2011	2012
4. Other Sectors	2367	1811	2439	3053	2585	2213	1969	1954
a. Commercial/Institutional	632	515	712	922	714	646	573	413
b. Residential	1256	924	1444	1871	1613	1332	1171	1085
c. Agriculture/Forestry/Fisheries	479	371	283	261	258	234	225	235

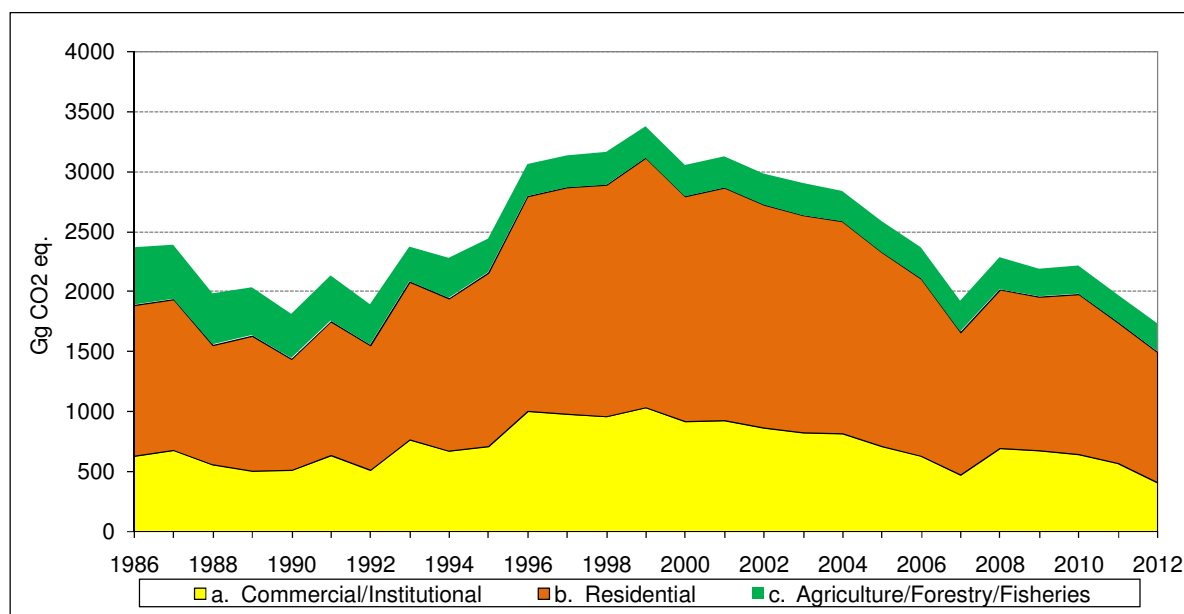


Figure 3.2.17: GHG emissions from Other Sectors.

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

Commercial	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	solid	Level	CO ₂	1.92		12	
	liquid	Level	CO ₂	0.37		44	
2012	liquid	Level, Trend	CO ₂	1.36	1.70	10	10

Residential	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	solid	Level	CO ₂	3.06		6	
	liquid	Level	CO ₂	1.13		23	
		Level	CH ₄	0.52		40	
2012	solid	Trend	CO ₂	0.01	5.22	91	4
	liquid	Level, Trend	CO ₂	2.35	2.10	8	7
	gaseous	Level, Trend	CO ₂	0.96	1.55	18	12
		Level	CH ₄	0.45	0.11	32	

Methodology

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

$$Emissions = \sum (EF_{abc} * Activity_{abc})$$

Where:

EF = Emission Factor (kg/TJ);

Activity = Energy Input (TJ);

a = Fuel type;

b = Sector-activity; and

c = Technology type.

Activity data

The consumption of fuels in the commercial sector and households has been combined under "Široka potrošnja" in our basic source of data (Statistical Yearbook of Electricity Generating Industries). 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: 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 (see Table 3.2.47).

Table 3.2.47: Estimates of Inappropriate Consumption of Fuel Oil in Commercial Sector and Households

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

All quantities of residual fuel oil, reported as consumed in Other consumption in LEG, are presented as consumption in the commercial/institutional sector in this report. 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.

Since 2005, data on fuel used in commercial and residential sector have been available from JQ.

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. All NCV are presented in the Table 3.2.48.

Table 3.2.48: NCVs for the fuel used in Commercial Sector and Households.

Year	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Fuel Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1986	9.390	11.880		41.82	39.74	46.00	33.500	12.17
1987	9.650	11,820		41,78	39.80	46.00	33.500	12.17
1988	9,440	12,000		41,71	39.80	46.00	34.080	12.17
1989	9,820	12,050		41,85	39.90	46.00	34.100	12.17
1990	9.810	12.760		41.87	39.80	46.00	34.100	12.17
1991	9.980	12.879		41.88	39.80	46.00	34.100	12.17
1992	10.260	12.589		41.90	39.90	46.00	34.100	12.17
1993	10.070	13.351		41.90	39.80	46.00	34.100	12.17
1994	9.960	12.666		41.90	39.86	46.00	34.100	12.17
1995	10.220		17.404	41.90	40.00	46.00	34.100	12.17
1996	9.690		16.353	41.90	40.00	46.00	34.100	12.17
1997	9.610		18.203	41.90	40.00	46.05	34.080	12.17
1998	10.010		18.531	41.90	40.00	46.05	34.080	12.17
1999	9.690		18.563	41.90	40.00	46.05	34.080	12.17
2000	10.170		17.983	41.90	40.00	46.05	34.080	12.26
2001	10.660		18.834	41.90	40.00	46.05	34.080	12.51
2002	10.350		19.000	41.90	40.00	46.05	34.080	12.77
2003	10.138		19.000	41.90		46.05	34.080	13.03
2004	10.301		19.000	41.90		46.05	34.080	13.29
2005	10.803	11.724		42.60		46.05	34.080	13.56
2006		12.877		41.90		46.05	34.072	13.84
2007			13.447	42.60		46.05	34.076	14.12
2008			14.391	42.60		46.05	34.096	14.41
2009			16.264	42.60		46.05	34.080	14.71
2010			16.120	42.60		46.05	34.080	14,71
2011			16.000	42.60		46.05	34.087	14,71
2012			16.043	42.60		46.05	34.093	14,71

Emission factors

We have used country specific CO₂ 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 and are presented in the Tables 3.2.49 (commercial sector) and Tables 3.2.50 (residential sector).

Table 3.2.49: EFs for the fuel used in Commercial Sector.

	Unit	Lignite (Velenje)	Sub-bituminou s Coal - domestic	Fuel Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
CO ₂ EF	t/TJ	Table 3.2.1	101.2	74.0	77.4	63.0	Table 3.2.5	108.5
CO ₂ EF*OF	t/TJ	Table 3.2.2	99.2	73.3	76.6	62.4	Table 3.2.5	107.4
CH ₄ EF	t/TJ	0.010	0.010	0.01	0.01	0.005	0.005	0.30
N ₂ O EF	t/TJ	0.0014	0.0014	0.0006	0.0006	0.0001	0.0001	0.0040

Table 3.2.50: EFs for the fuel used in Households.

Year	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
CO ₂ EF	t/TJ	Table 3.2.1	101.2	74.0	63.0	Table 3.2.5	108.5
EF*OF	t/TJ	Table 3.2.2	99.2	73.3	62.4	Table 3.2.5	107.4
CH ₄ EF	t/TJ	0.3	0.3	0.01	0.005	0.005	0.30
N ₂ O EF	t/TJ	0.0014	0.0014	0.0006	0.0001	0.0001	0.0040

Recalculations

Following the recommendation by 2012 EU review, emissions from sub bituminous coal have been included in the residential sector for the period 2006-2008. Due to the fact that no data on consumption of coal are available, emissions have been interpolated.

Future Improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

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

	Fuel type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	liquid	Level	CO ₂	1.65		15	
2012	liquid	Level, Trend	CO ₂	0.75	1.55	23	13

This chapter should present all consumption of fuel in agriculture, forestry, and fishing. However, only the consumption of fuel for mobile sources in these sectors is presented here. Not enough data are available for the consumption of fuel in stationary sources in Slovenia; consequently, these quantities are included in the Commercial / Institutional sector.

Methodology

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

$$Emission_{(p,y)} = EF_{(p)} * Cons_{Fuel(y)}$$

Where

Emission_(p,y) - Emission of pollutant p in year y (ton/yr);

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

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

Activity data

The consumption of fuels until year 2000 has been calculated from data on fuel consumption in state owned agriculture enterprises and corresponding agriculture land. The same energy intensity have been used to calculate fuel used on total agricultural land. For estimation of

fuel consumption in Agriculture from year 2000 onwards, we used the same energy intensity (fuel consumption/ha of land) as observed in 2000. Results of calculation are presented in the Table 3.2.51 for gasoline and Table 3.2.52 for diesel.

Table 3.2.51: Estimate of Consumption of Gasoline in Agriculture.

	1986	1990	1995	2000	2005	2010	2011	2012
Cultivated Land in State owned Agriculture ent. (1000 ha)	70	77	62	31	-	-	-	-
Total Cultivated Land (1000 ha)	647	653	634	509	485	483	458	480
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	3.440	3.264	3.417

Table 3.2.52: Estimate of Consumption of Diesel in Agriculture.

	1986	1990	1995	2000	2005	2010	2011	2012
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	59.379	56.355	58.992

The consumption of fuels in the entire forestry is estimated on the basis of consumption of fuel in state-owned logging enterprises. Data used are presented in the Table 3.2.53.

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

Table 3.2.53: The Calculation of the Consumption of Fuels in State Owned Forest

	1986	1990	1995	2000	2005	2010	2011	2012
Consumption of Fuel in State owned Forest (1000 t)	6.902	5.922	3.680	2.808				
Cut in State owned Forest (1000 m ³)	1438	1230	862	907	919	1138	1297	1447
Consumption of Fuel per Cut Quantities (tons per 1000 m ³)	4.8	4.8	4.3	3.1				
Consumption of gasoline per Cut Quantities (tons per 1000 m ³)					0.28	0.18	0.16	0.18
Consumption of diesel per Cut Quantities (tons per 1000 m ³)					2.95	1.03	1.03	0.99
Total Cut (1000 m ³)	3501	2435	2092	2609	3236	3374	3897	3911
Total Consumption of Fuel in Forestry (1000 t)	16.804	11.720	8.931	8.077				
Gasoline (1000 tonnes)	1.680	1,172	0.893	0.808	0.917	0.616	0.637	0.699
Diesel (1000 tonnes)	15.124	10,548	8.038	7.272	9.536	3.486	4.037	3.874

Source of activity data

Data needed for estimation of consumption of fuels in Agriculture and Forestry is available for years from 1986 to 2012 (SORS: Statistical Yearbook RS, 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). EFs are presented in the Table 3.2.54.

Table 3.2.54: EFs of the Consumption of Fuels in Agriculture and Forestry.

	Unit	gasoline	Gas/Diesel Oil
CO ₂ EF	t/TJ	71.7	74.0
CO ₂ EF *OF	t/TJ	71.0	73.3
CH ₄ EF	t/TJ	0.08	0.004
N ₂ O EF	t/TJ	0.002	0.03

Recalculations

No recalculations have occurred in this sector.

Future Improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary. We will also try to obtain more up- to-date value on fuel consumption per hectare of agricultural land.

3.2.9 Other (IPCC: 1 A 5)

3.2.9.1 Other Mobile (IPCC: 2 A 5 b)

Key category - Base year: no

Key category - Year 2012: no

Emissions from jet kerosene in Slovenian Army and Police have been included in this category. Fuel used (TJ) and GHG emissions are presented in the Table 3.2.55.

Table 3.2.55: GHG Emissions in the period 1986-2012.

	1986	1990	1995	2000	2005	2010	2011	2012
fuel in TJ	577	444	19	43	46	40	47	47
Gg CO₂ eq.	41	32	1	3	3	3	3	3

Methodology

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

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

Activity data

Since 2008, the consumption of jet kerosene in Slovenian army and police has been obtained. These data are not available for the period 1986-2007. Following the recommendation from AAR 2011, the fuel used in Slovenian army and Police has been estimated using correlation with the number of aircrafts in the Slovenian army. To estimate emissions in the period 1986-1990/91, when Slovenia was still part of Yugoslavia, the fuel used for the international aviation has been estimated taking into account the correlation with the number of passenger s 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 CO₂/TJ, 0.001 t CH₄/TJ and 0.002 t N₂O/TJ for jet kerosene as well.

Recalculations

No recalculation has been performed for this category.

Future Improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

3.2.10 Uncertainty and Time Series Consistency

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

Table 3.2.56: Uncertainties of activity data as used in the 2014 submission.

		IPCC GPG	1986	2012
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 good data collection systems may keep the random error to about 2-3%. Experts believe that for most developed countries 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 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 an accredited laboratory in accordance with the EN ISO 17025 ("General requirements for the competence of testing and calibration laboratories"). Public power plants have presented their plan of measures to ensure that fuel consumption will be measured without intermediate storage before combustion in the installation applying measuring devices resulting in a maximum permissible uncertainty of less than +/- 2.5% for the measuring process.

3.2.11 Source Specific QA/QC and Verification

QA/QC

The source category QA/QC is covered by the 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 is compared with the sum of fuel used from verified ETS reports. The NCV values are also checked. If these numbers are not the same as the ones in ETS, data for GHG inventory are taken into account 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 substituted with data from verified reports from installations included in ETS, if necessary. ETS data are also used for different types of waste used as 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 with energy balance data, reported in the Joint Questioner. As data in JQ are rounded to 1000 units, the difference should be 500 units or less. If it is higher, the reasons for this should be found.

During the 2011 review, the data from CRF tables were compared with the data from Statistical Yearbook in kilotons of oil equivalent and some differences were found. We are aware of these differences, they occur because data presented in the Statistical Yearbook are not appropriate for use in GHG inventory. The reason is that fuel consumption is rounded to kilotons of oil equivalent which 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).

Verification

In the last review report the ERT strongly reiterates the recommendation that Slovenia develop CS CO₂ EFs for all fuels that have a significant share of fuel mix for each key category. The most important liquid fuels used in Slovenia are diesel and gasoline (in Transport sector) and Gas oil and LPG (in Other sectors). In road transport which is the biggest user of diesel and gasoline we are not using IPCC default emission factors but EFs which are build in the Copert model. The verification of these factors has been done and results are described further below.

To develop country specific emission factor we need to obtain an average elementary composition of each kind of liquid fuel and on net calorific value. We did carry out a research of elementary composition of liquid fuels that are used in Slovenia and we found out that no one of the distributors of LF provide exact elementary composition of LF. For this reason we have decided to make a comparison of our EFs used with other sources. For gas oil and LPG we have made the research and some examples are presented in the table 3.2.57.

Table 3.2.57: CO₂ EFs in t/TJ for LPG and gas oil from different sources.

	IPCC 1996	IPCC 2006	Range from IPCC 2006	Germany	Austria	Italy
LPG	63	63.1	61.6 – 65.6	65	64	63 - 65.6
Gas oil	74	74.1	72.6 – 74.8	74	75	73.9 - 74.4

In Croatia and Hungary, like in Slovenia, the IPCC default EFs from IPCC 1996 Guidance are used. The CO₂ EFs we are using for gas oil is quite similar as in some other European

countries but a little smaller for LPG. For both fuels these values are almost the same as the default values from IPCC 2006 Guidelines, what we believe is the most recent scientific literature. For this reason we have assumed that our emissions are not underestimated.

For road transportation thorough examination of all input data, the model calculation and the data reported in CRF tables as part of AC/QC procedure were 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 CO₂ 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. CO₂ 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 CO₂ emission factors, expressed in t CO₂/ TJ fuel, are calculated automatically by CRF Reporter and used for reporting requirements only.

Thorough examination showed that all input data and calculated CO₂ emissions reported in CRF Tables were accurate. CO₂ emission factors (g CO₂/ kg fuel) used for emission calculation are comparable with the Revised 1996 IPCC Guidelines. Differences between CO₂ emissions factors (t CO₂/ TJ) presented in CRF Tables and those stated in the Revised 1996 IPCC Guidelines arise from differences in applied net calorific values. In the period 2006-2012, additional slight deviations occurred due to the use of biofuel.

Decreasing trend of CO₂ implied EF for gasoline from 1986 to 2012 is attributed to the introduction of unleaded gasoline in the country, which has a lower carbon content than leaded gasoline. Leaded and unleaded gasoline has different H:C and O:C ratios. The value for H:C ratio in unleaded gasoline compared to the leaded one is 1.89 vs. 1.92. The value for O:C ratio in unleaded gasoline compared to the leaded one is 0.016 vs. 0.

We also conducted verification exercise for CO₂ emissions. We estimated CO₂ emissions of road transport category by applying a Tier 1 with a default EF from 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Comparison showed differences in emission calculation between COPERT 4 and Tier 1 method. COPERT 4 gives slightly lower emissions from diesel, but rather higher emissions from gasoline. In general, emissions calculated with COPERT 4 are not underestimated.

Information on CO₂ implied emission factors (IEFs) for gasoline and diesel is presented in Annex 2 (Table 1.8: Road transport: CO₂ implied emission factors 1986–2012).

CH₄ and N₂O emissions were thoroughly examined as well, including emissions arising from biofuels. New version of COPERT 4 (version 9.0) delivers some improvements in emission calculations and also corrects some bugs in software performance. CH₄ and N₂O emissions reported in CRF Tables are accurate. CH₄ and N₂O emissions from biofuels have been calculated using the COPERT 4 model as well, based on the total amount of fossil fuels and biofuels used. Owing to the reporting requirements regarding the disaggregation of fossil fuels and biofuels in the CRF tables, the emissions of CH₄ and N₂O from biodiesel and bioethanol have been reported under 1A3B Biomass.

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

GHG emissions in CO₂ equivalent for each category are presented in the table 3.3.1 and on the Figure 3.3.1.

Table 3.3.1: Fugitive emissions of GHGs.

in Gg CO ₂ eq..	1986	1990	1995	2000	2005	2010	2011	2012
Total	536	459	413	374	370	359	364	348
Coal Mining and Hand.	479	401	358	331	337	330	335	319
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	29	29	29

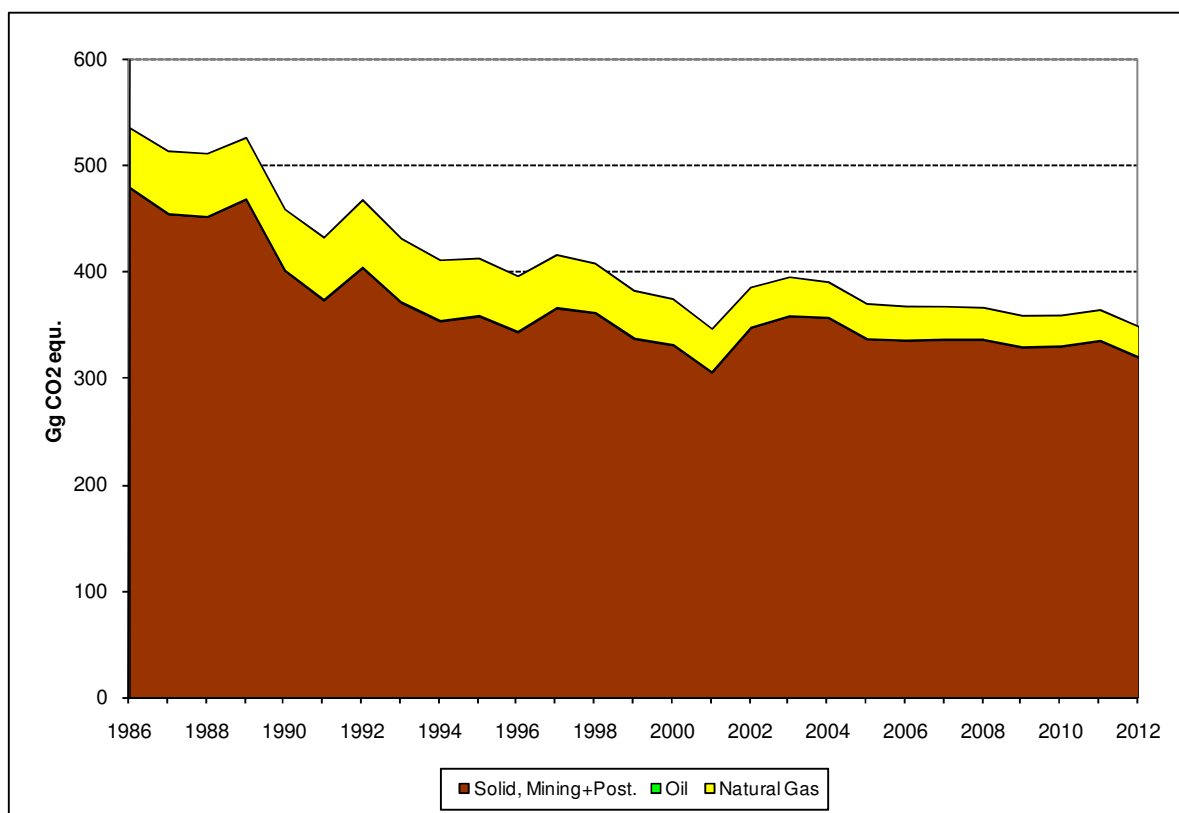


Figure 3.3.1: Fugitive emissions in Gg CO₂ eq..

3.3.1 Solid Fuels (IPCC: I B I)

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

	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Level	CO ₂	0.46		41	
	Level	CH ₄	1.38		17	
2012	Trend	CO ₂	0.28	0.31	37	43
	Level, Trend	CH ₄	0.86	0.90	21	25

This chapter encompasses emissions arising from production, processing, and storage of coal. The most important component of those emissions are CH₄ emissions that arise in mining and post-mining activities although CO₂ emissions occur as well.

Methodology

*Methane emission (t) = (EF1(m³ CH₄/t) + EF2(m³ CH₄/t)) * excavated coal (t/year) * 0.67*

*CO₂ emission (t) = EF3(m³ CO₂/t) * excavated coal (t/year) * 1.8*

EF1 = Methane emission factor in coal excavation (m³ CH₄/t)

EF2 = Methane emission factors in post-mining activities for coal (m³ CH₄/t)

EF3 = CO₂ emission factor in coal excavation (m³ CO₂/t)

Activity data

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

Table 3.3.2: Excavation of Coal in Slovenia 1986 – 2012

Pit	1986	1990	1995	2000	2005	2010	2011	2012	Closed in
Velenje	5,001	4,210	3,917	3,743	3945	4,011	4,066	3,967	
Trbovlje - Hrastnik	1,242	905	812	737	594	419	435	311	
Zagorje	315	244	75						1997
Senovo	120	108	45						1996
Kanižarica	126	94	35						1996
Laško	25								1990
Total Coal Excavation (Gg)	6,828	5,561	4,883	4,480	4,540	4,430	4,501	4,278	

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, no special research project has been done, thus, since 1997, the emission factor recommended in the study period has been assumed.

Details from the study:

Data on amount of exhaust air used for ventilation of mines and methane content in the outlet air was obtained from technical services in each mine. For coal mines having more ventilation stations, data from each ventilation station was considered. Chemical analysis of all samples was done in Chemical-technological laboratory in coal mine Trbovlje-Hrastnik. Air sampling at the exit valves was held once a month in the middle of the month and in the middle of the working week, when CH₄ concentrations are generally the highest. Air flow was measured with congestive pressure (Pittot Prandt tube). Proportions of CH₄ were determined on the basis of IR detection. Range of uncertainties of EFs for mining was from 8 to 100%, it depended on amount of methane in the air.

From the measurement of methane de-sorption in samples it was found that, after long enough period, all methane is released. It was assumed that the total EF for the type of coal or for the coal from the particular mine was constant. The total EF was determined as EF from mining plus EF from post-mining activities. For Velenje and Trbovlje coal mine the total EF was determined to be 4 m³/t coal.

In 1994, the new method of excavation has been introduced in the Velenje Coal mine which affected EFs from mining activities. Due to the new technology of mining, the coal is broken into smaller pieces which causes more methane to be released from the coal during mining and, consequently, less methane is available for emissions during post-mining activities. This excavation methodology in the Velenje coal mine has been applied until now, while no major changes of mining practice have occurred in the Trbovlje-Hrastnik coal mine in the reporting period.

Table 3.3.3: Emission Factors for CH₄ in Coal Excavation 1986 – 2012 (m³ CH₄/t coal)

Pit	1986	1990	1995	1997-2012
Velenje	0.95	0.33	3,56	3.00
Trbovlje - Hrastnik	0.62	0.88	0,46	1.00
Zagorje	1.39	3.59	11.30	Closed since 1997
Senovo	0.57	0.63	1.53	Closed since 1996
Kanižarica	0.33	0.45	1.21	Closed since 1996
Laško	3.82	Closed since 1990		

Table 3.3.4: Emission Factors for CH₄ in Post Mining Activities 1986 – 2012 (m³ CH₄/t coal)

Pit	1986	1990	1995	1997-2012
Velenje	3.05	3.67	0.44	1.00
Trbovlje - Hrastnik	2.38	2.12	2.54	3.00
Zagorje	1.61	2.00	2.00	Closed since 1996
Senovo	2.43	2.37	1.47	Closed since 1996
Kanižarica	2.67	2.52	1.79	Closed since 1996
Laško	0.18	Closed since 1990		

In the same study, the CO₂ EFs for post-mining activities have been determined using the same sampling method. Due to a large variation between years, the average value for 1986-1996 has been used for all reporting years.

Table 3.3.5: Emission Factors for CO₂ in Coal Excavation 1986 – 2012 (m³ CO₂/t coal)

Pit	1986-2012
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 CH₄ from Mining & Post Mining Activities 1986 – 2012 (Gg CH₄)

	1986	1990	1995	2000	2005	2010	2011	2012
Mining Activities	4.13	2.12	10.24	8.02	8.33	8.34	8.46	8.18
Post-Mining Activities	12.96	12.30	2.72	3.99	3.84	3.53	3.60	3.28
Total	17.09	14.42	12.96	12.01	12.17	11.87	12.06	11.47

Table 3.3.7: Emission of CO₂ from Mining Activities 1986 – 2012 (Gg CO₂)

	1986	1990	1995	2000	2005	2010	2011	2012
Mining Activities	120.2	98.4	86.20	79.0	81.3	80.6	81.8	78.6

Recalculations

No recalculations have been performed for this category.

Future Improvements

For the next submission, emissions from the abandoned and closed coal mines will be included in the inventory. We will thoroughly examine also other changes of methodology as described in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

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

3.3.2.1 Oil (IPCC: I B 2)

Key category - Base year: no

Key category - Year 2012: NO (not occurring)

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 have not occurred since 2003.

Methodology

GHG emissions in this category are the sum of CH₄ emissions from production, processing and storage of crude oil:

- CH₄ emission1: Emissions from the production of crude oil,
- CH₄ emission2: Emissions from the processing of crude oil, and
- CH₄ emission3: Emissions from the storage of crude oil

$CH_4 \text{ emission1} := \text{production of crude oil (ton)} \times \text{calorific value} \times \text{emission factor (kgCH}_4\text{/TJ)}$

$CH_4 \text{ emission2} := \text{quantities processed (ton)} \times \text{calorific value} \times \text{emission factor (kgCH}_4\text{/TJ)}$

$CH_4 \text{ emission3} := \text{quantities processed (ton)} \times \text{calorific value} \times \text{emission factor (kgCH}_4\text{/TJ)}$

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 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 CH₄/PJ. and for processing from 90 to 1400 kg CH₄/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
Total (Gg)	0.0201	0.0204	0.0197	0.0056	0.0001	0.0001	0.0000

3.3.2.2 Natural Gas (IPCC: I B 2)

Key category - Base year: no

Key category - Year 2012: no

CH₄ emissions

CH₄ emissions = Production + Transport + Distribution + Leakages at consumers

Table 3.3.9: Fugitive emissions from Natural gas in Gg CH₄

	1986	1990	1995	2000	2005	2010	2011	2012
production	0.010	0.031	0.024	0.010	0.006	0.009	0.003	0.003
transport	0.854	0.886	0.823	0.489	0.273	0.204	0.209	0.215
distribution	1.024	0.911	0.825	0.556	0.494	0.372	0.357	0.365
gas use	0.181	0.205	0.289	0.349	0.339	0.413	0.430	0.435
total	2.069	2.033	1.961	1.403	1.112	0.998	0.999	1.030

Production

Amount of NG produced and corresponding emissions are presented in the Table 3.3.10.

Table 3.3.10: Fugitive emissions from production of Natural gas in 1000 Sm³ of CH₄.

	unit	1986	1990	1995	2000	2005	2010	2011	2012
production	1000 m ³	7371	23631	18217	7419	4225	6673	2323	2000
emissions	1000 m ³	15	47	36	15	8	13	5	4

Activity data

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

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

Emission factors

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

Transport, distribution and use of natural gas

Gasification of Slovenia began 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 were 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. Today, the total length of the gas pipeline network in Slovenia, which is constantly growing, exceeds 1000 km.

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 concluding construction works, so that only the characteristic markings and meter-regulating stations show that there are kilometres and kilometres of pipes under the surface.

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, 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. On 1 November 2011, the company name was changed to Plinovodi d.o.o., in order to comply with European Directive and to prepare for the certification process for an independent transmission system operator. In 2012, the national regulatory authority issued the decision on the certification that Plinovodi d.o.o. as a transmission system operator complies with the requirements for the independent transmission system operator and the Government of Republic of Slovenia designated the company Plinovodi d.o.o. as a transmission system operator.

Legislation

Before 1974, companies used different standards. The material for pipelines was made according to the JUS (Yugoslav standard), which was transferred from DIN (West Germany standard) to a high degree. In some domains also East German standard TGL (Technische Güte- und Lieferbedingungen) was 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 were made according to these standards, particularly DVGW standard (Deutsche Vereinigung des Gas- und Wasserfaches e.V.). Until 2002, when new regulation was passed, DVGW had been the main directive for planning, construction, operation and maintenance of pipeline system. Today standard SIST EN 12007, completely in line with CEN (standard of European Committee for Standardization), is used in Slovenia.

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 by J. Reichert and M. Schoen: Methanemissionen 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 past. Although Slovenia had never used east European standards and had been rather west-oriented in this and in many other fields, 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 consciousness of people involved in the building and maintenance of pipelines is on a higher level in independent Slovenia as it was in the past. For this, rather human than legislative 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 EFs are suggested as for former USSR, which had very different legislation and also different geographic and economic conditions than Yugoslavia and particularly than Slovenia.

Justification of trends for EF

In the submissions 2004 and 2005, EFs 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 carried out by IE (Energy institute from Ljubljana). In the in-country review report 2004 and in the centralised review report 2005, it is stated that emission factor is too low for an east European country. To make emissions more believable, the E Germany EFs were used in the later submissions, what was accepted by ERT during in-country review of the initial report in April 2007.

However, EFs used for 1986 emissions are not appropriate for present situation. While decrease of EFs in transport pipelines is a consequence of more rigorous control and higher level of maintenance, the situation concerning distribution pipelines is different. From the picture below, presenting length of distribution and service pipelines, it is evident that Slovenian natural gas distribution network has been expanded after 1995. More than a half of old steel distribution pipelines were replaced and the cast iron pipelines were replaced even before 1990. All new pipelines are built according to EU legislation and standards. As the implementation of the EU regulations and adaptation to the new legislation is a long-term and continuous process, no particular turning point can be set..

Transport

For estimation of fugitive emissions from transport of natural gas we have taken the following leakages into account:

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

Emissions of CH₄ in 1000 Sm³ are presented in the table 3.3.11.

Table 3.3.11: Fugitive emissions from transport of Natural gas in 1000 Sm³ of CH₄.

	1986	1990	1995	2000	2005	2010	2011	2012
pipelines	950	1007	864	515	309	227	235	244
pneumatic stations	124	124	165	120	66	66	66	66
M&R stations	198	187	132	0	0	0	0	0
Routine mending	8	10	11	7	2	2	2	2
AC building / damage	2	3	62	90	32	10	10	10
compressor station	NO	NO	NO	NO	0.14	0.14	0.14	0.14
TOTAL	1282	1330	1233	732	409	305	313	322

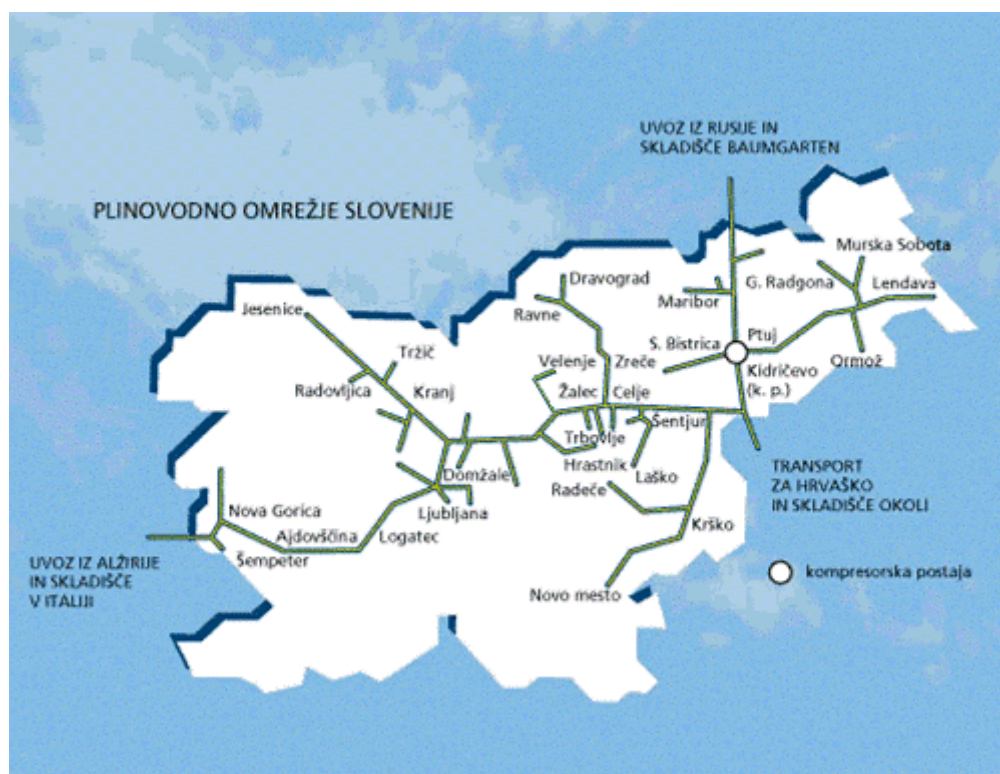
Activity data

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 CO₂ Emission Factor in Energy Use and CH₄ Emission Factor in Transport and Distribution of Natural Gas, Ljubljana: Institute of Energy Industries, 1998). For the period 1997 - 2007, data have been obtained directly from company Geoplin Plinovodi, and since 2008 from Energy Agency.

Table 3.3.12: Length of transport pipelines in km.

	1986	1990	1995	2000	2005	2010	2011	2012
pipelines	740	784	927	948	960	1018	1054	1093

In line with the Act Amending the Energy Act, the company Geoplin plinovodi, d.o.o. has been carrying out tasks of the transmission system operator since 1 January 2005. On 25 October 2011, the company changed its name to Plinovodi d.o.o. The company is a subsidiary company of Geoplin d.o.o. and is 100-percent owned by the parent company.

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

In 2012, Plinovodi d.o.o. operates and owns 1094 kilometres of Slovenian gas transmission network which is a part of the European gas network. from the network is composed of longitudinally welded steel pipes, which are protected with anticorrosive isolative material and dug in ground approximately 1.5 m deep. The central part of the Slovenian gas network includes the main pipeline (M1) from Ceršak to Rogatec, (M2) from Rogatec, via Podlog, to Vodice, and (M4) from Roden to Novo mesto, with a nominal pressure of 50 bar, and the main pipeline (M3) from Šempeter pri Novi Gorici to Vodice, with a nominal pressure of 67 bar. The above-mentioned connections of the transmission network ensure a reliable supply of natural gas to Slovenia.

As demand for natural gas is increasing, the compressor station in Kidričevo began to work in 2002. Its maximum amount of compressed natural gas is 260.000 Sm³/h with 50 bars. In station there are two centrifugal compressors, both with 3.2 MW, but only one is operating at the time, while the second one is only for backup.

Emission factors

Emission factors for the emission of methane from pipelines have been taken from German article. For emissions from pipeline in the period 1986 to 1992, EF 1284 m³/km for East Germany has been used. From 1993, the 10% reduction of emissions annually has been taken in account. Since 2009, the EF 223 m³/km for West Germany has been used.

Table 3.3.13: EFs for fugitive emissions from transport pipelines.

	1986	1990	1995	2000	2005	since 2009
EF in 1000 Sm ³ /km	1,284	1,284	932	544	322	223

All data on other losses from transport of natural gas have been obtained from company Plinovodi. Losses from metering and regulation station have been zero since 2000, because no mechanical metering stations exist 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 have taken the following leakages into account:

- 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 Sm³ of CH₄.

	1986	1990	1995	2000	2005	2010	2011	2012
distribution pipelines	599.0	369.1	3212	184.0	157.9	122.5	117.3	117.0
M&R stations	7.5	9.7	12.7	24.6	31.3	37.4	38.6	39.8
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	929.6	987.8	901.6	621.5	509.2	619.1	643.9	669.6
total	1536.6	1367.1	1236.8	832.9	739.8	558.2	535.3	547.8

Activity data

Activity data for the period 1986 to 2005 for distribution of natural gas have been taken from the research project, prepared by the Economic Interest Association of Natural Gas Distributors.

For the previous submissions, data for the years after 2005 have been extrapolated using the same increasing trend. For the present submission, data on distribution network for the period 2008 to 2012 have been obtained from the Energy Agency of the republic of Slovenia. Data for 2006 and 2007 have been interpolated.

Data include the following:

- type and length of distribution pipelines, (table 3.3.15)
- number of M&R stations, (table 3.3.16)
- number and type of inspected gas meters (table 3.3.17)
- typical volume of gas meters
- leakages during construction and maintenance work
- type and length of service pipelines (table 3.3.18)

Table 3.3.15: Length of distribution pipelines in km.

pressure	material	1986	1990	1995	2000	2005	2010	2011	2012
high	PE and PVC	39	80	216	693	992	1,347	1,424	1,434
high	Steel (old)	166	199	200	40	0	0	0	0
high	Steel (new)	0	0	0	30	66	83	86	87
/	cast iron	36	0	0	0	0	0	0	0
middle	PE and PVC	16	32	86	277	703	615	624	656
low	PE and PVC	23	48	130	416	627	952	954	927
Total	(km)	281	360	632	1,455	2,389	2,998	3,087	3,104

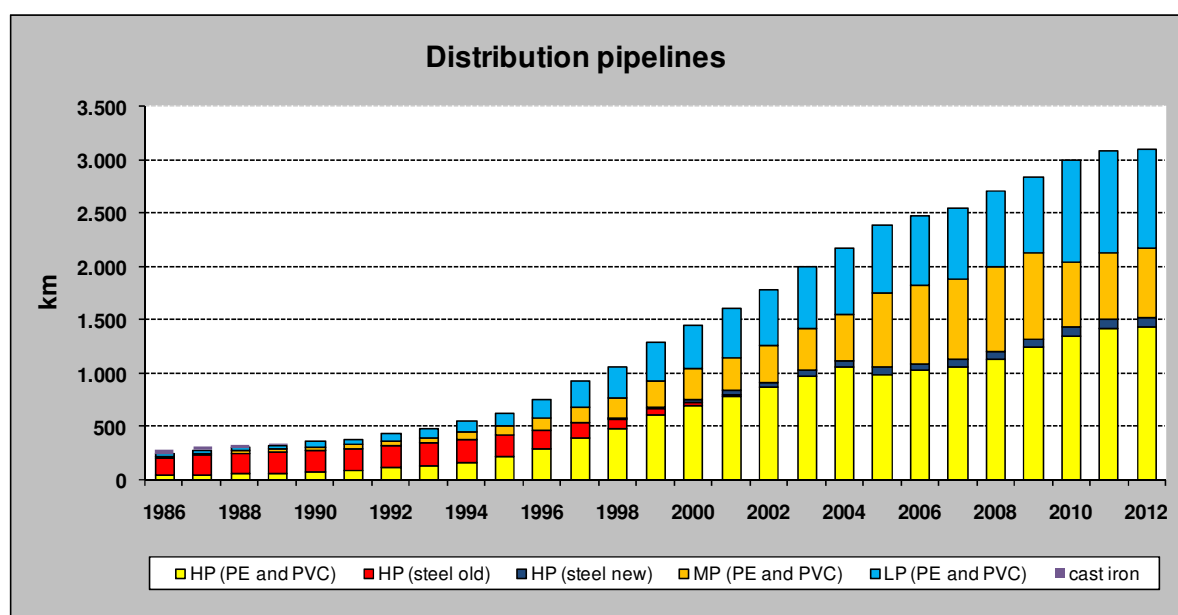


Figure 3.3.3: Length of distribution pipelines by material and pressure.

The length of pipelines is available for distribution and for service network. For the purpose of inventory the disaggregation of pipelines according to the pressure, which is the same as in the German article, has been done:

- High pressure (HP): 4 bars and more
- Middle pressure (MP): from 0.25 to 4 bars
- Low pressure (LP): less than 0.25 bar

The new data on distribution network are presented in the table 3.3.15 and on the figure 3.3.3.

Table 3.3.16: Number of meter-regulation stations

	1986	1990	1995	2000	2005	2010	2011	2012
M&R stations	37	48	63	122	155	185	191	197

Table 3.3.17: Number of inspected gas meters

gas meter	1986	1990	1995	2000	2005	2010	2011	2012
G4	9062	8414	12228	19992	17261	17261	17261	17261
G6 DO G10	56	71	80	101	89	89	89	89
over G10	110	135	231	381	349	349	349	349
total	9228	8620	12539	20474	17699	17699	17699	17699

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

From data obtained from Energy Agency is evident, that the length of service pipelines determined by the research project has been overestimated. Only data on the length of service pipelines in Ljubljana and vicinity was available for this research for the year 2005; the ratio between the length of service and distribution network was 0.6. The same ratio had been used to determine the length of service pipelines for Slovenia.

Data from Energy Agency are now available for the whole country and the new ratio is much lower (0.42). For the present submission, whole length of service pipelines before 2008 has been recalculated using this new ratio, while the actual data have been used since 2008. All service pipelines are working under low pressure.

The new data on service pipelines are presented on the figure 3.3.4 and in the table 3.3.18.

Table 3.3.18: Length of service pipelines in km.

	1986	1990	1995	2000	2005	2010	2011	2012
PE and PVC	33	69	185	607	1024	1249	1286	1326
steel (old)	71	85	86	17	0	0	0	0
cast iron	16	0	0	0	0	0	0	0
total	120	154	271	624	1024	1249	1286	1326

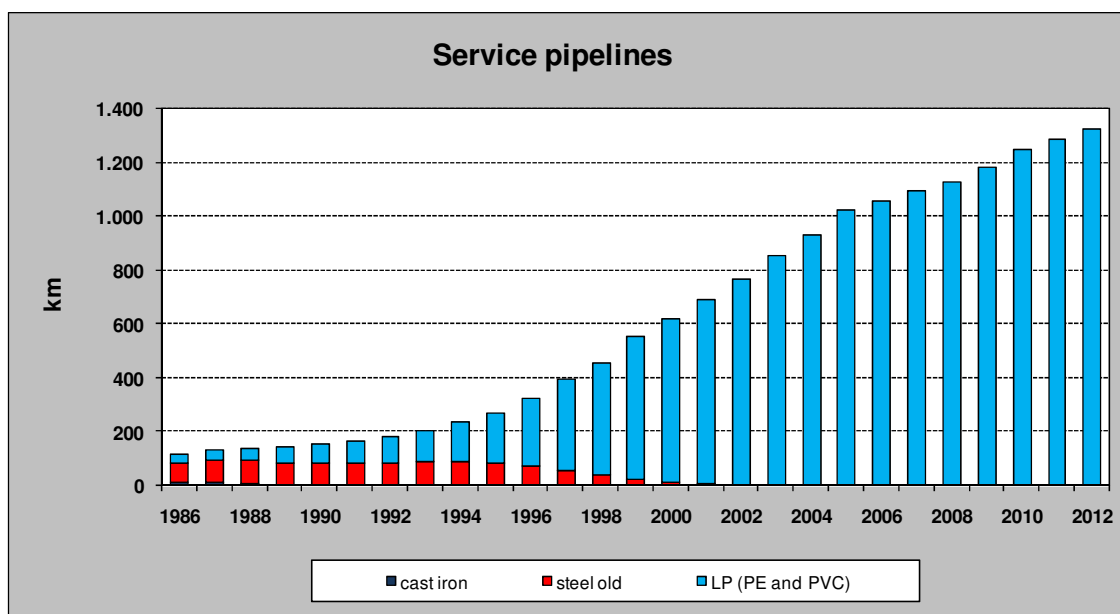


Figure 3.3.4: Length of service pipelines by material.

Emission factors

Emission factors for the emission of methane from the distribution and service pipelines have been taken from German article. For emissions from pipeline for the period 1986 to 1992, EF for East Germany has been used. The 10% reduction of emissions annually has been taken into account from 1993 until 2011, when all EFs are the same as in the W Germany.

Table 3.3.19: EFs for fugitive emissions from distribution pipelines in 1000 Sm³/km.

pressure	material	1986	1990	1995	2000	2005	2010	2011	2012
high	PE and PVC	148	148	108	64	38	22	21	21
high	Steel (old)	1648	1648	1201	709				
high	Steel (new)				82	82	82	82	82
/	cast iron	8396							
middle	PE and PVC	247	247	180	106	63	37	34	34
low	PE and PVC	445	445	324	192	113	67	62	62

Table 3.3.20: EFs for fugitive emissions from service pipelines in 1000 Sm³/km..

	1986	1990	1995	2000	2005	2010	2011	2012
PE and PVC	2101	2101	1532	904	534	315	292	292
steel (old)	9890	9890	7210	4257				
cast iron	9890							

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

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.

Leakages from households

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

Table 3.3.21: Methane emissions from gas used in households in 1000 Sm³ CH₄.

	1986	1990	1995	2000	2005	2010	2011	2012
households	271	308	433	523	509	619	643	670

Activity data

Activity data for emissions from this source are represented by the number of households using natural gas. This data have been obtained from research project, carried out by the Economic Interest Association of Natural Gas Distributors.

We have assumed that in the beginning only one appliance was used in each household, while in 2006, there are approximately 1.8 appliances per household. This is very rough estimate, but having no better data we have taken this presumption into account.

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

	1986	1990	1995	2000	2005	2010	2011	2012
households	54,282	61,570	78,368	112,431	141,353	171,978	178,857	185,011
appliances	54,282	61,570	101,878	174,268	254,435	309,560	321,942	334,820

Emission factor

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

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

	1986	1990	1995	2000	2005-2012
Emission factor	5	5	4.25	3	2

Leakages from industry

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

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

Following the recommendation by ERT to estimate fugitive emissions from industry sector, Slovenia conducted a telephone survey in 10 plants which are the biggest consumers of

natural gas in Slovenia and combust 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 plants are regularly checked and all plants are also using 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 agreed that there was no possibility for any leakages of natural gas from the boilers during combustion process. Due to the common practice that installations are usually working 24 hours a day all year long, any leakages from this source are extremely unlikely and it's also unlikely that potential leakages would not be detected. Therefore we, just as many other EU member states, are now assuming that leakages in industry are not occurring (NO).

CO₂ emissions from transmission of natural gas

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

There is no methodology available for calculation CO₂ 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 for use in our inventory. Therefore we have estimated CO₂ emissions using the same methodology as for calculating fugitive emissions of CH₄ from natural gas and using country specific data for fraction of CO₂ in the natural gas.

For the period 1986-1997 this fraction is available for every year and for the period 1998-2012 the average fraction 0.077% v/v has been used. Density of CO₂ is 1.828 kg/m³.

Recalculations

The length of natural gas pipelines in Slovenian transport and distribution network for the period 1986-2005 were, estimated in the research in 2006. In the same research, the length of service pipelines was estimated on the basis of data from one distribution company to be almost 60% of the size of distribution network. For 2014 submission, the very detailed data on transport, distribution and service natural gas network have been obtained from Energy agency of the Republic of Slovenia. The data on length for each type of pipelines, disaggregated according to the material and pressure, is available for 2008-2012. On the basis of the same data, the ratio between length of distribution and service pipelines was estimated to be 42.8% and this ratio was used for estimation of length of service pipelines for the period 1986-2007. As data on pressure in pipeline systems is also available, more precise EFs have been used. Due to all reasons above, fugitive emissions of CO₂ and CH₄ have been recalculated for the period 1986-2011.

Future Improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

Source specific QA/QC and verification.

Following recommendation from the former reviews we have performed the verification of emissions from transport and distribution of natural gas. The results are presented in the Table 3.3.24 below. Here the low emission factors from the 2006 IPCC GL from Table 4.2.8 have been used to calculate emissions from the production and transmission and use of natural gas. In the last column, emissions from the Slovenian inventory are presented.

In our inventory, emissions from compressor station are included in Transmission.

Table 3.3.24: Methane emission factors for fugitive emissions from gas used (households).

	AD	unit	EF	unit	IPCC 2006 GL	NIR 2014
production	2000	1000 m ³	0.05	% of net prod.	1	4
transmission	1094	km	200	m ³ /km	219	322
Compressor stations	4.3	MW	6000	m ³ /MW	29	IE
MRS	197	stations	1000	m ³ /station	197	40
distribution	4430	km	100	m ³ /km	443	507
gas use	334819	appliances	2	m ³ /appliance	670	670
TOTAL					1548	1543

In the previous submission, our fugitive emissions from natural gas were low. Now, since more precise data on distribution network have been used, emissions have become even lower. But specific methane losses are not appreciably under the low benchmark (difference is less than 0.4 per cent), which indicates emissions are still reasonable.

It is important to know that Slovenian distribution network is very new. Almost 80 per cent has been built in the last 20 years and more than a half after the year 2000. All old steel and cast iron pipes were already replaced with the new PE or PVC pipes with very low leakages. In addition, low emissions also affect the strict EU legislation in this field which requires good maintenance and, last but not least, the high price of natural gas, which is almost entirely imported as Slovenian production is negligible.

4 INDUSTRIAL PROCESSES (CRF sector 2)

Industrial activities unrelated 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 CO₂, CH₄, N₂O, and PFCs. Some industrial sources also produce NO_x, NMVOCs, CO, and SO₂.

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

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

Emissions from industrial processes in Slovenia account for 5.4% of total national GHG emissions, excluding LULUCF. They amounted to 1317 Gg CO₂ equivalents in the base year and to 1014 Gg CO₂ equivalents in 2012. The main source of emissions is mineral industry with about 56% of emissions, followed by consumption of F-gases with 22% and metal production with 18% of emissions. Significantly lower are contributions from chemical industry (0.1%). The main source of emissions from this sector is cement industry, which is responsible for 32% of GHG emissions from industrial processes. Due to the world economic crises, total emissions of GHG from industrial processes considerably decreased in 2009 and remained at approximately the same level also in 2010. In the year 2012, an increase of total emissions was observed, mainly due to the increase of emissions from metal production. Process emissions of GHG (in Gg CO₂ eq.) for 1986-2012 are shown in Figure 4.0.1.

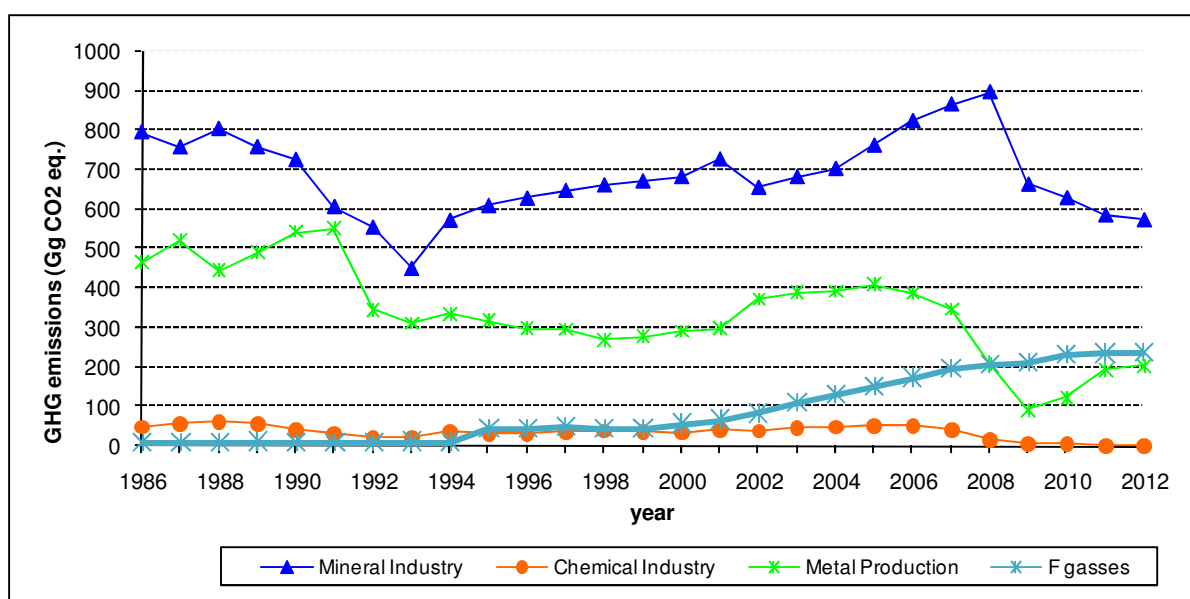


Figure 4.0.1: Process emissions of GHG from different types of industries.

MINERAL INDUSTRY

4.1 Cement Production

	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Level	CO ₂	1.99		11	
2012	Level, Trend	CO ₂	1.16	1.41	15	16

4.1.1 Source category

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

The basic raw material for the production of cement is marl, which is a homogeneous mixture of limestone and clay and which was formed 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 (CaCO₃), is prepared by mixing limestone and clay components: from such with 35% of CaCO₃ to limestone with more than 95% of CaCO₃. 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 SiO₂, Al₂O₃, and Fe₂O₃. 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 CaCO₃, the main constituent of limestone, to lime (CaO), while CO₂ 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 CO₂, most of the SO₂ 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 the same place and are inseparable in concept.

CO₂ from carbon in fuel has been estimated from fuel consumption for each fuel type. Emissions of this kind have already been included in 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 have been obtained from the SORS for the period 1986–1998, and directly from the two plants

producing cement for the years 1999–2012. Activity data on clinker produced in the period 2005–2012 have been obtained from two plants in the scope of Greenhouse Gas Emission Trading System (verified ETS reports).

For national allocation plan purposes linked to emissions trading system more detailed data have been 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 CO₂/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 obtained from two plants. For the period 2005–2012 we have obtained plants data on CaO and MgO composition of clinker and EFs from verified ETS reports. Country specific EFs from these reports have been used to calculate CO₂ emissions using IPCC methodology.

EFs from both before and after 2005 are 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 plants. The same sources of raw material and methodology were used for calculation of EFs both before and after 2005. 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 ₂ /t of clinker)		
	Plant 1	Plant 2	TOTAL
1986 -1998			0,5410
1999	0.5407	0.5438	0.5410
2000	0.5387	0.5438	0.5407
2001	0.5386	0.5438	0.5405
2002	0.5387	0.5438	0.5405
2003	0.5392	0.5438	0.5410
2004	0.5377	0.5410	0.5391
2005	0.5383	0.5422	0.5399
2006	0.5374	0.5386	0.5379
2007	0.5375	0.5451	0.5405
2008	0.5383	0.5449	0.5406
2009	0.5374	0.5487	0.5406
2010	0.5365	0.5487	0.5404
2011	0.5372	0.5313	0.5363
2012	0.5378	0.5470	0.5385

Cement kiln dust (CKD) is not included in emission calculation as in both cement plants 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 CO₂ 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 the 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. Emission review team (ERT) recommended showing that the estimated CO₂ process emissions from cement production are comparable and consistent with the emissions reported under the EU ETS. EU ETS reports cannot be publicly revealed due to sensitivity of information. All documentation is available for internal communication with ERT 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 the web site of Environment Agency of the Republic of Slovenia.

<http://www.arso.gov.si/podnebne%20spremembe/Register%20emisij%20kuponov/Javno%20dostopna%20poro%C4%8Dila/Poro%C4%8Dilo%20o%20izpolnitvi%20obveznosti%20za%20leto%202012.pdf>

Annual amount of clinker produced and CO₂ emissions arising from cement production are shown in Figures 4.1.1 and 4.1.2.

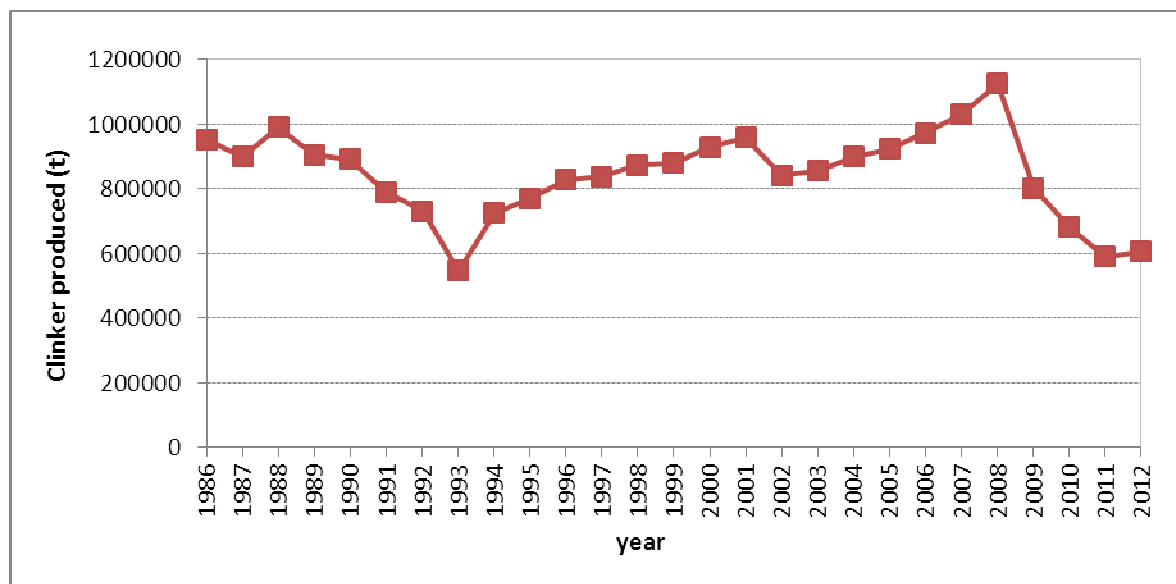


Figure 4.1.1: Clinker production in ton/year.

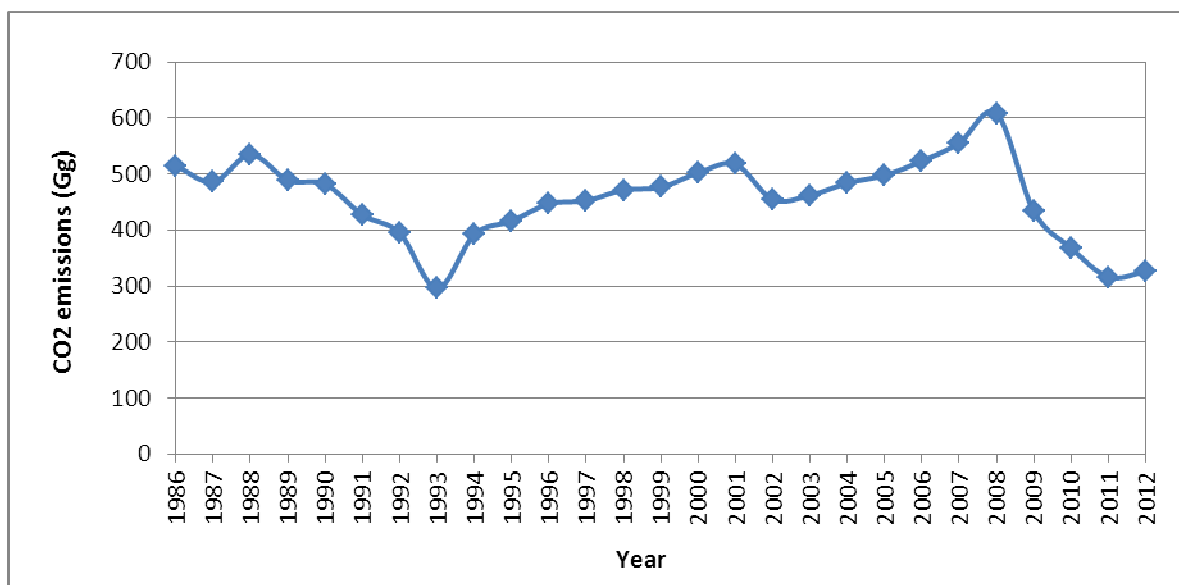


Figure 4.1.2: CO₂ emissions from cement production.

4.1.3 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgement.

Uncertainty of activity data amounts to 2%.

Uncertainty of emission factor amounts to 2%.

4.1.4 Source specific recalculations

No recalculations have been performed since last submission.

4.1.5 Source-specific planned improvements

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

4.1.6 Source-Specific QA/QC and verification

QC procedures for the two plant data collected under the Emissions Trading Scheme (ETS) have been performed. Amount of clinker produced, composition of clinker and calculated EFs for the whole period have been thoroughly examined. All data checked were correct. Activity data on clinker production obtained from verified ETS reports were cross checked through direct communication with plant representatives. We also compared data on cement production and clinker production. Clinker production does not entirely track cement production due to additional clinker imports. Cement has been produced not only from domestically produced clinker but also from imported clinker.

4.2 Lime Production

	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Level	CO ₂	0.85		32	
2012	Trend	CO ₂	0.26	1.00	38	22

4.2.1 Source category description

CO₂ 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 2012). In Slovenia, there are three lime producers.

Lime is generated by heating the input raw material (limestone and dolomite) to high temperature (900-1200°C). During this process, limestone is converted into CaO and emits CO₂.

4.2.2 Methodological issues

CARBON DIOXIDE EMISSIONS

CO₂ emission was calculated according to IPCC methodology. Similar to cement production, more detailed data were obtained directly from lime producers for the period 1999-2004. Data on fraction of CaO and MgO in lime for the period 1999-2004 enabled us to determine our own emission factor. We have estimated country specific EF to be 749 kg CO₂/ton of lime and applied this emission factor to calculate CO₂ emissions for the period 1986–1998. Emissions for the period 1999-2004 have been calculated using the year-specific EFs. The EFs for the period 2005-2012 are based on the data provided by three lime plants in the scope of Greenhouse Gas Emission Trading System (verified ETS reports). Implied emission factors (IEF) were derived from emissions and activity data on annual production of quicklime. Plants data on amount of CaO and MgO in lime produced or amount of carbonates from raw material were used for emission calculations. 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 the year 2005 and for EU ETS data (after 2005), are 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 of EFs before and after 2005. Before the year 2005, the producers 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 CaCO₃ 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 ₂ /t of lime)
1986-1998	0.749
1999	0.744
2000	0.749
2001	0.751
2002	0.749
2003	0.752
2004	0.750
2005	0.735
2006	0.726
2007	0.724
2008	0.723
2009	0.725
2010	0.721
2011	0.730
2012	0.744

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 CO₂ 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.

Table 4.2.2: Lime production emissions from producer 1.

Year	CaO (t)	MgO (t)	EF (tCO ₂ /t) CaO	EF (tCO ₂ /t) MgO	Emissions CO ₂ (t)
2005	87142	1597	0.785	1.092	70150
2006	105200	1885	0.785	1.092	84641
2007	94178	1291	0.785	1.092	75340
2008	90633	1393	0.785	1.092	72668
2009	65411	1257	0.785	1.092	52721
2010	87423	1463	0.785	1.092	70225
2011	80298	6471	0.785	1.092	70101
2012	55425	5456	0.785	1.092	49467

Table 4.2.3: Lime production emissions from producer 2.

Year	CaO (t)	MgO (t)	EF (tCO ₂ /t) CaO	EF (tCO ₂ /t) MgO	Emissions CO ₂ (t)
2005	13869	249	0.785	1.092	11159
2006	13788	228	0.785	1.092	11072
2007	17222	332	0.785	1.092	13882
2008	9256	215	0.785	1.092	7500
2009	8733	213	0.785	1.092	7089
2010	11504	333	0.785	1.092	9394
2011	12230	291	0.785	1.092	9918
2012	15737	343	0.785	1.092	12729

Table 4.2.4: Lime production emissions from producer 3.

Year	CaCO ₃ (t)	EF (tCO ₂ /t)	Emissions CO ₂ (t)
2005	90993	0.44	40037
2006	88068	0.44	38750
2007	77738	0.44	34205
2008	67816	0.44	29839
2009	25432	0.44	11190
2010	24156	0.44	10629
2011	24355	0.44	10716
2012	26831	0.44	11806

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.

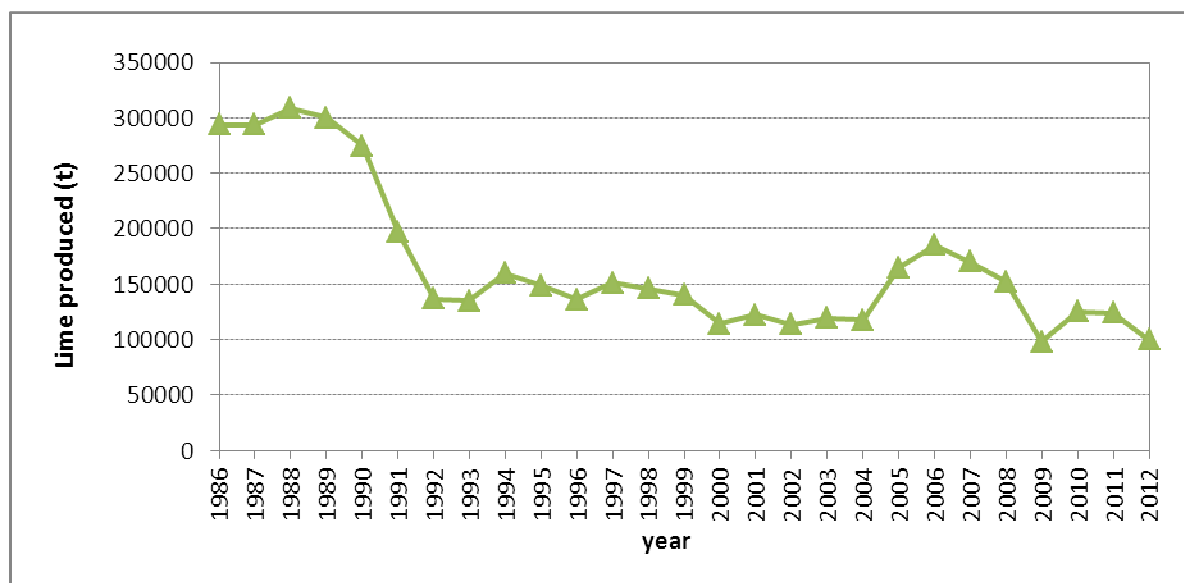
Annual emission factor is then calculated from total CO₂ emissions for all three plants, and total amount of lime produced in these three plants.

Table 4.2.5: Total CO₂ emissions of all three producers, total lime production and calculated IEF.

Year	2006	2007	2008	2009	2010	2011	2012
Lime Produced (t)	185240	170464	152227	97970	125117	124219	99528
Total emissions CO ₂ (t)	134462	123426	110007	71000	90248	90735	74001
IEF (kg CO ₂ /t)	726	724	723	725	721	730	744

The limestone used for lime production contains mostly CaCO₃. In the limestone there is also a small amount of dolomite, which, in addition to CaCO₃, consists also of MgCO₃. High-calcium lime is the main type of lime. Quicklime and hydrated lime are the main types of lime produced in Slovenia.

Annual amount of lime produced and CO₂ emissions arising from lime production are shown in Figures 4.2.1 and 4.2.2.

**Figure 4.2.1: Lime production in tons/year.**

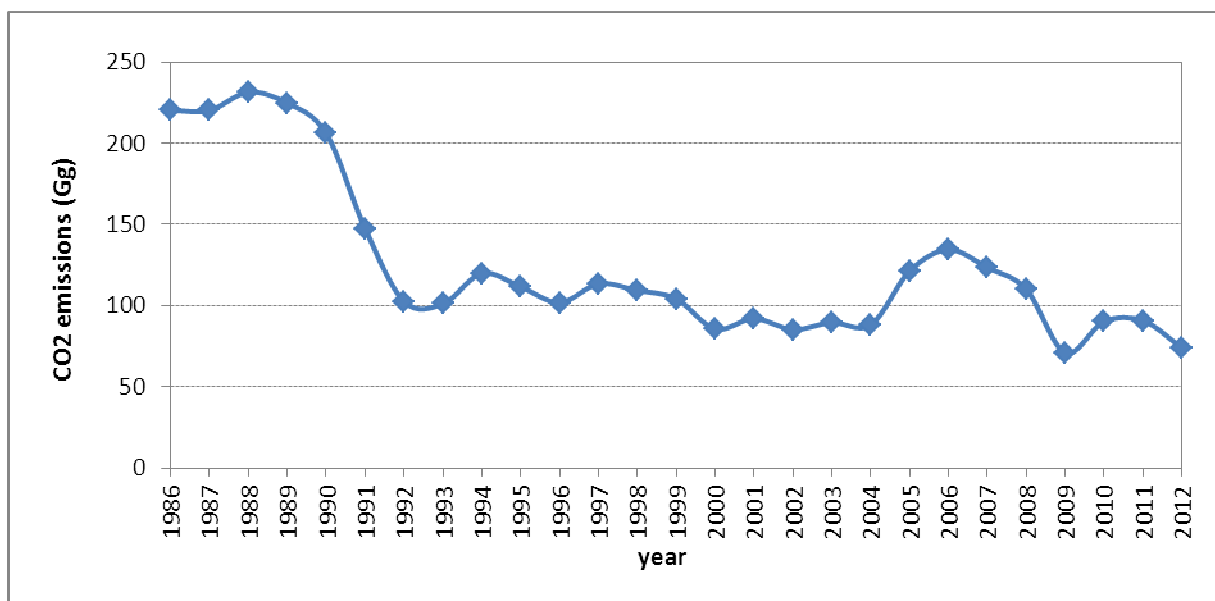


Figure 4.2.2: CO₂ emissions from lime production.

4.2.3 Uncertainties and time-series consistency

Uncertainty estimates are 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

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

4.3 Limestone and Dolomite Use

	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
2012	Level, Trend	CO ₂	0.57	0.66	29	32

4.3.1 Source category description

Limestone and dolomite are used in many industries. During heating to high temperature, carbonates convert to oxides, emitting CO₂. 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 the production of iron and steel, in technology for the reduction of SO₂ emissions in the process of consumption of coal, in

ceramics production, mineral wool production and production of TiO₂. Total CO₂ 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 CO₂ emissions. Primary production from ore existed only in 1986 and 1987, after 1990 steel production is based on utilization of scrap iron and steel. Activity data on CaCO₃ consumption were obtained directly from iron and steel producers. CO₂ emissions have been calculated according to IPCC methodology. Default emission factor, 440 kg CO₂/ton limestone, has been applied for the whole period.

SO₂ Scrubbing

Using technology for reduction of SO₂ emissions in the process of consumption of coal is causing emissions of CO₂. CO₂ emissions from scrubbing have been calculated from consumption of additive CaCO₃ and appropriate emission factor.

Activity data on CaCO₃ 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 SO₂ in Slovenia. Data on CaCO₃ and MgCO₃ for the period 2005–2012 have been obtained from verified ETS reports. Default emission factor, 440 kg CO₂/ton limestone and 522 kg CO₂/ton magnesium carbonate, have been applied for the whole period.

Ceramics production

Limestone and dolomite use in bricks and ceramics production was also taken into account. Activity data on CaCO₃ and MgCO₃ due to limestone and dolomite use in ceramics production for the period 2005–2012 have been obtained from verified ETS reports. Default emission factor, 440 kg CO₂/ton limestone and 522 kg CO₂/ton magnesium carbonate, have been 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 CO₂/ton dolomite has been applied for the whole period 1986-2012.

Manufacture of dyes and pigments

Limestone has been used in manufacturing of TiO₂ pigment for neutralization processes. Activity data on CaCO₃ use for the period 1986–2012 have been obtained from the producer. Default emission factor 440 kg CO₂/ton calcium carbonate has been applied for the whole period.

Table 4.3.1: CO₂ emissions from limestone and dolomite use.

	Units	1986	1990	2005	2010	2011	2012
CaCO ₃ consumption in iron and steel production	t	43297	1896	1928	2156	3267	3093
EF CaCO ₃	t CO ₂ /t	0.44	0.44	0.44	0.44	0.44	0.44
CO ₂ emission from iron and steel production	Gg	19.1	0.83	0.85	0.95	1.43	1.36
Consumption of additive CaCO ₃	t	0.0	0.0	187221	206975	232738	247773
EF CaCO ₃	t CO ₂ /t	0.44	0.44	0.44	0.44	0.44	0.44
Consumption of additive MgCO ₃	t	0.0	0.0	0.0	547	794	774
EF MgCO ₃	t CO ₂ /t	0.522	0.522	0.522	0.522	0.522	0.522
CO ₂ emissions from SO ₂ scrubbing	Gg	0.0	0.0	82.4	91.4	102.8	109.4
CaCO ₃ consumption in ceramics production	t	0.0	0.0	1998	1791	1744	910
EF CaCO ₃	t CO ₂ /t	0.44	0.44	0.44	0.44	0.44	0.44
MgCO ₃ consumption in ceramics production	t	0.0	0.0	1	18.4	35.2	46.4
EF MgCO ₃	t CO ₂ /t	0.522	0.522	0.522	0.522	0.522	0.522
CO ₂ emissions from ceramics production	Gg	0.0	0.0	0.88	0.80	0.79	0.42
CaCO ₃ consumption in production of dyes and pigments	t	39579	36089	78381	110479	110256	82420
EF CaCO ₃	t CO ₂ /t	0.44	0.44	0.44	0.44	0.44	0.44
CO ₂ emissions from production of dyes and pigments	Gg	17.4	15.9	34.5	48.6	48.5	36.3
Dolomite consumption in production of mineral wool	t	22901	20624	24844	22042	24624	26505
EF dolomite	t CO ₂ /t	0.477	0.477	0.477	0.477	0.477	0.477
CO ₂ emissions from production of mineral wool	Gg	10.9	9.83	11.9	10.5	11.7	12.6
Total CO₂ emissions	Gg	47.4	26.5	130.4	152.2	165.3	160.1

4.3.3 Uncertainties and time-series consistency

Following the recommendation from ICR 2013, a survey has been carried out in order to determine the completeness of reporting in the category Limestone and dolomite use. No additional sources have been found. Consequently we have lowered the uncertainty estimates of activity data to 10% and thereby equalize them with other sources in the Mineral production.

Uncertainty estimates are based on expert judgement.

Uncertainty of activity data amounts to 10%.

Uncertainty of emission factor amounts to 10%.

4.3.4 Recalculations

No recalculations have been performed since last submission.

4.3.5 Source-specific planned improvements

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

4.3.6 Source-Specific QA/QC and verification

We carried out a survey to determine that all limestone and dolomite use in the country was accounted for. We approached Tax administration of the Republic of Slovenia and The Agency of the Republic of Slovenia for Public Legal Records and Related Services to examine other potential limestone and dolomite users. No new sources were found. Completeness in emission estimation was confirmed.

4.4 Soda Ash Production and Use

Key category - Base year: no

Key category - Year 2012: no

4.4.1 Source category description

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

4.4.2 Methodological issues

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

Data on consumption was obtained from the Statistical Office of the Republic of Slovenia (SORS) until 1997. Later on these data were not available anymore. Consumption of soda ash for the period 1998-2012 was calculated from the data on import and export published by SORS as well. Stock changes were disregarded. Use of soda ash in glass production is reported in sector 2.A.7.1 Glass production. CO_2 emissions from consumption have been calculated according to IPCC methodology, applying an emission factor of 415 kg CO_2 /ton of Na_2CO_3 .

4.4.3 Uncertainties and time-series consistency

Uncertainty estimates are 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

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

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

Key category - Base year: no

Key category - Year 2012: no

4.5.1 Source category description

This chapter comprises CO₂ emissions from glass manufacturing. They are reported in sector 2.A.7.1 Glass Production.

4.5.2 Methodological issues

CO₂ emissions from glass production for the period 1999-2012 have been calculated taking into account the consumption of all carbonates in glass production. Data on carbonate use in glass production have been obtained from glass producers. Amount of all carbonates used in glass production is included in this sector. Those carbonates are: limestone (CaCO₃), magnesium carbonate (MgCO₃), soda ash (Na₂CO₃), potash (K₂CO₃), and barium carbonate (BaCO₃). Default IPCC emission factors have been used for calculation of CO₂ emissions. They are 440 kg CO₂/ton limestone, 522 kg CO₂/ton magnesium carbonate, 318 kg CO₂/ton potassium carbonate, 223 kg CO₂/t barium carbonate, 415 kg CO₂/t sodium carbonate.

Calculation of CO₂ emissions from glass production for the period 1986-1998 has been performed in another way due to lack of data on carbonate consumption. Average implied emission factor for the years 1999-2007 has been multiplied with the annual glass production data. Data on glass production have been obtained from glass producers.

4.5.3 Uncertainties and time-series consistency

Uncertainty estimates are 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

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

CHEMICAL INDUSTRY

4.6 Nitric Acid Production

Key category - Base year: no

Key category - Year 2012: no

4.6.1 Source category description

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

4.6.2 Methodological issues

NITROUS OXIDE EMISSIONS

Emissions for the period 1997-2005 have been estimated according to IPCC methodology, applying an emission factor of 5.5 kg N_2O /ton nitric acid. Data on amount of nitric acid produced have been obtained from the SORS. Since 2006 there is no production of nitric acid in Slovenia. No emissions of N_2O have originated from this 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 category - Base year: no

Key category - Year 2012: no

4.7.1 Source category description

There had been 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 had been discontinued as early as in 1995.

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

In the production of silicon carbide (SiC), CO_2 is released as a by-product. Petrol coke is used as a source of carbon. Data on the consumption of petrol coke in the production of silicon carbide were provided by the producer. The CO_2 emissions have been estimated on

the basis of IPCC methodology using input data on petrol coke used and carbon content in coke and product. From 1995 onwards there has been no production of silicon carbide in Slovenia. The petrol coke used in the process may contain volatile compounds which will form methane. Methane emissions have been calculated using suggested IPCC emission factor 10.2 kg/t petrol coke.

4.7.2 Methodological issues

CARBON DIOXIDE EMISSIONS

For the year 2012, this subsector comprises CO₂ emissions only from calcium carbide consumption. In 2012 there was no production of calcium carbide, since the only carbide factory had been closed down in the first quarter of 2008.

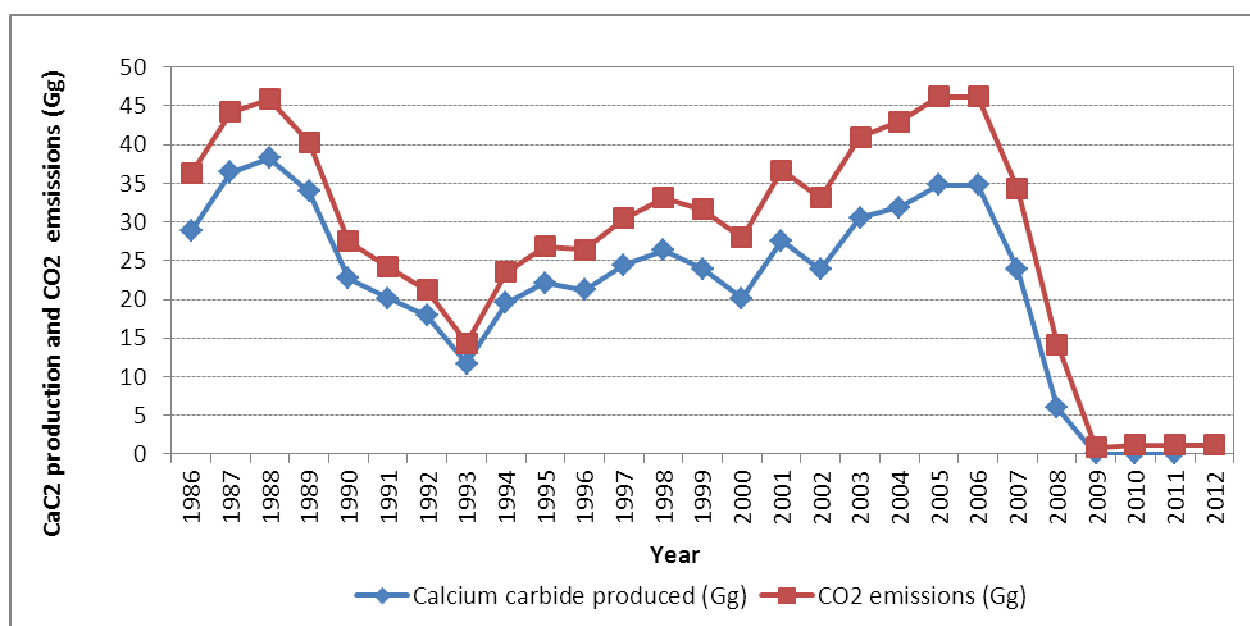


Figure 4.7.1: Production of calcium carbide and CO₂ emissions arising from production and consumption of calcium carbide.

Data on annual production of CaC₂ is the input data for calculation of CO₂ emissions arising from production of calcium carbide. Until 1997, those data were obtained from the SORS, but afterwards SORS changed its methodology of gathering and presenting carbides. SORS data became inapplicable. We found alternative source of data of CaC₂ produced. We have obtained data directly from the producer and applied them for emissions calculation for the entire period. CO₂ emissions from production have been calculated using suggested IPCC emission factor 1090 kg CO₂/ton of calcium carbide. In the year 2012 there was no production of calcium carbide, since the only carbide factory had been closed down in the first quarter of 2008.

Emission arises also in consumption. Until 1997, data on consumption of CaC₂ was obtained from SORS. Afterwards those data were not available anymore. We tried to estimate consumption from SORS data on import and export and data on production received from producer, but considerable fluctuations in consumption of calcium carbide in individual years were observed. To obtain smoother time series, we decided to estimate consumption of

CaC₂ using moving averages. As a result, we have used estimated data on CaC₂ consumption for the period 1998-2007.

For the period 2008-2012 we have estimated consumption of CaC₂ from SORS data on import and export, while there has been no production of CaC₂ since 2008. CO₂ emissions from calcium carbide consumption have been calculated using recommended IPCC emission factor 1100 kg CO₂/ton of calcium carbide.

Production of calcium carbide and CO₂ emissions arising from production and consumption of calcium carbide are shown in Figure 4.7.1.

4.7.3 Uncertainties and time-series consistency

Uncertainty estimates are 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 category - Base year: no

Key category - Year 2012: no

4.8.1 Source category description

This chapter describes sources of other greenhouse gases. In Slovenia, there are no other industrial sources of N₂O except 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 CH₄/t methanol was applied.

Production data of methanol have been obtained from Statistical Office of the Republic of Slovenia for the period 1986-2010. In 2012 there was no production of methanol in Slovenia.

4.8.3 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgement.

Uncertainty of activity data amounts to 30%.

Uncertainty of emission factor for CH₄ amounts to 80%

4.8.4 Recalculations

No recalculations have been performed in this category.

4.8.5 Future improvements

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

METAL PRODUCTION

4.9 Iron and Steel Production

Key category - Base year: no

Key category - Year 2012: 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 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 CO₂. Most emissions occur in smelting iron scrap in electric arc furnace (EAF). The furnace is first filled with steel scrap, 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. Annual amount of steel produced is shown in Figure 4.9.1.

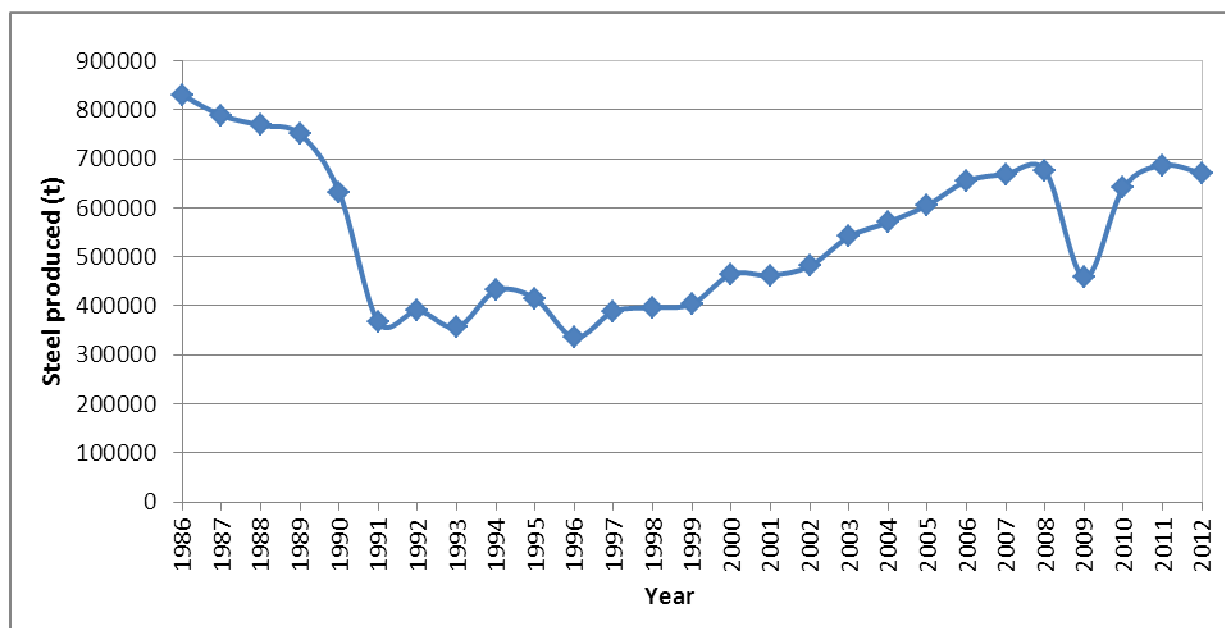


Figure 4.9.1: Production of steel in ton/year.

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, CO₂ emissions also take place as a result of graphite electrode consumption in the EAF. CO₂ emissions originate in consumption of limestone and dolomite as well, but they have been dealt with in chapter Mineral Industry, as laid down by the IPCC Guidelines.

In Slovenia, there are three iron and steel producers. Primary production from ore existed only in the 1986 and 1987, after 1990 steel production is based on utilization of scrap iron and steel. In the period 1986–1987 production of pig iron from ore still occurred. The disaggregation into the consumption of fuel as an additive and the consumption of fuel as an energy product was impossible. Consequently, for these two years the decision was made 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 1988–2012 all coke consumption is included in the industrial processes sector.

Activity data on the amount and carbon content of input and output materials were obtained from three steel producers. In our case, input materials were mostly coke, FAT coke, graphite electrodes, scrap iron, metal additions. For allocation plan purposes more detailed data have been available from 1999 onwards, which enabled us to determine our own emission factor. Average EF for the period 1999–2004 was 47 kg CO₂/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 different type of steel production (from ore).

For the period 2005–2012, we have used precise and verified data obtained from verified ETS reports in the scope of Greenhouse Gas Emission Trading System. Emissions and country specific implied emission factors were derived from amounts and carbon content of input and output material. Figure 4.9.2 shows CO₂ emissions contributed by different input materials and steel produced for 2005–2012.

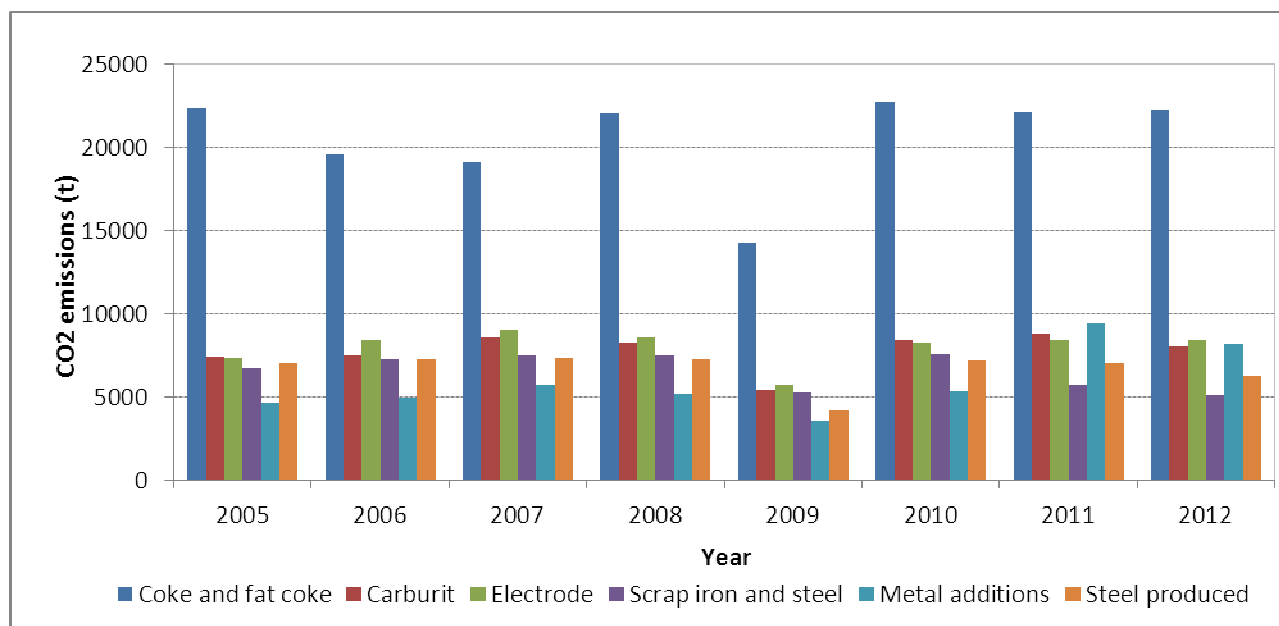


Figure 4.9.2: CO₂ emissions contributed by different input material and steel produced for 2005–2012.

4.9.3 Uncertainties and time-series consistency

Uncertainty estimates are 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

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

4.10 Ferroalloys Production

Key category - Base year: no

Key category - Year 2012: no

4.10.1 Source category description

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

In ferroalloy production, raw ores, coke and slagging materials are smelted together under high temperature. Usually, alloy formation occurs in electric arc furnaces, where heating is accomplished by passing current through graphite electrodes. Carbon reduction of metallic oxides occurs as both coke and graphite electrodes are consumed. Carbon captures oxygen from metal oxides to form carbon monoxide, while ores are reduced to molten base metals. Component metals then combine in the solution. Carbon monoxide is then converted to carbon dioxide. Annual amount of ferroalloys produced is shown in Figure 4.10.1.

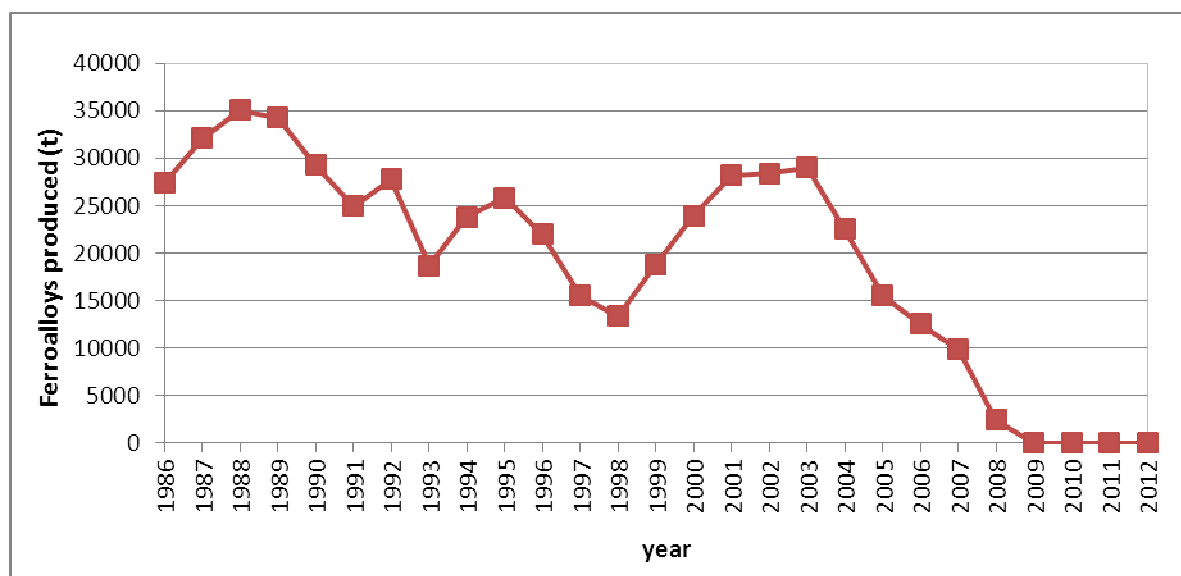


Figure 4.10.1: Ferroalloys production in ton/year.

4.10.2 Methodological issues

CARBON DIOXIDE EMISSIONS

There was no production of ferroalloys in Slovenia in the year 2012, since the only carbide factory had been closed down in the first quarter of 2008. This subsector contributed no CO₂ emissions in 2012.

CO₂ emissions have been calculated from the consumption of fuels, while data on ferroalloys produced have been used only for the QC activity. Like in the production of steel, the presentation of fuels has been 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. CO₂ emissions from the consumption of wood chips, considered 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 had been 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 2012. Input data on fuel consumption for the entire period have been obtained from that producer. The producer has also supplied data on quantities and type of ferroalloys produced and has thus enabled us to verify them by calculating emissions in accordance with the alternative method. A comparison of the two methods has yielded very similar results.

The trend in the CO₂ implied EF has 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 levels of annual consumption of coke and electrodes over time and different amounts and type of annual ferroalloys produced have also caused variation in the implied EF. Different ferroalloys have different CO₂ emissions factors (Revised 1996 IPCC Guidelines, Table 2.15, pg 2.31).

4.10.3 Uncertainties and time-series consistency

Estimates are 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

	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Level	CO ₂	0.34		46	
	Level	PFC	1.07		25	
2012	Level	CO ₂	0.43	0.15	38	22
	Trend	PFC	0.09	1.66	56	11

4.11.1 Source category description

Aluminium is produced in two phases. First, alumina (Al₂O₃) is extracted from bauxite ore. Aluminium is then produced in the second phase in an electrochemical process in electrolysis cells, where alumina disintegrates into its components: aluminium and oxygen. Molten aluminium gathers on the cathode while oxygen reacts with carbon in the anode, causing the consumption of anodes, which have to be replaced.

In addition to CO₂, perfluorocarbons (PFCs) also 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 on the anode. This stops the production of the metal and increases the cell voltage. Factors that affect the generation of PFCs are frequency and duration of anode effects and 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 CF₄ and C₂F₆ emission factors.

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

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

Technology used in production of aluminium since Slovenian aluminium plant has been 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,
- 2007 (21st Dec) discontinuance of electrolysis unit B,
- 2010 reduction of production in electrolysis unit C due to economic crisis.

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

In 1988, a new electrolysis unit C with annual production capacity of 40000 t of aluminium was built and its electrolysis technology was taken from Aluminium Pechiney. Simultaneously, reduction cells in electrolysis unit B were reconstructed to use prebaked anodes.

In 2002, upgrading the aluminium production that includes construction of the second half of the electrolysis unit C with annual production capacity of 40000 t of aluminium was carried out. Due to 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 technologically improved point feeding prebaked anode Pechiney has been in operation. Annual production of aluminium in 2009 and 2010 were halved compared to 2008. Significant drop in aluminium production occurred due to world economic crisis. In 2012, production of aluminium increased considerably and almost reached pre-crises values. It amounted to 83278 t.

4.11.2 Methodological issues

CARBON DIOXIDE EMISSIONS

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

CO₂ emissions from primary aluminium production are most precisely estimated from the consumption of anodes. Their consumption in 2012 amounted to 404 kg/ton Al. The emission factor is 3.62 t CO₂/ton anodes. The significant decline of CO₂ emissions in 2009 occurred due to smaller aluminium production. Slightly higher emissions of CO₂ were observed in 2010, but they were still far from pre-crises values. In 2012, production of aluminium increased considerably (Figure 4.11.1).

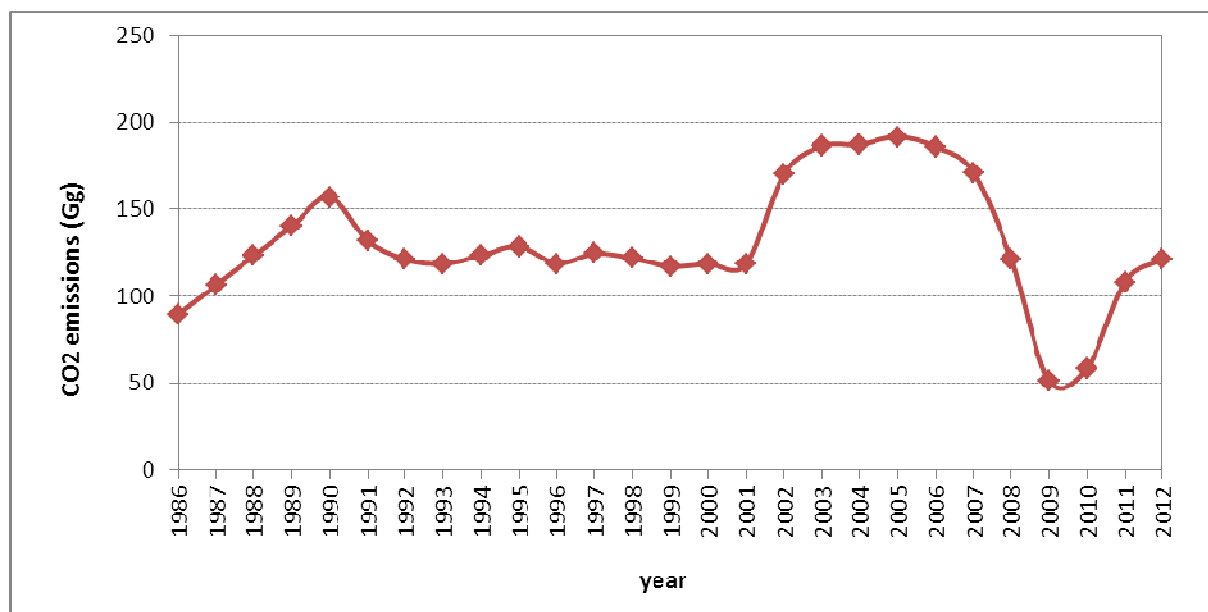


Figure 4.11.1: CO₂ emissions from aluminium production.

In 2012, electrolysis unit C with point feeding prebaked anode Pechiney technology was in operation.

IPCC methodology is used for CO₂ emission calculation.

$$ECO_2 = (MP \cdot NAC \cdot (100 - S - Ash) / 100) \cdot 44 / 12$$

ECO₂ = CO₂ emissions from prebaked anode consumption, tonnes CO₂

MP = total metal production, tonnes Al

NAC = net prebaked anode consumption per tonne of aluminium, tonnes C/ tonne Al

S = sulphur content in baked anodes, wt %

Ash = ash content in baked anodes, wt %

44/12 = CO₂ molecular mass: carbon atomic mass ratio

To improve transparency of CO₂ emission from aluminium production, this chapter comprises only emissions arising from consumption of anodes. CO₂ emissions from anode burn-off have been excluded from this chapter and they are now reported under sector Other 2.C.5.

PFC EMISSIONS

Data on emission calculations of tetrafluoromethane (CF₄) and hexafluoroethane (C₂F₆) 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 CF₄ and C₂F₆ emission factors from 1995 to 2012. The CF₄ emission factor has fallen from the base year 1995 till now from 0.191 kg CF₄/ton Al to 0.0402 kg CF₄/ton Al and C₂F₆ emission factor from 0.021 kg C₂F₆/ton Al in the base year to 0.0052 kg C₂F₆/ton Al in 2012.

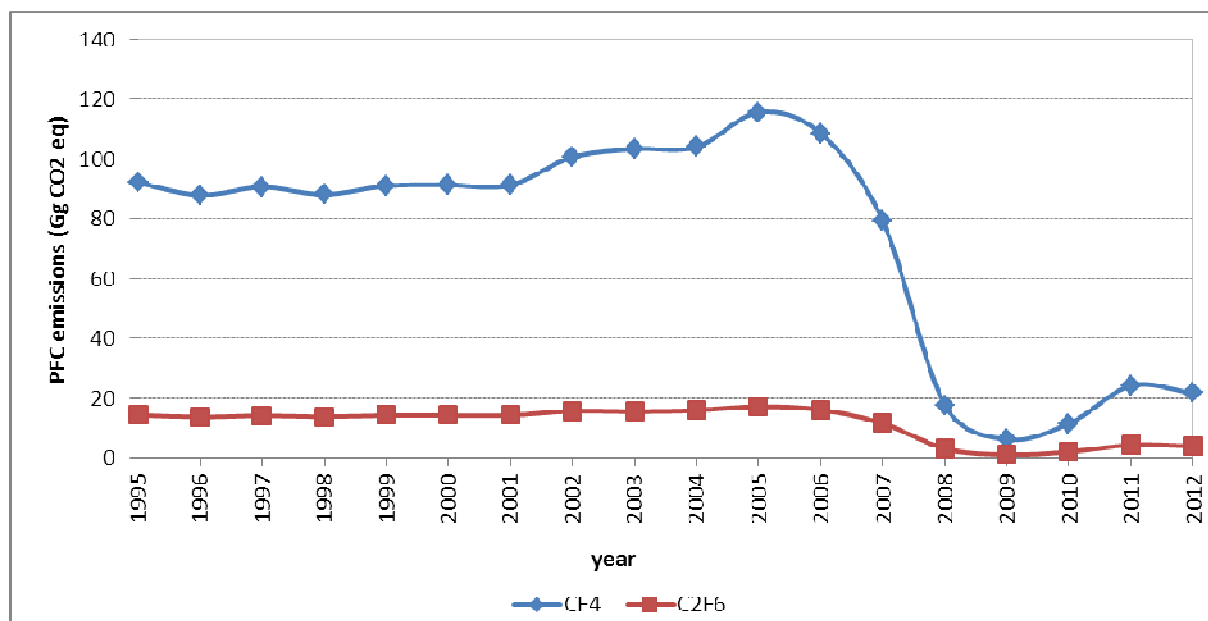


Figure 4.11.2: Emissions of CF₄ and C₂F₆ emitted during anode effect in aluminium production.

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 3) was used for calculating of PFC emissions in electrolysis unit C for the period 2005 - 2012. Annually determined emission factors have been used for emission calculation. Pechiney overvoltage method has been used for emissions calculation for both gases. All data has been obtained from producer's electronically recorded anode-effect inventory. Emissions of CF₄ and C₂F₆ in aluminium production are shown in Figure 4.11.2.

Explanation of methodology is included according to ERT recommendations. In 2012, electrolysis unit C with point feeding prebaked anode Pechiney technology has been in operation.

IPCC methodology is used for CF₄ and C₂F₆ emission calculation.

$$ECF_4 = MP \cdot OVC \cdot AEO / CE$$

$$EC_2F_6 = ECF_4 \cdot F_{C_2F_6/CF_4}$$

ECF₄ = emissions of CF₄ from aluminium production, kg CF₄

EC₂F₆ = emissions of C₂F₆ from aluminium production, kg C₂F₆

OVC = Overvoltage coefficient for CF₄, (kg CF₄/tonne Al)/mV

AEO = anode effect overvoltage, mV

CE = aluminium production process current efficiency expressed, percent (e.g., 95 percent)

MP = metal production, tonnes Al

F C₂F₆/CF₄ = weight fraction of C₂F₆/CF₄, kg C₂F₆/kg CF₄

4.11.3 Uncertainties and time-series consistency

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

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

4.11.4 Recalculations

CO₂ emissions for the year 2011 were recalculated according to new data on sulphur content in baked anodes.

4.11.5 Future improvements

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

4.11.6 Source-Specific QA/QC and verification

Data obtained from aluminium producer was thoroughly examined. Possible inconsistencies were consulted with producer expert team. We also visited the factory and observed production operation and data acquiring in person.

4.12 Other Metal Production (IPCC: 2 C 5)

Key category - Base year: no

Key category - Year 2012: no

4.12.1 Source category description

This chapter comprises CO₂ emissions arising from anode burn-off in the process of anode production. Emissions have been reported in sector Other 2.C.5 - Aluminium anode burn-off.

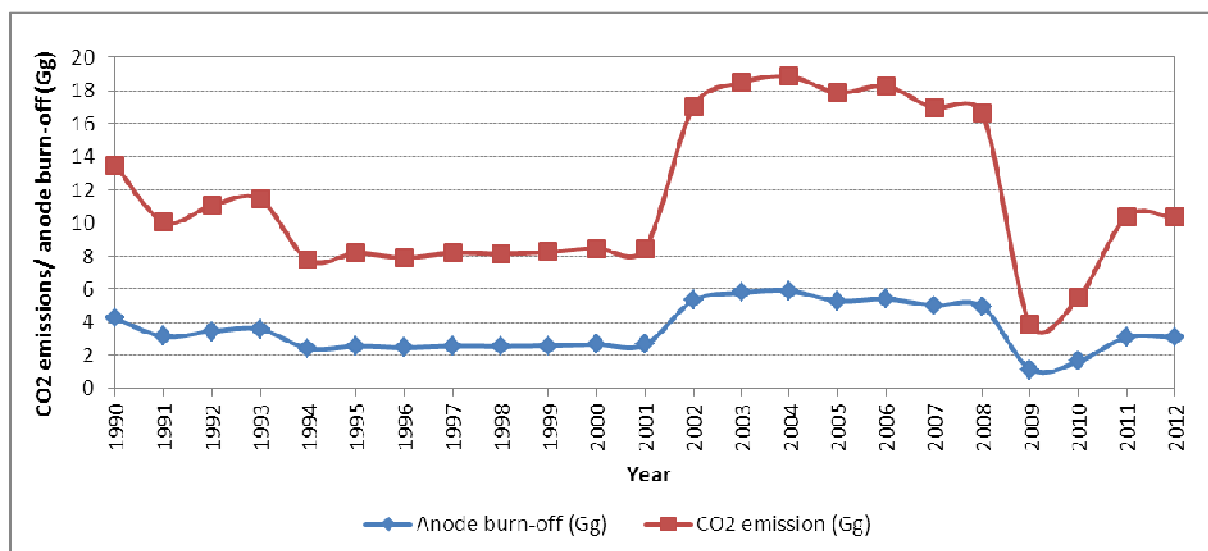


Figure 4.12.1: CO₂ emissions from anode burn-off in the process of anode production.

4.12.2 Methodological issues

CO₂ emissions from anode burn-off in anode baking process were excluded from the sector on aluminium production. They are reported separately in this chapter. Anodes are used in potline cells - pots for the production of aluminium. CO₂ emissions generated in the process of green anodes baking arise from oxidation of volatile substances from a tar pitch and from burning-off the covering material (petroleum coke). EF for anode burn-off is a plant specific. Data on amount of anodes, operational parameters and emissions of CO₂ are provided by the producer expert service. CO₂ EF for 2012 is 3.33 t CO₂/ t anode burn-off. Figure 4.12.1 shows CO₂ emissions arising from anode burn-off in the process of anode production.

4.12.3 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgement.

Uncertainty of activity data amounts to 10%.

Uncertainty of emission factors amounts to 10%

4.12.4 Recalculations

CO₂ emissions for the year 2011 were recalculated according to new data on amount of baked anodes.

4.12.5 Future improvements

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

4.13 Source-Specific QA/QC and Verification

QC procedures for plant data included in the inventory, 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 have been collected by EU ETS experts from Slovenian Environment Agency. As national inventory team and EU ETS experts work together in the same institution, even in the same unit, it is very easy to access these hard copy reports for each company. In addition to the data, reports also include the description of monitoring of this data, eventual stops and changes of production. As Slovenia is a small country with only 15 installations from EU ETS report process emissions (2 cement, 3 lime, 3 steel, 4 glass producers, 3 ceramics producers), 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 to composition data for clinker or lime production. Sources of data for calculation of emissions factors have stayed the same over the whole period. There have been no difficulties of time series consistency.

4.14 Emissions Related to Consumption of Halocarbons and SF₆

Refrigeration and AC Equipment	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
2012	Level, Trend	HFC	0.75	11.29	22	17

4.14.1 Source category description

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

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

	period	gases
Refrigeration and AC equipment		
- domestic refrigeration	1995-2012	HFC-134a
- commercial refrigeration	1995-2012	HFC-32, HFC-125, HFC-134, HFC-143a
- industrial refrigeration	1997-2012	HFC-32, HFC-125, HFC-134, HFC-143a
- stationary air conditioning	2000-2012	HFC-32, HFC-125, HFC-134, HFC-143a
- mobile air conditioning	1995-2012	HFC-134a
Foam blowing		
- hard foam	1995-2012	HFC-134a
- soft foam	1995-2012	HFC-134a
Fire extinguishers	1997-2012	HFC-227ea
Aerosols and meter dose inhalers	2003-2012	HFC-134a
Electrical equipment	1986-2012	SF ₆
Noise insulation windows	1995-1997	SF ₆

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

HFCs

HFCs began to be used in Slovenia in 1993 as a substitute for CFCs, which are ozone-depleting substances. They asserted themselves in particular in those fields where no other, more appropriate alternatives (e.g. hydrocarbons, CO₂ etc.) were available.

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

In the 1995 base year only HFC-134a was used, while also the other F-gases like R-125 and R-143a and HFC mixtures like R-402a, R-404a, R-407a, R-407c, R-410a, R-417a and R-507a have been used since 1998. 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 2012, nearly 50% of all HFC emissions arose from MAC. Production and sales of cars with air conditioning has risen sharply in recent years.

In a research project carried out by the Chamber of Commerce and Industry of Slovenia in 1999 and covering the use of HFC for the period 1995-1997 potential emissions according to Tier 1a and 1b methods as well as actual emissions according to Tier 2 method have been calculated. After this no new research has been done and, except for emissions from MAC, all other emissions have been calculated with extrapolation and assuming that R-134a was the only HFC used. 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 the next submissions.

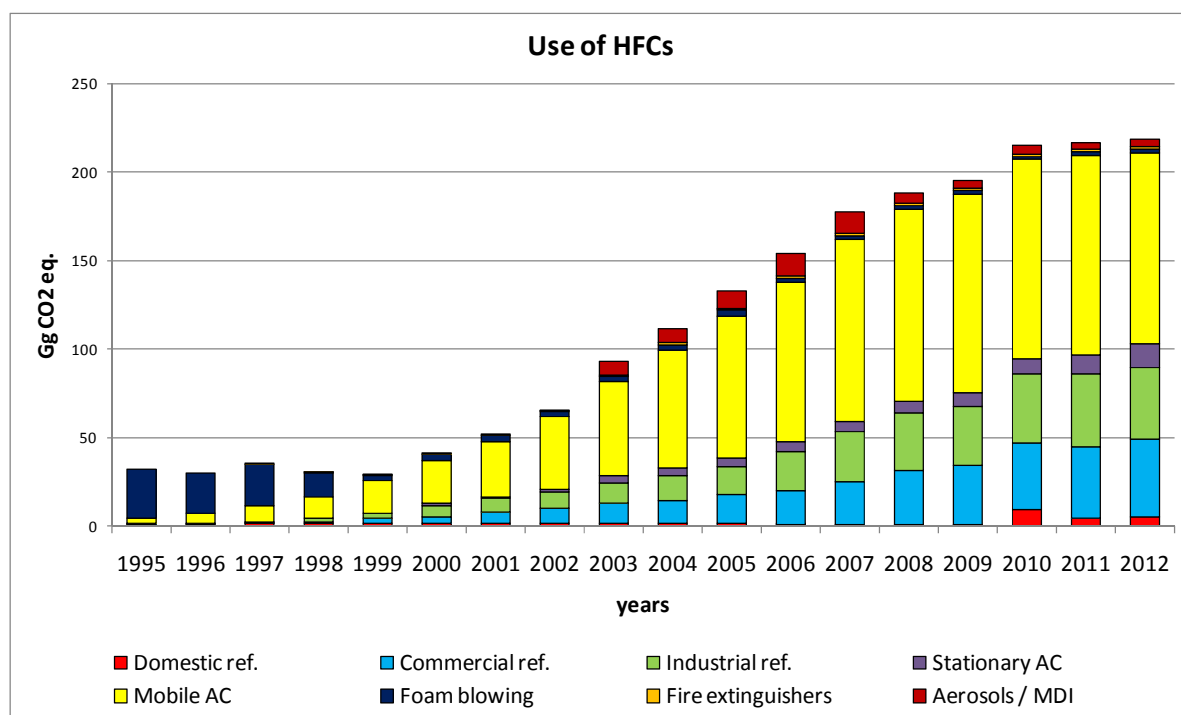


Figure 4.14.1: HFC and SF₆ emissions from different sources.

Following the recommendation from ERT, the other F-gases and blends have been included in the inventory in addition to HFC-134a and AD have been updated according to the data from industry and from the new database, established in 2011. This 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 the 1st filling and to maintain the equipment which is filled with ODS and F-gases in commercial sector and in industry. In these reports, total amount of each F-gas or blend, 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 such a way that 2012 data will be collected and reported separately for four types of use (commercial, industrial, and 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. This tax is calculated on the basis of pollution units referring to CO₂ equivalents. When introducing 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 would be reached.

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

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

SF₆

SF₆ 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). SF₆ insulated switchgear and circuit breakers were first used in Slovenia in 1976. A general increasing trend can be observed, and particularly since 1993, the use of equipment with SF₆ as insulating gas has increased strongly. This type of equipment is not produced in Slovenia and there is no export of SF₆ in equipment.

In 2006, a research covering all high-voltage equipment in Slovenia was done by The Milan Vidmar Electric Power Institute, Ljubljana. Estimation of SF₆ emissions for the period 1986-2005 was performed. Since then data from F-gases data base have been used.

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

4.14.2 Methodological issues

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

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

where:

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

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

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

k = Production/assembly losses (%)

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

$E_{\text{operation}, t}$	=	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, potential emissions have been calculated according to IPCC Tier 1b method. For the years 1998-2008, estimation has been carried out according to recommended methodology of European Commission. Due to lack of data on production, imports, exports and destroyed amounts of HFC, estimation of potential emissions for this period are based on the amounts filled into new manufactured products. Since 2009, the data on bulk import and destroyed amount of F-gases have been used, while the data on export have still not been available. We have estimated also the import and export data on HFC-134a in product (MAC only) for the whole period 1995-2012.

2.F.1 Refrigeration and AIR Conditioning Equipment

The following chapters describe types of refrigeration and air-conditioning equipment considered in individual sub-categories, refrigerants used in the respective applications and method used for the calculation of emissions in Slovenia.

Domestic refrigeration:

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

Since 1996, all household refrigerators produced and sold in Slovenia have been filled in with R-600 (isobutane). The amount of HFC-134a in imported refrigerators was estimated in the study of 1999. Afterwards, the amount in new appliances decreased until 2006, when according to the information from experts there were 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 it was closed.

The amount of refrigerant used was estimated in the study of 1999 and we have used projections from this study to determine amount for Standalone 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 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 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, many of them are filled during installation. For this reason we have assumed that all amounts of F-gases have been filled in Slovenia. We have also included estimates on amount of F-gases in small home AC appliances. In addition to HFC-134a, the following blends have been used: R-404a, R-407a, R-407c, R-410a, R-417a, and R-507a.

Emission factors are presented in the Table 4.14.2. Product lifetime is considered to be 20 years and emissions from disposal have not been calculated yet.

Mobile AC

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

There is one car producer in Slovenia and data on amount filled in new cars have been obtained from the personal contact with the producer.

Activity data for HFC stocks in MAC was annually estimated from amount of HFC in new cars equipped with air-conditioning, amount of HFC in operating systems and amount of HFC in disposed cars. The data were obtained from official database of registered vehicles. Product lifetime is considered to be 12 years

Product life factor (EF) was estimated in accordance with directive 2006/40/EC of the European parliament and of the council relating to emissions from air-conditioning systems in motor vehicles. The directive states that MAC value of 20% is appropriate for countries with no recovery and recycling program, and 10% for the countries with such a program. Slovenia started to implement that directive in 2006. 20% for MAC system emission rate was applied until 2006 due to the 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 afterwards. The 13% for the year 2012 has been chosen according to that assumption. We assumed that a certain adaptation period is needed for total implementation of recycling program. 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 from EFs from GPG, the value (range) from 2006 Guidelines is included in the table as well. Emission factors for all categories except mobile AC have been taken from research made by Chamber of commerce and industry of Slovenia in 1999. The experts have chosen the emission factors according to their own experiences and according to some suggestions from IPCC Guidelines.

Table 4.14.2: HFC emissions and emission factors used in refrigeration and air conditioning appliances for 2012 and comparison with EF from IPCC GPG and 2006 Guideline (if different).

	EF Production (%)	EF Use (%)	EF Disposal (%)	HFC emissions (Gg CO ₂ eq)
Domestic refrigeration Range from GPG 2000	1 0.2 - 1	0.5 0.1 – 0.5	30	5.14
Commercial refrigeration Stand alone Range from GPG 2000 Range from 2006 Guidelines	3 0.5 – 3	5 1 – 10 1 – 15	20	43.52
Medium and large Range from GPG 2000 Range from 2006 Guidelines	3 0.5 – 3	20 10-30 10-35	10	
Industrial refrigeration Range from GPG 2000	3 0.5 – 3	16 7 - 25	10	40.90
Stationary Air Conditioning Range from GPG 2000 Range from 2006 Guidelines	0.6 0.2 - 1	1-10 1 – 5 1 -10	NO	13.13
Mobile Air Conditioning Range from GPG 2000	0.5 0.5	13 10 - 20	65	108.58

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 an average value of 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 a year, but a part of HFC remains in the foam and is probably slowly released during the

following 20-25 years. Considering the fact that this product is entirely destined for export, there are no emissions from application of the product on the domestic market and emissions arise in the importing countries.

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

Soft Foam

In the production of soft foam total 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 HFC-134a was used for this purpose.

2.F.3 Fire extinguishers

The evidence of F-gases used in fire extinguishers in our database is incomplete, because not all enterprises are aware of this reporting obligation. Generally used fire extinguishing agents include dust, CO₂, or water. Halon systems were replaced by HFC.

Data about HFC used as a replacement for CFC was collected for the research made in 1999. In this research it was assumed that 400 kg of HFC would 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, total amount was replaced with substitutes until the end of 2005. Due to the lack of detailed data we have assumed that all CFC was replaced with HFC, which is probably an overestimation. Since 2005, 100 kg of HFC is assumed to be used every year for 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 the 1st filling has decreased from 35% as it was estimated in 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 began to use HFC-134a in the MDI in 2003 as replacement for the CFC. Due to the lack of country specific data we have used Austrian data about amount of HFC-134a in MDI divided by 4, which is the ratio between Austrian and Slovenian population (8 Mi and 2 Mi respectively). Austrian data have been chosen from cluster of neighbouring countries because of the high quality of Austrian inventory, which is complete and very transparent.

Since 2011, the national data on medical equipment with HFC-134a sold in Slovenia have been obtained. A comparison of emissions calculated from national data with those calculated from Austrian inventory for 2011 and 2012 shows that emissions from national data are slightly lower than emissions from Austrian inventory. In 2011, the difference was -9.3% and in 2012 it was -4.8%. Due to the absence of national data we believe that using

Austrian data for the period 2003 to 2010 is the best available method which gives reliable and conservative emission estimates.

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 have been 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

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

Table 4.14.3: SF₆ emissions in high-voltage equipment.

Emissions from	Units	1986	1990	1995	2000	2005	2010	2011	2012
manufacturing	kg	0.1	0.0	0.9	1.4	2.6	2.1	0.0	2.1
stock	kg	428.4	431.1	481.2	657.1	786.7	690.1	690.1	667.8
disposal	kg								440.0
Total SF₆ emissions	kg	428.5	431.1	482.1	658.5	789.3	692.2	690.6	713.9
Total SF₆ emissions	Gg CO₂ eq	10.2	10.3	11.5	15.7	18.9	16.5	16.5	17.6

As production of SF₆ in Slovenia doesn't exist and until now no equipment including SF₆ 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 SF₆ used to fill new equipment.

Equipment use emissions are determined by the amount of SF₆ used to service equipment. SF₆ which has been recovered from equipment before servicing and returned after servicing is not included in the estimate.

Upon ERT recommendation, the SF₆ emissions from electrical equipment are reported in CRF table 2(II)F under emissions from stocks, with the exception of installation emissions which are reported under manufacturing emissions.

2.F.8 Other

Upon ERT recommendation, emissions of SF₆ from 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 occurred. Since 1997 there has been no use of SF₆ for soundproof windows in Slovenia. According to the Regulation on certain fluorinated greenhouse gases, placing of double glazed windows filled with SF₆ on the market has also been 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 are based on expert judgement and 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

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

For the next submission we will also thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

4.14.5 Recalculations

Improved data on amount of HFC in new refrigeration and AC equipment as well as SF₆ in electrical equipment have been obtained for 2011 and emissions from use and from the first filling have been recalculated.

In addition, HFC emissions from disposal of refrigeration equipment in domestic and commercial sector have been added and corresponding emissions have been recalculated for the period 2006 to 2011.

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

For emissions of HFC from fire extinguishers it was determined that HFC emission in tons of HFC are very similar to emissions in Austria although population in Slovenia is four times smaller. But when comparing HFC emissions in Gg CO₂ eq., the difference is almost as high as factor 10. The reason is that, in addition to HFC-227ea, HFC-32 has been used in Austria with very high GWP (11,700), which 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 has been used for foam blowing in Slovenia since 1996.

The results of comparison for Refrigeration and AC equipment are in the table 4.14.5.

Table 4.14.5: HFC emissions from Refrigeration and AC equipment in 2012 in comparison with emission from neighbouring and some middle and east European countries.

	Population	Emissions of HFC	Emissions of HFC per capita
unit	Million	t HFC	t HFC / Million
Germany	81.799600	4782.550	58.5
Italy	59.715625	4378.380	73.3
Czech Republic	10.674947	1105.680	103.6
Slovakia	5.422366	216.650	40.0
Lithuania	3.601138	120.910	33.6
Hungary	10.075034	423.060	42.0
Austria	8.169929	742.500	90.9
Croatia	4.490751	277.970	61.9
Slovenia	2.048847	126.290	61.6

After the January submission a comparison of total emissions of HFC in Refrigeration and AC equipment in Slovenia in 2012 with the neighbouring and some middle European countries has been made and results have shown that our emissions per capita are somewhere in the middle. We have not made a comparison of HFC emissions in CO₂ eq. because of the variations in types of HFC and relevant GWPs.

Our conclusion is that the emissions in tonnes HFC per capita are almost the same as in Croatia, higher than in Hungary, Slovakia, Germany and Lithuania but lower than in Austria, Italy and Czech Republic. (Emissions per capita in Czech Republic are even higher than in Austria and we are in doubt if they are realistic). The lower emissions in Slovenia comparing to Austria or Italy could be explained with the higher GDP, hotter climate (Italy), and large service (tourist) sector (Austria). In Slovenia, a lot of appliances are still using ODS and for this reason they are not included in our GHG inventory.

5 SOLVENT AND OTHER PRODUCT USE (CRF sector 3)

5.1 Overview

Solvents and related compounds are important for air pollutants inventory as well as for greenhouse gas inventory because they are a significant source of emissions of non-methane volatile organic compounds (NMVOCs). NMVOC is regarded as an indirect greenhouse gas. The NMVOC emissions in the atmosphere oxidise to CO₂ over a period of time. No other greenhouse gases are emitted in significant amounts from the use of solvents and related compounds. Solvents and related compounds include chemical cleaning substances used in dry cleaning, printing, metal degreasing, and a variety of industrial applications as well as household use. This category comprises also 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 N₂O 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 N₂O.

5.2 Other products use

	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base year	Level,	N ₂ O	0.32		47	

N₂O EMISSIONS

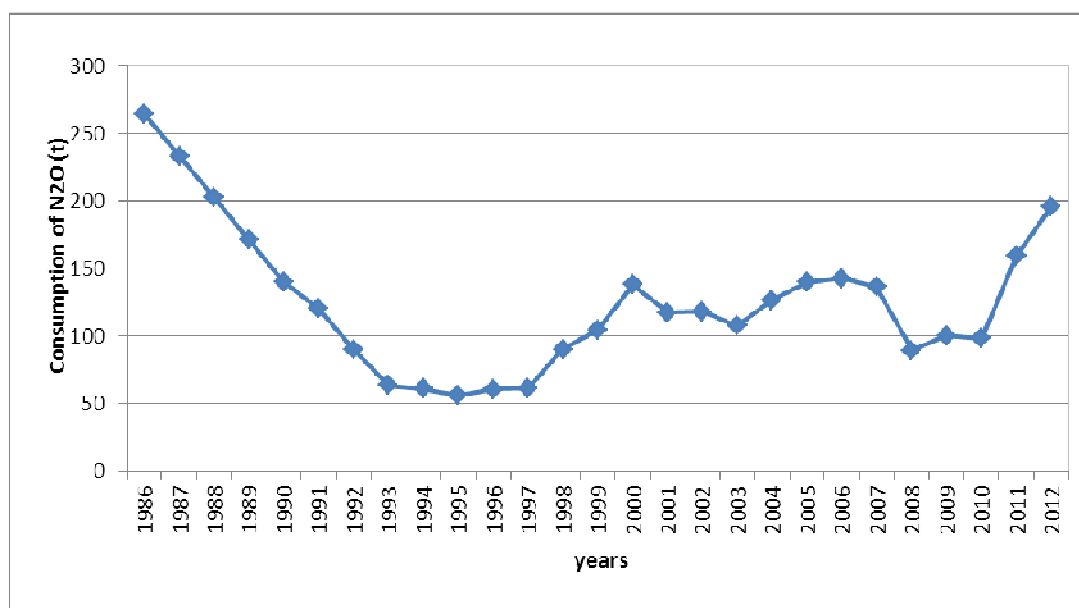


Figure 5.2.1: Consumption of N₂O.

This chapter presents N₂O emissions arising from the use of N₂O in the health service and to a lesser extent also in fire extinguishers and other use. Emissions of N₂O for the year 1986 and the period 1993 - 1998 was estimated in the scope of research project done by the Chamber of Commerce and Industry of Slovenia. Data for the period 1987 – 1992 was estimated by nearest-neighbour interpolation method. Data required for emission calculation from 1999 onwards have been obtained from the SORS. Consumption of N₂O has been calculated from data on import and export. Since 1999 there has been no N₂O production in Slovenia. All N₂O emissions arising from the use of N₂O are reported under 3.D.1 Use of N₂O for Anaesthesia.

5.2.1 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgement.

Uncertainty of activity data amounts to 50%.

Uncertainty of emission factor amounts to 20%

5.2.2 Recalculations

No recalculations have been performed for this category.

5.2.3 Source-specific planned improvements

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

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 CH₄ emissions from enteric fermentation and manure management as well as N₂O emissions from manure management and emissions from agricultural soils (direct and indirect emissions and emissions from grazing animals).

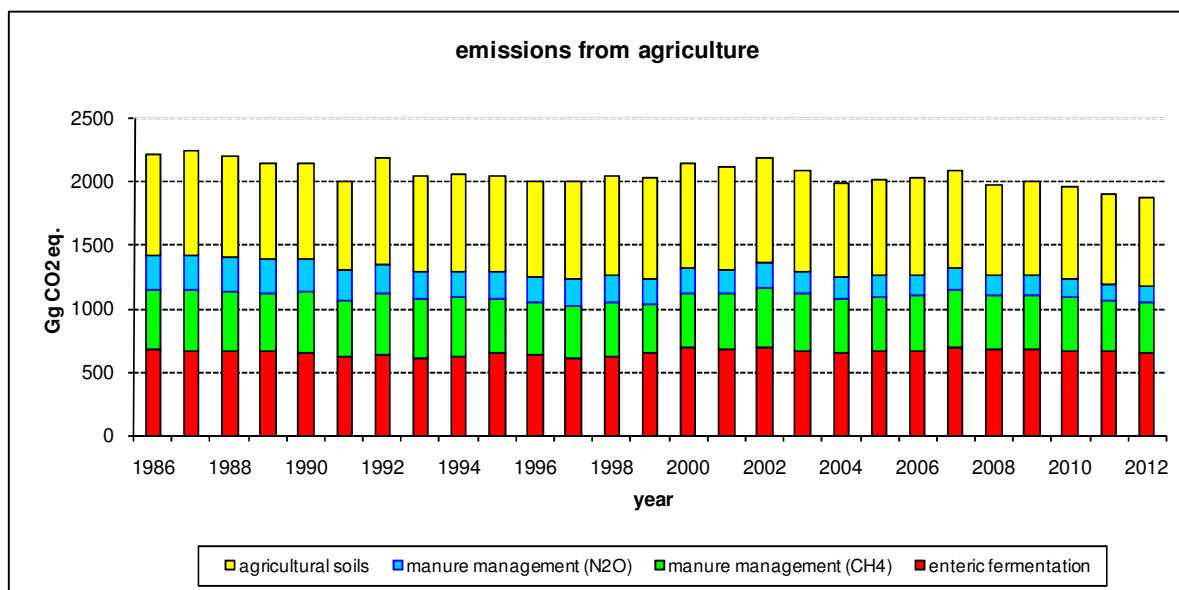


Figure 6.0.1: CH₄ and N₂O emissions from agriculture activities in Gg CO₂ eq.

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 exist for these sub-categories.

6.1 CH₄ Emissions from Enteric Fermentation

	Animal type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Dairy Cattle	Level	CH ₄	1.48		16	
	Non-dairy Cattle	Level	CH ₄	1.01		27	
2012	Dairy Cattle	Level, Trend	CH ₄	0.86	1.06	20	21
	Non-dairy Cattle	Level, Trend	CH ₄	1.31	0.51	11	35

Swine, goats, horses, sheep

Key category - Base year:

no

Key category - Year 2012:

no

6.1.1 Source category description

CH₄ 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 comprise 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.

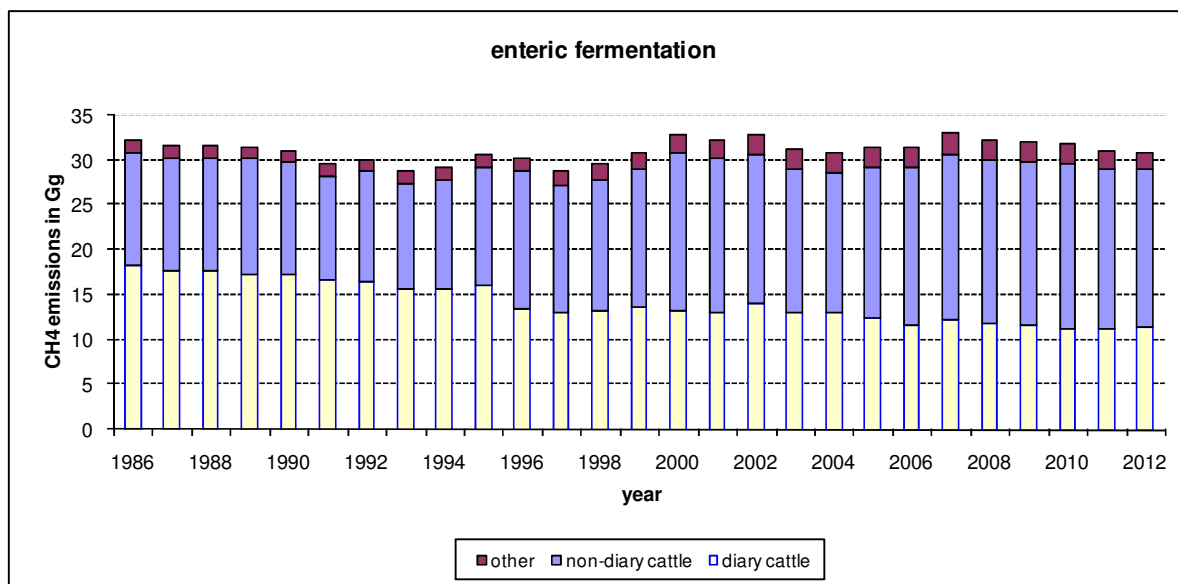


Figure 6.1.1: CH₄ emissions from enteric fermentation in Gg.

CH₄ 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 CH₄ emissions from enteric fermentation, while non-dairy cattle represent about 53% of total CH₄ from enteric fermentation. Jointly, cattle are responsible for almost 87% of total CH₄ 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 CH₄ 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 number of calves per cow and year, 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, managed by Agricultural Institute of Slovenia (reported by Božič et al., 2009 or calculated on request).

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

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

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

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

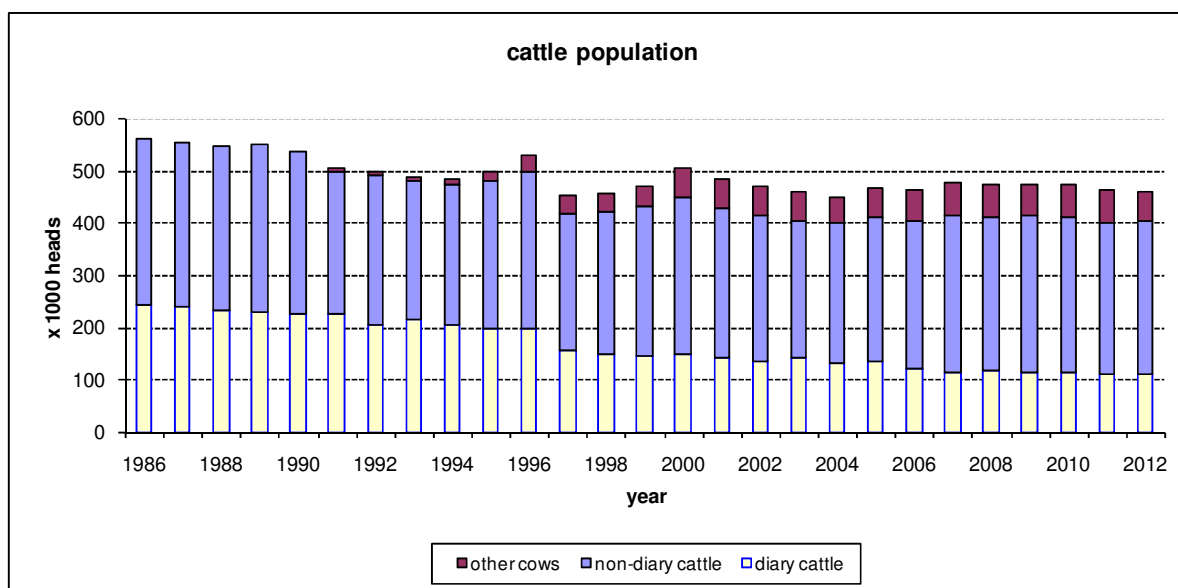


Figure 6.1.2: Number of cattle, dairy and non-dairy in thousands.

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 published revised data on livestock numbers and production for the period 1991-2002. These data were published in Rapid Reports No. 256. The main purpose of this 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 were 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 due to 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 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 they were applied for 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. SORS collects data on animal population in December and reports them in the current year. In the FAO database, these data are applied for 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.

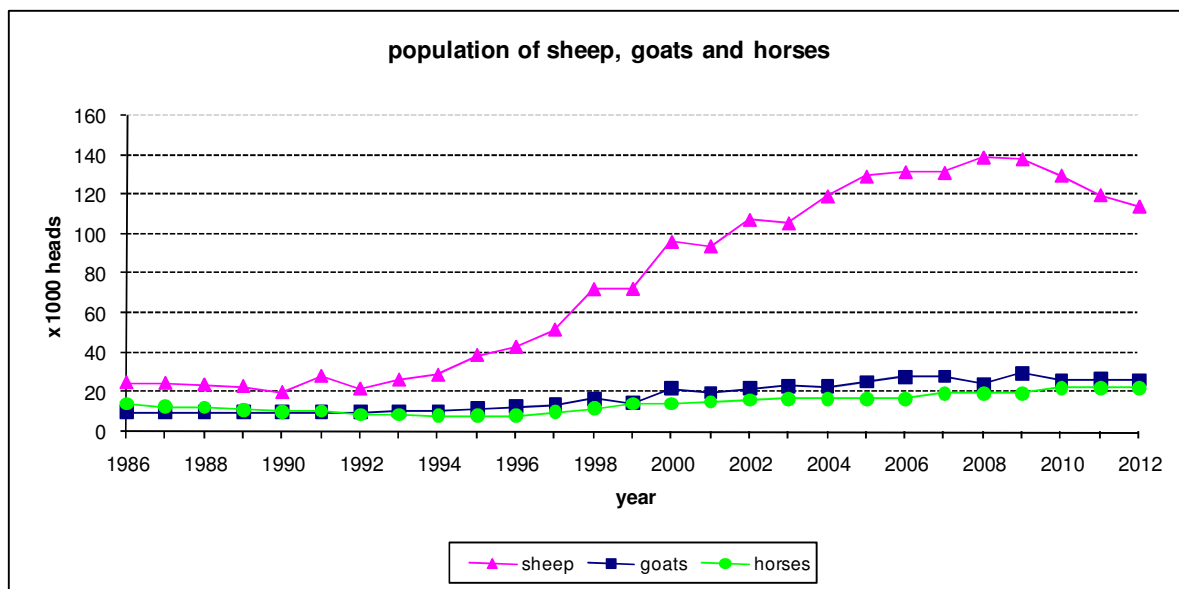


Figure 6.1.3: Number of sheep, goats and horses in thousands.

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 January 1, 2000 and June 1, 2009. On the basis of the results, typical lactation curves for the range between 3500 and 12000 kg of milk in standard lactation were calculated for the intervals of 500 kg. Expected daily milk yields (for each individual day in lactation) were calculated for all these classes.

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

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

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

$$DE\% = dOM - 3.1.$$

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

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

The ratio NE/DE was calculated as suggested by IPCC (1996).

Emission factor was calculated from data on gross energy intake (GE) and methane conversion rate (Y_m) according to IPCC (1996):

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

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 in kg/head/year.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Milk yield	2817	2763	2772	2795	2775	3252	2835	2800	3014
EF	76.9	76.4	76.5	76.7	76.6	81.0	77.5	77.4	79.5
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Milk yield	3831	3975	4091	4252	4625	4807	5198	5062	3831
EF	87.2	88.6	89.8	91.4	95.1	96.8	100.2	99.1	87.2
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Milk yield	4853	5479	5708	5726	5764	5531	5517	5516	5593
EF	97.4	102.6	104.0	104.4	104.8	102.8	102.8	102.9	103.6

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 – 2012. 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.

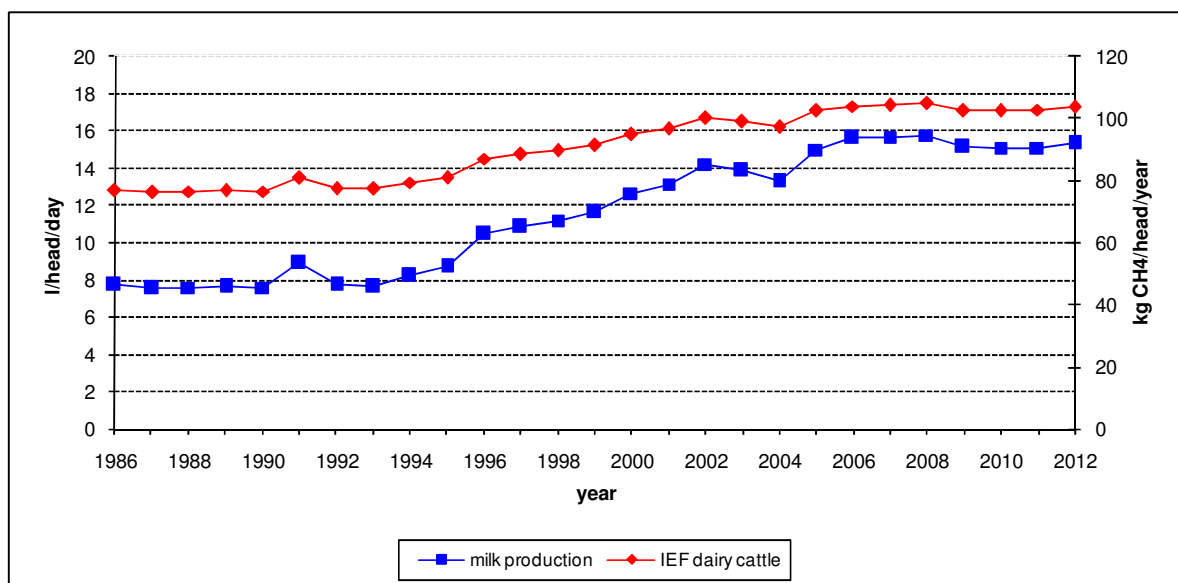


Figure 6.1.4: Milk production per cow in kg milk/head/day and IEF in kg CH₄/head/year.

The increase in IEF for dairy cattle is due to the increase in the milk yield. In 2010, the CS EF was slightly higher than IPCC EF for dairy cattle for Western Europe (100 kg/head/year) and considerably higher than EF for Eastern Europe (81 kg/head/year). Since agriculture sector in Slovenia is more similar to the systems in the countries from West Europe, the CS EF of 102.9 kg/head/year 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 heads of non-dairy cattle according to different categories are reported by the SORS (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 SORS) was 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 of national feeding standards (Verbič and Babnik, 1999) and the expected feed intake was estimated according to Kirchgeßner et al. (2008). In the first step the required concentrations of the metabolisable energy were assessed. In the second step they were converted into organic matter digestibility (dOM) by the use of equation

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

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

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

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

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 slaughter 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 out 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 2006-2012, 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 68.7 % in 2012.

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. In calculating methane emissions, until 2000, 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 in 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
	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
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Other cows	80.5	80.5	80.5	80.5	80.5	80.5	80.5	80.5	80.5
Other cattle	43.9	44.4	44.8	44.9	44.6	44.4	44.5	44.4	44.3
Non-dairy c.	49.4	50.6	51.1	50.9	50.9	50.5	50.8	50.7	50.1

After 1990, the non dairy cattle category also includes suckler-cows. SORS 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 SORS 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 have not been published in the Statistical Yearbook so far. 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 counted before 1992, we consider the number of 10.000 heads as an estimate.

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

6.1.2.4 Horses

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

6.1.2.5 Swine

The number of swine (Figure 6.1.5) has been taken from the Statistical Yearbook, methane emissions have been estimated by applying default emission factors according to IPCC methodology 1.5 kg per year.

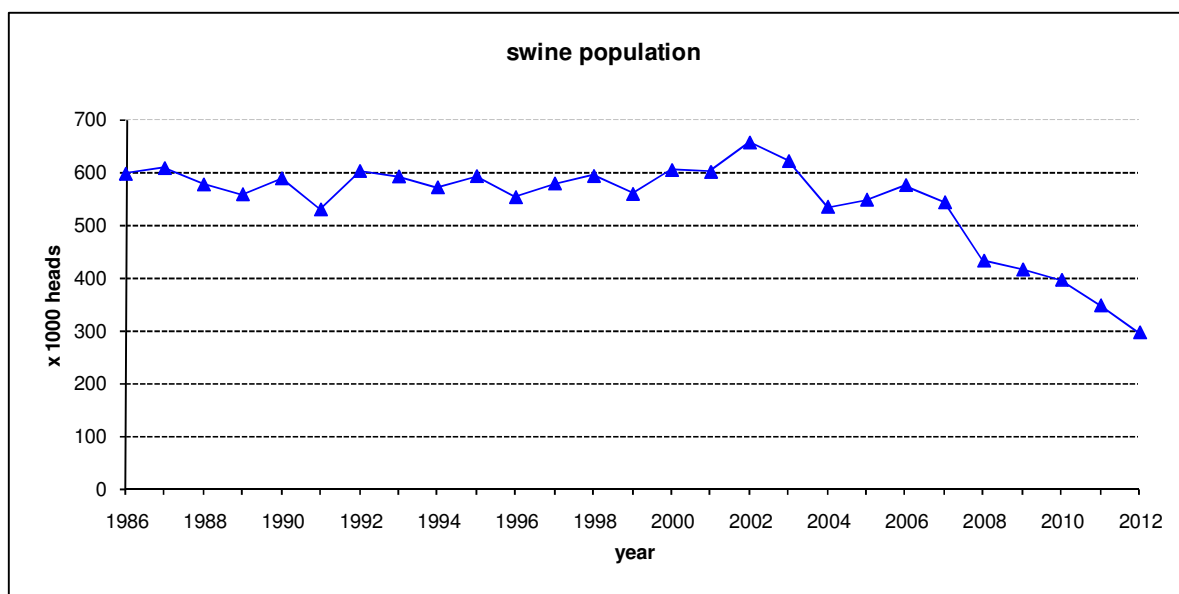


Figure 6.1.5: Number of swine in thousands.

6.1.3 Uncertainties and time-series consistency

Data on the number of livestock are not collected according to ownership of the livestock but according to who manages the livestock. The sample for the statistical survey on the number of livestock is selected according to the sampling methodology. Data collected using 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 represent a specific weight in their size class. Based on information from SORS, the uncertainty of activity data is 10%.

According to 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 the range 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

Very minor recalculations have occurred for the years 2010 and 2011 due to the updated data on population of horses.

6.1.5 Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

6.2 CH₄ Emissions from Manure Management

	Animal type	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Dairy Cattle	Level	CH ₄	0.59		35	
	Swine	Level	CH ₄	0.88		29	
2012	Dairy Cattle	Level	CH ₄	0.48	0.18	30	
	Non-dairy Cattle	Level, Trend	CH ₄	0.57	0.54	28	34
	Swine	Level, Trend	CH ₄	0.31	0.97	26	24

goats, horses, sheep, poultry

Key category - Base year: no

Key category - Year 2012: no

6.2.1 Source category description

In storing solid and/or liquid manure, both methane and N₂O are emitted. Emissions depend largely on the type of manure storage. Methane arises in significantly larger amounts when manure is managed as slurry, while N₂O prevails in storage of solid manure.

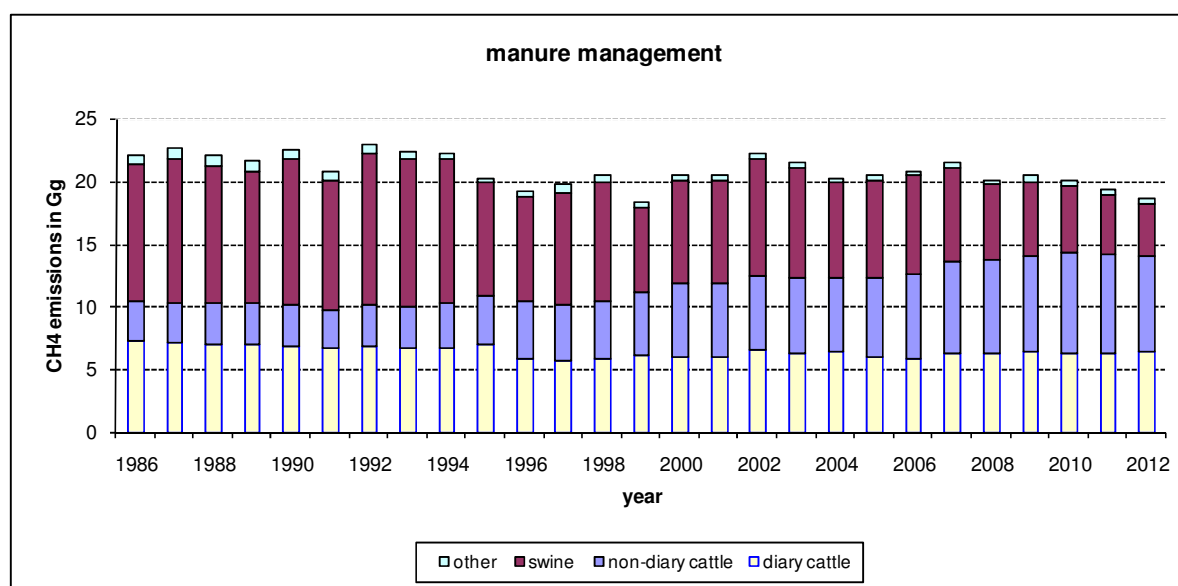


Figure 6.2.1: CH₄ emissions from manure management in Gg.

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 m³ 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).

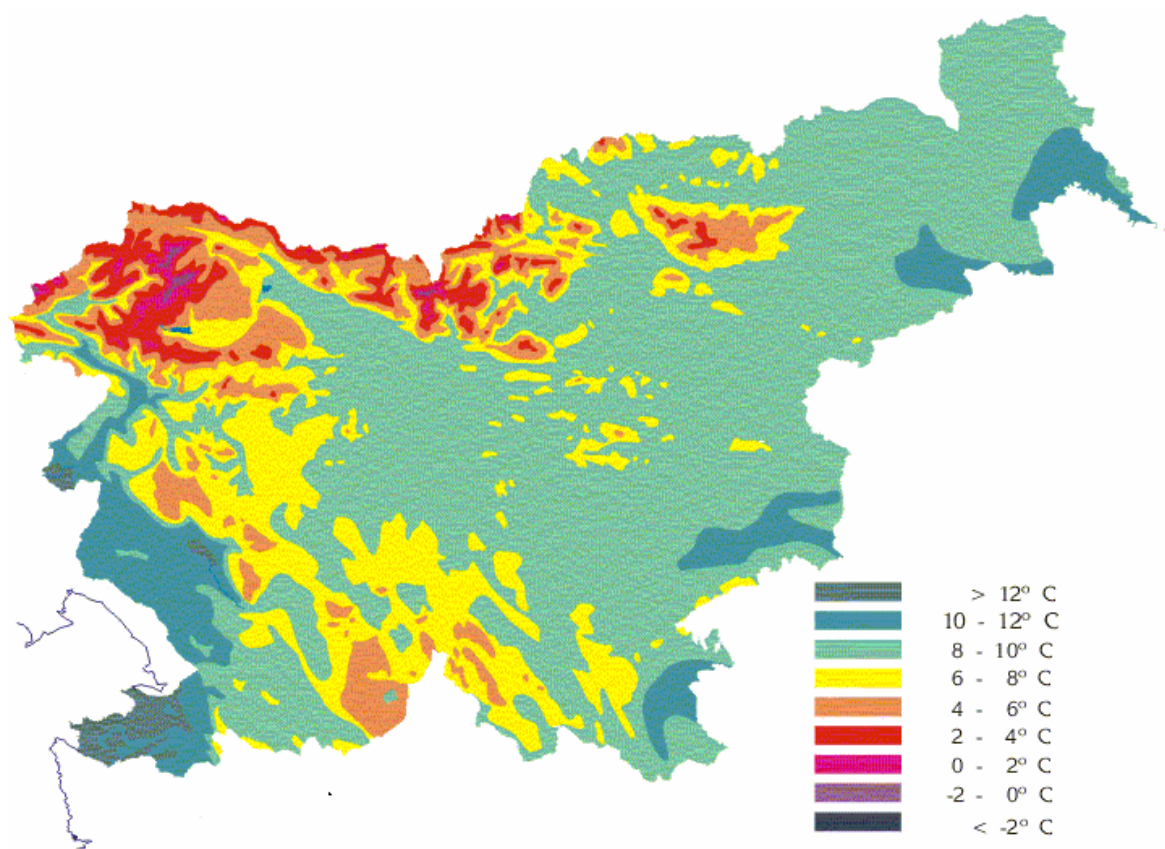


Figure 6.2.2: The average yearly temperature in Slovenia.

(http://www.arso.gov.si/podro-cja/vreme_in_podnebie/napovedi_in_podatki/temperaturna_karta.html)

6.2.2 Methodological issues

6.2.2.1 Cattle

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

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

As for methane producing capacity of manure B_0 for dairy cows, the value of 0.24 m³/kg VS was considered, for other bovine animals it was 0.17 m³/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 heads 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 SORS 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 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 reliable. In 2010 data for the sample survey on agricultural production methods were collected for the first time along with the Agriculture Census (SORS). It gave considerably lower value for liquid systems (29.1%). The results are difficult to explain. Due to fact that there are no historical data on agricultural production methods it was decided to preserve the consistency of time series and to retain estimates based on farm structure. A decision whether to adopt new values based on sample survey data or not will be reconsidered until the next submission of NIR.

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 were 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 will graze for 141 days on the average, 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 2000-2012. 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. Census data regarding the proportion of grazed animals are not available for 2010. However, there are data of the sample survey on agricultural production methods in 2010 which are very close to 2000 census data (12.6 vs. 11.7 %, values corrected for the length of grazing season). It is intended to adopt the new estimates (sample survey data 2010) before the next year submission of NIR

Data on the number of livestock were the same as those used for calculating methane emissions from enteric fermentation. Emission factors are presented in the table 6.2.1.

After performing the Tier 2 QA/QC procedures we have found out that the CH₄ IEF for dairy cattle is the highest of the reporting parties. After performing standard checks no mistakes have been found in the calculation. When comparing all parameters used, we have 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%, 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: CH₄ EFs for cattle for manure management in 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
	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
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Dairy cattle	48.1	49.7	51.4	53.2	54.9	55.9	57.5	57.5	57.8
Non-dairy c.	18.5	19.0	19.8	20.3	21.0	21.5	22.2	22.2	21.9

Based on “encouragement” from AAR 2010, we have investigated which MCF from IPCC 2006 guidelines is the most appropriate. Since liquid-base systems have the heaviest impact on EF and are also very sensitive to temperature effects, we have decided to take 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). 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 in kg/head/year using MCF 39% and MCF 20%

	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
	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
	2004	2005	2006	2007	2008	2009	2010	2011	2012
MCF 39%	48.1	49.7	51.4	53.2	54.9	55.9	57.5	57.5	57.8
MCF 20%	25.3	26.1	27.0	27.9	28.7	29.2	30.0	30.0	30.2

Although EFs, when using MCF from IPCC 2006, seem more appropriate for cool climate, we decided to not use it for the GHG inventory until IPCC 2006 guidelines would be accepted as official manual for GHG inventories. We also believe that because our base year emissions have been calculated with MCF 39%, it is more appropriate that we continue using this value until the end of the Kyoto period.

6.2.2.2 Swine

Activity data

The population of swine (Figure 6.2.3) is divided into three segments:

- a) commercial pig farms,
- b) market oriented family farms, and
- c) small scale family farms.

Data published by the SORS allow a breakdown of the entire herd into commercial pig farms and family farms for the period 1986-2002. 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 SORS. 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 kept on farms with up to 10 pigs have been considered as small scale family farm production, pigs on family farms breeding more than 10 pigs have been considered as market oriented family farm production. From 1986 to 2000, the fraction of pigs in small scale family farm production 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 SORS. 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, 2008-2012) the numbers of pigs on small scale family farms were obtained by interpolating the values for neighbouring years. In the case of the time period 2008-2012, the estimate was done by extrapolation of values for 2006 and 2007. Further decrease of pigs on farms keeping less than 10 pigs was observed during the period 2000-2012.

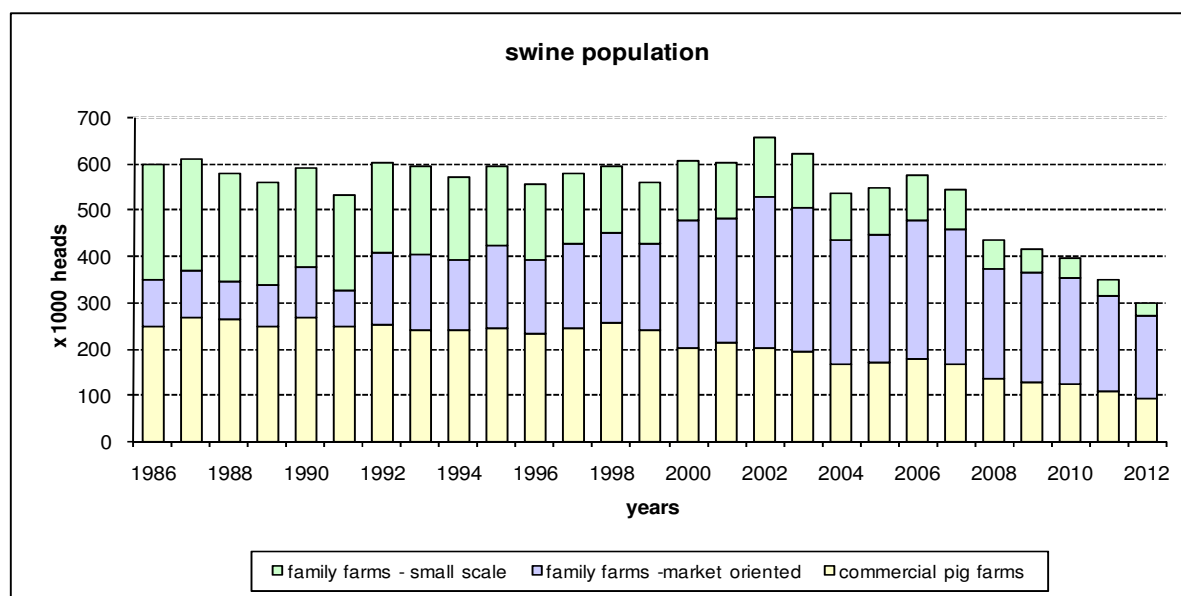


Figure 6.2.3: Number of swine in thousands.

Emission factor

Annual emissions of methane ($E_{M \text{ MANURE}}$) have been estimated according to the IPCC method. Quantities of excreted volatile solids (VS) have been calculated using default value of 0.5 kg of VS/day (IPCC, 1996). For the methane-producing capacity of manure B_0 , the value for swine (0.45 m³/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.

Years from 1995 to 1999 were 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 mechanic separation separated 80% of VS on that commercial farm, while the remainder (20%) was captured as biogas. For large commercial farms it is generally considered that the ratio between the liquid part, which flows off to lagoons, and the liquid part, which is used as fertilizer, is the same as prior to 1995 (3:1). The estimated average manure conversion factor $K_{F \text{ MANURE}}$ for that period was 0.378. Due to new farm reconstructions leading to improved slurry separation and introduction of additional capacity of anaerobic digesters, the methane conversion factor MCF on big farms after 1999 had decreased to 0.213 until 2005 and further to 0.112 in 2012.

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) was used for calculations until 2006. Since then, farm reconstructions occurred also on family farms and average MCF has decreased to 0.363 in 2012.

Table 6.2.3: CH₄ EFs in kg/head/year for swine for manure management.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
CH₄ EFs	18.2	19.0	19.1	19.0	19.8	19.5	20.0	20.0	20.3
	1995	1996	1997	1998	1999	2000	2001	2002	2003
CH₄ EFs	15.2	15.1	15.6	16.0	12.2	13.6	13.6	14.1	14.2
	2004	2005	2006	2007	2008	2009	2010	2011	2012
CH₄ EFs	14.2	14.3	13.8	13.9	13.8	14.2	13.6	13.8	14.1

Small scale family farm production

For small scale family farm production, it is estimated that 95% of pigs are 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.

In 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.

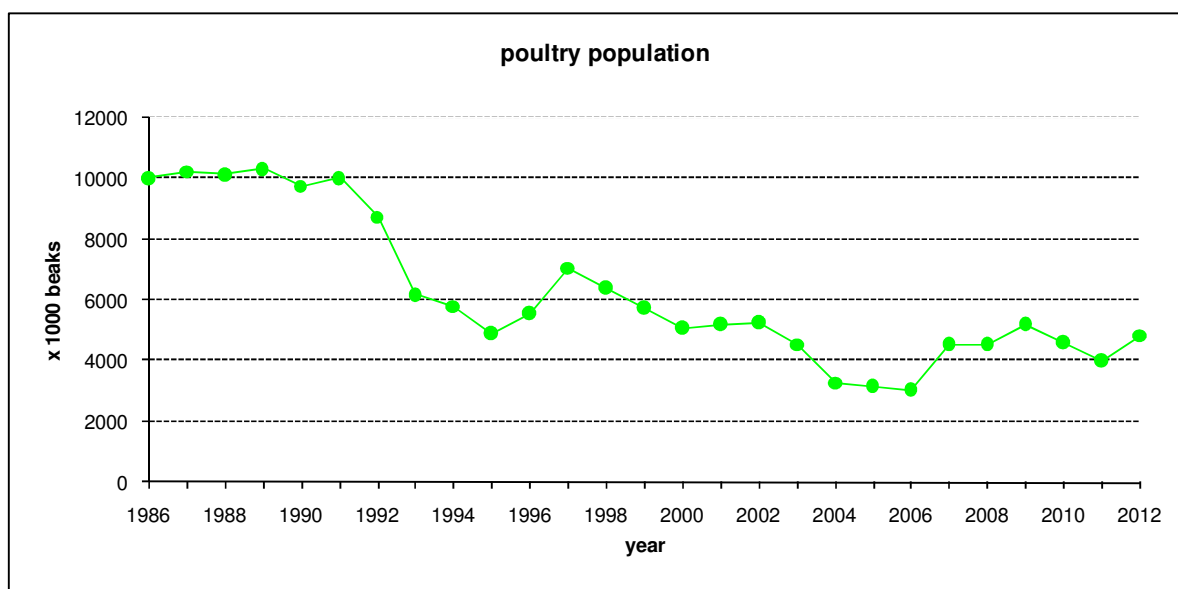


Figure 6.2.4: Number of poultry in thousands.

6.2.3 Uncertainties and time-series consistency

Uncertainty of activity data amounts to 10% (Source: SORS, KIS)

There is no suggestion for uncertainty in the IPCC GPG. It is our experts' judgement that EFs for manure management are less accurate than those 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

Very minor recalculations have occurred for the years 2010 and 2011 due to the updated data on population of horses.

6.2.5 Future improvements

A decision whether to adopt new values based on sample survey on agriculture production methods to prepare new estimatin for allocation data for cattle will be reconsidered and recalculation will be performed if necessary.

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

6.3 N₂O Emissions from Manure Management

	MMS	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Solid storage and dry lot	Level	N ₂ O	1.03		26	
2012	Solid storage and dry lot	Level	N ₂ O	0.45	0.11	31	23

Liquid systems, Anaerobic lagoons, other systems: Key category - Base year: no
Key category - Year 2012: 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.

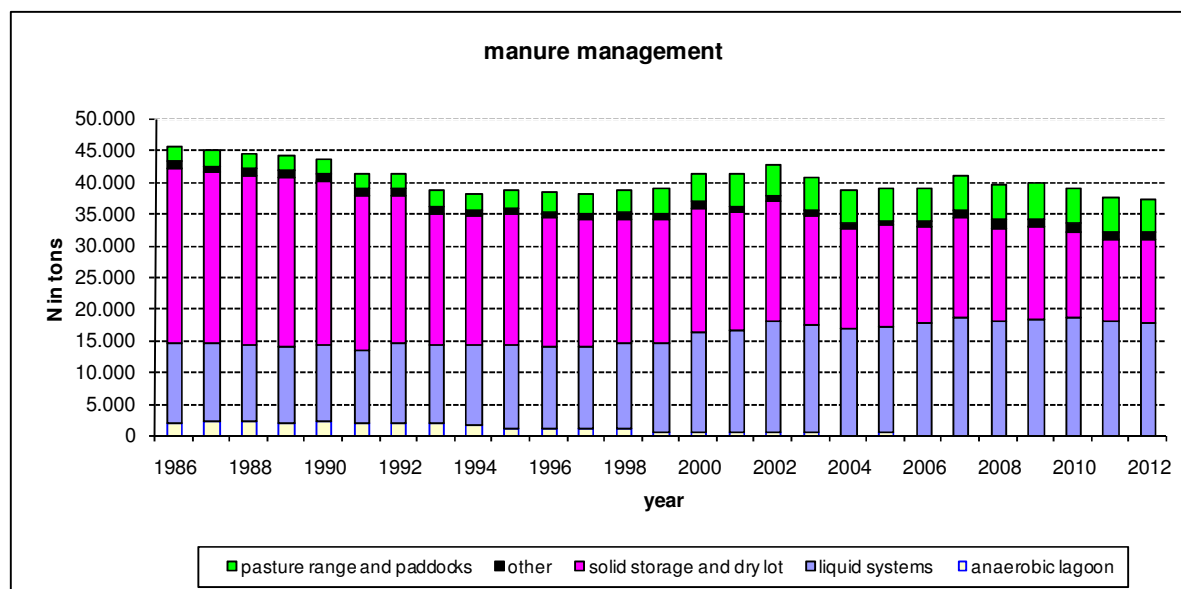


Figure 6.3.1: Nitrogen excretion per different AWMS in tons.

6.3.2 Methodological issues

Emissions of nitrous oxide (Figure 6.3.1), arising during manure storage, have been estimated on the basis of data on the number of farm animals in Slovenia, allocation data on usage of different AWMS and nitrogen excretion rates of individual animal species and categories.

The manure management system usage data used to estimate N₂O emissions from manure management are the same as those used to estimate CH₄ emissions from manure management and are presented in the Figure 6.3.2 and in the Annex 3 to NIR.

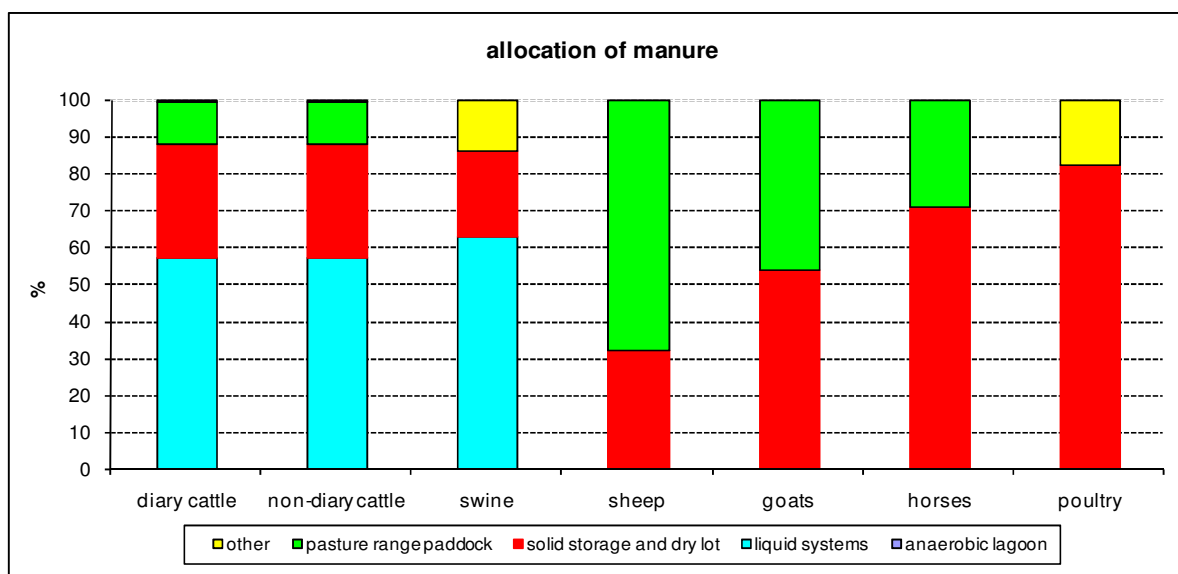


Figure 6.3.2: Use of different AWMS by animal type in 2012.

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) has been used:

$$N \text{ excretion (kg/year)} = 52.5 + 0.0105 \times M \text{ (kg/year)}$$

and the results are presented in the table 6.3.1.

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). Nitrogen excretion rates for non-dairy cattle varied between 35 and 42.6 kg kg of N per year (Table 6.3.2). As fixed N excretion values were used for suckling cows and other bovine animals the variation was due exclusively to changes in the proportions of the above mentioned cattle categories.

Table 6.3.1: Nitrogen excretion rates for dairy cattle in kg/head/year.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Nex	82.1	81.5	81.6	81.8	81.6	86.6	82.3	81.9	84.1
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Nex	85.8	92.7	94.2	95.5	97.1	101.1	103.0	107.1	105.7
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Nex	103.5	110.0	112.4	112.6	113.0	110.6	110.4	110.4	111.2

Table 6.3.2: Nitrogen excretion rates for non-dairy cattle.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Nex	35.0	35.0	35.0	35.0	35.0	35.8	35.9	36.3	36.5
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Nex	37.2	39.1	40.0	39.9	39.9	41.6	41.6	42.1	42.4
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Nex	41.5	42.4	42.6	42.3	42.5	42.3	42.6	42.5	42.0

For sows and pregnant gilts 36 kg of N per year was used 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). The country specific nitrogen excretion rate for pigs vary between 11.6 and 13.1 kg per year. These values were obtained by dividing the total N excretion (as estimated on the basis of the number of sows, pregnant gilts and fattening pigs) by the number of total pig population (including piglets, un-pregnant gilts and boars). Therefore, the values for country specific nitrogen excretion rate seems apparently to low when compared to values for sows, pregnant gilts and fattening pigs.

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 several reasons why Slovenia did not use IPCC default value for N excretion rates.

The first one 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 have agreed to use N excretion rates from Menzi, 1997 for cattle and EMEP/CORINAIR for swine. With this choice we have harmonised our reporting of NH₃ emissions for CLRTAP with GHG reporting. This was also important because at that time began to build our common database with the aim to calculate emissions for both conventions on the base of the same data and same methodological approaches, where possible.

The second reason is that the 1996 Reference Guidelines states that default nitrogen excretion rates from Table 4-20 need further attention and that they might be too high for cattle and swine. There is also suggestion to use data from Ammonia Expert Panel of the UN-ECE when available. We have used results from AEP (EMEP/CORINAIR) for swine, while Swiss data have been taken for cattle due to close resemblance of cattle production in both countries. According to 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.

Table 6.3.3: Nex for non-dairy cattle, calculated according to IPCC methodology.

2012	population	default Nex	adj. factor	Nex
young cattle (under 1 year)	146,560	70	0.3	21
young cattle (1-2 years)	120,016	70	0.6	42
non-dairy cattle over 2 years	82,465	70	1	70
non-dairy cattle (total)	349,041			39.8
Used in submission 2014				42.0

To verify Nex used for non-dairy cattle we have calculated 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 2012 is in the Table 6.3.3. For non-dairy cattle the Nex value is 39.8 kg/head/year, which is a little lower than Nex value we have used for 2012 and 2014 submission. For the previous years the verification process has given similar results.

We are not able to perform the same verification procedure also for swine due to 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 for others, we get value 10.89 kg N/animal/year, which is probably too low, because not all fattening pigs are younger than 6 months.

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

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

Following recommendation from 2011 review, Nex used in Slovenia has been compared to the value used in neighbouring countries and other European countries with similar management practice. The comparison has been made with 2009 data. The N excretion rate of swine as reported by Slovenia is the second highest in the 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 comprising anaerobic digesters and poultry manure without bedding has changed from 0.005 to 0.0035 kg N_2O -N /kg N. IPCC default value equals to 0.005 kg N_2O -N /kg N. The biggest decrease in IEF in 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 in 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 experts (Verbič, 2004). It was estimated that during the grazing season all sheep, 80% of goats and 50% of horses are put out to the pasture. 215 days of grazing season have been considered for sheep and 210 for goats and horses. It has been considered that these animals were in straw based systems for the remaining period.

For poultry, floor system on bedding was assumed for broilers, and combined floor system (1/4) and battery-cage systems (3/4) were assumed for layers and allocated to other systems.

6.3.3 Uncertainties and time-series consistency

Activity data consist of data on livestock populations, nitrogen excretion rates and MMS usage. The Nex has the larger contribution to the uncertainty of activity data. IPCC GPG suggests 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 reflect 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

Very minor recalculations have occurred for the years 2010 and 2011 due to the updated data on population of horses.

6.3.5 Future improvements

A decision whether to adopt new values based on sample survey on agriculture production methods to prepare new estimatin for allocation data for cattle will be reconsidered and recalculation will be performed if necessary.

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

6.4 Emissions from Agricultural Soils

	Emissions from Agricultural Soils	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Direct	Level	N ₂ O	1.68		14	
	Indirect	Level	N ₂ O	1.29		28	
2012	Direct	Level, Trend	N ₂ O	1.29	0.66	12	33
	Indirect	Level, Trend	N ₂ O	1.00	0.50	16	36

Three sources of N₂O are distinguished in the IPCC methodology: direct emissions from agricultural soil, direct soil emissions from animal production (grazing animals) and N₂O emissions indirectly induced by agricultural activities.

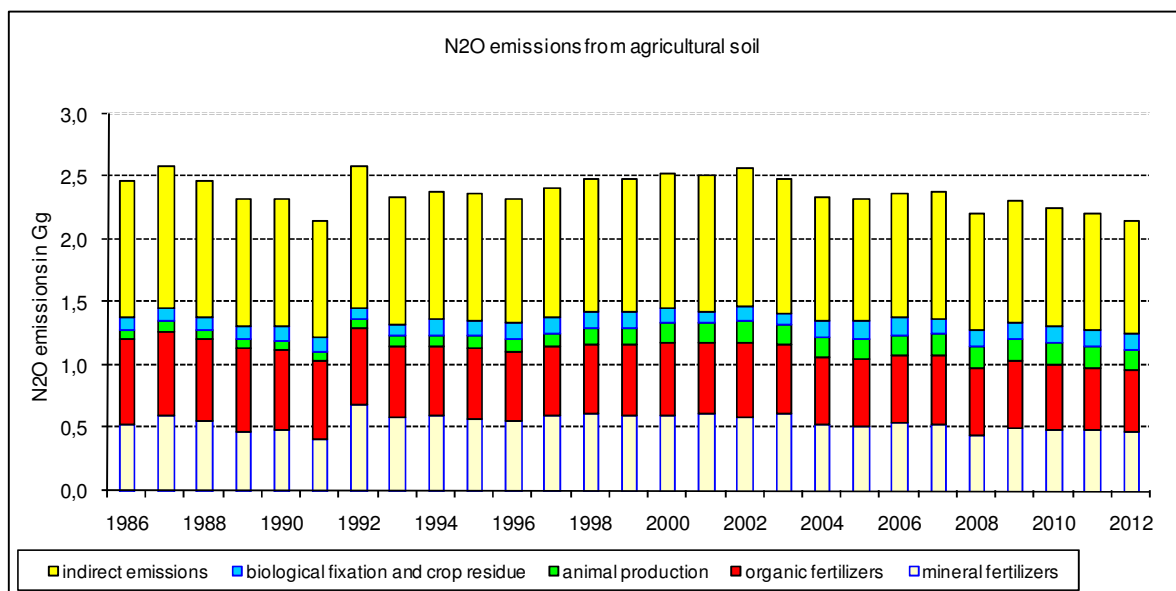


Figure 6.4.0: N₂O emissions from agricultural soil in Gg.

6.4.1 Direct N₂O Emissions from Agricultural Soil

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 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.

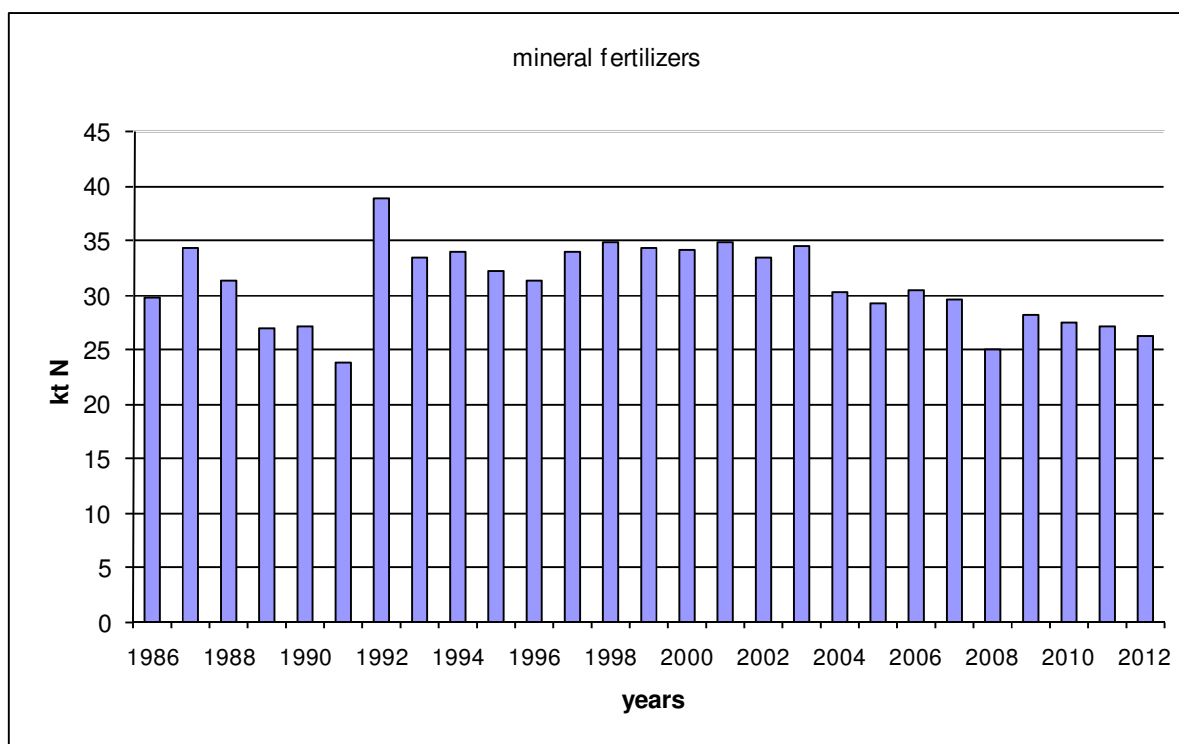


Figure 6.4.1: Amount of mineral fertilizers in kt N.

From 1987-1991 on the figure 6.4.1, use of fertilizers shows constant decrease and a sharp increase in 1992 – the amount of fertilizers used in 1992 is the highest in the whole reporting period. One of the reasons is reduction in industrial production, poor economic situation and war for independence in 1991. In 1992, Slovenia became independent and economic situation started to improve. It is very likely that farmers did not use all fertilizers in the year 1992, had just renewed their stocks. The consumption of N fertilizers per hectare of utilised agricultural area in Slovenian agriculture was decreasing from 2001 to 2008. The decrease is attributable to measures of Rural Development Programme which stimulates 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.

N, which is dispersed into the atmosphere in the form of ammonia and NO_x (10%; IPCC, 1996), was subtracted from the total estimated quantity of emitted N. 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 N₂O-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 (N₂O Emissions from Manure Management).

We have estimated emissions according to the default method from IPCC GPG Equation 4.23. We have subtracted the N that is emitted on the pasture and N that is dispersed into the atmosphere in the form of ammonia and NO_x from the total estimated quantity of emitted N. 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 N₂O-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 (SORS) 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 where 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 N₂O-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 N₂O-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 soil 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 of 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.

Comparing and covering of data from both maps we determined that 9,902 ha of organic soil was agriculture land and that 6,665 ha was arable land in 2002.

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 6 per cent lower in 2002 than in 1991.

Table 6.4.3: Area of cultivated organic soil in ha and N₂O emissions in CO₂ eq.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Area	7405	7338	7270	7203	7136	7069	7001	6934	6867
N₂O	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	6800	6732	6665	6695	6725	6755	6786	6816	6846
N₂O	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	6876	6906	6885	6864	6868	6884	6891	6854	6864
N₂O	26.80	26.91	26.83	26.75	26.77	26.83	26.86	26.71	26.75

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

Code	Utilized area (ha)	2005	2010	2011	2012
1100	Arable land	3232	2259	2320	2330
1180	Other permanent crops on arable land	0	1	1	1
1190	Greenhouses	0	0	0	0
1211	Vineyards	0	0	0	0
1221	Intensive orchards	0	18	23	23
1222	Extensive orchard	7	10	13	13
1240	Other permanent crop	16	0	0	0
1300	Meadows and pastures	763	279	225	225
1321	Swampy meadows and pastures	2294	3717	3677	3677
1410	Overgrown areas	112	217	279	279
1420	Forest plantation	127	10	10	10
1500	Mixed land use area	354	306	262	262
1600	Uncultivated agriculture land	0	71	38	38
1800	Forest trees on agricultural land	0	2	3	3
2000	Forest	788	920	924	924
3000	Built-up areas and related surfaces	364	398	438	438
4100	Swamps	58	45	33	33
4210	Reeds	11	13	13	13
4220	Other marshy areas	55	26	24	24
7000	Waters	110	90	98	98
Total	Use of histosols (all uses)	8291	8383	8383	8393
Total	Agricultural use of hist. (1100-1800)	6906	6891	6854	6864
Total	Cultivated histosols (1100 - 1240)	3255	2289	2358	2368

Detailed data about use of agricultural area for 2005, 2010, 2011, and 2012 are in the Table 6.4.4. The data for 2006 have been interpolated. For the N₂O emission, we have taken 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 N₂O emissions from the sewage sludge have been included in Slovenian GHG inventory for the period 2000-2008 in resubmission on October 16, 2010. In this year's submission, the data before 2000 have been included. In Slovenia fertilisation by sewage sludge is extremely low due to the very rigorous restrictions listed in the environmental permit. In 2010, N₂O emissions from sewage sludge amounted to 0.09 Gg CO₂ eq.

Activity data

Since 2000, data on sewage sludge applied to 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 NH₃ and NO_x 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 NH₃ and NO_x

N_{SS} = annual amount of sewage sludge nitrogen

Frac_{SS} = fraction of sewage sludge nitrogen that volatilises as NH₃ and NO_x

For the calculation of NH₃ volatilisation the CORINAIR default emission factor for slurry spreading (0.15 kg NH₃-N per kg sewage sludge N) was applied (EEA 2007) while for NO_x-N losses the conservative emission factor of 1% of sewage sludge nitrogen (Freibauer and Kaltschmitt, 2001) has been used. Frac_{SS} used is therefore 0.16. All these values have been taken from Austrian GHG inventory submission 2010.

The direct N₂O emissions are calculated according to the equation:

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

For EF_{DIR} IPCC default value of 0.0125 kg N_2O -N/kg N has been used. The results are presented in the table below.

Table 6.4.5: Data used for calculation of direct soil emissions.

Year	Sewage sludge applied kg dm	Sewage sludge kg N	Frac _{SS}	Sewage sludge applied kg N	EF kg N_2O - N/kg N	Emissions kg N_2O	Emissions Gg CO_2 eq.
1986-1995	2,000,000	78,000	0.16	65,520	0.0125	1287	0.399
1996	1.800,000	70,200	0.16	58,968	0.0125	1158	0.395
1997	1.600,000	62,400	0.16	52,416	0.0125	1030	0.319
1998	1,400,000	54,600	0.16	45,864	0.0125	901	0.279
1999	850,000	33,150	0.16	27,846	0.0125	547	0.170
2000	300,000	11,700	0.16	9,828	0.0125	193	0.060
2001	500,000	19,500	0.16	16,380	0.0125	322	0.100
2002	1,100,000	42,900	0.16	36,036	0.0125	708	0.219
2003	455,000	17,745	0.16	14,906	0.0125	293	0.091
2004	126,000	4,914	0.16	4,128	0.0125	81	0.025
2005	71,160	2,775	0.16	2,331	0.0125	46	0.014
2006	27,300	1,065	0.16	894	0.0125	18	0.005
2007	18,200	710	0.16	596	0.0125	12	0.004
2008	10,200	398	0.16	334	0.0125	6	0.002
2009	10,515	410	0.16	344	0.0125	7	0.002
2010	455,000	17,745	0.16	14,906	0.0125	293	0.091
2011	1,000	39	0.16	33	0.0125	1	0.000
2012	1,000	39	0.16	33	0.0125	1	0.000

6.4.1.3 Uncertainties and time-series consistency

Uncertainty estimates are 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

Very minor recalculations have occurred for the years 2010 and 2011 due to the updated data on population of horses.

6.4.1.5 Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

6.4.2 Nitrous oxide emissions from grazing animals

Key category - Base year: no

Key category - Year 2012: 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 (N₂O Emissions from Manure Management). IPCC methodology (1996) suggests using the same emission factor (0.02 kg N₂O-N/kg of emitted N) for all grazing animals, regardless of their species and the climatic conditions.

Uncertainties and time-series consistency

Uncertainty estimates are 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

Very minor recalculations have occurred for the years 2010 and 2011 due to the updated data on population of horses.

Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

6.4.3 Indirect N₂O emissions from Agricultural Soil

6.4.3.1 Source category description

The most important indirect sources of nitrous oxide are (Figure 6.4.1):

- Volatilisation of ammonia and nitrogen oxides (NO_x)
- Nitrogen leaching and runoff
- Municipal sewage sludge

6.4.3.2 Methodological issues

Nitrous oxide arising due to volatilization of NH₃ and NO_x

In fertilizing agricultural soils with nitrogen fertilizers, some N volatilises in form of ammonia and nitrogen oxides (NO_x). This N has not been considered in determining emissions from fertilizing with mineral fertilizers (4.D.1.1), organic fertilizers (4.D.1.2) 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 N₂O. Emissions are attributed to the place of origin of ammonia and NO_x, not to the place where N is re-deposited, causing N₂O 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 N₂O-N/kg NH₃ and NO_x-N (IPCC, 1996) has been considered.

Emissions from animal manure

Numerous factors influence the fraction of volatilised N in form of ammonia and nitrogen oxides, such as: the ratio between N excreted in dung and N excreted in urine, the manner of slurry storage, the manner of slurry application etc. In spite of differences, IPCC (1996), for the time being, suggests a generic emission factor; 20% of the excreted N are supposed to volatilise in form of ammonia and nitrogen oxides. Emissions of nitrous oxide have been calculated by multiplying the estimated quantities of volatilised N with emission factor of 0.01 kg N₂O-N/kg NH₃-N and NO_x-N (IPCC, 1996).

Emissions from sewage sludge

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

N₂O emissions from atmospheric deposition of NO_x and NH₃ are calculated according to the equation below:

$$N_2O = N_{SS} * Frac_{SS} * EF_{AD} * 44/28$$

Where EF_{AD} is IPCC default 0.01 kg N₂O -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, during decomposition, releases 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 N₂O-N is emitted (IPCC, 1996). The applied emission factor is a sum of partial factors (denitrification in soil or in groundwater 15 g N₂O-N/kg N, denitrification in river sediments 2.5 g N₂O-N/kg N, nitrification in rivers 5 g N₂O-N/kg N, nitrification in estuaries 2.5 g N₂O-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 N₂O-N/kg of leached/run-off N).

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

Emissions of N₂O from leaching/runoff of applied or deposited nitrogen was calculated according the equation bellow:

$$N_2O_{LEACH} = N_{SS} * Frac_{LEACH} * EF_{LEACH} * 44/28$$

Where $Frac_{LEACH}$ is IPCC default 0.3 kg N/kg N input to the soils and EF_{LEACH} is IPCC default 0.025 kg N₂O-N/kg N.

6.4.3.3 Uncertainties and time-series consistency

Uncertainty estimates are 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

Very minor recalculations have occurred for the years 2010 and 2011 due to the updated data on population of horses.

6.4.3.5 Future improvements

A decision whether to adopt new values based on sample survey on agriculture production methods to prepare new estimatin for allocation data for cattle will be reconsidered and recalculation will be performed if necessary.

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

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 starts at EARS, where all necessary data obtained from SORS are inserted into the excel spreadsheets. This file is then sent to KIS, where agricultural experts check their calculations comparing then with the ones in the spreadsheets. All differences are then discussed and corrected, if necessary.

At the Agricultural Institute of Slovenia, a special Animal Science Department was founded to make additional research on animal breeding. Two services are focused specially 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 ones 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 final checks. Writing the relevant chapter for NIR undergoes the same procedure.

Besides QA/QC procedures described above, the following Tier 2 QA/QC procedures have been performed for the submission 2012:

- Enteric fermentation - CH₄ – Country specific CH₄ EF for cattle has been compared with IPCC default
- Manure management – CH₄ - Country specific CH₄ EFs for cattle and swine have been compared with IPCC default and with EFs used in other European countries with similar climate
- Manure management – N₂O – 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)

	Forrest Land	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	FL remaining FL	Level	CO ₂	10.75		2	
	Land converted to FL	Level	CO ₂	3.23		5	
2012	FL remaining FL	Level, Trend	CO ₂	21.04	17.58	1	2
	Land converted to FL	Level, Trend	CO ₂	2.99	0.42	6	38

	Cropland	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	CL remaining CL	Level	CO ₂	0.87		30	
	Land converted to CL	Level	CO ₂	0.98		28	
2012	CL remaining CL	Level, Trend	CO ₂	0.66	0.35	25	41
	Land converted to CL	Level	CO ₂	1.01	0.06	16	

	Grassland	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Land converted to GL	Level	CO ₂	2.92		7	
2012	Land converted to GL	Level, Trend	CO ₂	3.42	0.84	5	28

	Settlements	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Land converted to SM	Level	CO ₂	2.46		9	
2012	Land converted to SM	Level	CO ₂	2.50	0.06	7	

	Other Land	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Land converted to OL	Level	CO ₂	0.58		36	
2012	Land converted to OL	Level	CO ₂	0.61	0.05	26	

7.1 Overview over the Sector

The Land Use, Land-Use Change and Forestry (LULUCF) sector in 2012 as a whole functioned as a CO₂ sink of -4,375.11 Gg CO₂, because total emissions arising from the sector were smaller than total removals.

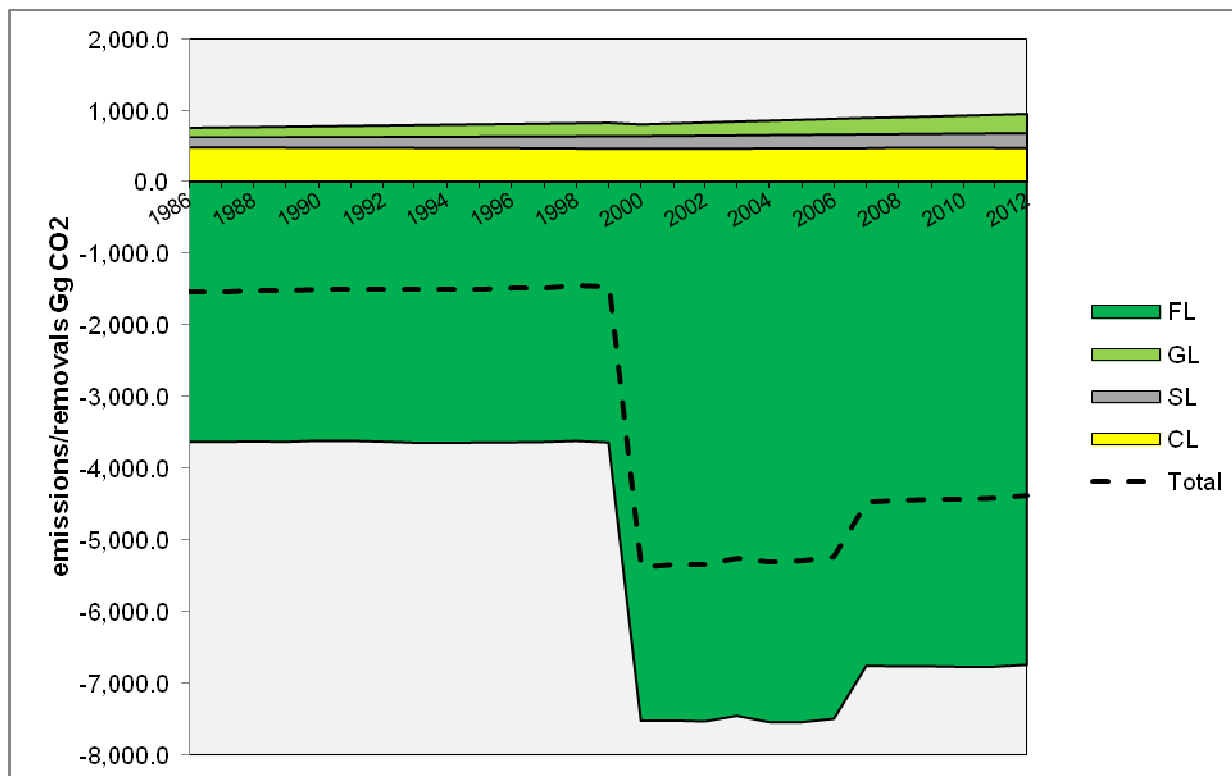


Figure 7.1: Net emissions and removals in the LULUCF sector in 1986-2012 by land-use category, Gg CO₂.

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 Land Use, Land-Use Change and Forestry (IPCC 2003, hereinafter GPG2003), 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 N₂O emissions from N fertilization, N₂O emissions from drainage of soils, N₂O emissions from disturbance associated with land-use conversion to cropland, CO₂ emissions from agricultural lime application, and non-CO₂ 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 GPG2003 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.

Areas of all land uses in reporting year are presented in Table 7.1.1

Table 7.1.1: Land use by categories in year 2012.

Area	kha	%
Forest land	1,209.55	59.66
Cropland	237.24	11.70
Grassland	427.42	21.08
Wetlands	13.76	0.68
Settlements	109.04	5.38
Other land	30.29	1.49
Sum	2,027.30	100.00

Table 7.1.2 summarizes the CO₂ emissions and removals in consequence of carbon losses and gains for the years 1986 – 2012. The total net removals of CO₂ from LULUCF sector from 1986 to 2012 vary between -1,454.18 Gg (1998) and -5,367.66 Gg (2000). The main sink category in LULUCF in Slovenia is Forest land remaining Forest land.

Table 7.1.2: CO₂ emissions and removals from LULUCF sector by top-level land categories in Gg CO₂

Year	Total	Forest Land	Cropland	Grassland	Wetlands	Settlements	Other land
	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂
2012	-4,375.1	-6,737.7	468.0	965.5	56.2	700.6	172.3
2011	-4,414.3	-6,761.7	469.2	953.9	55.7	697.4	171.2
2010	-4,432.6	-6,764.4	469.3	942.9	55.2	694.2	170.2
2009	-4,437.7	-6,756.1	472.9	930.7	54.6	691.0	169.1
2008	-4,454.2	-6,756.3	472.9	919.2	54.1	687.8	168.0
2007	-4,468.3	-6,748.6	465.3	909.8	53.6	684.7	167.0
2006	-5,226.9	-7,488.0	463.9	897.4	53.0	681.0	165.8
2005	-5,293.7	-7,535.6	462.6	885.0	52.4	677.4	164.6
2004	-5,312.5	-7,534.7	461.1	872.2	51.7	673.8	163.3
2003	-5,244.9	-7,447.3	459.6	859.4	51.1	670.2	162.1
2002	-5,342.4	-7,525.2	458.1	846.6	50.5	666.6	160.9
2001	-5,347.7	-7,512.0	458.3	833.3	49.9	662.9	159.7
2000	-5,367.7	-7,513.3	458.4	820.1	49.3	659.3	158.5
1999	-1,468.0	-3,634.7	459.5	842.3	49.1	657.8	158.0
1998	-1,454.2	-3,614.1	460.6	836.7	48.8	656.3	157.5
1997	-1,475.7	-3,628.9	461.7	831.1	48.6	654.8	157.0
1996	-1,484.2	-3,633.6	465.7	825.7	48.3	653.2	156.5
1995	-1,493.0	-3,636.0	467.0	820.2	48.1	651.7	156.0
1994	-1,503.8	-3,640.2	468.2	814.8	47.8	650.2	155.5
1993	-1,508.8	-3,638.2	468.8	809.4	47.6	648.7	155.0
1992	-1,501.3	-3,624.2	470.1	803.9	47.3	647.1	154.5
1991	-1,495.3	-3,611.8	471.4	798.5	47.1	645.6	153.9
1990	-1,501.1	-3,611.1	472.6	793.1	46.8	644.1	153.4
1989	-1,522.5	-3,626.1	473.9	787.6	46.5	642.6	152.9
1988	-1,525.0	-3,622.1	475.2	782.2	46.3	641.0	152.4
1987	-1,535.3	-3,626.0	476.5	776.7	46.0	639.5	151.9
1986	-1,539.8	-3,624.0	477.7	771.3	45.8	638.0	151.4

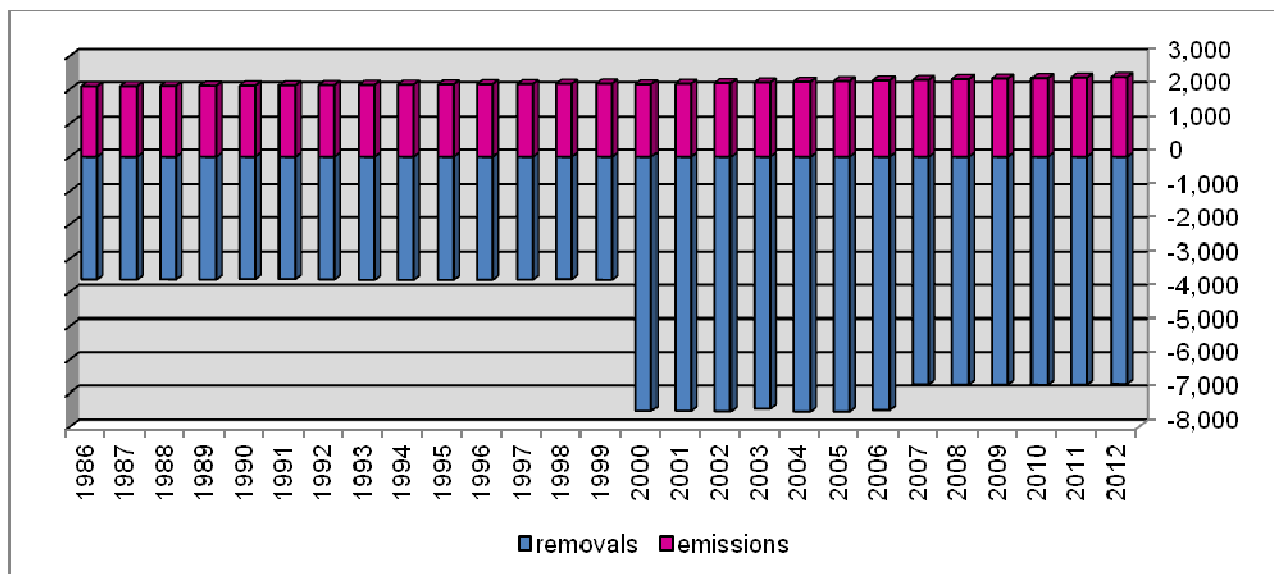


Figure 7.2: LULUCF sector emissions and removals from 1986 to 2012.

7.2 Methodological Issues for LULUCF in Slovenia

7.2.1 Land use and land use change in the period 1986-2012

In the previous National Inventory Report, an updated version of the Agricultural Land Use Map (ALUM) of Ministry of Agriculture and the Environment (MAE) was used. Two versions of ALUM map were used to capture land use changes: the one published in 2002 and the other published in 2012. This is the first Slovenian database, where directly comparable data could be used for estimation of land use change. This enabled us acquiring a much better estimation of land use change trends compared to the former auxiliary and less accurate data source used to cover land use change in earlier reports. However, changes in methodology of data acquisition in database in the 10-year period were subject to constant change due to adaptation of the common agricultural policy (EU CAP).

The ALUM 2002 and 2012 have seven main categories: agricultural land, forest, built-up areas and related surfaces, swamps and other marshy areas, dried open areas with special vegetation, open areas with little or no vegetation and, at the end, waters (Table 7.2.1 and Table 7.2.2). According to GPG2003, Slovenian land use category Agricultural land is separated in two categories: cropland and grassland; categories dried open areas with special vegetation and open areas with little or no vegetation are in one class (Table 7.2.4).

Rules and information on data processing, analysis and assessment of ALUM are defined in Slovenian legislature in the act: Rules on evidence of actual agricultural and forestal land use (UL 122/2008). ALUM is publicly available on internet on URL: <http://rkg.gov.si/GERK/WebViewer>.

ALUM is Slovenian control record for the LPIS – Land parcel identification system, which is led and coordinated by European Commission (<http://ies.jrc.ec.europa.eu/our-activities/support-for-member-states/lpis-iacs.html>).

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

Definition of forest: Land spanning more than 0.25 hectares with trees higher than 5 meters and canopy cover more than 10 percent, or trees able to reach this threshold *in situ*. It includes abandoned agricultural land with natural expansion of forest. Abandoned agricultural lands on an area larger than 0.5 ha, which have been abandoned for more than 20 years, with minimal tree height of 5.00 m and tree crown cover up to 75 %, are defined as forests.

Definition of cropland:

- **Annual:** arable land for growing non-woody vegetation (cereals, potatoes, forage crops, vegetable crops, oilseed, ornamental plants, herbs, strawberries, hop fields...) and agricultural fallow ground. Also temporary meadows and greenhouses.
- **Perennial:** permanent crops on arable land such as vineyards, extensive and intensive orchards, olive groves, nursery (for grapevines, fruit and forest trees), forest plantations and forest trees on agricultural land.

Definition of grassland: Agricultural areas overgrown by grass and other herbs which are regularly cut or grazed. These areas are not in tillage or fallow ground. Included are areas covered with some forest trees (less than 50 trees / ha) and alpine pastures. In this class there are swamp pastures and meadows on organic or mineral-organic soils, where the groundwater rises few times in the year. It includes also uncultivated agricultural land.

Definition of wetlands: there are fens and raised bogs. Vegetation is higher than on swamp pastures and meadows and there is no cutting of grass or grazing. There are areas overgrown with reeds and frequently flooded low situated areas. None of these areas is in agricultural use. This class also comprises inland water bodies (major rivers, lakes and water reservoirs).

Definition of settlements: every piece of land with buildings, roads, parking places, mines, stone pits and other infrastructure in human use.

Definition of other land: non-forest land covered with vegetation lower than 2 meters or covered less than 75 percent, which is not used in agriculture. It also comprises areas with little or no vegetation as rocks, sands, sand banks (bigger than 5000 m²), waste and other opened areas. This land is not classified in other land use definitions.

In NIR 2009, three National land use classes were included in the forest land area: forest (ID 2000), overgrown areas (ID 1410), and dried open areas with special vegetation (ID 5000). The latter category (ID 5000) is not comparable with definition of forest land. This class is in category Other land now.

Classification of national land use classes from ALUM into six main categories from GPG2003 is presented in the next tables (Table 7.2.1, Table 7.2.2 and Table 7.2.4).

Table 7.2.1: 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 7.2.2: Categories in ALUM in 2012

Main category	National class ID	Remarks
Arable land		
	1100	Arable land
	1130	Temporary meadows
	1160	Hop fields
	1180	Other permanent crops on arable land
	1190	Green houses
	1211	Vineyards
	1212	Nursery
	1221	Intensive orchards
	1222	Extensive orchards
	1230	Olive groves
	1240	Other permanent crops
	1300	Meadows and pastures
	1321	Swampy meadows and pastures
	1330	Alpine meadows
	1410	Overgrown areas
	1420	Forest plantation
	1500	Mixed land use areas (arable land and forest, small areas)
	1600	Uncultivated agriculture land
	1800	Forest trees on agricultural land
Forest		
	2000	Forest
Built-up areas and related surfaces		
	3000	Built-up areas and related surfaces
Marshy areas		
	4100	Swamps
	4210	Reeds
	4220	Other marshy areas
Dried open areas with special vegetation		
	5000	Dried open areas with special vegetation
Dried open areas with special vegetation		
	6000	Open areas with little or no vegetation
Waters		
	7000	Waters

Table 7.2.3: Uncertainties for ALUM database.

Agricultural Land Use Map	% errors in land use
ALUM 2002	4.68
ALUM 2012	4.68 or less

The uncertainty of 4.68 % was calculated in the research done by contractor of the Ministry for ALUM 2002 (source: http://rkg.gov.si/GERK/documents/RABA_PodProjD_2002.pdf). Lines of polygons (more than 15,000) on orthophoto images were re-checked, checking in the field was carried out and error matrix for all land-use categories was prepared. The

conclusion was reached (see page 41) that the percentage of errors in land use is 4.68 %, which includes topology errors, errors in photointerpretation of land use class and errors in the compliance of polygons between the borders of the captured sheets at a scale 1: 5,000 (TTN 5). It is assumed that percentage of errors in the subsequent ALUMs is even smaller, since the quality of orthophoto images and the whole QA/QC for land use upgrading system have improved.

Table 7.2.4: Categories from ALUM 2002 and 2012 classified in six main categories of GPG2003.

LULUCF category	LULUCF subcategory	National class ID	Category description
FOREST LAND	FL	2000	Forest
CROPLAND	CL_a	1100	Arable land
	CL_a	1130	Temporary meadows
	CL_a	1160	Hop fields
	CL_a	1190	Green houses
	CL_w	1180	Other permanent crops on arable land
	CL_w	1211	Vineyards
	CL_w	1212	Nursery
	CL_w	1221	Intensive orchards
	CL_w	1222	Extensive orchards
	CL_w	1230	Olive groves
	CL_w	1240	Other permanent crops
	CL_w	1420	Forest plantation
GRASSLAND	GL_a	1300	Meadows and pastures
	GL_a	1321	Swampy meadows and pastures
	GL_a	1330	Alpine meadows
	GL_a	1600	Uncultivated agriculture land
	GL_w	1410	Overgrown areas
	GL_w	1500	Mixed land use (arable land and forest, small areas)
	GL_w	1800	Forest trees on agricultural land
WETLANDS	WL	4100	Swamps
	WL	4210	Reeds
	WL	4220	Other marshy areas
	WL	7000	Waters (inland water bodies)
SETTLEMENTS	SL	3000	Built-up areas and related surfaces
OTHER LAND	OL	5000	Dried open areas with special vegetation
	OL	6000	Open areas with little or no vegetation

The cropland is divided into two subcategories: annual and perennial (woody) cropland.

7.2.1.1 Land use change matrix

The land areas in the period 2002-2012 are represented by geographically explicit land-use data with a resolution capture of 50 cm in the scale of 1:1.000 (following approach 3 for representing land areas; GPG2003). Direct and repeated assessment of land use with full spatial coverage also enables calculation of spatially explicit land-use change matrices. In 2002, the new Slovenian land-use map (ALUM) was issued by Ministry for Agriculture, Forestry and Food (MAFF, now Ministry of Agriculture and the Environment, MAE). The method is in constant use by MAE. We took the latest available map, the 2012 map, which

is based on orthophoto images taken in 2010, 2011 and 2012. With these two land-use layers we could find out the land use changes in the period 2002 - 2012. The annual figures for areas in transition between different land uses have been derived from basic assumption (based on expert judgment) that known patterns of land use changes in Slovenia are constant in nature. Yet, there are changes in the matrix as a result of adaptation of agricultural policy and forest area coordination between MAE and Slovenia Forest Service. 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 to 2002, the same annual changes were applied.

Table 7.2.5: The average annual land use change matrix for IPCC land use categories.

		to							
	2002-2012	FL	CL_a	CL_w	GL	WL	SL	OL	Total [ha/year]
from	FL		71	155	2,728	58	584	215	3,811
	CL_a	129		290	4,885	23	424	0	5,751
	CL_w	132	192		1,322	2	208	0	1,856
	GL	3,815	2,246	1,004		136	938	34	8,174
	WL	55	14	1	300		72	19	461
	SL	247	112	516	1,569	22		5	2,471
	OL	279	1	1	746	12	11		1,049
	Total [ha/year]	4,656	2,636	1,967	11,551	252	2,237	273	23,573

Note: According to expert judgment provided by Slovenian Forestry Institute, the conversions - gray shaded cells - are not occurring in the nature, but are a result of the intersection, i.e. crosstabulation process of two raster layers.

Method for establishing land use change matrix:

- Vector data of map 2002 and 2012;
- Rasterizing the data to pixel 10 × 10 m;
- Cut with the official national border;
- Reclassifying national land use classes into LULUCF subcategories according to Table 7.2.4.
- Crosstabulation of raster data to obtain the land use change matrix.

The results:

The changes resulted from the land use change matrix (Table 7.2.5) are relatively high for Slovenia. The results show that the average 1.3 % of country area per year was subject to land use change or 13.2 % of the country area in 10 years (2002-2012). Although lots of changes took place in the nature during the period 2002-2012, the extent of conversions resulting from land use change matrix is non-realistic for Slovenia. The reason for this high percentage is mainly in methodology. Majority of the converted areas is in small land use changes that occur due to the differences in polygons borders, which produce the so called sliver polygons when intersecting two layers. Furthermore, the weakness of vectorization process is a subjective photointerpretation, by which various land use types are determined in the shape of polygons. The latter were often interpreted incorrectly, in the past mostly due to poor quality of orthophotos, but later also by accident due to human subjectivity which produced unreal changes. A part of changes can be attributed to rasterization process and poor quality of orthophotos which were the basis for making the land use map in 2002 (ALUM 2002). We made a survey (Zizek Kulovec & Nastran, 2013; in review, see ppt from JRC Technical Workshop: [Zizek Kulovec: Slovenia land use change matrix](#)) in discovering discrepancies for deforestation (land converted from forest land). The survey showed that the results in land use change matrix are approximately 7-times higher than

the actual change in nature. We plan to continue our effort in establishing the land use change matrix, which will represent the actual land use changes in country more realistically.

Land use areas for each land use were calculated using the following equation:

$$Area_{LU, \text{year of inventory}} = Area_{LU, \text{previous inventory year}} + Area_{\text{land converted to LU}} \quad \text{(Equation 1)}$$

$Area_{LU, \text{year of inventory}}$ - area of selected land use category in year of inventory [ha]

$Area_{LU, \text{previous inventory year}}$ - area of selected land use category in previous year [ha]

$Area_{\text{land converted to LU}}$ - area of land converted to selected land use category [ha]

Table 7.2.6: Areas for land uses from 1986 to 2012 in kha.

Year	5. Total	5.A Forest Land	5.B. Cropland	5.C Grassland	5.D Wetland	5.E Settlement	5.F Other land
	kha	kha	kha	kha	kha	kha	kha
2012	2,027.30	1,209.55	237.24	427.42	13.76	109.04	30.30
2011	2,027.30	1,208.75	240.37	424.17	13.98	108.96	31.07
2010	2,027.30	1,207.95	243.49	420.92	14.20	108.89	31.85
2009	2,027.30	1,207.15	246.62	417.67	14.43	108.82	32.62
2008	2,027.30	1,206.34	249.75	414.42	14.65	108.74	33.40
2007	2,027.30	1,205.54	252.88	411.17	14.87	108.67	34.17
2006	2,027.30	1,204.74	256.00	407.92	15.09	108.60	34.95
2005	2,027.30	1,203.94	259.13	404.67	15.31	108.52	35.72
2004	2,027.30	1,203.14	262.26	401.43	15.53	108.45	36.50
2003	2,027.30	1,202.34	265.39	398.18	15.75	108.37	37.27
2002	2,027.30	1,201.54	268.51	394.93	15.97	108.30	38.05
2001	2,027.30	1,200.73	271.64	391.68	16.20	108.23	38.82
2000	2,027.30	1,199.93	274.77	388.43	16.42	108.15	39.60
1999	2,027.30	1,199.13	277.90	385.18	16.64	108.08	40.37
1998	2,027.30	1,198.33	281.03	381.93	16.86	108.00	41.15
1997	2,027.30	1,197.53	284.15	378.68	17.08	107.93	41.92
1996	2,027.30	1,196.73	287.28	375.43	17.30	107.86	42.70
1995	2,027.30	1,195.93	290.41	372.19	17.52	107.78	43.47
1994	2,027.30	1,195.12	293.54	368.94	17.75	107.71	44.25
1993	2,027.30	1,194.32	296.66	365.69	17.97	107.64	45.02
1992	2,027.30	1,193.52	299.79	362.44	18.19	107.56	45.80
1991	2,027.30	1,192.72	302.92	359.19	18.41	107.49	46.57
1990	2,027.30	1,191.92	306.05	355.94	18.63	107.41	47.35
1989	2,027.30	1,191.12	309.18	352.69	18.85	107.34	48.12
1988	2,027.30	1,190.32	312.30	349.44	19.07	107.27	48.90
1987	2,027.30	1,189.52	315.43	346.20	19.29	107.19	49.67
1986	2,027.30	1,188.71	318.56	342.95	19.52	107.12	50.45

7.2.2 Carbon stocks in litter and soils

The existent databases of soils 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 on soil physical and chemical properties, but no data on 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 the fact that each organic subhorizon was sampled within an area of 25×25 cm. separately. Volume of roots and coarse fragments (soil skeleton > 2 mm) were subtracted from volume of soil sample. Carbon stock in litter was calculated according to equation 2:

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

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

Table 7.2.7: Average carbon stock in litter (from 8×8 km grid survey).

Layer	Average carbon stock [$t\ ha^{-1}$]	n
O_i horizon	1.44 ± 0.15	143
O_{fh} horizon	8.85 ± 1.42	145
litter ($O_i + O_{fh}$)	10.41 ± 1.50	143

Source: Kobal et al. 2011.

SOILS

Carbon stock in mineral part of soil (SOM) was calculated from the following equation 3.

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

C_{pool} - carbon stock [$Gg\ ha^{-1}$]
 D_i - thickness [m] of soil horizon i
 ρ_i - soil bulk density [$g\ cm^{-3}$]
 k - number of subhorizon 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 4.

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

ρ_i - soil bulk density [$g\ cm^{-3}$]
 C_{org} - the organic carbon content and clay content (both in %)

The above 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).

In 2012, average carbon stock was estimated by additional field sampling on non-forest land and previous estimates were corrected. Carbon stock in mineral part of soil (SOM) was calculated for 0–40 cm soil depth. For soil horizons with the depth of the lower boundaries below 40 cm, a constant value of carbon stock within horizon was assumed.

Table 7.2.8: Average carbon stock (SOC) on 40 cm depth in mineral part of soil.

Land use	Average carbon stock [t ha ⁻¹]	The number of sampling locations
Cropland annual	80.66	15
Cropland perennial	78.89	15
Grassland annual	89.64	10
Grassland perennial	69.24	9
Wetlands	113.68	11
Settlements	44.82	GL_a × 0.5

Source: Zlindra 2013

On the basis of data on green areas in urban land for municipality Ljubljana the expert judgment was provided that soil carbon stock in settlements equals to half a value of soil carbon stock in the category Grassland annual.

Table 7.2.9: Average carbon stock in mineral soils for Forest land (from 8 × 8 km grid survey).

Layer	Average carbon stock [t ha ⁻¹]	The number of sampling locations
M ₁₀ horizon	35.25 ± 2.06	141
M ₄₀ horizon	68.32 ± 6.22	136
Mineral soils	103.31 ± 7.90	136

Source: Kobal et al. 2011.

7.3 Forest Land (5A)

7.3.1 Source category description

Forest land category includes CO₂ 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-CO₂ emissions from biomass burning are reported.

Area of forest land in Slovenia in year 2012 was 1,209.55 kha, which covered 59.7 % of the country. 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 represent 80.0 % of total growing stock (beech – 31.0 %, spruce – 33.9 %, fir – 8.2 %, oak – 5.8 %, pine – 4.1 %).

The majority, 77.8 % of forests in Slovenia are private property, 22.2 % of forests are public (owned by the state or local communities) (Annual report on forests, SFS 2012). 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 a 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 and, 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 (1993, section 2) forest land is defined as area overgrown with forest trees in the form of stands or other forest plants which provide 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 of 5 m and with minimal area of 0.25 hectares (2,500 m²). Abandoned agricultural land on area larger than 0.25 ha, which has been abandoned for more than 20 years, with minimal tree height of 5 m and tree crown cover up to 75 % are defined as forests.

Particular attention should be paid to change in methodology of data acquisition when distinguishing between forest and abandoned agricultural land, where spontaneous afforestation occurred. Only those lands designated as forest by Slovenia Forest Service remain forest, all other lands are classified in other national class (e.g. 1410 or 1500).

Table 7.3.1: Activity data for Forest land (1986 – 2012) 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 Wetland 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
2012	1,209.5	1,117.5	92.0	4.0	76.0	2.0	4.0	6.0
2011	1,208.7	1,116.7	92.0	4.0	76.0	2.0	4.0	6.0
2010	1,207.9	1,115.9	92.0	4.0	76.0	2.0	4.0	6.0
2009	1,207.1	1,115.1	92.0	4.0	76.0	2.0	4.0	6.0
2008	1,206.3	1,114.3	92.0	4.0	76.0	2.0	4.0	6.0
2007	1,205.5	1,113.5	92.0	4.0	76.0	2.0	4.0	6.0
2006	1,204.7	1,112.7	92.0	4.0	76.0	2.0	4.0	6.0
2005	1,203.9	1,111.9	92.0	4.0	76.0	2.0	4.0	6.0
2004	1,203.1	1,111.1	92.0	4.0	76.0	2.0	4.0	6.0
2003	1,202.3	1,110.3	92.0	4.0	76.0	2.0	4.0	6.0
2002	1,201.5	1,109.5	92.0	4.0	76.0	2.0	4.0	6.0
2001	1,200.7	1,108.7	92.0	4.0	76.0	2.0	4.0	6.0
2000	1,199.9	1,107.9	92.0	4.0	76.0	2.0	4.0	6.0
1999	1,199.1	1,107.1	92.0	4.0	76.0	2.0	4.0	6.0
1998	1,198.3	1,106.3	92.0	4.0	76.0	2.0	4.0	6.0
1997	1,197.5	1,105.5	92.0	4.0	76.0	2.0	4.0	6.0
1996	1,196.7	1,104.7	92.0	4.0	76.0	2.0	4.0	6.0
1995	1,195.9	1,103.9	92.0	4.0	76.0	2.0	4.0	6.0
1994	1,195.1	1,103.1	92.0	4.0	76.0	2.0	4.0	6.0
1993	1,194.3	1,102.3	92.0	4.0	76.0	2.0	4.0	6.0
1992	1,193.5	1,101.5	92.0	4.0	76.0	2.0	4.0	6.0
1991	1,192.7	1,100.7	92.0	4.0	76.0	2.0	4.0	6.0
1990	1,191.9	1,099.9	92.0	4.0	76.0	2.0	4.0	6.0
1989	1,191.1	1,099.1	92.0	4.0	76.0	2.0	4.0	6.0
1988	1,190.3	1,098.3	92.0	4.0	76.0	2.0	4.0	6.0
1987	1,189.5	1,097.5	92.0	4.0	76.0	2.0	4.0	6.0
1986	1,188.7	1,096.7	92.0	4.0	76.0	2.0	4.0	6.0

Table 7.3.2: Emissions/removals from Forest land (1986 – 2012) in Gg CO₂

Year	A. Total Forest Land	A.1. Forest Land remaining Forest Land	A.2. Land converted to Forest Land	A.2. Land converted to Forest Land				
				A.2.1 Cropland converted to Forest Land	A.2.2 Grassland converted to Forest Land	A.2.3 Wetlands converted to Forest Land	A.2.4 Settlements converted to Forest Land	A.2.5 Other Land converted to Forest Land
	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂
2012	-6,776.3	-5,938.4	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2011	-6,772.0	-5,934.1	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2010	-6,767.8	-5,929.9	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2009	-6,763.5	-5,925.6	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2008	-6,759.3	-5,921.3	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2007	-6,755.0	-5,917.1	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2006	-7,548.6	-6,710.7	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2005	-7,543.8	-6,705.9	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2004	-7,538.9	-6,701.0	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2003	-7,534.1	-6,696.2	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2002	-7,529.3	-6,691.4	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2001	-7,524.4	-6,686.5	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
2000	-7,519.6	-6,681.7	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1999	-3,650.4	-2,812.5	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1998	-3,648.4	-2,810.5	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1997	-3,646.4	-2,808.4	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1996	-3,644.3	-2,806.4	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1995	-3,642.3	-2,804.4	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1994	-3,640.2	-2,802.3	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1993	-3,638.2	-2,800.3	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1992	-3,636.2	-2,798.3	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1991	-3,634.1	-2,796.2	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1990	-3,632.1	-2,794.2	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1989	-3,630.1	-2,792.1	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1988	-3,628.0	-2,790.1	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1987	-3,626.0	-2,788.1	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5
1986	-3,624.0	-2,786.0	-837.9	-31.8	-609.6	-3.5	-57.5	-135.5

* Emissions in carbon stock change in category Forest land. Emissions from burning biomass (wildfires) are not included in this table.

Removals CO₂ in category Forest land range from -3,624.0 Gg CO₂ (1986) to -7,548.6 Gg CO₂ (2006).

Forest land remaining forest land (CO₂) and Land converted to forest land (CO₂) were identified as key source categories. Concerning the CH₄ or N₂O emissions, Forest land remaining forest land and Land converted to forest land have not resulted in a key source.

7.3.2 Methodological issues

7.3.2.1 Forest land remaining forest land

In the period from 1986 to 2012, annual removals were between -2,786.0 Gg CO₂ (1990) and -6,710.7 Gg CO₂ (2006).

Carbon stock changes in living biomass

In accordance with the decision tree provided in the GPG2003, carbon stock changes in living biomass in Forest land remaining forest land are estimated by Tier 3, stock change method (Method 2). 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 (FECS), made in years 1995, 2000, 2007 and 2012, were used for our calculations.

For calculations the equation 3.2.3 from GPG2003 was used:

$$\Delta C = \frac{(C_{t2} - C_{t1})}{t_2 - t_1} * A \quad \text{(Equation 5)}$$

ΔC – annual change in carbon stocks in living biomass [t C ha⁻¹]

A – area of Forest land remaining forest land [ha]

C_t – total carbon in biomass calculated at time t_1 or t_2 [t C]

Carbon stock in living biomass was calculated from merchantable volume (V) multiplied by basic wood density (D), biomass expansion factor (BEF_2), root-to-shoot ratio (R) and carbon fraction of dry matter (CF). These parameters, except carbon fraction of dry matter, are determined separately for tree species.

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

V – merchantable volume (i.e. growing stock) [m³ ha⁻¹]

D – basic wood density [t d.m. m⁻³]

BEF_2 – biomass expansion factor for conversion of merchantable volume to aboveground tree biomass

R – root-to-shoot ratio

j – tree species

CF – carbon fraction of dry matter [default = 0.5 t C (t d.m.)⁻¹]

Parameters:**Growing stock (V)**

Growing stock is volume over bark of all living trees more than 9.99 cm in diameter at breast height (1.3 m). It 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, i.e. Forest and Forest Ecosystem Condition Survey (FECS). The survey provides accurate and trustworthy information on carbon stock and growing stock volume, since it was harmonised by the COST Action E43 and also took into account many recommendations provided by IPCC (2003), FAO (2006) and MCPFE (2002, 2003) (Kusar et al. 2010). FECS was carried out in 1995, 2000, 2007 and 2012. Inventory was performed on concentric permanent fixed plots of sampling grid with the density 4 × 4 km. Growing stock in 1995 was 271.94 m³/ha (s.e. = 3.91 %), in 2000 283.19 m³/ha (s.e. = 4.88 %), in 2007 313.58 m³/ha (s.e. = 4.21 %) and in 2012 333.74 (s.e. = 4.08 %).

For the estimation of growing stock of Slovenian forests from 1986 to 2012, the following methodology was applied:

- the growing stock volume is from FECS 1995, 2000, 2007 and 2012
- the growing stock between these years was interpolated;
- the growing stock from 1995 to year 1986 was extrapolated.

Table 7.3.3 Growing stock in Slovenian forests from 1986 to 2012.

Year	Growing stock [m ³ /ha]		Year	Growing stock [m ³ /ha]
2012*	333.74		1998	278.69
2011	329.71		1997	276.44
2010	325.68		1996	274.19
2009	321.64		1995*	271.94
2008	317.61		1994	269.69
2007*	313.58		1993	267.44
2006	309.24		1992	265.19
2005	304.90		1991	262.94
2004	300.56		1990	260.69
2003	296.21		1989	258.44
2002	291.87		1988	256.19
2001	287.53		1987	253.94
2000*	283.19		1986	251.69
1999	280.94		* Inventory year	

This year's calculation of living biomass was based on two major factors; the first being the available data of the FECS 2012 and the second being the improved (corrected) database from 2007. Consequently, the estimate of the growing stock in forests from 2007 was corrected and the estimate of the growing stock from 1995 was also taken into account. However, it is also the fact that the growing stock from 1995 was estimated by two different methods (angle-count /Bitterlich/ and the-fix tree (6-tree) method) that usually produce the results differing from the results of the control sampling method used in 2000, 2007 and 2012 (on the same 4x4 km national sampling grid). This is also the major reason for

relatively high shift from 1999 to 2000. However, until 2000, there is no other reliable data for the period. The second reason for high shift is also because of higher cutting intensity in the period prior to 2000 and lower accumulation rate, consequently.

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

% of growing stock		Year			
Scientific name	Common name	1995	2000	2007	2012
<i>Picea abies</i>	Spruce	32.97	33.39	31.19	31.14
<i>Fagus sylvatica</i>	Beech	31.35	31.65	31.22	31.13
<i>Abies alba</i>	Fir	9.82	9.27	8.36	7.44
<i>Quercus petraea</i>	Oak	5.84	5.09	5.66	5.61
<i>Pinus sylvestris</i>	Scots Pine	4.88	4.09	4.02	4.37
<i>Acer pseudoplatanus</i>	Maple	2.34	3.24	3.27	3.34
<i>Carpinus betulus</i>	Hornbeam	2.60	1.62	2.19	2.25
<i>Castanea sativa</i>	Chestnut	1.53	1.52	1.65	1.62
<i>Pinus nigra</i>	Black Pine	-	1.16	1.56	1.64
<i>Ostrya carpinifolia</i>	Hop Hornbeam	1.05	0.82	1.33	1.50
Remaining		7.62	8.15	9.56	9.98
TOTAL		100.00	100.00	100.00	100.00

Biomass expansion factor (BEF_2) and Root-to-shoot ratio (R)

The default value given in GPG2003 (Table 3A.1.10) has been adopted in calculations ($BEF_2 = 1.15$ for conifers and broadleaves). Values have been taken from the lower limits of the range (for temperate climatic zone), because they are more suitable for mature forests or those with high growing stock.

Root-to-shoot ratio (R) values have been adopted from Table 3A.1.8. Mean values (aboveground biomass > 150 t ha⁻¹) for conifers (0.23) and for broadleaves (0.24) have been used.

Wood density (D)

According to analyses of national data from previous researches done by Slovenian Forestry Institute (SFI) and Biotechnical Faculty, basic wood density is for *Fagus sylvatica* ($D = 0.584 \text{ t m}^{-3}$) and *Abies alba* ($D = 0.394 \text{ t m}^{-3}$). For other species the default values from table 3A.1.9-1 of GPG2003 have been used.

Carbon fraction of dry matter (CF)

The default value given in the GPG2003 has been adopted as the carbon fraction of dry matter ($CF = 0.5 \text{ t C (t d.m.)}^{-1}$).

Table 7.3.5: Parameters (D, BEF₂, R and CF) used for selected tree species.

Common name	WD	BEF2	R	CF
	[t m ⁻³]	[dimensionless]	[dimensionless]	[t C(t d.m.) ⁻¹]
Spruce	0.400	1.15	0.23	0.50
Beech	0.584	1.15	0.24	0.50
Fir	0.394	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 GPG2003, 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 GPG2003.

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

$\Delta C_{FF_{DOM}}$ – annual change in carbon stocks in dead organic matter [t C yr⁻¹]

$\Delta C_{FF_{DW}}$ – change in carbon stocks in dead wood [t C yr⁻¹]

$\Delta C_{FF_{LT}}$ – change in carbon stocks in litter [t C yr⁻¹]

Dead wood content is all non-living woody biomass not contained in the litter, either standing or lying on the ground. According to definition from FECS 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 from FECS 2007 and 2012. Thus, the dead wood biomass for the period prior to the year 2007 has been extrapolated based on data of FECS 2007 and 2012. For calculations the equation 3.2.12 from GPG2003 has been 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 C yr⁻¹]

A – area of managed Forest land remaining forest land [ha]

B_{t2} – dead wood stock at time t_2 for managed Forest land remaining forest land [t d.m. ha⁻¹]

B_{t1} – dead wood stock at time t_1 for managed Forest land remaining forest land [t d.m. ha⁻¹]

T – time period between t_1 and t_2 [yr]

CF – carbon fraction of dry matter (default = $0.5 \text{ t C (t d.m.)}^{-1}$]

According to FECS 2007 and 2012, dead wood stock amounted to 9.56 t d.m./ha (19.75 m³/ha) and 9.57 t d.m./ha (19.76 m³/ha). The share of dead wood was 5.9 % of growing stock in 2012.

For carbon stock changes in litter “a pool is not a source” approach was used. Under the latter 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 et al. 2011) show relatively stable carbon stocks in litter in Forest land remaining forest land. Results are explained in ‘carbon stock changes in soils’. Furthermore, the data on carbon stock of dead wood also show a stable trend, at least for the period between the last two FECSs.

Carbon stock changes in soils

In accordance with GPG2003, for carbon stock changes in soils “a pool is not a source” approach was used. Under the latter 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, carbon stock in mineral soil remains constant as long as the land remains forest. Results of our preliminary expertise for period 1996 – 2006 (Kobal et al. 2011), show relatively stable carbon stocks in forest soils. In the last 20-year period, no major fluctuation in forest management regime and no major disturbance event that could affect the soil carbon stock have occurred. In addition, soil also depends on the climate and bedrock factors largely depend on the source of carbon coming from dead wood and litter. Since those two pools seem to be stable, soil pool is therefore assumed to be stable.

Changes in carbon stock in litter and soils in Forest land remaining forest land in period 1996 – 2006

For 1996, three soil subsamples were taken for organic (Litter) and mineral layer (SOM) from each plot. For mineral part of soil, samples were taken with soil auger ($\varnothing = 7 \text{ cm}$) at fixed depth (0–5, 5–10 and 10–20 cm) and for organic layer within 25 × 25 cm square. Subsamples were taken 5 m apart from plot center, 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 2006, soil survey was made according to the methodology for BioSoil demonstration project. Soil subsamples for organic and mineral layer were taken as in 1996, with 5 replicates in each plot (center of the plot and celestial direction). Volume of roots and coarse fragments were subtracted from volume of soil sample. For evaluation of temporal changes a paired t-test was performed.

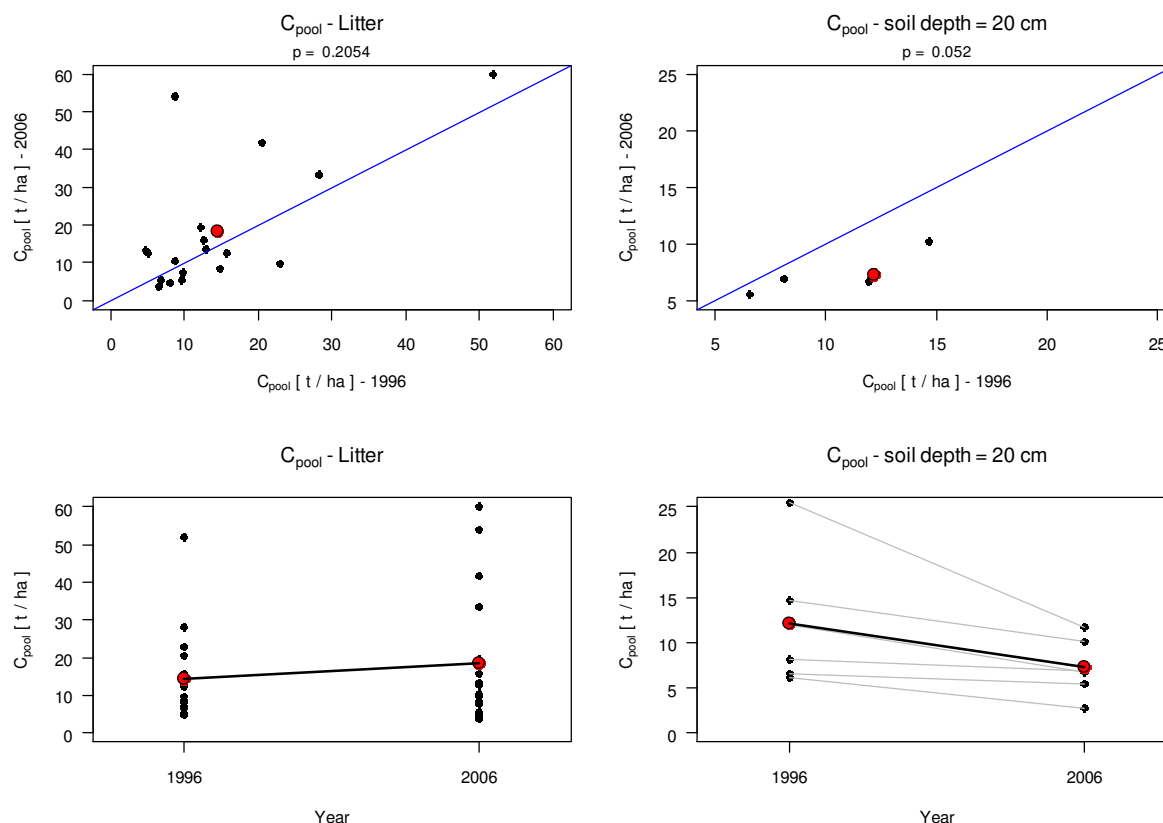


Figure 7.3: Carbon stock in forest soils and litter (1996-2006).

Carbon stock changes in litter had slightly increased from the year 1996 to the 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 decreased, but the changes were not significant ($p = 0.052$).

Preliminary results on limited number of sampling plot, show relatively stable carbon stocks in forest soils for observed period with insignificant differences between organic - litter layers and also for mineral layer. Taking into account momentarily valid literature values for central European forests, we can conclude that there are no significant changes in forest soils within periods e.g. 5-10 years, provided the land use has not changed (forest remaining forest; source: SFI project report 2011).

7.3.2.2 Non-CO₂ greenhouse gas emission

N₂O 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 relatively small, less than half percent of country’s area in the year 2003, which was the most problematic year in the reporting period. For calculations the Tier 2 (country level estimated of area burned) was used and estimation of GHGs directly released in fires.

For calculations of emissions from wildfires the equation 3.2.20 from GPG2003 was applied.

$$L_{fire}[tGHG] = A * B * C * D * 10^{-6} \quad \text{(Equation 9)}$$

A – area burnt [ha]

B – mass of available fuel [kg d.m. ha⁻¹]

C – combustion efficiency (Table 3A.1.12 in GPG2003)

D – emission factor [g (kg d.m.)⁻¹] (Table 3A.1.16 in GPG2003)

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 (GPG2003)

Gas		Emission factor (D) [g / kg d.m.]
CO ₂	carbon dioxide	1,580
CO	carbon oxide	130
CH ₄	methane	9
NO _x	nitrogen oxide	0.7
N ₂ O	nitrous oxide	0.11
NMHC	non methane hydrocarbons	10

Mass of available fuel (B) was calculated from average growing stock in the region, where the majority of the wildfires occurred (Karst region, see Slovenia forest fire risk map: [Forest fire risk map SFS](#)). The fraction of the biomass combusted ($C = 1 - 0.545$) was adopted from Table 3A.1.12 (GPG2003). Inserting these values in equation 3.2.20 of IPCC (2003), the GHG emissions shown in Table 7.3.7 were calculated.

According to national statistics about 70 % of areas affected by wildfires in forests actually occur in the Karst region. Database of forest fire is in the domain of Slovenia Forest Service (since 1994), which describes and records forest fire by information, such as location, type of fire, start and end of fire, area burned, type of vegetation burned etc. Data are available for the forest management unit – OE Sežana: [Forest management plan OE Sežana](#), of which area is approximately the same as that of forest risk map. Average growing stocks from forest management plans of OE Sežana were applied and the values interpolated/extrapolated to whole reporting period.

Table 7.3.7 Forest land affected by wildfires and resulting GHG emissions 1986-2012.

Year	Area	Mass of available fuel	CO ₂	CO	CH ₄	NO _x	N ₂ O	NMHC
	ha	t d.m. / ha	t	t	t	t	t	t
2012	606.53	95.14	38,595.5	3,175.6	219.8	17.1	2.7	244.3
2011	159.08	93.19	10,300.4	847.5	58.7	4.6	0.7	65.2
2010	52.06	91.23	3,376.6	277.8	19.2	1.5	0.2	21.4
2009	114.73	89.26	7,453.9	613.3	42.5	3.3	0.5	47.2
2008	46.69	87.29	2,987.6	245.8	17.0	1.3	0.2	18.9
2007	98.61	85.31	6,408.9	527.3	36.5	2.8	0.4	40.6
2006	1,022.81	83.32	60,604.4	4,986.4	345.2	26.9	4.2	383.6
2005	142.23	81.32	8,180.0	673.0	46.6	3.6	0.6	51.8
2004	76.87	79.32	4,286.7	352.7	24.4	1.9	0.3	27.1
2003	1,592.84	77.31	86,800.2	7,141.8	494.4	38.5	6.0	549.4
2002	77.47	75.30	4,122.8	339.2	23.5	1.8	0.3	26.1
2001	240.36	73.27	12,483.6	1,027.1	71.1	5.5	0.9	79.0
2000	124.14	71.24	6,287.9	517.4	35.8	2.8	0.4	39.8
1999	321.10	68.82	15,712.4	1,292.8	89.5	7.0	1.1	99.4
1998	725.10	66.50	34,285.8	2,821.0	195.3	15.2	2.4	217.0
1997	383.33	64.18	17,493.4	1,439.3	99.6	7.8	1.2	110.7
1996	243.75	61.87	10,721.7	882.2	61.1	4.8	0.7	67.9
1995	148.88	59.55	6,303.2	518.6	35.9	2.8	0.4	39.9
1994	n.a.	57.23	NE	NE	NE	NE	NE	NE
1993	n.a.	54.91	NE	NE	NE	NE	NE	NE
1992	319.37	52.59	11,941.6	982.5	68.0	5.3	0.8	75.6
1991	624.90	50.27	22,335.4	1,837.7	127.2	9.9	1.6	141.4
1990	615.77	47.94	20,990.5	1,727.1	119.6	9.3	1.5	132.9
1989	120.00	46.94	4,005.2	329.5	22.8	1.8	0.3	25.3
1988	181.75	45.94	5,936.5	488.4	33.8	2.6	0.4	37.6
1987	n.a.	44.93	NE	NE	NE	NE	NE	NE
1986	n.a.	43.93	NE	NE	NE	NE	NE	NE

All data related to the burned areas are based on databases of Slovenia Forest Service (SFS). The areas are identified and geo-located. Annual data related to fires are annually published by SFS. All GHG emissions from wildfires are reported under Forest land remaining forest land.

7.3.2.3 Land converted to forest land

Data for land use change from other land uses to forest land 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 uses converted to forest land, IPCC GPG Tier 2 approach is used.

The average annual area converted from other land uses to forest land is 4.6 kha, according to land use change matrix. As described in chapter 7.2.1, land use change to forests mainly appear from grassland and from cropland (Table 7.2.5). 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 directly human induced, these areas are listed under spontaneously expansion of forest. However,

SFS system of forest management differentiates forest land covered by management plans according to production function and other ecological and social functions.

Conversions to forest land occur only by natural regeneration (afforestation) occurring on abandoned land, thus no clearing of living biomass was provided in previous land use.

Definition of forest (Slovenian Act on Forests) related to management plans: Land spanning more than 0.25 hectares with trees higher than 5 meters and canopy cover more than 10 percent, or trees able to reach these threshold in situ. It includes abandoned agricultural land (cropland, grassland) with natural expansion of forest (covered with trees 20-75 %). When natural expansion takes place 20 years or more, trees cover over 75 % of the area and diameter in breast height (DBH) exceeds 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 increase and decrease of carbon stock related to the areas in transition into forest land. The annual increment of stem wood over bark on areas converted to forests was estimated to be 2.16 m³/ha (Wisdom Slovenia, 2006). For the calculation, the equation 3.2.23 (following equations 3.2.4 and 3.2.5) from GPG2003 was used. No distinction between intensively and extensively managed forests was made, because all areas converted to forest land are managed extensively (naturally regenerated forests with minimum human intervention).

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

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⁻¹ yr⁻¹]

CF – carbon fraction of dry matter (default = 0.5 t C (t d.m.)⁻¹)

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

G_W – average annual aboveground biomass increment [t d. m. ha⁻¹ yr⁻¹]

R – root-to-shoot ratio appropriate to increments

$$G_W = I_v * D * BEF_1$$

I_v – average annual net increment [m³ ha⁻¹ yr⁻¹]

D – basic wood density [t d.m. m⁻³]

BEF_1 – biomass expansion factor for conversion of annual net increment (including bark) to aboveground tree biomass increment

BEF_1 values were used according to Table 3A.1.10 (GPG2003) 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 basic wood densities were used for conifers ($D = 0.400$ t d.m. m⁻³) and for broadleaves ($D = 0.580$ t d.m. m⁻³).

Average annual increment (I_v) on areas converted to forest land was 2.16 m³ ha⁻¹ yr⁻¹ (Wisdom Slovenia, 2006, p. 57, class 1410).

Root-to-shoot ratio (R) values were adopted from Table 3A.1.8. Mean values for conifers ($R = 0.46$; aboveground biomass <50 t ha⁻¹) and for broadleaves ($R = 0.43$; aboveground biomass <75 t ha⁻¹) were used.

Table 7.3.8: Factors for calculation of CO₂ accumulation in land converted to Forest land.

Tree group	I _v	WD	R	BEF ₁
	[m ³ ha ⁻¹ yr ⁻¹]	[t d.m. m ⁻³]	[dimensionless]	[dimensionless]
Conifers	2.16	0.400	0.46	1.3
Broadleaves	2.16	0.580	0.43	1.3

Carbon stock changes in dead organic matter

In the Tier 1 calculation, the average transfer rate into the 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 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 (GPG2003).

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 GPG2003. As mentioned before, no distinction between intensively and extensively managed forests was made, because all lands converted to forest land are managed extensively (naturally regenerated forests with minimum human intervention).

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

$\Delta C_{LFmineral}$ – annual change in carbon stock in mineral soils [t C yr⁻¹]
 $SOC_{ExtForest}$ – stable soil organic carbon stocks of the new, extensively managed forest [t C ha⁻¹]
 $SOC_{non-forestland}$ – soil organic carbon stocks of the non-forest land prior to its conversion [t C ha⁻¹]
 $A_{ExtForest}$ – land area [ha]
 $T_{ExtForest}$ – time period [default 20 years]
 $SOC_{ExtForest} = SOC_{40}$

Country specific value for organic carbon in soils ($SOC_{40} = 103.31 \text{ t C ha}^{-1}$) has been 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 - $SOC_{non-forestland}$ are presented in Table 7.2.8 and used in calculations.

7.3.3 Uncertainties and time-series consistency

FECS is based on a very comprehensive quality assurance system, which allows the exact identification of the right location of the grid and sample points guaranteed by the repeated measurement of the same trees. It also promptly indicates implausible figures for individual

parameters during the measurements on site and, in comparison with the previous period, every missing tree. More information on quality assurance is available in Annex 3.b.

One of the goals of FECS 2012 was to obtain accurate and reliable data about the state of volume of wood growing stock (carbon stock) and dead wood stock as the basis for KP/UNFCCC reporting for all Slovenian forests. Some of the indicators from FECS 2007 and 2012 are in Table 7.3.9.

Table 7.3.9: Indicators from FECS 2007 and 2012

Parameter	FECS 2007	FECS 2012
Growing stock	313.58 m ³ /ha (± 4.21 %)	333.74 m ³ /ha (± 4.08 %)
Dead wood	19.75 m ³ /ha	19.76 m ³ /ha
Soil and litter	see chapter 7.2.2	

7.3.4 Source specific QA/QC and verification

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 field manual for FECS was prepared (Kovac et al. 2007, updated 2012).
- 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 of 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 field measurements and work of Slovenian Forest Service (SFS) teams.
- Field data was entered in database and checked for major discrepancies.
- All data used for our calculation is stored on our data server and protected from unauthorized access.

All soil samples (from soil inventory on 8 x 8 km) were delivered and stored in laboratory at SFI according to internal quality management system.

In 2012, national forest inventory was carried out for the fourth time. Although the methodology of inventory stayed the same as in FECS 2007, some additional protocols were established in 2012 to ensure consistency over time (see Annex 3.b). Moreover, a comparison was made between data on growing stock by Slovenian Forestry Institute (SFI) and Slovenia Forest Service (SFS) to verify the reliability of the estimates.

When estimating stand densities at the country level (hectare values for the number of trees, basal area and growing stock), an inconsistency was shown between the estimates of forest inventory by FECS on the sampling grid of 4x4 km (Hočevár et al. 2006) and estimates of Slovenia Forest Service, which were derived from the estimates based on forest management units. The latter included 14 different sampling grids (Pisek 2010), by which not all forest area was covered, because only some of these forest management units covered also protection forests, wildlife pens and forest reserves.

In the 10-year period of forest management plan renovation, the SFS survey was repeated on permanent sampling plots, therefore it was possible to perform the estimates at the country level given as the averages of the previous period. The estimation for each year would be burdened with a high uncertainty, since dynamics of the repeated measurements on the permanent sampling plots by particular forest management area and units was not consistent with the principles of random sampling at the country level. According to the concept of multistage sampling, an assumption could be made that 10% of forest management plans are renovated each year and permanent sampling plots are established on systematic grids on area of the forest management units. Although all sampling plots were renovated in the 10-year period, the annual dynamics showed high differences. For example, in 2008, 38% of all renovated plots were concentrated only in two forest management areas. Therefore, the data by SFS for the last decade on average (median) refer to the year 2005.

Comparing estimates by FECS (sampling grid of 4x4 km) with SFS sampling plots, a sampling grid of 1x1 km (Hladnik and Žižek 2012) was taken into account. The analysis of growing stock of 2007 (Slovenian Forestry Institute) showed that differences between SFS and SFI data are not statistically significant when based on comparable sampling grid for the average year 2005 (Figure 7.4). This analysis proves the reliability of the SFI inventory estimates on growing stock and thus verifies the data.

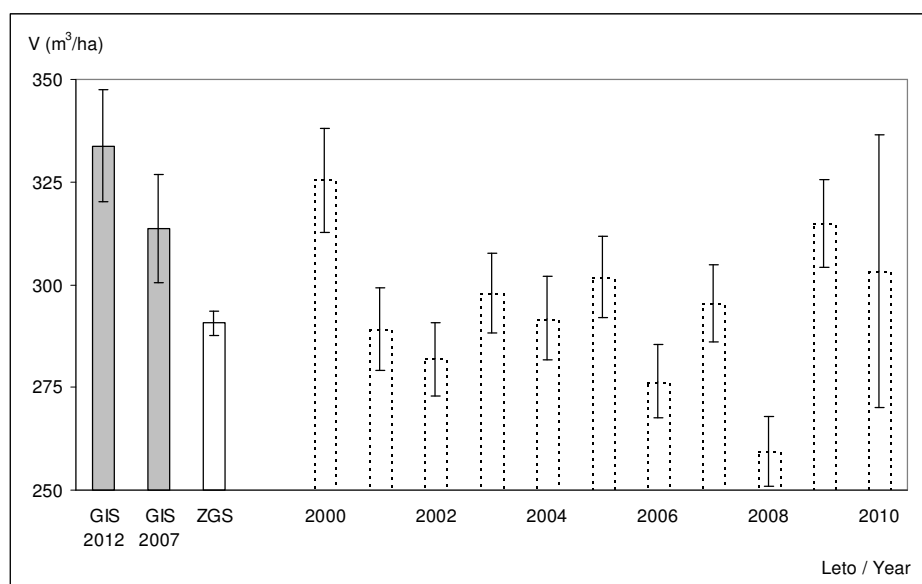


Figure 7.4: Comparison of growing stock estimates between SFS and SFI

Slovenia has applied “a pool is not a source” approach when reporting for net carbon stock changes in the litter and mineral soil carbon pools under forest management, thus assuming no change in those pools. According to the Rules on the protection of forests (Official Gazette RS, no. 92/2000), the national forest soil survey should be performed every 10 years (2005, 2015, 2025 etc.) on the systematic sampling grid of 16x16 km covering all the country area. Since there is no other data available, analysis based on data from BioSoil and ICP Forest demonstration projects and showing no statistically significant difference in carbon pools for the period 1996-2006 was provided.

Several countries bound by UNFCCC/KP reported soil carbon changes using Yasso07 model. A recent study in Slovenia also considered change in stock of Corg in the soil during the 1986-2012 period using the Yasso07 model, in which the estimated input of litterfall on one of the Intensive monitoring (Level II, ICP Forest) sampling plots (Kobal et al. 2014) were studied. For the period 1986-2014, a slight increase in soil carbon stock was

predicted by the model. Taking into account different combinations of temperature and precipitation, diverse scenarios were predicted by the model. Assuming stable litter input, larger influence on C_{org} decrease was predicted for the temperature change compared to precipitation change. However, many uncertainties are included in the model estimates ranging from litter input estimates, climate change uncertainties, climate-litter production feedbacks, starting value estimates, etc. Determination of the uncertainty of model calculations requires conducting simulations and their interpretation.

Considering the above two approaches, it is difficult to predict a clear trend of soil carbon changes over a longer time period. Because the deadwood biomass, which is another important carbon input to soil and litter, showed also a stable trend of carbon change over time (based on FECS 2007 and 2012), Slovenia applied the conservative approach "pool is not a source" for litter and soil.

7.3.5 Source specific recalculations

Calculations of emissions from biomass burning were rechecked, mass of available fuel was calculated according to growing stock in Karst region where the vast majority of wildfires occur. Recalculations were also made due to the change in activity data (land use change matrix) and new information on activity data on organic soil from the sector Agriculture, new available data on growing stock and deadwood biomass presented by the FECS 2012.

7.3.6 Source specific planned improvements

For the next submission we will continue our efforts to establish improved land use change matrix as one of major challenges in the future and to gather as much as possible information on uncertainties estimates, QA/QC procedures, and verification. Slovenia plans to improve the system of land use change monitoring and method of constructing the land use change matrix. Furthermore, it is of primary importance for Slovenia to improve the methodology of land area presentation, particularly to harmonize the areas of forest management and deforestation activities between the reporting under the Convention and KP. Although the system for monitoring land uses has been well established, Slovenia plans to use sampling to detect land use changes rather than layer cross-tabulation based on vector data, since lots of problems and unreal changes were detected by this method.

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

7.4 Cropland (5B)

7.4.1 Source category description

Cropland category includes CO₂ 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. Included are also CO₂ emissions from agricultural lime application.

Table 7.4.1: Activity data for cropland (1986 – 2012) in kha

Year	5.B. Total Cropland	5.B. Organic soil	5.B.1. Cropland remaining Cropland	5.B .2. Land converted to Cropland ⁽¹²⁾	5.B.2.1 Forest Land converted to Cropland	5.B.2.2 Grassland converted to Cropland	5.B.2.3 Wetland 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
2012	237.2	6.0	165.4	71.8	5.8	66.0	NO	NO	NO
2011	240.4	6.0	168.6	71.8	5.8	66.0	NO	NO	NO
2010	243.5	6.0	171.7	71.8	5.8	66.0	NO	NO	NO
2009	246.6	6.1	174.8	71.8	5.8	66.0	NO	NO	NO
2008	249.7	6.0	177.9	71.8	5.8	66.0	NO	NO	NO
2007	252.9	5.8	181.1	71.8	5.8	66.0	NO	NO	NO
2006	256.0	5.7	184.2	71.8	5.8	66.0	NO	NO	NO
2005	259.1	5.7	187.3	71.8	5.8	66.0	NO	NO	NO
2004	262.3	5.6	190.5	71.8	5.8	66.0	NO	NO	NO
2003	265.4	5.5	193.6	71.8	5.8	66.0	NO	NO	NO
2002	268.5	5.5	196.7	71.8	5.8	66.0	NO	NO	NO
2001	271.6	5.4	199.8	71.8	5.8	66.0	NO	NO	NO
2000	274.8	5.4	203.0	71.8	5.8	66.0	NO	NO	NO
1999	277.9	5.4	206.1	71.8	5.8	66.0	NO	NO	NO
1998	281.0	5.4	209.2	71.8	5.8	66.0	NO	NO	NO
1997	284.2	5.4	212.4	71.8	5.8	66.0	NO	NO	NO
1996	287.3	5.4	215.5	71.8	5.8	66.0	NO	NO	NO
1995	290.4	5.5	218.6	71.8	5.8	66.0	NO	NO	NO
1994	293.5	5.5	221.7	71.8	5.8	66.0	NO	NO	NO
1993	296.7	5.6	224.7	71.8	5.8	66.0	NO	NO	NO
1992	299.8	5.6	227.8	72.0	6.0	66.0	NO	NO	NO
1991	302.9	5.7	230.9	72.0	6.0	66.0	NO	NO	NO
1990	306.0	5.7	234.0	72.0	6.0	66.0	NO	NO	NO
1989	309.2	5.8	237.2	72.0	6.0	66.0	NO	NO	NO
1988	312.3	5.8	240.3	72.0	6.0	66.0	NO	NO	NO
1987	315.4	5.9	243.4	72.0	6.0	66.0	NO	NO	NO
1986	318.6	5.9	246.6	72.0	6.0	66.0	NO	NO	NO

Cropland covered 11.7 % of country area in 2012. Cropland land use is divided 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). Emissions of CO₂ in category cropland range from 420.4 Gg CO₂ (1997) to 467.3 Gg CO₂ (2012) (Table 7.4.2).

Table 7.4.2: Emissions from cropland (1986 – 2012) in Gg CO₂

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 Wetland converted to Cropland	5.B.2.4 Settlements converted to Cropland	5.B.2.5 Other Land converted to Cropland
	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂
2012	467.3	184.5	282.9	129.3	153.5	NO	NO	NO
2011	465.8	184.5	281.4	127.8	153.5	NO	NO	NO
2010	463.2	183.4	279.9	126.3	153.5	NO	NO	NO
2009	464.2	185.8	278.4	124.9	153.5	NO	NO	NO
2008	461.4	184.5	276.9	123.4	153.5	NO	NO	NO
2007	451.1	175.7	275.4	121.9	153.5	NO	NO	NO
2006	447.0	173.3	273.7	120.2	153.5	NO	NO	NO
2005	443.0	170.9	272.0	118.5	153.5	NO	NO	NO
2004	438.8	168.4	270.3	116.8	153.5	NO	NO	NO
2003	434.6	166.0	268.6	115.1	153.5	NO	NO	NO
2002	430.4	163.5	266.9	113.4	153.5	NO	NO	NO
2001	427.8	162.6	265.2	111.7	153.5	NO	NO	NO
2000	425.2	161.7	263.5	110.0	153.5	NO	NO	NO
1999	423.6	160.8	262.8	109.3	153.5	NO	NO	NO
1998	422.0	159.9	262.1	108.6	153.5	NO	NO	NO
1997	420.4	159.0	261.4	107.9	153.5	NO	NO	NO
1996	421.7	161.0	260.7	107.2	153.5	NO	NO	NO
1995	423.0	163.0	260.0	106.4	153.5	NO	NO	NO
1994	424.2	165.0	259.3	105.7	153.5	NO	NO	NO
1993	424.8	166.9	257.9	104.4	153.5	NO	NO	NO
1992	426.1	168.9	257.2	103.7	153.5	NO	NO	NO
1991	427.4	170.9	256.5	102.9	153.5	NO	NO	NO
1990	428.6	172.9	255.8	102.2	153.5	NO	NO	NO
1989	429.9	174.9	255.0	101.5	153.5	NO	NO	NO
1988	431.2	176.8	254.3	100.8	153.5	NO	NO	NO
1987	432.5	178.8	253.6	100.1	153.5	NO	NO	NO
1986	433.7	180.8	252.9	99.4	153.5	NO	NO	NO

7.4.2 Methodological issues

7.4.2.1 Cropland remaining cropland

In the period from 1986 to 2012 the annual emissions were between 159.0 Gg CO₂ (1997) and 184.5 Gg CO₂ (2012).

Carbon stock changes in living biomass

Annual cropland remaining annual cropland

For annual crops, increase in biomass stock in a single year is assumed equal to biomass losses from harvest and mortality in that same year – thus there is no net accumulation of biomass carbon stocks (GPG2003).

Perennial cropland remaining perennial cropland

The data for perennial cropland are available from 1956 onwards from SORS (Statistical office of the Republic of Slovenia). However, because national land use classes were aggregated in that time (e.g. orchards and vineyards together), it is not possible to estimate or to stratify those areas and therefore the estimation of emissions/removals can not be provided at the moment.

Perennial cropland converted to annual cropland

The average of annual land use change from perennial cropland to annual in the time period from 1986 to 2012 was 192 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 (GPG2003) was used.

(Equation 12)

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

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

C_{after} – value of carbon stocks immediately after conversion is 0

C_{before} – IPCC default value for carbon stocks in woody biomass before is 63.0 t C ha⁻¹

ΔC_{growth} – IPCC default value for annual crops carbon accumulation rate 5.0 t C ha⁻¹

Value for the annual crops carbon accumulation rate ($\Delta C_{\text{growth}} = 5.0 \text{ t C ha}^{-1} \text{ yr}^{-1}$) was adopted from Table 3.3.8 (GPG2003) and value for carbon stock in woody biomass before conversion ($C_{\text{before}} = 63.0 \text{ t C ha}^{-1}$) was adopted from Table 3.3.2 (GPG2003). The values for temperate climate were chosen as this is the 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 2012 was 290 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 (GPG2003) was used.

(Equation 13)

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

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

C_{after} – value of carbon stocks immediately after conversion is 0

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

ΔC_{growth} – IPCC default value for perennial crops carbon accumulation rate 2.1 t C ha^{-1}

Value for the perennial crops carbon accumulation rate ($\Delta C_{growth} = 2.1 \text{ t C ha}^{-1} \text{ yr}^{-1}$) was adopted from Table 3.3.8 (GPG2003) and value for carbon stock in annual crops biomass before conversion ($C_{before} = 5.0 \text{ t C ha}^{-1}$) was adopted from Table 3.3.8 (GPG2003). The values for temperate climate were chosen as this is the 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 (GPG2003) was used.

$$\Delta C_{CCmineral} = \frac{[SOC_0 - SOC_{0-T}] * A}{T} \quad \text{(Equation 14)}$$

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

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

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

T – time period [default 20 years]

A – land area [ha]

$SOC = SOC_{CL}$

SOC_{CL} – Slovenian national value for organic carbon stocks in mineral soils for cropland

Slovenian national values for organic carbon stock in mineral soil for cropland (cropland annual: $SOC_{CLannual} = 80.66 \text{ t C ha}^{-1}$; cropland perennial: $SOC_{CLperennial} = 78.89 \text{ t C ha}^{-1}$) are presented in Table 7.2.8.

Organic soils

Total area of organic soils in cropland category in 2012 was 6,046 ha. According to expert judgement, areas of arable land on organic soils are relatively constant from 1995 onwards.

For calculations emissions from organic soil Tier 1/Tier 2 methodology and equation 3.3.5 from GPG2003 was used:

$$\Delta C = \sum (A * EF) \quad \text{(Equation 15)}$$

A – land area of organic soils [ha]
EF – emission factor for climate type (10 t C ha⁻¹)

Emission factor (EF = 10 t C ha⁻¹) for warm temperate climatic temperature regime from Table 3.3.5 (GPG2003) was adopted.

Liming

For calculations of emissions due to liming Tier 1 methodology and equation 3.3.6 (GPG2003) were used.

$$\Delta C_{\text{lime}} = M_{\text{limestone}} * EF_{\text{limestone}} + M_{\text{dolomite}} * EF_{\text{dolomite}} \quad \text{(Equation 16)}$$

ΔC_{lime} – annual C emissions from agricultural lime application [t C yr⁻¹]
M – the annual amount of calcic limestone or dolomite [t yr⁻¹]
EF – emission factor (default value = 0.12)

According to expert judgement, in the period 1986 to 1996 averagely 100,000 Mg per year and 1,500 Mg in 2012 of calcic limestone (CaCO₃) or dolomite (CaMg(CO₃)₂) were used in Slovenia for liming. There are no data available on areas, where liming is being applied. Although some liming occurs on agricultural land, experts from agricultural sector assume it is predomintaly present on arable land to keep the soil pH near to neutral, while amount of lime applied on grassland is very limited or negligible. Moreover, liming is not a common practice in forestry, when conversions from forest land to cropland or to other land uses occur, as stated by Slovenia Forestry Service. Values for the period between 1996 and 2012 were interpolated. Default emission factor (EF = 0.12) was adopted from GPG2003.

7.4.2.2 Land converted to cropland

The average annual area converted from other land uses to cropland is 2,636 ha to annual cropland and 1,967 ha to perennial cropland according to land use change matrix. However, conversions from forest land to cropland and grassland to cropland appear. According to expert judgement, there are no conversions from wetland, settlements and other land to cropland.

The average annual area converted from forest land to cropland is 226 ha (to annual cropland: 71 ha; to perennial cropland: 155 ha). The average annual area converted from grassland to cropland is 3,250 ha (to annual cropland: 2,246 ha; to perennial cropland: 1,004 ha).

Carbon stock changes in living biomass

For the calculations of the annual change in carbon stocks in living biomass on land converted to cropland the Tier1/Tier2 methodology and equation 3.3.8 (GPG2003) were used.

(Equation 17)

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

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

*ΔC_{growth} – IPCC default value for carbon accumulation rate
accumulation rates: annual crops is 5.0 t C ha^{-1} , perennial crops is 2.1 t C ha^{-1}*

C_{after} – value of carbon stocks immediately after conversion is 0

*C_{before} – value of biomass carbon stocks immediately before
conversion to cropland (forest land, grassland)*

Values for the perennial crops carbon accumulation rate ($\Delta C_{growth} = 2.1 \text{ t C ha}^{-1}$) and for the annual crops accumulation rate ($\Delta C_{growth} = 5.0 \text{ t C ha}^{-1}$) were adopted from Table 3.3.8 (GPG2003). The carbon stock in forest land (C_{before}), calculated from growing stock, represented in Table 7.3.3. Values of country-specific emission factors (as C_{before}) for the following categories were calculated on basis of growing stock (GS: mean, s.e.) and were presented in the inventory on non-forest land uses in 2012 (FECS 2012): Grassland annual ($10.9 \text{ m}^3/\text{ha}$, 50%), Grassland perennial ($173.8 \text{ m}^3/\text{ha}$, 33%).

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.

$$\Delta C_{LC_{DOM}} = \Delta C_{LC_{DW}} + \Delta C_{LC_{LT}} \quad (\text{Equation 18})$$

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

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

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

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

(Equation 19)

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

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

C_{after} – value of carbon stocks immediately after conversion is 0

C_{before} – value of carbon stocks in dead wood [$t\ C\ ha^{-1}$]

Values for carbon stock in dead wood (C_{before}) were calculated from FECS 2007 and FECS 2012 data.

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

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

$L_{conversion} = C_{after} - C_{before}$
 C_{after} – carbon stock after conversion is 0
 C_{before} – carbon stock in litter [$t\ C\ ha^{-1}$]

Value for carbon stock in litter ($C_{before} = 10.41\ t\ C\ ha^{-1}$) was taken from Table 7.2.7.

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 (GPG2003) were used.

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

$\Delta C_{LC_{mineral}}$ – annual change in carbon stocks in mineral soils [$t\ C\ yr^{-1}$]
 SOC_0 – soil organic carbon stocks in the inventory year [$t\ C\ ha^{-1}$]
 SOC_{0-T} – soil organic carbon stocks T years prior to the inventory [$t\ C\ ha^{-1}$]
 T – time period [default = 20 years]
 A – land area [ha]

$SOC = SOC_{CL}$
 SOC_{CL} – Slovenian national value for organic carbon stocks in mineral soils for cropland

Slovenian national values for organic carbon stocks in mineral soils for cropland (cropland annual: $SOC_{CL_{annual}} = 80.66\ t\ C\ ha^{-1}$; cropland perennial: $SOC_{CL_{perennial}} = 78.89\ t\ C\ ha^{-1}$) are presented in Table 7.2.8.

Organic soils

In this year submission areas of organic soil were revised according to area data from Pedology map and should be consistent with the ones in Agricultural sector.

N₂O emissions in soils of land converted to cropland

For calculations of N₂O emissions associated with land conversion to cropland Tier 1 methodology and equations 3.3.14 and 3.3.15 (GPG2003) were used.

(Equation 22)

$$N_2O - N_{conv} = N_2O_{net-min} - N$$

$$N_2O_{net-min} - N = EF_1 * N_{net-min}$$

$N_2O - N_{conv}$ – N₂O emissions as a result of the disturbance associated with land-use conversion of forest land, grassland, or other land to cropland, [kg N₂O-N yr⁻¹]

$N_{net-min} - N$ released annually by net soil organic matter mineralisation as a result of the disturbance, [kg N yr⁻¹]

EF_1 – IPCC default emission factor used to calculate emissions from agricultural land caused by added N, either in the form of mineral fertilisers, manures, or crop residues, [kg N₂O-N/kg N]. (The default value is 0.0125 kg N₂O-N/kg N)

(Equation 23)

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

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

$\Delta C_{LC\min\text{eral}}$ – annual carbon stock change in soils (land converted to cropland) [kg C yr⁻¹]

C:N ratio – the ratio by mass of C to N in the soil organic matter (SOM), [kg C (kg N)⁻¹]

Default value for C:N ratio (15.0 kg C (kg N)⁻¹) was used from GPG2003. Values for annual carbon stock change in soils ($\Delta C_{LC\min\text{eral}}$) were taken from calculations of carbon stock changes in soils for land (forest land and grassland) converted to cropland. For emission factor (EF_1), the default value (0.0125 kg N₂O-N/kg N) was used.

The average annual emissions of N₂O from land converted to cropland were 0.045 Gg N₂O.

Table 7.4.3: N₂O emissions of Grassland and Forest land converted to cropland

Conversion (N ₂ O emissions)	from Forest land	from Grassland
	t N ₂ O-N / yr	t N ₂ O-N / yr
to Cropland	9.04	35.78

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 estimates provided by Slovenia.

The following uncertainties for 2012 were estimated (Table 7.4.4). They are based on uncertainty values (as standard error) calculated on basis of FECS 2012 data.

Table 7.4.4: Uncertainty estimates related to Cropland

Variable		Uncertainty
Uncertainty in cropland remaining cropland		
Uncertainty in biomass accumulation rates		± 75 % (95 % CI, GPG2003 table 3.3.2)
Uncertainty from land converted to cropland		
Carbon stocks in previous land use	Grassland annual	± 50 % (S.E., FECS 2012)
	Grassland perennial	± 33 % (S.E., FECS 2012)
	Forest land	± 4 % (S.E., FECS 2012)

7.4.4 Category-specific QA/QC and verification

Data on organic soil areas were revised and harmonized with the Agricultural sector.

7.4.5 Category-specific recalculations

Recalculations were made mostly for the emissions due to revision of area conversions between cropland perennial and annual within the Cropland remaining cropland category.

Data about organic soils were reviewed and synchronized with data for Agricultural sector. New expert judgment on liming was also provided in 2012.

N₂O emissions associated with land conversion to cropland, perennial cropland remaining perennial cropland were revised, use of data rechecked and improvements were included in 2014 submission.

7.4.6 Source-specific planned improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

7.5 Grassland (5C)

7.5.1 Source category description

Grassland category includes CO₂ 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. CO₂ emissions from agricultural lime application are included in Cropland category.

Table 7.5.1: Activity data for Grassland in 1986 – 2012 in kha

Year	5.C. Total Grassland	5.C. Organic soil	5.C.1. Grassland remaining Grassland	5.C.2. Land converted to Grassland	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
2012	427.4	0.8	249.4	178.0	54.0	124.0	NO	NO	NO
2011	424.2	0.8	246.2	178.0	54.0	124.0	NO	NO	NO
2010	420.9	0.9	242.9	178.0	54.0	124.0	NO	NO	NO
2009	417.7	0.8	239.7	178.0	54.0	124.0	NO	NO	NO
2008	414.4	0.8	236.4	178.0	54.0	124.0	NO	NO	NO
2007	411.2	1.1	233.2	178.0	54.0	124.0	NO	NO	NO
2006	407.9	1.1	229.9	178.0	54.0	124.0	NO	NO	NO
2005	404.7	1.2	226.7	178.0	54.0	124.0	NO	NO	NO
2004	401.4	1.3	223.4	178.0	54.0	124.0	NO	NO	NO
2003	398.2	1.3	220.2	178.0	54.0	124.0	NO	NO	NO
2002	394.9	1.3	216.9	178.0	54.0	124.0	NO	NO	NO
2001	391.7	1.3	213.7	178.0	54.0	124.0	NO	NO	NO
2000	388.4	1.3	210.4	178.0	54.0	124.0	NO	NO	NO
1999	385.2	1.3	207.2	178.0	54.0	124.0	NO	NO	NO
1998	381.9	1.3	203.9	178.0	54.0	124.0	NO	NO	NO
1997	378.7	1.3	200.7	178.0	54.0	124.0	NO	NO	NO
1996	375.4	1.3	197.4	178.0	54.0	124.0	NO	NO	NO
1995	372.2	1.3	194.2	178.0	54.0	124.0	NO	NO	NO
1994	368.9	1.4	190.9	178.0	54.0	124.0	NO	NO	NO
1993	365.7	1.4	187.7	178.0	54.0	124.0	NO	NO	NO
1992	362.4	1.4	184.4	178.0	54.0	124.0	NO	NO	NO
1991	359.2	1.4	181.2	178.0	54.0	124.0	NO	NO	NO
1990	355.9	1.4	177.9	178.0	54.0	124.0	NO	NO	NO
1989	352.7	1.4	174.7	178.0	54.0	124.0	NO	NO	NO
1988	349.4	1.4	171.4	178.0	54.0	124.0	NO	NO	NO
1987	346.2	1.4	168.2	178.0	54.0	124.0	NO	NO	NO
1986	342.9	1.5	164.9	178.0	54.0	124.0	NO	NO	NO

Grassland covers 21.1 % of country's total area. Grassland land use includes: meadows and pastures, swampy meadows and pastures, alpine meadows, mixed land use (arable land and forest, small areas) and uncultivated agriculture land.

Table 7.5.2: Emissions from Grassland (1986 – 2012) in Gg CO₂

Year	5.C. Total Grassland	5.C.1. Grassland remaining Grassland	5.C.2. Land converted to Grassland	5.C.2.1 Forest Land converted to Grassland	5.C.2.2 Cropland converted to Grassland	5.C.2.3 Wetland converted to Grassland	5.C.2.4 Settlements converted to Grassland	5.C.2.5 Other Land converted to Grassland
	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂
2012	965.5	7.4	958.1	1,219.3	-261.2	NO	NO	NO
2011	953.9	7.4	946.5	1,207.7	-261.2	NO	NO	NO
2010	942.9	8.0	934.9	1,196.1	-261.2	NO	NO	NO
2009	930.7	7.4	923.3	1,184.5	-261.2	NO	NO	NO
2008	919.2	7.5	911.7	1,172.9	-261.2	NO	NO	NO
2007	909.8	9.7	900.1	1,161.3	-261.2	NO	NO	NO
2006	897.4	10.5	886.9	1,148.1	-261.2	NO	NO	NO
2005	885.0	11.3	873.8	1,135.0	-261.2	NO	NO	NO
2004	872.2	11.6	860.6	1,121.8	-261.2	NO	NO	NO
2003	859.4	12.0	847.4	1,108.6	-261.2	NO	NO	NO
2002	846.6	12.3	834.3	1,095.5	-261.2	NO	NO	NO
2001	833.3	12.3	821.1	1,082.3	-261.2	NO	NO	NO
2000	820.1	12.2	807.9	1,069.1	-261.2	NO	NO	NO
1999	842.3	12.1	830.2	1,091.4	-261.2	NO	NO	NO
1998	836.7	12.1	824.6	1,085.8	-261.2	NO	NO	NO
1997	831.1	12.0	819.1	1,080.3	-261.2	NO	NO	NO
1996	825.7	12.2	813.5	1,074.7	-261.2	NO	NO	NO
1995	820.2	12.3	808.0	1,069.2	-261.2	NO	NO	NO
1994	814.8	12.4	802.4	1,063.6	-261.2	NO	NO	NO
1993	809.4	12.5	796.8	1,058.1	-261.2	NO	NO	NO
1992	803.9	12.6	791.3	1,052.5	-261.2	NO	NO	NO
1991	798.5	12.8	785.7	1,046.9	-261.2	NO	NO	NO
1990	793.1	12.9	780.2	1,041.4	-261.2	NO	NO	NO
1989	787.6	13.0	774.6	1,035.8	-261.2	NO	NO	NO
1988	782.2	13.1	769.1	1,030.3	-261.2	NO	NO	NO
1987	776.7	13.3	763.5	1,024.7	-261.2	NO	NO	NO
1986	771.3	13.4	757.9	1,019.1	-261.2	NO	NO	NO

CO₂ emissions in category Grassland range from 771.3 Gg CO₂ (1986) to 965.5 Gg CO₂ (2012). Land converted to grassland (CO₂) was identified as key source category. Grassland remaining grassland (CO₂) 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 that there is no change in living biomass carbon stocks. It is reasonable to expect, the biomass carbon stock to be in an approximately steady-state in grassland where management practices are static and 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 (GPG2003) was used.

$$\Delta C_{GGsoils} = \Delta C_{GGmineral} - \Delta C_{GGorganic} - \Delta C_{GGliming}$$

(Equation 24)

$\Delta C_{GGsoils}$ - annual change in carbon stocks in soil [t C yr⁻¹]
 $\Delta C_{GGmineral}$ - annual change in carbon stocks in mineral soils [t C yr⁻¹]
 $\Delta C_{GGorganic}$ - annual changes in carbon stocks in organic soils [t C yr⁻¹]
 $\Delta C_{GGliming}$ - annual C emissions from lime application to grassland [t C yr⁻¹]

Mineral soils

For calculations of annual carbon stock changes in mineral soils in Grassland remaining grassland Tier 2 methodology and equation 3.4.8 (GPG2003) were used.

Due to the expert judgment it is assumed that there have been no change in grassland management in the default time period of 20 years. The country-specific values were used according to values provided by the inventory on non-forest land in 2012 (Table 7.2.8).

Organic soils

Total area of organic soils in grassland category in 2012 was 0.8 kha.

For calculations emissions from organic soil Tier 1/Tier 2 methodology and equation 3.4.10 from GPG2003 were used:

$$\Delta C = \sum (A * EF)$$

(Equation 25)

A – land area of organic soils
 EF – emission factor for climate type (2.5 t C ha⁻¹)

Emission factor (EF = 2.5 t C ha⁻¹) for warm temperate climatic temperature regime from Table 3.4.6 (GPG2003) was adopted.

Liming

All information about liming in Slovenia is presented 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 8,935 ha. Conversions from forest land to grassland and cropland to grassland occur, however, according to expert judgement, there are no conversions from wetland, settlements and other land to grassland. Due to the necessary assurance for Slovenian land area consistency through the whole time series, also conversions from wetland, settlements, other land to grassland are included in the land use change matrix.

The average annual area converted from forest land to grassland is 2,728 ha. The average annual area converted from cropland to grassland is 6,207 ha (from cropland perennial: 1,322 ha; from cropland annual: 4,885 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 (GPG2003) were used.

(Equation 26)

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

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

ΔC_{growth} – default value for carbon accumulation rate (13.5 t d.m. ha⁻¹, 6.75 t C ha⁻¹)

C_{after} – value of carbon stocks immediately after conversion is 0

C_{before} – biomass carbon stocks (forest land, cropland)

Values for the carbon accumulation rate ($\Delta C_{growth} = 6.75 \text{ t C ha}^{-1}$; $13.5 \text{ t d.m. ha}^{-1} * 0.5$; warm temperate wet) were adopted from Table 3.4.9 (GPG2003). The carbon stock in forest land (C_{before}) is represented in Table 7.2.9. The growing stock in forest land (C_{before}) is represented in Table 7.3.3. Values of country-specific emission factors (as C_{before}) for the following categories were calculated on basis of growing stock (GS: mean, s.e.) and presented in the inventory on non-forest land uses in 2012 (FECS 2012): Cropland annual (2.7 m³/ha, 130%), Cropland perennial (25.8 m³/ha, 51%).

Carbon stock changes in dead organic matter

Carbon stock changes in dead organic matter were calculated for dead wood and litter pool in conversion from forest land to grassland. The following equation was used.

$$\Delta C_{LG_{DOM}} = \Delta C_{LG_{DW}} + \Delta C_{LG_{LT}}$$

(Equation 27)

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

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

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

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

(Equation 28)

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

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

C_{after} – value of carbon stocks immediately after conversion is 0

C_{before} – value of carbon stocks in dead wood [t C ha⁻¹]

Values for carbon stock in dead wood (C_{before}) were calculated from FECS 2007 and 2012 data.

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

(Equation 29)

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

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

C_{after} – carbon after conversion is 0

C_{before} – carbon stock in litter [t C ha⁻¹]

Value for carbon stock in litter ($C_{\text{before}} = 10.41 \text{ t C ha}^{-1}$) was taken from Slovenian Forestry Institute Research study (Kobal M., Simoncic P., 2011).

Carbon stock changes in soils

For calculations of emissions from soils in land converted to grassland Tier 2 methodology and equation 3.3.3 (GPG2003) were used.

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

(Equation 30)

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

SOC_0 – soil organic carbon stock in the inventory year [t C ha⁻¹]

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

T – time period [default = 20 years]

A – land area [ha]

$$SOC = SOC_{GL}$$

SOC_{GL} – Slovenian national value for organic carbon stock in mineral soils

Slovenian national values for organic carbon stock in mineral soil for grassland (grassland annual: SOC_{GLannual} = 89.64 t ha⁻¹; grassland perennial: SOC_{GLperennial} = 69.24 t ha⁻¹) are presented in Table 7.2.8.

7.5.3 Uncertainties and time-series consistency

The following uncertainties for 2012 were estimated (Table 7.5.3). They are based on uncertainty values (as standard error) calculated on basis of FECS 2012 data.

Table 7.5.3: Uncertainty estimates related to grassland

Variable		Uncertainty (95% CI)
Uncertainty in grassland remaining grassland		
Uncertainty in biomass accumulation rates		± 75 % (95% CI, GPG2003 table 3.4.2)
Uncertainty from land converted to grassland		
Carbon stocks in previous land use	Cropland annual	± 130 % (S.E., FECS 2012)
	Cropland perennial	± 51 % (S.E., FECS 2012)
	Forestland	± 4 % (S.E., FECS 2012)

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

Recalculations were made due to new data on soil organic carbon and biomass stock on grasslands, since inventory was performed on non-forest land in 2012.

Data about organic soils were reviewed and synchronized with data for Agricultural sector.

N₂O emissions associated with Land conversion to cropland, Perennial cropland remaining perennial cropland were revised, use of data rechecked and improvements were included in 2014 submission.

7.5.6 Source-specific planned improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

7.6 Wetlands (5D)

7.6.1 Source category description

Wetlands are defined (GPG2003) as land that is covered or saturated by water for all or part of the year and that does not classify as forest land, cropland, grassland or settlements categories. Emissions in Wetlands remaining wetlands are not estimated, conversions from other land uses to wetlands, except from forest land and grassland, do not occur in Slovenia. Wetlands covered 0.7 % of country area in 2012. Wetland land use includes: swamps, reeds, other marshy areas and waters (inland water bodies).

Table 7.6.1: Activity data of Wetlands (1986 – 2012) in kha

Year	5.D Total wetlands	5.D.1 Wetland remaining wetlands	Land converted to wetlands					
			5.D.2 Land converted to wetlands	5.D.2.1 Forest converted to wetlands	5.D.2.2 Cropland converted to wetlands	5.D.2.3 Grassland converted to Wetlands	5.D.2.4 Settlements converted to wetlands	5.D.2.5 Other land converted to wetlands
	kha	kha	kha	kha	kha	kha	kha	kha
2012	13.8	7.8	6.0	2.0	NO	4.0	NO	NO
2011	14.0	8.0	6.0	2.0	NO	4.0	NO	NO
2010	14.2	8.2	6.0	2.0	NO	4.0	NO	NO
2009	14.4	8.4	6.0	2.0	NO	4.0	NO	NO
2008	14.6	8.6	6.0	2.0	NO	4.0	NO	NO
2007	14.9	8.9	6.0	2.0	NO	4.0	NO	NO
2006	15.1	9.1	6.0	2.0	NO	4.0	NO	NO
2005	15.3	9.3	6.0	2.0	NO	4.0	NO	NO
2004	15.5	9.5	6.0	2.0	NO	4.0	NO	NO
2003	15.8	9.8	6.0	2.0	NO	4.0	NO	NO
2002	16.0	10.0	6.0	2.0	NO	4.0	NO	NO
2001	16.2	10.2	6.0	2.0	NO	4.0	NO	NO
2000	16.4	10.4	6.0	2.0	NO	4.0	NO	NO
1999	16.6	10.6	6.0	2.0	NO	4.0	NO	NO
1998	16.9	10.9	6.0	2.0	NO	4.0	NO	NO
1997	17.1	11.1	6.0	2.0	NO	4.0	NO	NO
1996	17.3	11.3	6.0	2.0	NO	4.0	NO	NO
1995	17.5	11.5	6.0	2.0	NO	4.0	NO	NO
1994	17.7	11.7	6.0	2.0	NO	4.0	NO	NO
1993	18.0	12.0	6.0	2.0	NO	4.0	NO	NO
1992	18.2	12.2	6.0	2.0	NO	4.0	NO	NO
1991	18.4	12.4	6.0	2.0	NO	4.0	NO	NO
1990	18.6	12.6	6.0	2.0	NO	4.0	NO	NO
1989	18.9	12.9	6.0	2.0	NO	4.0	NO	NO
1988	19.1	13.1	6.0	2.0	NO	4.0	NO	NO
1987	19.3	13.3	6.0	2.0	NO	4.0	NO	NO
1986	19.5	13.5	6.0	2.0	NO	4.0	NO	NO

Table 7.6.2: Emission from Wetlands (1986 – 2012) in Gg CO₂

Year	5.D Total wetlands	5.D.1 Wetland remaining Wetlands	Land converted to wetland					
			5.D.2 Land converted to Wetlands	5.D.2.1 Forest converted to Wetlands	5.D.2.2 Cropland converted to wetlands	5.D.2.3 Grassland converted to Wetlands	5.D.2.4 Settlements converted to Wetlands	5.D.2.5 Other land converted to Wetlands
	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂
2012	56.2	NE	56.2	44.5	NO	11.8	NO	NO
2011	55.7	NE	55.7	43.9	NO	11.8	NO	NO
2010	55.2	NE	55.2	43.4	NO	11.8	NO	NO
2009	54.6	NE	54.6	42.9	NO	11.8	NO	NO
2008	54.1	NE	54.1	42.3	NO	11.8	NO	NO
2007	53.6	NE	53.6	41.8	NO	11.8	NO	NO
2006	53.0	NE	53.0	41.2	NO	11.8	NO	NO
2005	52.4	NE	52.4	40.6	NO	11.8	NO	NO
2004	51.7	NE	51.7	40.0	NO	11.8	NO	NO
2003	51.1	NE	51.1	39.4	NO	11.8	NO	NO
2002	50.5	NE	50.5	38.8	NO	11.8	NO	NO
2001	49.9	NE	49.9	38.2	NO	11.8	NO	NO
2000	49.3	NE	49.3	37.6	NO	11.8	NO	NO
1999	49.1	NE	49.1	37.3	NO	11.8	NO	NO
1998	48.8	NE	48.8	37.1	NO	11.8	NO	NO
1997	48.6	NE	48.6	36.8	NO	11.8	NO	NO
1996	48.3	NE	48.3	36.6	NO	11.8	NO	NO
1995	48.1	NE	48.1	36.3	NO	11.8	NO	NO
1994	47.8	NE	47.8	36.1	NO	11.8	NO	NO
1993	47.6	NE	47.6	35.8	NO	11.8	NO	NO
1992	47.3	NE	47.3	35.5	NO	11.8	NO	NO
1991	47.1	NE	47.1	35.3	NO	11.8	NO	NO
1990	46.8	NE	46.8	35.0	NO	11.8	NO	NO
1989	46.5	NE	46.5	34.8	NO	11.8	NO	NO
1988	46.3	NE	46.3	34.5	NO	11.8	NO	NO
1987	46.0	NE	46.0	34.3	NO	11.8	NO	NO
1986	45.8	NE	45.8	34.0	NO	11.8	NO	NO

7.6.2 Methodological issues

7.6.2.1 Wetlands remaining wetlands

The methodology for this category is not covered by GPG2003, but is addressed in Appendix 3A.3 Wetlands remaining wetlands: Basic for future methodological development. Slovenia has not reported emissions from wetlands due to the 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, except those from forest land and grassland. Due to the necessary assurance for Slovenian land area consistency through the whole time series, also conversions from cropland, settlements and other land to wetlands are included in the land use change matrix. Values for soil carbon stocks are presented in Table 7.2.8. Country-specific emission factor for living biomass was calculated from the growing stock on wetlands (GS = $41.5 \text{ m}^3 \text{ ha}^{-1}$) estimated in non-forest land inventory in 2012.

7.6.3 Uncertainties and time-series consistency

Uncertainty estimates are not reported here.

7.6.4 Category-specific QA/QC and verification

No specific QA/QC and verification were used for wetlands.

7.6.5 Category-specific recalculations

Recalculations were made due to new data on soil organic carbon and biomass stock on wetland, since inventory was carried out on non-forest land in 2012.

7.6.6 Source-specific planned improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and 2013 Supplement to the 2006 Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement). If necessary, recalculations will be performed.

7.7 Settlements (5E)

7.7.1 Source category description

This land use category is described (GPG2003) as including all development land, including transportation infrastructure and human settlements of any size, unless they are already included in 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 in urban area. Settlements covered 5.4 % of country area in 2012. Settlements land use includes: built-areas and related surfaces.

Table 7.7.1: Activity data of Settlements (1986-2012) in kha.

Year	5.E Total settlements	5.E.1. Settlements remaining settlements	Land converted to settlements					
			5.E.2 Land converted to settlements	5.E.2.1 Forest converted to settlements	5.E.2.2 Cropland converted to settlements	5.E.2.3 Grassland converted to settlements	5.E.2.4 Wetland converted to settlements	5.E.2.5 Other lands converted to settlements
	kha	kha	kha	kha	kha	kha	kha	kha
2012	109.0	67.0	42.0	12.0	12.0	18.0	NO	NO
2011	109.0	67.0	42.0	12.0	12.0	18.0	NO	NO
2010	108.9	66.9	42.0	12.0	12.0	18.0	NO	NO
2009	108.8	66.8	42.0	12.0	12.0	18.0	NO	NO
2008	108.7	66.7	42.0	12.0	12.0	18.0	NO	NO
2007	108.7	66.7	42.0	12.0	12.0	18.0	NO	NO
2006	108.6	66.6	42.0	12.0	12.0	18.0	NO	NO
2005	108.5	66.5	42.0	12.0	12.0	18.0	NO	NO
2004	108.4	66.4	42.0	12.0	12.0	18.0	NO	NO
2003	108.4	66.4	42.0	12.0	12.0	18.0	NO	NO
2002	108.3	66.3	42.0	12.0	12.0	18.0	NO	NO
2001	108.2	66.2	42.0	12.0	12.0	18.0	NO	NO
2000	108.2	66.2	42.0	12.0	12.0	18.0	NO	NO
1999	108.1	66.1	42.0	12.0	12.0	18.0	NO	NO
1998	108.0	66.0	42.0	12.0	12.0	18.0	NO	NO
1997	107.9	65.9	42.0	12.0	12.0	18.0	NO	NO
1996	107.9	65.9	42.0	12.0	12.0	18.0	NO	NO
1995	107.8	65.8	42.0	12.0	12.0	18.0	NO	NO
1994	107.7	65.7	42.0	12.0	12.0	18.0	NO	NO
1993	107.6	65.6	42.0	12.0	12.0	18.0	NO	NO
1992	107.6	65.6	42.0	12.0	12.0	18.0	NO	NO
1991	107.5	65.5	42.0	12.0	12.0	18.0	NO	NO
1990	107.4	65.4	42.0	12.0	12.0	18.0	NO	NO
1989	107.3	65.3	42.0	12.0	12.0	18.0	NO	NO
1988	107.3	65.3	42.0	12.0	12.0	18.0	NO	NO
1987	107.2	65.2	42.0	12.0	12.0	18.0	NO	NO
1986	107.1	65.1	42.0	12.0	12.0	18.0	NO	NO

Table 7.7.2: Emissions from Settlements (1986 – 2012) in Gg CO₂

Year	5.E Total settlements	5.E.1. Settlements remaining settlements	Land converted to settlements					
			5.E.2 Land converted to settlements	5.E.2.1 Forest converted to settlements	5.E.2.2 Cropland converted to settlements	5.E.2.3 Grassland converted to settlements	5.E.2.4 Wetland converted to settlements	5.E.2.5 Other lands converted to settlements
	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂
2012	700.6	NE	700.6	418.2	94.2	188.1	NO	NO
2011	697.4	NE	697.4	415.0	94.2	188.1	NO	NO
2010	694.2	NE	694.2	411.8	94.2	188.1	NO	NO
2009	691.0	NE	691.0	408.7	94.2	188.1	NO	NO
2008	687.8	NE	687.8	405.5	94.2	188.1	NO	NO
2007	684.7	NE	684.7	402.3	94.2	188.1	NO	NO
2006	681.0	NE	681.0	398.7	94.2	188.1	NO	NO
2005	677.4	NE	677.4	395.0	94.2	188.1	NO	NO
2004	673.8	NE	673.8	391.4	94.2	188.1	NO	NO
2003	670.2	NE	670.2	387.8	94.2	188.1	NO	NO
2002	666.6	NE	666.6	384.2	94.2	188.1	NO	NO
2001	662.9	NE	662.9	380.6	94.2	188.1	NO	NO
2000	659.3	NE	659.3	377.0	94.2	188.1	NO	NO
1999	657.8	NE	657.8	375.4	94.2	188.1	NO	NO
1998	656.3	NE	656.3	373.9	94.2	188.1	NO	NO
1997	654.8	NE	654.8	372.4	94.2	188.1	NO	NO
1996	653.2	NE	653.2	370.9	94.2	188.1	NO	NO
1995	651.7	NE	651.7	369.3	94.2	188.1	NO	NO
1994	650.2	NE	650.2	367.8	94.2	188.1	NO	NO
1993	648.7	NE	648.7	366.3	94.2	188.1	NO	NO
1992	647.1	NE	647.1	364.8	94.2	188.1	NO	NO
1991	645.6	NE	645.6	363.2	94.2	188.1	NO	NO
1990	644.1	NE	644.1	361.7	94.2	188.1	NO	NO
1989	642.6	NE	642.6	360.2	94.2	188.1	NO	NO
1988	641.0	NE	641.0	358.7	94.2	188.1	NO	NO
1987	639.5	NE	639.5	357.1	94.2	188.1	NO	NO
1986	638.0	NE	638.0	355.6	94.2	188.1	NO	NO

CO₂ emissions in category Settlements range from 638.0 Gg CO₂ (1986) to 700.6 Gg CO₂ (2012).

Land converted to settlements (CO₂) was identified as key source category.

7.7.2 Methodological issues

7.7.2.1 Settlements remaining settlements

GPG2003 provides a basic method for estimating CO₂ 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 2,154 ha. The average annual area converted from forest land to settlements is 584 ha. The average annual area converted from cropland to settlements is 632 ha (from perennial cropland: 208 ha and from annual cropland: 424 ha) and from grassland to settlements to 938 ha.

According to expert judgement there are no conversions from wetlands and other land to settlements. Due to the necessary assurance for Slovenian land area consistency through whole time series, these conversions were also 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 (GPG2003) were used.

$$\Delta C_{FS_{LB}} = A * (C_{after} - C_{before}) \quad \text{(Equation 31)}$$

$\Delta C_{FS_{LB}}$ – annual change in carbon stocks in living biomass due to conversion of forest land to settlements [t C yr⁻¹]

A – area of land converted annually from forest land to settlements [ha yr⁻¹]

C_{after} – carbon stocks in living biomass immediately following conversion to settlements [t C ha⁻¹]

C_{before} – carbon stocks in living biomass immediately before conversion to settlements [t C ha⁻¹]

Values for soil carbon stocks are presented in Table 7.2.8. Country-specific emission factor for living biomass was calculated from the growing stock on settlements (GS = 19.1 m³ ha⁻¹) estimated in non-forest land inventory in 2012.

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

Recalculations were made due to new data on soil organic carbon on settlements since inventory was carried out for non-forest land in 2012. Besides, expert judgment was performed for soil carbon stock based on data for green areas in urban land from the Ljubljana municipality.

7.7.6 Category-specific planned improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

7.8 Other land (5F)

7.8.1 Source category description

Other land is defined (GPG2003) as including bare soil, rock, ice and all unmanaged land areas which do not classify as any other land use category. This land use category is included to allow the total of identified land areas to match the national area. Other land covered 1.5 % of country area in 2012. 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 (1986-2012) in kha.

Year	5.F Other land	5.F.1. Other land remaining other land	Land converted to other land					
			5.F.2. Land converted to other land	5.F.2.1 Forest land converted to other land	5.F.2.2 Cropland converted to other land	5.F.2.3 Grassland converted to other land	5.F.2.4 Wetlands converted to other land	5.F.2.5 Settlements converted to other land
	kha	kha	kha	kha	kha	kha	kha	kha
2012	30.3	26.3	4.0	4.0	NO	NO	NO	NO
2011	31.1	27.1	4.0	4.0	NO	NO	NO	NO
2010	31.8	27.8	4.0	4.0	NO	NO	NO	NO
2009	32.6	28.6	4.0	4.0	NO	NO	NO	NO
2008	33.4	29.4	4.0	4.0	NO	NO	NO	NO
2007	34.2	30.2	4.0	4.0	NO	NO	NO	NO
2006	34.9	30.9	4.0	4.0	NO	NO	NO	NO
2005	35.7	31.7	4.0	4.0	NO	NO	NO	NO
2004	36.5	32.5	4.0	4.0	NO	NO	NO	NO
2003	37.3	33.3	4.0	4.0	NO	NO	NO	NO
2002	38.0	34.0	4.0	4.0	NO	NO	NO	NO
2001	38.8	34.8	4.0	4.0	NO	NO	NO	NO
2000	39.6	35.6	4.0	4.0	NO	NO	NO	NO
1999	40.4	36.4	4.0	4.0	NO	NO	NO	NO
1998	41.1	37.1	4.0	4.0	NO	NO	NO	NO
1997	41.9	37.9	4.0	4.0	NO	NO	NO	NO
1996	42.7	38.7	4.0	4.0	NO	NO	NO	NO
1995	43.5	39.5	4.0	4.0	NO	NO	NO	NO
1994	44.2	40.2	4.0	4.0	NO	NO	NO	NO
1993	45.0	41.0	4.0	4.0	NO	NO	NO	NO
1992	45.8	41.8	4.0	4.0	NO	NO	NO	NO
1991	46.6	42.6	4.0	4.0	NO	NO	NO	NO
1990	47.3	43.3	4.0	4.0	NO	NO	NO	NO
1989	48.1	44.1	4.0	4.0	NO	NO	NO	NO
1988	48.9	44.9	4.0	4.0	NO	NO	NO	NO
1987	49.7	45.7	4.0	4.0	NO	NO	NO	NO
1986	50.4	46.4	4.0	4.0	NO	NO	NO	NO

Table 7.8.2: Emissions from other land (1986–2012) in Gg CO₂

Year	5.F Other land	5.F.1. Other land remaining other land	Land converted to other land					
			5.F.2. Land converted to other land	5.F.2.1 Forest Land converted to other land	5.F.2.2 Cropland converted to other land	5.F.2.3 Grassland converted to other land	5.F.2.4 Wetlands converted to other land	5.F.2.5 Settlements converted to other land
	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂	Gg CO ₂
2012	172.3	NE	172.3	172.3	NO	NO	NO	NO
2011	171.2	NE	171.2	171.2	NO	NO	NO	NO
2010	170.2	NE	170.2	170.2	NO	NO	NO	NO
2009	169.1	NE	169.1	169.1	NO	NO	NO	NO
2008	168.0	NE	168.0	168.0	NO	NO	NO	NO
2007	167.0	NE	167.0	167.0	NO	NO	NO	NO
2006	165.8	NE	165.8	165.8	NO	NO	NO	NO
2005	164.6	NE	164.6	164.6	NO	NO	NO	NO
2004	163.3	NE	163.3	163.3	NO	NO	NO	NO
2003	162.1	NE	162.1	162.1	NO	NO	NO	NO
2002	160.9	NE	160.9	160.9	NO	NO	NO	NO
2001	159.7	NE	159.7	159.7	NO	NO	NO	NO
2000	158.5	NE	158.5	158.5	NO	NO	NO	NO
1999	158.0	NE	158.0	158.0	NO	NO	NO	NO
1998	157.5	NE	157.5	157.5	NO	NO	NO	NO
1997	157.0	NE	157.0	157.0	NO	NO	NO	NO
1996	156.5	NE	156.5	156.5	NO	NO	NO	NO
1995	156.0	NE	156.0	156.0	NO	NO	NO	NO
1994	155.5	NE	155.5	155.5	NO	NO	NO	NO
1993	155.0	NE	155.0	155.0	NO	NO	NO	NO
1992	154.5	NE	154.5	154.5	NO	NO	NO	NO
1991	153.9	NE	153.9	153.9	NO	NO	NO	NO
1990	153.4	NE	153.4	153.4	NO	NO	NO	NO
1989	152.9	NE	152.9	152.9	NO	NO	NO	NO
1988	152.4	NE	152.4	152.4	NO	NO	NO	NO
1987	151.9	NE	151.9	151.9	NO	NO	NO	NO
1986	151.4	NE	151.4	151.4	NO	NO	NO	NO

7.8.2 Methodological issues

7.8.2.1 Other land remaining other land

Consistent with the IPCC Guidelines, change in carbon stocks and non-CO₂ 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, however, included for checking overall consistency of land area and tracking conversions to and from other land.

7.8.2.2 Land converted to other land

According to expert judgement there are only conversions from forest land to other land.

7.8.3 Uncertainties and time-series consistency

The uncertainty estimates are not reported here.

7.8.4 Category-specific QA/QC and verification

No specific QA/QC and verification was used for other land.

7.8.5 Category-specific recalculations

Recalculations were made due to revised values of growing stock in category Forest land.

7.8.6 Category-specific improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

Acknowledgement:

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8 WASTE (CRF sector 6)

Waste management and treatment of biodegradable industrial and municipal wastes are sources of GHGs emissions. The inventory covers CH₄ emissions resulting from solid waste disposal on land, GHG emissions from waste incineration and CH₄ emissions from treatment of liquid wastes. This section also includes estimates of emission of N₂O from municipal sewage.

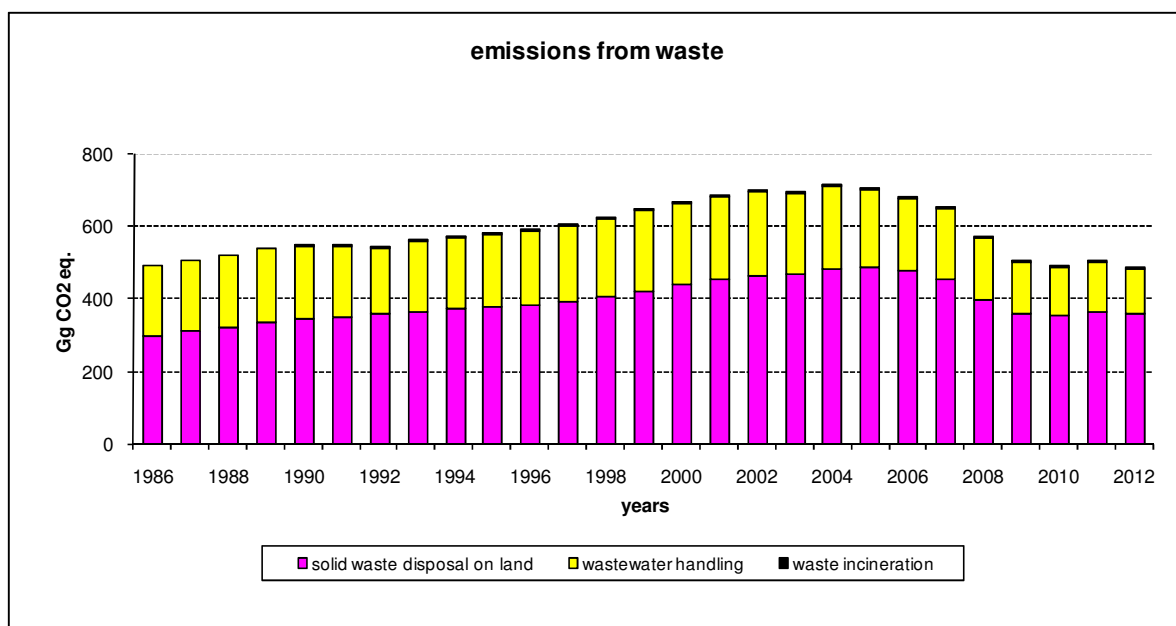


Figure 8.0.1: Emissions from solid waste disposal on land and from wastewater handling in Gg CO₂ eq. Emissions from waste incineration are very small and therefore not visible in this figure.

In 2012, emissions from the waste sector amounted to 488.34 Gg CO₂ eq, or 2.6 per cent of the total GHG emissions. Since 1986 emissions decreased by 1.3 per cent. The key driver for the fall of emissions is the decrease of biodegradable part of municipal waste deposited on the SWDS (Figure 8.0.1). Within the sector 73.5 per cent of the emissions were from solid waste disposal on land, followed by 25.4 per cent from wastewater handling while remaining 1.1 per cent of emissions were from waste incineration.

Almost 4.4 million tonnes of waste were generated in Slovenia in 2012 or 33% less than in 2011. The large decrease is the result of the reduction in the generated construction waste and also of the reclassification of some waste into by-products. Compared to 2011, the amount of municipal waste decreased by 7% and the amount of hazardous waste by 13%. Most of the hazardous waste was generated in manufacturing, i.e. 59% of total hazardous waste.

In 2012 a person in Slovenia generated on average 327 kg of municipal waste or almost 1 kg of municipal waste per day. This is 7% less than in 2011. As a result, public waste removal services collected 7% less municipal waste than a year before.

At the end of 2012 only 8 municipal SWDS have been active while many others had been already closed (16 SWDS) or they have been in the process of closure (19 SWDS). Many waste disposal sites have to be closed because they were not able to reach very high

technical standards prescribed by legislation. In this report word “**municipal waste**” means waste generated by households and other waste similar to household waste generated by the manufacturing, trade, service and other industries and the public sector. This types of waste is reported under number 20 according to the List of waste.

List of Waste (LoW) is a list of hazardous and non-hazardous waste listed in the Annex 4 of the Decree on Waste (OJ RS, No 103/2011) and is available on the web site below:

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000D0532:20020101:EN:PDF>

Waste is classified into groups according to the origin. In addition to the name, each waste has a six-digit classification number.

The amount of municipal waste **generated** in Slovenia showed an upward trend until 2008 (847 thousand tonnes), which was followed by a decline and, in comparison to 2008, its quantity decreased by 20% in 2012 (678 thousand tonnes). See Table 8.0.1.

Waste regulations have introduced a 5-stage waste hierarchy, according to which the top priority is given to the prevention of waste generation, followed by preparing for reuse, recycling, other recovery procedures (e.g. energy recovery), whereas waste disposal (e.g. landfilling, incineration without energy recovery) is deemed to be the least preferred option.

The volume of separately collected fractions of municipal waste has been increasing in recent years and accounted for almost 40% in 2012. The system of door-to-door separate collection of waste facilitates further processing of separately collected waste (recycling and recovery). In this way we contribute to the conservation of natural resources and to a decrease in the negative environmental impacts of waste deposited in landfills (e.g. CH₄ emissions and other landfill gasses and leachate waters, the impact on groundwater).

With the introduction of the separate collection of municipal waste and statutory requirements regarding the processing of mixed residual waste prior to disposal, the amount of deposited municipal waste in relation to generated waste has been declining. In 2002, 94% of generated municipal waste was deposited (713 thousand tonnes), compared to 46% in 2012 (315 thousand tonnes); see Table 8.0.1.

Table 8.0.1: Source and handling of municipal waste, collected by public waste removal services (data from SORS)

		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Generated MSW	kt	757	786	789	798	832	847	847	826	802	725	678
Landfilled MSW	kt	713	694	625	659	725	688	685	628	558	419	315
Disposal – Landfilled	%	94.2	88.2	79.2	82.6	87.2	81.2	80.8	76.0	69.6	57.8	46.4
Recovery	%	5.0	7.9	3.5	4.3	5.2	9.6	8.3	13.7	9.0	22.5	32.6
Treatment of packages	%	0.0	0.1	2.2	3.0	3.4	3.6	4.6	7.0	7.0	13.7	16.7
Other	%	0.8	3.8	15.0	10.0	4.1	5.6	6.3	3.4	14.4	6.1	4.2

Waste management pays particular attention to packaging waste, not so much because of the generated quantities and risk potential, but primarily because of its enormous volume, short life cycle and substantial portion of organic matter. Up to 2004, the majority of Slovenian packaging waste ended up in landfills. With the introduction of regulations providing for the payment of an environmental tax on packaging, the separate collection of packaging waste, the establishment of a system for processing packaging waste, and by focusing on achieving the objectives set for the recovery and recycling of packaging waste, packaging waste management has seen substantial improvement.

Waste-water is treated in municipal or common waste-water treatment plants classified by level of treatment as specified in regulations. As a rule, primary treatment is defined as the mechanical or chemical elimination of a smaller quantity of organic loading and some suspended substances. Secondary treatment is a process of biological purification. It removes a large amount of organic substances and nutrients (20%-30%). Tertiary treatment eliminates organic matter and a large amount of nutrients (nitrogen, phosphors).

In recent years, the amount of waste water treated by secondary or tertiary treatment processes has increased. Since 2002, the quantity of waste water treated by these processes increased by 211% or from 38 million m³ (in 2003) to 81 million m³ (in 2012). Tertiary waste-water treatment was almost non-existent in Slovenia in 2002, while in 2012, as much as 37% of waste water, or 48 million m³, was treated by tertiary processes.

According to the 2012 data approximately 55% of population in Slovenia are connected to waste-water treatment plants, 90 of them are large (more than 2000 population equivalents) and 260 are medium. Nearly half the population still uses septic tanks, of these, less than one per cent is comprised of small municipal waste-water treatment plants (of less than 50 population equivalents).

Waste incineration is not important source of GHG emissions. The large amount of waste is incinerated in one small thermal power plant and in the industry (mostly cement plants) and corresponding emissions are reported in the energy sector. The remaining incinerated waste which is reported here consists mostly from clinical and hazardous wastes.

8.1 CH₄ Emissions from Solid Waste Disposal sites

	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Level	CH ₄	1.15		21	
2012	Level	CH ₄	1.28	0.22	13	

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 and new Operational Programme for the time period from 2013 until 2020

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 this basis National environmental action Programme was adopted in 2006 and 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 a new regulation period in waste management has already started. The National environmental action Programme formed the basis for the Operational Programme for waste disposal and its goal was the reduction of deposited biodegradable waste for the period 2009-2013; it was adopted by the government in 2008. However, the Rules on the landfill of waste adopted in 2000 had already comprised provisions regarding reduction of biodegradable waste and these were also included in the Decree on the treatment of biodegradable waste, which was adopted in 2008 and repealed the mentioned Rules.

The Operational Programme from 2008 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.

Measures for achieving the listed goals are also a part of the Operational Programme:

- the existing landfills should be closed down, if the adjustment to the existing provisions were too expensive or technically difficult to manage;
- reconstruction and enlargement of the existing landfills, which will be operating until the end of 2008;
- construction of a 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:

- by 10% in years 2008-2009,
- by 5% in years 2009 – 2010, 2011– 2012 and 2013 – 2015 in accordance with the 1995 amount.

A new strategic document, Operational Programme from 2013 adopted in this area provides the certain measures for achieving the following targets by 2020:

- increasing the recycling rate of municipal waste to 61–64%;
- increasing the incineration rate to approximately 25%; and
- decreasing the disposal of municipal waste in landfills to 11–15%.

These targets require an investment in infrastructure and in addition, greater attention will have to be devoted to raising public awareness.

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 with 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 the case 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 Tier 2 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 emissions 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 equations (1) and (2):

$$CH_4 \text{ generated in year } t \text{ (Gg/yr)} = \sum_x [(A \cdot k \cdot MSW(x) \cdot L_0(x)) \cdot e^{-k(t-x)}] \quad (1)$$

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)

MSW(x) = total municipal solid waste landfilled (Gg/yr)

L₀ = methane generation potential (Gg CH₄/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 a mixture of slow and fast degradable components in the waste. The half time period is 14 years.

The methane generation potential (Lo) depends on the composition of waste, on waste disposal practices and on the physical characteristics of 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):

$$CH_4 \text{ emitted} = (CH_4 \text{ generated} - R) \cdot (1 - OX) \quad (2)$$

where:

R = CH_4 recovered (Gg/yr)

OX = oxidation factor (fraction)

Activity data and parameters

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 was performed based on the presumption that in 1964, 50% of population was included in municipal waste collection system and that this percentage slightly increased and reached 60% in 1977 and 76% in 1995.

The composition of waste 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 impact on emissions in the reported period, this error is not considerable. Data is presented in the table 8.1.1.

We have also assumed that in that period the amount of waste per person was 470 kg/year or 1.29 kg/day. This amount is in the middle if we compare it 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 was deposited on municipal SWDS. Since 1995 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.	Deposit waste (t) = Generated
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 the data provided by SURS (data submitted to EUROSTAT), over 1 million tons of municipal waste were produced in that period. It is inferred that this amount, due to the unclear definition of municipal waste, included industrial waste as well. The calculation of quantities in the table 8.1.2 takes into account the assumption that all collected municipal waste was landfilled (which is quite accurate for Slovenian circumstances).

Table 8.1.2: Quantities of landfilled waste in the period 1995 - 2000.

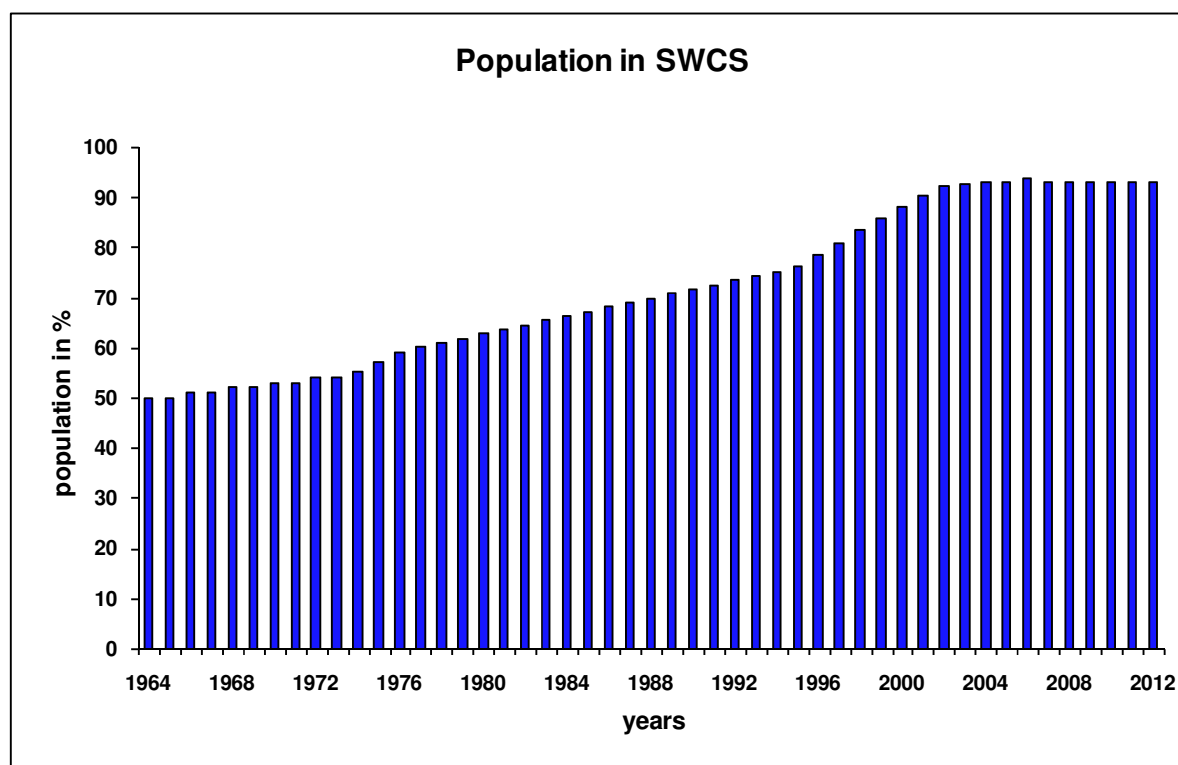
year	Urban population	Coverage in %	Waste disposal rate in kg/per./y.	Deposited waste (t) = Generated
1995	1,510,504	76.0	468	707,000
1996	1,561,674	78.4	464	725,000
1997	1,606,565	80.9	462	743,000
1998	1,651,310	83.3	461	761,000
1999	1,702,019	85.7	458	780,000
2000	1,749,847	87.9	457	800,000

The amount of waste in the period 2001 - 2012

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 have used data by the Slovenian Environment Agency, which collects data on the formation and handling all types of waste in Slovenia on a regular basis. Data are collected by means of forms which are set down by the law and must be filled in once a year (for the preceding year) by the reporting agent. In addition the quantities of collected mixed waste and separate fractions of municipal waste from households, reporting agents also provide data on 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 SORS generates its annual reports on waste handling. Results from this reports are presented in the table 8.1.3

Table 8.1.3: Quantities of landfilled waste in the period 2001 - 2012.

year	Urban population	Coverage in %	Waste disposal rate in kg/per./y.	Deposit waste (t)
2001	1,795,222	90.1	457	820,000
2002	1,854,535	92.3	443	840,000
2003	1,874,203	92.5	451	844,606
2004	1,873,992	93.0	433	810,647
2005	1,881,047	94.0	422	793,118
2006	1,881,713	93.6	446	838,883
2007	1,884,055	93.0	431	811,674
2008	1,886,601	93.0	441	831,834
2009	1,889,147	93.0	405	731.008
2010	1,905,813	93.0	391	623.224
2011	1,911,610	93.0	415	646.318
2012	1,911,610	93.0	343	446.394

**Figure 8.1.1: Population served by solid waste collection systems**

Despite the fact that the data on the amount of waste in the period 1995-2000 were provided by the SORS and obtained from Slovenian Environmental Agency for 2001-2012, the time consistency is ensured. In both sets data are gathered from all SWDS in Slovenia. The only difference is that questioners are now sent from and returned to SEA, which means that SEA has the right to individual data. Before, according to Statistical law, SEA got only aggregated data and no control of individual SWDS were possible. All data gathered by SEA are sent to SORS where they are processed and published.

On the figure 8.1.1 the population served by solid waste collection systems since 1964 is presented. This coverage has increased from 50% in 1984 to 94% in 2005 and since then did not change a lot.

Deposited waste and from tables 8.1.1 to table 8.1.3 and corresponding biodegradable part of waste is presented on the table 8.1.4.

Table 8.1.4: Quantities of landfilled waste in the period 1964 - 2012.

Year	Deposited waste (t)	Biodegradable waste (t)	Year	Deposited waste (t)	Biodegradable waste (t)
1964	383,180	180,095	1989	664,069	332,034
1965	387,847	182,288	1990	671,980	342,710
1966	400,205	188,096	1991	681,580	354,421
1967	405,318	190,499	1992	687,897	364,585
1968	416,386	195,702	1993	694,418	374,986
1969	418,907	196,886	1994	702,108	386,160
1970	430,074	202,135	1995	707,000	445,410
1971	432,961	203,492	1996	725,000	456,750
1972	444,532	208,930	1997	743,000	468,090
1973	448,243	210,674	1998	761,000	479,430
1974	460,768	216,561	1999	780,000	491,400
1975	482,226	226,646	2000	800,000	504,000
1976	504,485	237,108	2001	820,000	483,800
1977	518,699	243,789	2002	840,000	470,400
1978	533,040	250,529	2003	844,606	430,749
1979	546,537	256,873	2004	810,647	381,004
1980	559,969	263,185	2005	793,118	348,972
1981	572,769	269,202	2006	838,883	347,298
1982	583,024	274,021	2007	811,674	294,747
1983	593,592	278,988	2008	831,834	284,743
1984	604,686	284,203	2009	731,008	260,296
1985	622,376	292,517	2010	623,224	187,146
1986	633,037	297,528	2011	646,318	124,995
1987	644,144	309,189	2012	446,394	83,860
1988	655,907	321,395			

Methane correction factor (MCF) accounts for the effect of management practices on CH₄ generation. Unmanaged disposal sites present lower methane-generating potential, because a larger fraction of waste decomposes aerobically in the top layers of the unmanaged SWDS.

The IPCC guidelines describe a managed SWDS site as a site with one off the following:

- cover material
- mechanical compacting
- levelling of waste.

For calculation implied MCF the following default MCF from IPCC GPG from Table 5.1 have been used:

- 0.6 for uncategorised unmanaged SWDS and
- 1 for managed SWDS.

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. According to our estimate, roughly a half of the waste was collected at managed SWDS (Ljubljana – Barje) and a half at unmanaged SWDS. As the depth of the 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.

1977 presented an accelerated rate of controlled placement of waste, which resulted in disposing of three quarters of waste on managed solid waste disposal sites in that year; we have therefore assumed a MCF of 0.90. After 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 increased linearly in the period from 1977 to 1986 MCF, and it has been equal to 1 since 1986.

Following the recommendation from the 2013 review report the table 8.1.5 have been added to clearly represent how MCF has been determined.

Table 8.1.5: Calculation of MCF.

Year	Unmanaged SWDS	Managed SWDS	calculation	Implied MCF
1964 - 1976	50 %	50 %	$(0.6 * 50 + 1 * 50) / 100$	0.8
1977	25 %	75 %	$(0.6 * 25 + 1 * 75) / 100$	0.9
1978 - 1985	Linear interpolation from 25 % to 0 %	Linear interpolation from 75 to 100 %	Linear interpolation	Linear interpolation
Since 1986	0 %	100 %	$1 * 100 / 100$	1

Degradable organic carbon (DOC) is the organic carbon that is accessible to biochemical decomposition. It is a function of the composition of waste and can be calculated from a weighted average of carbon content of various components of waste.

$$DOC = (0.4 \bullet A) + (0.17 \bullet B) + (0.15 \bullet C) + (0.3 \bullet D)$$

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

The fractions used for GHG emission calculations are presented in the table 8.1.6.

Table 8.1.6: Fractions of degradable waste in deposited 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	10.90
1987	12.0	5.0	25.0	5.0	48.0	10.90
1988	12.0	5.0	25.0	5.0	49.0	10.90
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	12.76
2006	20.8	0.0	14.2	6.4	41.4	12.37
2007	16.7	0.0	10.7	8.9	36.3	10.96
2008	15.9	0.0	11.0	7.3	34.2	10.21
2009	11.4	0.0	15.6	8.6	35.6	9.48
2010	12.6	0.0	11.8	5.6	30.0	8.50
2011	8.4	0.0	7.2	3.7	19.3	5.56
2012	8.0	0.0	9.9	0.9	18.8	4.95

For mixed waste, which represents the major part of municipal and similar types of waste, we have 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 1986 to 1988: 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) and for the values in between the expert estimates have been used.

In 2005 and partly in 2006, new screening analyzes of mixed municipal waste were performed. The results were as followed: 22.1% A, 17.5% C and 7.5% D, or, together, 47% of all degradable wastes.

Considering all waste disposed of in SWDS and fraction of degradable waste in other types of disposed wastes, we have estimated the following composition of waste for 2005: A: 20.4%, C: 16.5% and D: 7.1%. The fraction of waste "garden waste or park waste" is zero because legislation prohibits deposition of such type of waste on SWDS.

Table 8.1.7: Amounts of different wastes deposited on municipal SWDS and results for screening analyzes for mixed MSW (code from LoW 20 03 01) for the period 2008 to 2012.

year	All waste deposited on the SWDS (t)	Municipal solid waste – MSW (t)	Mixed fraction of MSW – code 20 03 01 (t)	A paper textiles %	C food waste %	D wood straw %
2008	831,834	684,719	616,588	20.2	13.5	9.2
2009	731,008	627,686	524,734	14.8	14.4	11.1
2010	623,224	557,901	516,502	14.0	13.8	6.4
2011	646,318	419,228	380,414	14.2	12.1	6.1
2012	446,394	314,952	290,284	12.2	15.2	1.2

Table 8.1.8: Disaggregation of different types of biodegradable waste according to composition.

Main code	Type of wastes	Additional code	A paper and textile	C food	D wood
02 01	wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing	01, 02, 03, 99		x	
02 01	wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing	07			x
02 02	wastes from the preparation and processing of meat, fish and other foods	01, 02, 03, 99		x	
02 03	wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea...	01, 02, 03, 04, 99		x	
02 04	wastes from sugar processing	99		x	
02 05	wastes from the dairy products industry	01, 99		x	
02 06	wastes from the baking and confectionery industry	01, 02		x	
02 07	wastes from the production of alcoholic and non-alcoholic beverages	01, 02, 04			
03 01	wastes from wood processing and the production of panels and furniture	01, 05			x
03 03	wastes from pulp, paper and cardboard production and processing	01			x
03 03	wastes from pulp, paper and cardboard production and processing	10, 99	x		
04 02	wastes from the textile industry	09, 10, 21, 22	x		
15 01	packaging	01	x		
15 01	packaging	03			x
15 01	packaging	09	x		
17 02	wood, glass and plastic	01			x
19 08	wastes from waste water treatment plants not otherwise specified	09		x	
19 12	wastes from the mechanical treatment of waste	01	x		
19 12	wastes from the mechanical treatment of waste	07			x
19 12	wastes from the mechanical treatment of waste	08	x		
20 01	separately collected fractions	01			
20 01	separately collected fractions	08, 25		x	
20 01	separately collected fractions	10, 11	x		
20 01	separately collected fractions	38			x
20 02	garden and park wastes	01			x
20 03	other municipal wastes - mixed municipal wastes	01	x	x	x
20 03	other municipal wastes	02		x	

Since then the screening analyses have been done for mixed part of municipal solid waste for every landfill many times per year and results are presented in the table 8.1.7. For other

types of wastes the disaggregation on table 8.1.8 has been used. The composition of waste and the composition of its biodegradable part are taken from the yearly reports on deposited waste on MSW disposal sites.

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.

IPCC Guidelines, 1996 provide a default value of 0.77 for DOC_F . Based on a review of the 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 mainly consists of CH_4 and CO_2 (usually considered half of each gas). We apply 0.5 as the most commonly used 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.

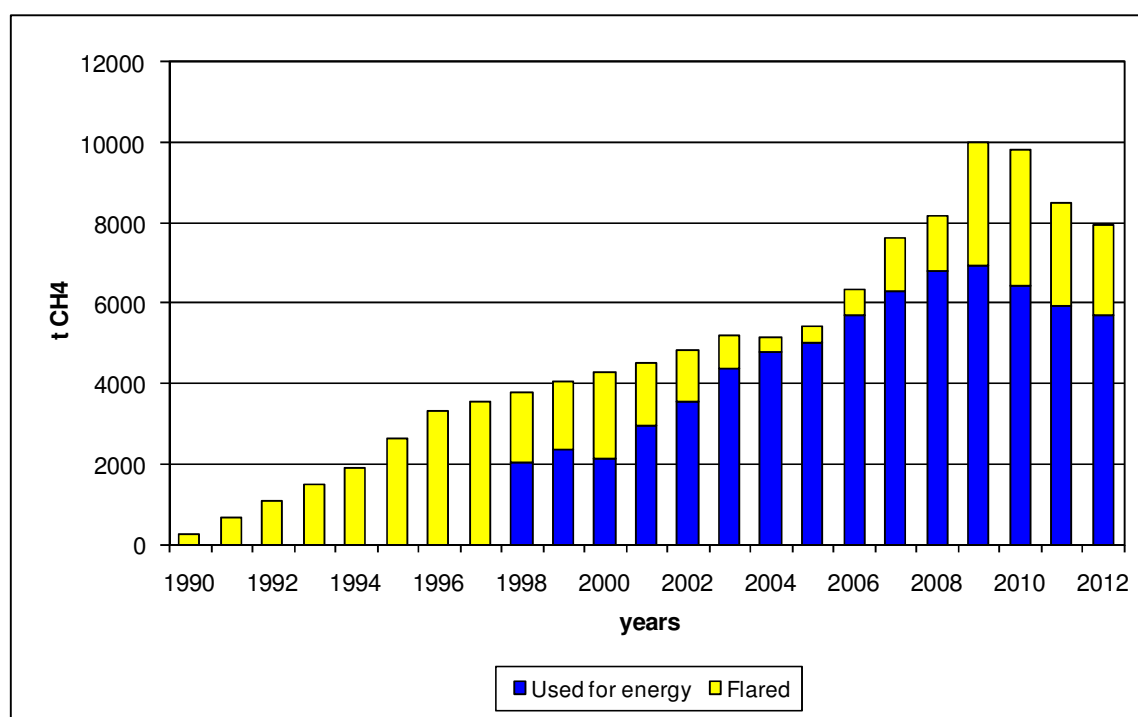


Figure 8.1.2: Methane recovery in tons.

Data on the quantities of recovered methane from 2000 on were provided by the Waste Sector (SEA) and for previous years directly by the disposal sites. Since there are no data on the amount of recovered methane for 2001, an interpolated value was used in calculation.

Energy use of methane after 1998 is reported in Energy sector in 1.A.1.a Public electricity and heat production, and the remaining amount is assumed to be flared. Before 1998, all methane recovered on SWDS was flared. Emissions from flaring are reported under

biomass used in commercial sector 1.A.4.a.. A detailed data on methane recovery are presented in the Figure 8.1.2 and Table 8.1.9.

Table 8.1.9: Recovery of methane, generated at SWDS

	Unit	1998	1999	2000	2001	2002	2003	2004
Recovery	t CH ₄	3794	4036	4278	4520	4820	5210	5165
Recovery	TJ	191	203	216	228	243	263	260
used for electricity	TJ	102	120	107	149	178	221	241
Difference - flared	TJ	89	83	109	79	65	42	19
flared	t CH ₄	1770	1655	2155	1564	1288	825	383

	Unit	2005	2006	2007	2008	2009	2010	2011	2012
Recovery	t CH ₄	5422	6366	7633	8165	10011	9816	8513	7938
Recovery	TJ	273	321	385	411	505	495	429	400
used for electricity	TJ	253	288	317	343	349	324	298	287
Difference - flared	TJ	20	33	68	68	156	171	131	113
flared	t CH ₄	402	651	1344	1359	3087	3396	2601	2243

Oxidation factor (OX) reflects the portion of CH₄ from SWDS that is oxidised in the soil or other material covering the waste. The amount of CH₄ that oxidises turns primarily to CO₂. If OX is zero, no oxidation takes place, and if OX is 1, then 100% of CH₄ 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 the first order decay method are presented in the Figure 8.1.3.

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 is shown only after a certain time delay.

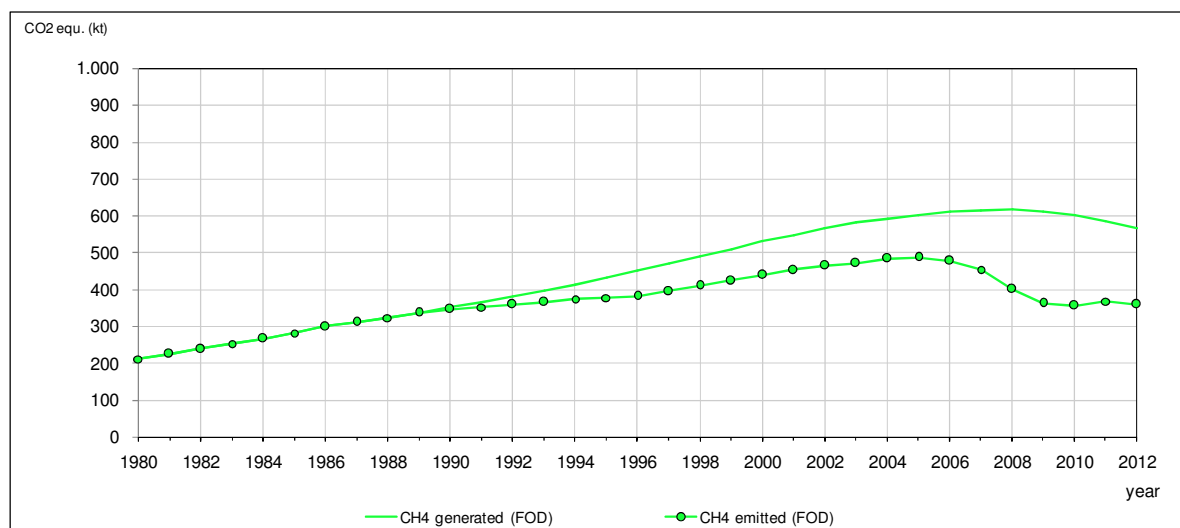


Figure 8.1.3: Methane emissions from SWDS in Gg CO₂ eq.

8.1.4 Uncertainty

Uncertainty estimates are based on expert judgement.

Uncertainty of activity data amounts to 30%.

Uncertainty of emission factor amounts to 40%

8.1.5 Source specific recalculations

No recalculations have been made in this category.

8.1.6 Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

8.2 Emissions from Wastewater Handling

Domestic and Commercial	KC	Gas	Contribution to Level%	Contribution to Trend%	Rank KC level	Rank KC trend
Base Year	Level	CH ₄	0.45		42	
2012	Trend	CH ₄	0.18	0.46	46	37

8.2.1 Source category description

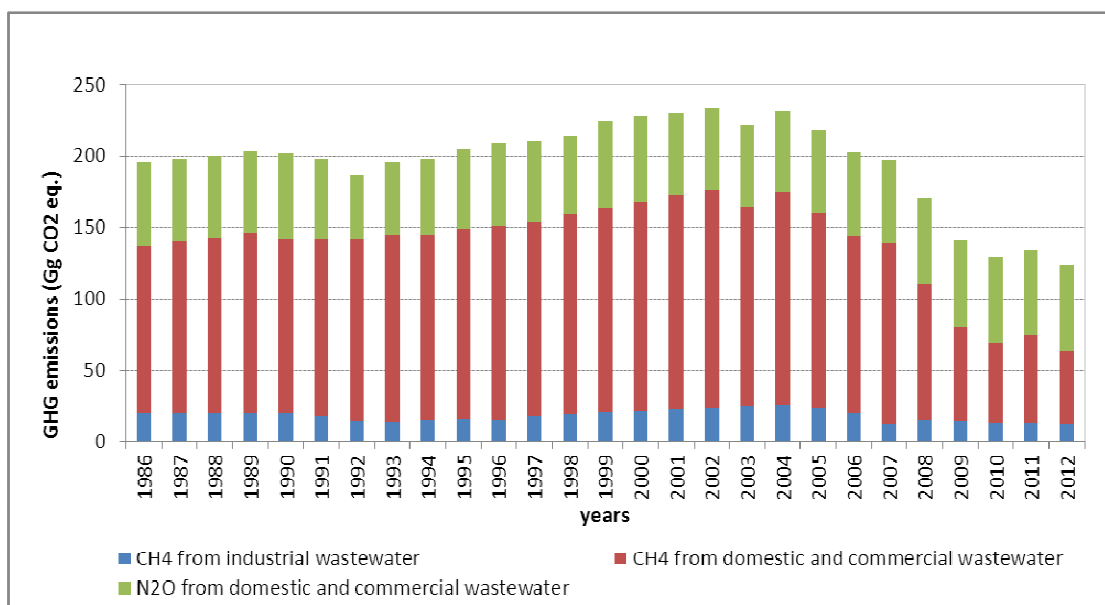


Figure 8.2.1: Emissions of methane and nitrous oxide from wastewater treatment.

Wastewater could be a source of methane when treated or disposed anaerobically. It can also be a source of nitrous oxide emissions. Wastewater originates from a variety of domestic and industrial sources and may be treated on site (uncollected), severed 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 CH₄ and N₂O emissions from domestic and industrial wastewater treatment for the period 1986-2011. Emissions in Figure 8.2.1 are expressed in Gg CO₂ equivalent. Conversion factors of 21 for CH₄ and 310 for N₂O were used in the calculations. Referring to the third IPCC assessment report, 1 g CH₄ and 1 g N₂O have the greenhouse effect of 21 and 310 g CO₂, 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 ₄ emissions (Gg)	CH ₄ emissions (Gg)	N ₂ O emissions (Gg)	CH ₄ emissions (in Gg CO ₂ eq.)	CH ₄ emissions (in Gg CO ₂ eq.)	N ₂ O emissions (in Gg CO ₂ eq.)
1986	0.95	5.57	0.19	19.9	117.0	58.9
1987	0.95	5.73	0.19	19.9	120.3	57.9
1988	0.94	5.88	0.18	19.7	123.6	57.2
1989	0.93	6.04	0.18	19.6	126.8	57.2
1990	0.93	5.84	0.19	19.5	122.7	59.6
1991	0.84	5.94	0.18	17.7	124.8	56.0
1992	0.71	6.06	0.14	14.9	127.2	44.5
1993	0.65	6.26	0.16	13.8	131.5	50.8
1994	0.73	6.18	0.17	15.3	129.8	53.0
1995	0.78	6.31	0.18	16.3	132.6	55.6
1996	0.75	6.44	0.19	15.7	135.2	57.6
1997	0.82	6.53	0.18	17.2	137.0	56.2
1998	0.89	6.68	0.18	18.8	140.3	55.7
1999	0.97	6.84	0.19	20.3	143.6	60.1
2000	1.02	6.99	0.19	21.4	146.9	60.2
2001	1.07	7.15	0.19	22.5	150.1	57.7
2002	1.13	7.31	0.18	23.7	153.4	56.8
2003	1.18	6.63	0.19	24.8	139.2	57.5
2004	1.22	7.10	0.18	25.7	149.1	56.5
2005	1.16	6.47	0.19	24.5	135.9	58.0
2006	0.95	5.93	0.19	19.9	124.6	57.9
2007	0.61	6.03	0.19	12.7	126.7	58.4
2008	0.74	4.53	0.19	15.6	95.1	59.5
2009	0.70	3.13	0.19	14.8	65.7	60.1
2010	0.64	2.67	0.19	13.4	56.0	60.2
2011	0.61	2.92	0.19	12.8	61.3	60.3
2012	0.59	2.44	0.19	12.3	51.1	60.4

8.2.2 Methodological issues

Domestic and Commercial Wastewater

CH₄ EMISSIONS

IPCC methodology has been used in calculating the emission of methane from domestic wastewater handling.

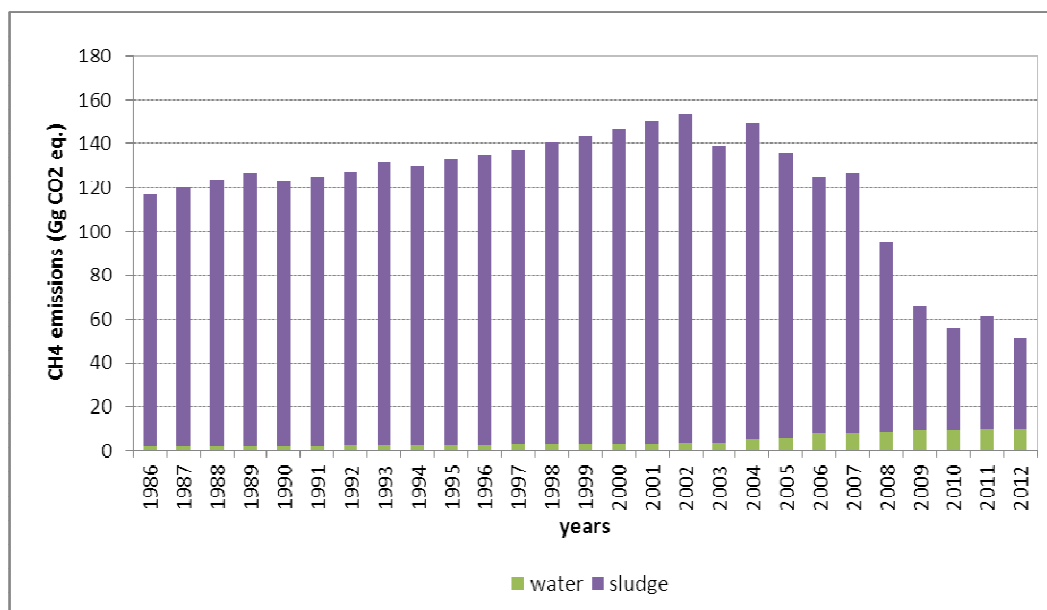


Figure 8.2.2: CH₄ emissions from domestic and commercial wastewater treatment.

As the first step, it is necessary to determine the quantity of total organic decomposable matter in the wastewater (TOW_{dom}) and sludge (TOS_{dom}). TOW_{dom} and TOS_{dom} are expressed in kg BOD/year.

$$TOW_{DOM} = P * D_{DOM} * (1 - DS_{DOM})$$

$$TOS_{DOM} = P * D_{DOM} * DS_{DOM}$$

P – population (in 1000 persons),

D_{DOM} – degradable organic component in wastewater (kg BOD/1000 persons/year),

DS_{DOM} – fraction of degradable organic component removed as sludge.

Secondly, the emission factor for wastewater and sludge is estimated. Emission factor in kg CH₄/kg of degradable organic component:

$$EF_i = B_0 * \sum_x (WS_{ix} * MCF_{ix}) \quad \text{for wastewater}$$

$$EF_j = B_0 * \sum_y (SS_{jy} * MCF_{jy}) \quad \text{for sludge}$$

B_0 – maximum methane-producing capacity for the wastewater or sludge (kg CH₄/kg BOD),

WS_{ix} – fraction of wastewater from source i treated in system x,

MCF_{ix} – methane conversion factor for an individual type of wastewater handling system (fraction),

SS_{jy} – fraction of sludge from source j treated in system y,

MCF_{jy} – methane conversion factor for sludge handling (fraction).

Total emissions of methane from wastewater and sludge handling are:

$$WM = \sum_i (TOW_i * EF_i - MR_i)$$

$$SM = \sum_j (TOW_j * EF_j - MR_j)$$

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:

$$TM = WM + SM$$

CH₄ emissions (in Gg CO₂ eq.) from domestic wastewater treatment for the period 1986 - 2012 are shown in Figure 8.2.2. Referring to the third IPCC assessment report, 1 g CH₄ has the greenhouse effect of 21 g CO₂.

Population

Dispersed settlements 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 2012, almost 99% of inhabitants were connected to one kind of treatment and only 0,2% of population did not have any wastewater treatment. Wastewater treatment is done in various ways. 45% of population use septic tanks, 0.5% primary treatment, about 54% undergo secondary and tertiary treatment. With regard to CH₄ 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.

The fraction and number of inhabitants according to various types of domestic wastewater treatment are shown in Figure 8.2.3 and Table 8.2.2. Data are taken from the SORS and the database on municipal wastewater treatment plants collected by the SEA.

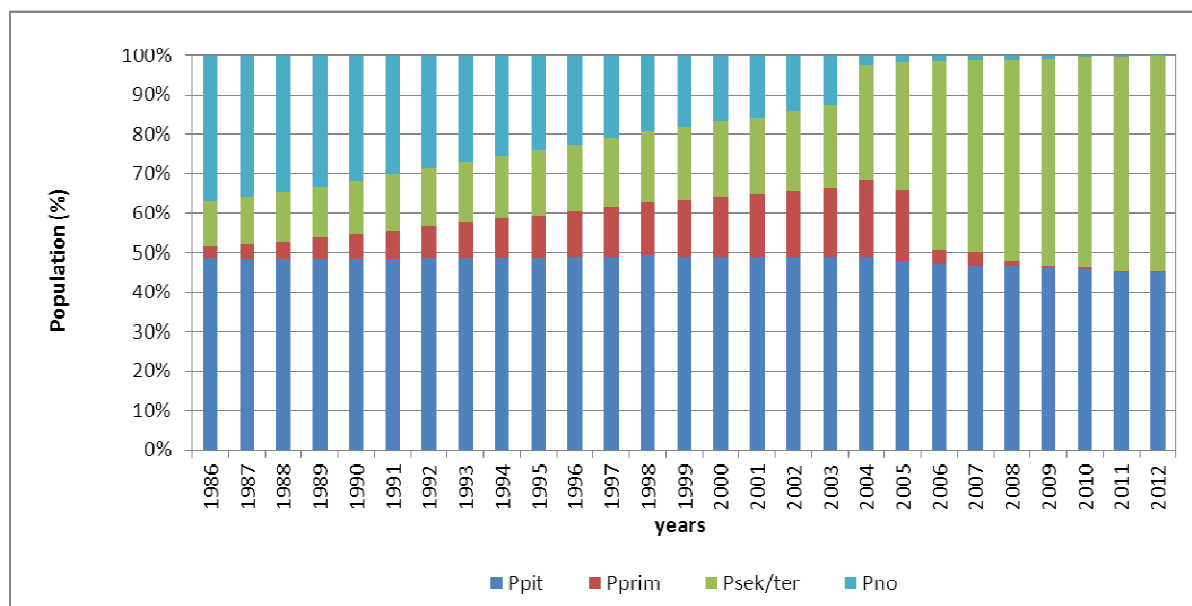


Figure 8.2.3: Fraction of inhabitants included into various types of domestic wastewater treatment (septic tanks (pit), primary treatment, secondary/tertiary treatment and no treatment).

Table 8.2.2: Number of inhabitants included into various types of domestic wastewater treatment.

Year	Number of inhabitants in 1000			
	Septic tanks	Primary treatment	Secondary and tertiary treatment	No treatment
1986	967	54	228	736
1987	968	71	239	716
1988	968	89	250	689
1989	969	106	261	660
1990	969	124	272	635
1991	970	141	282	605
1992	971	159	293	571
1993	971	176	304	537
1994	972	194	315	509
1995	973	211	326	480
1996	973	229	337	448
1997	974	246	348	417
1998	974	264	359	381
1999	975	281	369	362
2000	976	299	380	335
2001	976	316	391	310
2002	977	334	402	282
2003	978	351	413	255
2004	979	386	588	44
2005	962	360	644	37
2006	945	74	961	30
2007	942	73	985	25
2008	949	27	1033	24
2009	950	9	1069	19
2010	939	10	1094	8
2011	921	9	1120	5
2012	922	9	1122	5

Degradable organic component (D_{DOM}):

For domestic wastewater and sludge, biochemical oxygen demand (BOD) is the recommended degradable organic component indicator. IPCC default and national legislation value of 60 g BOD/person/day or 21900 kg BOD/1000 person/year was used for emission calculations.

Fraction of degradable organic component removed as sludge (DS_{DOM}):

The results of mass balances of operation of biological wastewater treatment plants show that the fraction of degradable organic compounds decomposing as sludge is around 40%.

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 according to the composition of the wastewater/sludge and its degradability, but the IPCC Guidelines provide only one default value of B_0 . The default (theoretical) value for B_0 - 0.6 kg CH_4 /kg BOD was used for emission calculations.

Methane conversion factor (MCF):

The calculated amount of generated methane depends on the methane conversion factor, which tells us which fraction is actually transformed into methane. MCF is 0 for completely aerobic systems and 1 for completely anaerobic systems. According to ERT, recommendation source of MCF data is included. MCF data are based on research project on emissions of methane from wastewater handling for Slovenia carried out by the Ministry of Environment, Spatial Planning and Energy (Dolenc, Žitko-Štemberger, 1999) and country expert judgement reflecting situation in the country. Source of MCF was also Revised 1996 IPCC Guidelines, Reference Manual, Waste, pg. 6.8.

Wastewaters are mostly handled aerobically, that is why $\text{MCF}=0$ is used for all types of wastewater treatment, except secondary/tertiary treatment. It is assumed only for secondary/tertiary treated wastewaters that MCF equals 0.05, which is to account for slight irregularities in wastewater treatment in biological wastewater treatment plants.

MCF value of 0.8 was assumed for handling sludge from septic tanks. The same value ($\text{MCF}=0.8$) was assumed for composting of sludge.

We used $\text{MCF}=1$ for sludge disposed of on managed waste disposal sites. MCF 0.8 was assumed for sludge left at wastewater treatment plant, due to more aerobic conditions there than in well-managed waste disposal sites.

Methane recovery (MR_i)

In calculating methane emissions, the quantity of methane recovered in sludge treatment in wastewater treatment plants is subtracted from the total methane production. Data on methane recovered for the period 2006-2012 were obtained from SORS. Data on recovery for previous years were collected in the frame of research project carried out by the Ministry of Environment, Spatial Planning and Energy. Data on methane recovered from domestic wastewater treatment is shown in the table 8.2.3. Energy use of methane is reported in Energy sector in 1.A.1.a Public electricity and heat production.

Table 8.2.3: Methane recovery from domestic wastewater treatment.

Year	CH4 Recovery (Gg)	Year	CH4 Recovery (Gg)	Year	CH4 Recovery (Gg)	Year	CH4 Recovery (Gg)
1986	0.066	1993	0.469	2000	0.828	2007	1.409
1987	0.066	1994	0.705	2001	0.828	2008	2.579
1988	0.066	1995	0.729	2002	0.828	2009	2.503
1989	0.066	1996	0.758	2003	0.828	2010	2.325
1990	0.417	1997	0.828	2004	0.828	2011	2.242
1991	0.475	1998	0.828	2005	0.828	2012	2.579
1992	0.517	1999	0.828	2006	0.933		

According to ERT recommendation the total decomposable matter in domestic wastewater is included (Table 8.2.4).

Table 8.2.4: Total decomposable matter in domestic wastewater

Year	Waste water	Sludge
	Total organic decomposable matter (Gg BOD)	Total organic decomposable matter (Gg BOD)
1986	16.41	10.94
1987	16.79	11.20
1988	17.17	11.45
1989	17.55	11.70
1990	17.94	11.96
1991	18.32	12.21
1992	18.70	12.46
1993	19.08	12.72
1994	19.46	12.97
1995	19.84	13.23
1996	20.22	13.48
1997	20.60	13.73
1998	20.98	13.99
1999	21.36	14.24
2000	21.74	14.50
2001	22.13	14.75
2002	22.51	15.00
2003	22.89	15.26
2004	25.66	17.11
2005	25.84	17.23
2006	26.02	17.35
2007	26.29	17.53
2008	26.40	17.60
2009	26.64	17.76
2010	26.84	17.89
2011	26.94	17.96
2012	26.99	17.99

N₂O EMISSIONS

IPCC methodology for calculation of N₂O emissions is based on the number of inhabitants in a particular country as well as average consumption of protein per inhabitant in every individual year. Model presumes 0.16 kg N/kg protein as a default fraction of nitrogen in protein (Frac_{NPR}). We also used IPCC default emission factor for N₂O emission calculation. Emission factor (EF) used was 0.01 kg of N₂O-N/kg of consumed nitrogen.

For emission calculation statistical data on the population from Statistical Office and data on consumption of protein from United Nations Food and Agriculture Organization (FAO) have been used. Due to a very high global warming potential of N₂O, relatively low amounts of N₂O formation can substantially contribute to GHGs emissions. Referring to the third IPCC assessment report, 1 g N₂O has the greenhouse effect of 310 g CO₂. Data on population, protein consumption and N₂O emissions in the period 1986-2012 are presented in Table 8.2.5.

Table 8.2.5: Population, protein consumption and N₂O emissions in the period 1986-2012.

Year	Population	Annual consumption of protein (kg/person/year)	N ₂ O emissions (Gg)	N ₂ O emissions (in Gg CO ₂ eq.)
1986	1985486	38.0	0.190	58.86
1987	1994066	37.2	0.187	57.86
1988	1996325	36.8	0.184	57.19
1989	1996377	36.8	0.185	57.25
1990	1999945	38.2	0.192	59.57
1991	1998912	35.9	0.181	55.96
1992	1994084	28.6	0.144	44.52
1993	1989408	32.8	0.164	50.78
1994	1989477	34.2	0.171	53.04
1995	1990266	35.8	0.179	55.59
1996	1986989	37.2	0.186	57.62
1997	1984923	36.4	0.181	56.25
1998	1978334	36.1	0.180	55.67
1999	1987755	38.8	0.194	60.13
2000	1990094	38.8	0.194	60.20
2001	1994026	37.2	0.186	57.74
2002	1995033	36.5	0.183	56.76
2003	1996433	37.0	0.186	57.51
2004	1997590	36.3	0.182	56.52
2005	2003358	37.2	0.187	58.03
2006	2010377	36.9	0.187	57.86
2007	2025866	37.0	0.188	58.40
2008	2032362	37.6	0.192	59.50
2009	2046976	37.7	0.194	60.10
2010	2050189	37.7	0.194	60.19
2011	2055496	37.7	0.195	60.35
2012	2058821	37.7	0.195	60.45

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 2010, 2011 and 2012, data for the year 2009 have been applied for the following years as well. We have also checked 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 N₂O is presented. Applied methodology is taken from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, 6.28.

The emissions of N₂O from human sewage are calculated as follows:

$$N_2O = Protein * Frac_{NPR} * EF * NR_{people}$$

N₂O – emissions of N₂O from human sewage (kg N₂O-N/year)

Protein – annual consumption of protein per capita (kg/person/year)

NR_{people} – number of people in country (population)

EF – emissions factor (kg N₂O-N/kg sewage-N produced)

Frac_{NPR} – fraction of nitrogen in protein

Industrial Wastewater

CH₄ 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 the one for domestic wastewater, explained in previous chapter. According to ERT recommendation, detailed description of methodology is included. CH₄ emissions (in Gg CO₂ eq.) from industrial wastewater treatment for the period 1986-2012 are shown in Figure 8.2.4. Referring to the third IPCC assessment report, 1 g CH₄ has the greenhouse effect of 21 g CO₂.

As the first step, the total output of organic components in wastewater for each individual industry (TOW_{ind}) and of sludge for each individual industry (TOS_{ind}) has to be determined.

$$TOW_{ind} = W * D_{ind} * (1 - DS_{ind})$$

$$TOS_{ind} = W * D_{ind} * DS_{ind}$$

W - Quantity of wastewater

D_{ind} - Concentration of organic component in the wastewater for an individual industry

DS_{ind} - Fraction of degradable organic component removed as sludge

Secondly, emission factors for wastewater and sludge for each industry were calculated as a product of methane conversion factors (MCF) and maximum methane producing capacity (B₀). Emission factors in kg CH₄/kg of degradable organic component:

$$EF_i = B_0 * \sum_x (WS_{ix} * MCF_{ix}) \quad \text{for wastewater}$$

$$EF_j = B_0 * \sum_y (SS_{jy} * MCF_{jy}) \quad \text{for sludge}$$

B₀ – maximum methane-producing capacity for the wastewater or sludge (kg CH₄/kg DC),

Ws_{ix} – fraction of wastewater from source i treated in system x,

MCF_{ix} – methane conversion factor for an individual type of wastewater handling system (fraction),

SS_{jy} – fraction of sludge from source j treated in system y,

MCF_{jy} – methane conversion factor for sludge handling (fraction).

Total emissions for wastewater and sludge for each industry have been calculated by multiplying emissions factors with TOW_{ind} and TOS_{ind}.

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:

$$TM = WM + SM$$

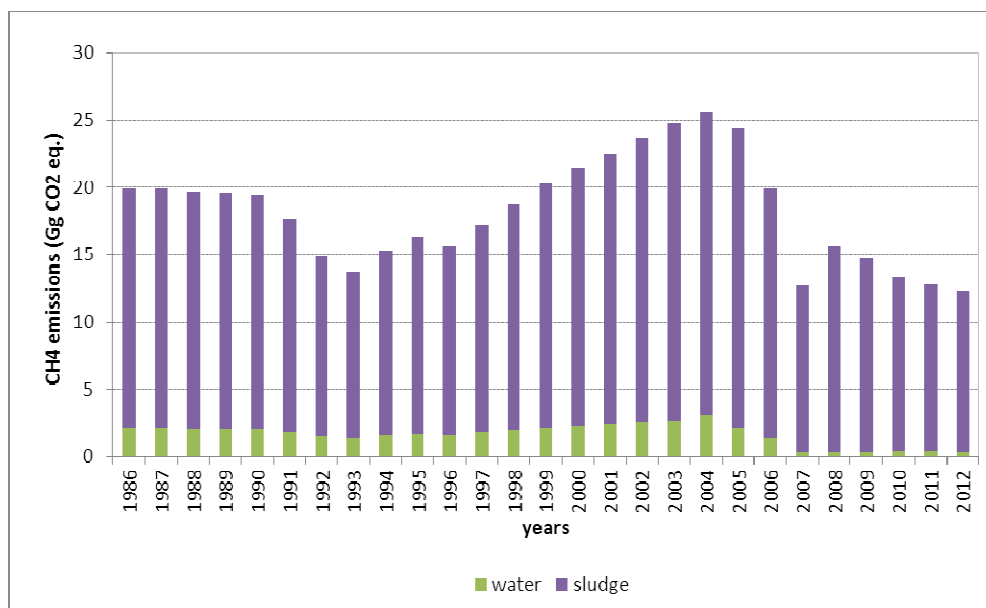


Figure 8.2.4: CH₄ emissions from industrial wastewater treatment.

Emissions of methane from industrial wastewater are calculated for the chosen industrial sectors with a large output of wastewater and high content of degradable organic components. In Slovenia, these are in particular the pulp and paper industry followed by production of soft drinks and alcohol beverage, pharmaceutical industry and meat processing, while minor quantities of organically degradable organic components are produced also by some other sectors. The major part of emissions was contributed by sludge treatment, while wastewaters contributed few per cents. Methane emissions in 2012 with regard to various industries are presented in Table 8.2.6.

Calculation of methane emissions for the whole period 1986-2012 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 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 2004-2012 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. Since actual monitored volumes of wastewater are not available before the year 2004, estimation of volumes of wastewater for the years 1986-2003 was performed. Estimation was based on ratio between data of actual volumes and data of production units for individual industries. We estimated volumes of wastewater for

the period 1986-2003 in such way that we multiplied these ratios for the year 2004 with data on annual production of individual industry. We decided to choose ratios for the year 2004, since this year most closely represents situation in previous years. Detailed description is presented in NIR 2012. Other parameters needed for emission calculation for the period 1986-2003 were adopted from 2004 data.

Table 8.2.6: Methane emissions in 2012 with regard to various industries.

Industry Type	CH ₄ from water (Gg)	CH ₄ from sludge (Gg)	CH ₄ total (Gg)	Share (%)
Production of leather	0.0012	0.000054	0.0013	0.2
Production of soft drinks and alcohol beverage	0.0607	0.002250	0.0629	10.7
Production of meat	0.0672	0.002021	0.0692	11.8
Production of pulp and paper	0.3401	0.003774	0.3438	58.6
Production of milk	0.0328	0.000114	0.0330	5.6
Production of food	0.0089	0.000026	0.0090	1.5
Production of pharmaceutical products	0.0586	0.008829	0.0674	11.5
Total	0.56949	0.01707	0.58656	100.0

Data on amount of wastewater output for individual industries for the whole period 1986-2012 are presented in Table 8.2.7.

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 wastewater handling is very low. MCF assumed to be 0.03. Most of sludge is incinerated, composted and exported, only a minor part is disposed on solid waste disposal sites. We assumed a value of 0.1 for MCF for sludge handling.

According to ERT recommendation, source of MCF data is included. MCF data are based on research project performed by National Institute of Chemistry, Ljubljana, 2009 and country expert judgement reflecting situation in the country.

Maximum methane producing capacity (B₀)

The methane producing potential (B₀) is the maximum amount of CH₄ that can be produced from a given quantity of wastewater or sludge. The CH₄ producing potential varies by the composition of the wastewater/sludge and its degradability. The default IPCC Guidelines value of 0.25 kg CH₄/kg COD was used for wastewater and sludge for all types of industries, except for production of pulp and paper. B₀ for pulp and paper industry was estimated from real operational data and amounted to 0.16 kg CH₄/kg COD. Calculation was based on formation of methane in anaerobic reactor.

Table 8.2.7: 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 (m ³)						
1986	18612812	960966	1993330	513066	992776	854301	
1987	18560824	948137	1993276	479440	1008278	908295	
1988	18199349	935331	1993223	445821	1023777	962289	
1989	17992579	922503	1993164	412196	1039279	1016283	
1990	17785835	909674	1993106	378570	1054778	1070278	
1991	15813639	778661	1897174	369069	1034204	1059647	
1992	13167759	736567	1773698	245566	921828	764296	
1993	12056736	686178	1812219	272168	767155	650592	
1994	13879156	678212	1906083	296905	835621	634050	
1995	15431625	459865	1879191	304715	911369	574572	
1996	14369458	529332	1881993	300437	885387	662932	
1997	16266638	496348	1941510	282961	926754	663706	
1998	18163843	463364	2001042	265483	968119	664480	
1999	20061023	430379	2060559	248007	1009486	665255	
2000	21397736	397395	2120086	230529	1050850	666029	
2001	22734450	364411	2179603	213054	1092218	666803	
2002	24071163	331427	2239130	195578	1133582	667578	
2003	25407851	298442	2298652	178100	1174950	668352	
2004	27672000	274700	1970685	136139	1133979	662367	1577989
2005	26947000	233185	1362038	178404	1230059	1420996	1368549
2006	21112000	238400	2074000	164120	986677	1143262	1544907
2007	12231000	281863	1771724	85040	984528	1393753	1487780
2008	16508000	228651	1572889	191920	981910	1334951	1523185
2009	15881919	11617	1533764	223853	901292	1162973	1765726
2010	13596494	9224	1737723	167710	865144	1268351	1633612
2011	12514742	22597	1785722	213732	871805	1161579	1560375
2012	12773572	39893	1543121	297757	820968	1119638	1465488

Methane recovery

Controlled process of anaerobic formation of biogas (mixture of CH₄ and CO₂) in anaerobic reactor is included in 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 Table 8.2.8. Share of recovered methane from total emitted methane from industrial waste water treatment is about 50%. Energy use of methane is reported in Energy sector in 1.A.1.a Public electricity and heat production.

Values of concentration of organic component in the wastewater (D_{ind}), fraction of degradable organic component removed as sludge (DS_{ind}), maximum methane producing capacity (B_0) and methane conversion factor (MCF) for individual industry for the year 2012 are specified in Table 8.2.9. Specified values have been used in subsequent calculations.

According to ERT recommendation, the total decomposable matter in industrial wastewater is included (Table 8.2.10).

Table 8.2.8: Methane recovery from industrial wastewater treatment.

Year	Industry type	
	Production of soft drinks and alcohol beverage	Production of pulp and paper
	Recovery CH ₄ (Gg)	
2004	0.259	0.764
2005	0.249	0.722
2006	0.318	0.747
2007	0.301	0.751
2008	0.297	0.646
2009	0.280	0.757
2010	0.271	0.770
2011	0.278	0.686
2012	0.271	0.768

Table 8.2.9: Quantities of concentration of organic component in the wastewater, fraction of degradable organic component removed as sludge, maximum methane producing capacity and methane conversion factor for selected industries.

Industry Type	D _{ind} (kg COD/m ³ wastewater)	DS _{ind}	B ₀	MCF sludge	MCF water
Production of pulp and paper	2.4	0.85	0.16	0.10	0.03
Production of meat	4.0	0.6	0.25	0.10	0.03
Production of milk	2.0	0.8	0.25	0.10	0.03
Production of leather	3.0	0.4	0.25	0.10	0.03
Production of pharmaceutical products	2.0	0.8	0.25	0.10	0.03
Production of food	1.5	0.8	0.25	0.10	0.03
Production of soft drinks and alcohol beverage	3.5	0.8	0.25	0.10	0.03

Table 8.2.10 Total decomposable matter in industrial wastewater

Year	Waste water	Sludge
	Total organic decomposable matter (Gg COD)	Total organic decomposable matter (Gg COD)
1986	19.77	47.56
1987	19.72	47.56
1988	19.38	46.92
1989	19.19	46.59
1990	19.00	46.27
1991	17.01	41.82
1992	14.25	35.07
1993	13.10	32.34
1994	14.87	36.35
1995	16.19	39.18
1996	15.26	37.27
1997	17.05	41.27
1998	18.84	45.27
1999	20.64	49.28
2000	21.90	52.14
2001	23.17	55.00
2002	24.44	57.86
2003	25.70	60.72
2004	29.37	61.46
2005	20.28	60.64
2006	12.65	49.09
2007	2.56	30.82
2008	2.90	39.68
2009	2.76	37.39
2010	3.11	33.02
2011	3.23	31.12
2012	2.56	30.43

8.2.3 Source specific QA/QC

We have checked activity data used for CH₄ and N₂O emission calculation for commercial waste water. SORS and FAOSTAT periodically report updated data. When updated data are published, we use them for emissions calculation. For data on protein consumption we have compared data published by Food and Agriculture Organization of the United Nations and World Health Organisation. We have also checked activity data used for CH₄ emission calculation for industrial waste water. We have made a comparison of emissions derived from actual volumes of wastewater and emissions calculated from production units for individual industry. The peer review of waste water was conducted in 2011 and no important errors have been found.

8.2.4 Uncertainty

Uncertainty estimates are based on expert judgement.

CH₄ from domestic waters:

Uncertainty of activity data amounts to 10%.

Uncertainty of emission factor amounts to 100%.

N₂O from domestic waters:

Uncertainty of activity data amounts to 15%.

Uncertainty of emission factor amounts to 250%.

CH₄ from industrial waters:

Uncertainty of activity data amounts to 25%.

Uncertainty of emission factor amounts to 50%.

8.2.5 Source-specific recalculations

CH₄ emissions from domestic and commercial waste water treatment were recalculated for the period 1986-2011. Recalculations were performed due to new data on number of inhabitants included into various types of domestic wastewater treatment obtained. New data on fraction of sludge treated in different ways were used for emission calculation as well.

8.2.6 Future improvements

We will thoroughly examine methodology included in 2006 IPCC Guidelines. We will perform recalculations, if necessary.

We will perform thorough examination of methane conversion factors used for industrial and commercial wastewater treatment.

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8.3 Waste incineration

Key category - base year: NO (not occurring)

Key category - 2012: no

8.3.1 Source category description

To reduce the number of the not estimated sources as much as possible, emissions from waste incineration were calculated and reported for the first time in the submission 2010. Since the purpose of waste incineration until 2008 in Slovenia was to remove waste which was not allowed to be deposited on SWDS, the amount of incinerated waste was small and emissions from this source were insignificant (5.4 Gg CO₂ eq. in 2012).

8.3.2 Methodological issues

Activity data

Amount of waste incinerated in Slovenia have been obtained from SEA. The data as presented in the Table 8.3.1 are available for individual plants from yearly reports for the period 2000-2012 for every category from waste classification. For the time before this period, only total amount of clinical and hazardous waste is available and there is absolutely no data on this issue available before 1990. 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 - 2012.

Year	biogenic	municipal solid waste	clinical waste	hazardous waste
1990	0	0	0	815
1991	0	0	0	815
1992	0	0	0	815
1993	0	0	0	815
1994	0	0	132	456
1995	0	0	0	268
1996	0	0	0	389
1997	0	0	214	73
1998	10	0	205	335
1999	0	0	85	1031
2000	0	0	109	1261
2001	0	0	280	1190
2002	260	0	441	946
2003	235	0	534	1382
2004	110	15	138	1366
2005	291	2	113	1325
2006	345	4	108	1616
2007	676	9	160	1987
2008	533	33	148	2091
2009	630	19	193	2585
2010	31	21	671	2836
2011	251	9	660	2860
2012	221	11	578	2994

CO₂ emissions from biogenic waste are not included in the national total amount of emissions.

Emission factors

Emission factors are presented in the table 8.3.2 and 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 - 2012.

	Unit	Biogenic Waste	Municipal Solid Waste	Clinical Waste	Hazardous Waste
CO ₂	t / t waste	1.289	0.55733	0.836	1.64175
CH ₄	t / t waste	NA	NA	NA	NA
N ₂ O	t / t waste	0.0004	0.00015	NA	NA

CO₂ emission factor for biogenic waste has been calculated using default EF from 1996 IPCC Guidelines, Table 1.1 for solid biomass (29.9 t C/TJ), NCV for biomass (12 TJ/kt) and Combustion efficiency for solid fuel (0.98). CO₂ emissions from the incinerated biogenic waste have not been included in the national total GHG emissions.

$$CO_2 \text{ EF (t/t waste)} = (29.9 * 12 * 0.98 * 44/12) / 1000$$

CO₂ emission factors for other types of waste have been calculated from default parameters presented in the table 8.3.3 below (source Table 5.6, GPG 2000) and using the following equation:

$$CO_2 \text{ EF (t/t waste)} = C \text{ Content of waste (\%)} * Fossil \text{ C of Total C} * Combustion \text{ efficiency.} * 44/12$$

Table 8.3.3: Parameters for calculation of CO₂ EF.

	unit	Municipal Solid Waste	Clinical Waste	Hazardous Waste
C Content of waste	%	40	60	50
Fossil Carbon as % of Total Carbon	%	40	40	90
Combustion efficiency	%	95	95	99.5

For calculation of N₂O emissions the upper values of EF for “heart or grate” incineration plant, presented in the Table 5.7 in GPG, 2000 have been used.

8.3.3 Uncertainty

Uncertainty of activity data amounts to 5%.

Uncertainty of CO₂ EF: 97% (IPCC Guidelines)

Uncertainty of N₂O EF: 100% (IPCC Guidelines)

8.3.4 Source-specific recalculations

No recalculations have been performed for this category.

8.3.5 Future improvements

For the next submission we will thoroughly examine methodology included in 2006 IPCC Guidelines and recalculations will be performed, if necessary.

8.4 Source specific QA/QC

Besides general QC checks, source specific checks have been performed for 2012 submission.

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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 purposes with SORS data

The peer review of waste water was conducted in 2011, no important errors have been found.

9 OTHER

No emissions have been reported under other.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 Justifications of Recalculations and Implication for Emission Levels

Recalculations were carried out for the whole period 1986-2011. The impact of recalculations on total GHG emissions is presented in the Table 10.1.1.

Table 10.1.1: Total changes due to recalculation with respect to the previous submission.

	1986	1990	1995	2000	2005	2008	2009	2010	2011
1. Energy	-12.77	-14.79	-12.94	-13.68	-9.64	-4.75	-8.47	-20.71	7.44
2. Industrial Processes						0.14	-0.25	7.55	-0.05
3. Solvents									
4. Agriculture								2.08	2.03
5. LULUCF	7668	7572	7492	4548	4494	5263	5250	5233	5220
6. Waste	3.80	16.23	32.15	46.85	14.80	-17.26	-44.81	-59.41	-56.26
Total w/o LULUCF	-8.97	1.45	19.21	33.17	5.17	-21.87	-53.53	-70.50	-46.85
Total with LULUCF	7659	7573	7512	4582	4499	5241	5196	5163	5173
Total in % w/o LULUCF	-0.04	0.01	0.10	0.18	-0.03	-0.10	-0.28	-0.36	-0.24
Total in % with LULUCF	70	81	79	51	43	45	53	53	52

10.1.1 Energy

1.A.1.a Energy Industries / Public electricity and heat production

In calculation of N₂O emissions from waste, an error has been found in the equation. For this reason, N₂O emissions from other fuel for the period 2009-2011 have been recalculated.

1.A.1.b and c. Energy Industries / Petroleum refining and Manufacturing of solid fuel and other energy industries

In 2003, Nafta Lendava, which was the only Slovenian refinery, had been closed but some other activities were going on in the same company and fuel used for these activities was reported to the SORS as fuel used for petroleum refinery. Following the recommendation of 2012, review of emissions since 2004 was reallocated from 1A1b Petroleum refining to 1A1c Manufacturing a solid fuel and other energy industries. When all data were rechecked, the error in NCV for natural gas for 2006 was eliminated and corresponding GHG emissions in 1A1c under gaseous fuel were recalculated.

1A4b Other sectors / Residential

Due to the updated data on wood consumption in households, the CH₄ and N₂O emissions have been recalculated for the period 2009-2011.

Following the recommendation of 2012, EU review emissions from sub-bituminous coal have been included in the residential sector for the period 2006-2008. Due to the fact that no data on consumption of coal are available, emissions have been interpolated.

1.B.2 Fugitive emissions from natural gas

The length of natural gas pipelines in Slovenian transport and distribution network for the period 1986-2006 have been estimated in the research in 2006. In the same research, the length of service pipelines has been estimated to be almost 60% of the size of distribution network on the basis of data by one distribution company. For 2014 submission, very detailed data on transport, distribution and service natural gas network have been obtained from Energy agency of the Republic of Slovenia. The data on length for each type of pipelines, disaggregated according to the material and pressure, is available for 2008-2012. From the same data the ratio between length of distribution and service pipelines has been estimated to be 42.8% and this ratio has been used for estimation of length of service pipelines for the period 1986-2007. As data on pressure in pipeline systems is also available, more precise EFs have been used. In addition, data on natural gas production for the period 1987-2008 have been slightly changed and now correspond to data in RA. Due to all the above reasons, the fugitive emissions of CO₂ and CH₄ have been recalculated for the period 1986-2011.

Table 10.1.2: Changes due to recalculation with respect to the previous submission in Energy sector in Gg CO₂ eq. and in %.

Energy	1986	1990	1995	2000	2005	2008	2009	2010	2011
A. Fuel Combustion						4.34	0.09	-12.56	15.37
1. Energy Industries							0.30	0.41	0.41
2. Manufacturing Ind.									
3. Transport									
4. Other Sectors						4.34	-0.20	-12.96	14.96
5. Other									
B. Fugitive Emissions	-12.77	-14.79	-12.94	-13.68	-9.64	-9.01	-8.57	-8.16	-7.93
1. Solid Fuels									
2. Oil and Natural Gas	-12.77	-14.79	-12.94	-13.68	-9.64	-9.01	-8.57	-8.16	-7.93
Total in Gg CO₂ eq	-12.77	-14.79	-12.94	-13.68	-9.64	-4.75	-8.47	-20.71	7.44
Total of Energy in %	-0.08	-0.10	-0.09	-0.09	-0.06	-0.03	-0.05	-0.13	0.05

10.1.2 Industrial processes

2.C.3 and 5 Metal Production / Aluminium Production and Other

CO₂ emissions from 2.C.3 Aluminium production for the year 2011 were recalculated due to new data on sulphur content in baked anodes obtained.

In category 2.C.5 Other (Aluminium anode burn-off), the CO₂ emissions for the year 2011 were recalculated due to new data on amount of baked anodes obtained.

Table 10.1.3: Changes due to recalculation with respect to the previous submission in Industrial processes in Gg CO₂ eq. and in %.

Industrial Processes	2006	2007	2008	2009	2010	2011
A. Mineral Products						
B. Chemical Industry						
C. Metal Production						0.221
D. Other Production						
E. Production of F-gases						
F. Consumption of F-gases	0.003	0.199	0.137	-0.250	7.550	-0.271
G. Other						
Total in Gg CO₂ eq.	0.003	0.199	0.137	-0.250	7.550	-0.050
Total of IP in %	0.000	0.014	0.010	-0.026	0.770	-0.005

2.F Consumption of HFC, PFC and SF₆

Improved data on amount of HFC in the new refrigeration and AC equipment as well as SF₆ in electrical equipment have been obtained for 2011 and emissions from use and from the first filling have been recalculated.

In addition, HFC emissions from disposal of refrigeration equipment in domestic, commercial and industrial sector have been added and corresponding emissions have been recalculated for the period 2006 to 2011.

10.1.3 Agriculture

Very minor recalculations have been done in the agriculture sector for the years 2010 and 2011 due to the updated data on population of horses. For this reason, GHG emissions have been recalculated in all categories: CH₄ from Enteric fermentation and Manure management as well as N₂O emission from Manure management, Direct and Indirect emissions from Agricultural soils and from Pasture.

Table 10.1.4: Changes due to recalculation with respect to the previous submission in Agriculture in Gg CO₂ eq. and in %.

Agriculture	2010	2011
A. Enteric Fermentation	1,153	1,153
B. Manure Management	0,090	0,090
C. Rice Cultivation		
D. Agricultural Soils	0,832	0,783
E. Prescribed Burning of Savannas		
F. Field Burning of Agricultural Residues		
G. Other		
Total in Gg CO₂ eq.	2,075	2,026
Total of Agriculture in %	0,106	0,107

10.1.4 LULUCF

All GHG emissions in all subcategories have been recalculated for the entire period 1986-2011, mostly due to the use of data from 1995 and 2012 FI and change of EFs. The detailed description of reasons is below:

5.A Forestland

The major reason of changes in emission factors, which resulted in recalculations of removal/emissions of GHG for final submission, was provided by national forest inventory (NFI) in 2012. Based on NFI 2012 data, growing stock and dead wood averages were calculated. In 2013, the database system of forest inventory was upgraded, which allowed for improvement of forest data for NFI 2007. As suggested by ERT, forest data, namely growing stock of NFI 1995, was included in calculation of emission factors for living biomass. Emission factor was corrected also for mass of available fuel under wildfires. Since more than 70% of wildfires in forests occur in Karst region, data on growing stock were applied from forest management plans OE Sežana. Minor changes occurred due to use of country-specific value of wood density for fir (0.394 t/m³) according to analysis by Martinčič (2010). Data on area of organic soils (Histosols) were added for transparency sake as recommended by MS Support Expert.

5.B Cropland

Area of organic soils was added to CC sub-category according to analysis from the Agricultural sector as recommended by ERT. Because not all data were available for the whole time series, missing values were filled according to other available data. Area of organic soils on agricultural land was calculated on basis of sums resulting from data analysis on organic soils in Agricultural sector (NIR 2013). Assumption was made that all area of organic soil in CL category is in CC sub-category. In addition, area of CC sub-category was corrected according to recommendation by ERT. For emissions resulting from cultivation of organic soil, a default emission factor 10 t C/ha was used in calculation. New emission factors were used in CL category for living biomass, both annual and perennial, due to new data on growing stock from inventory on non-forest land in 2012. New emission factors were also used due to data from soil monitoring on non-forest land in 2012. Because N₂O emissions from mineralization associated with land conversion to cropland were missing in the previous submission, they were added thereafter. Concerning liming, new expert judgment was performed about total amount of lime applied after survey of major sellers in 2012. Thus, interpolation of total amount of lime applied was made for period 1997-2012, as previous expert judgment was valid until 1996.

5.C Grassland

Area of organic soils was added to CC sub-category according to analysis from the Agricultural sector as recommended by ERT. The methodology of filling the missing values in the time series followed the one from sub-sector 5.B. Assumption was made that all area of organic soil in GL category is in GG sub-category. Assumption was also made that internal land use changes between GL annual and GL perennial, although detected by intersection method, hardly ever occur in reality. For emissions resulting from cultivation of organic soil, a default emission factor 2.5 t C/ha was used in calculation. Because ERT detected an inconsistency in reporting of sub-categories in GG category, the latter was corrected. New emission factors were used in the CL category for living biomass, both annual and perennial, due to new data on growing stock from inventory on non-forest land in 2012. New emission factors were also used due to data from soil monitoring on non-forest land in 2012. Because N₂O emissions from mineralization associated with land conversion to cropland were missing in the previous submission, they were added thereafter.

Table 10.1.5: Changes due to recalculation with respect to the previous submission in LULUCF sector in Gg CO₂ eq. and in %.

5. LULUCF	1986	1990	1995	2000	2005	2008	2009	2010	2011
A. Forest Land	7185	7187	7231	4440	4458	5268	5272	5276	5281
B. Cropland	115	101	84	65	57	60	58	52	50
C. Grassland	574	529	472	388	362	341	334	328	321
D. Wetlands	-92	-94	-97	-99	-101	-101	-102	-102	-102
E. Settlements	13	1	-14	-30	-37	-42	-43	-45	-47
F. Other Land	-127	-152	-184	-215	-245	-263	-270	-276	-282
Total in Gg CO₂ eq	7668	7572	7492	4548	4494	5263	5250	5233	5220
Total of LULUCF in %	83	84	84	46	46	54	54	54	54

5.D Wetlands

New emission factors were used in the WL category for living biomass due to new data on growing stock from inventory on non-forest land in 2012. New emission factors were also used due to data from soil monitoring on non-forest land in 2012.

5.E Settlements

New emission factors were used in the WL category for living biomass due to new data on growing stock from inventory on non-forest land in 2012. Assumption was made that 50%

of soil in settlements is sealed. Therefore, soil carbon stock was calculated as SOC for sub-category GL annual multiplied by 0.5.

5.F Other land

Activity data under OO category was reported for transparency sake. All recalculations were made in the sub-category land converted to OL, but only due to changes in emission factors or activity data of categories in other sub-sectors.

10.1.5 Waste

6.B.2.1 Domestic and commercial wastewater

CH₄ emissions from domestic and commercial wastewater treatment were recalculated for the period 1986-2011. Recalculations were performed due to new data on number of inhabitants included in various types of domestic wastewater treatment. New data on fraction of sludge treated in different ways were used for emission calculation as well.

Table 10.1.6: Changes due to recalculation with respect to the previous submission in Waste sector in Gg CO₂ eq.

6. Waste	1986	1990	1995	2000	2005	2008	2009	2010	2011
A. SWD on Land									
B. WW Handling	3.80	16.23	32.15	46.85	14.80	-17.3	-44.81	-59.41	-56.26
C. Incineration									
Total in Gg CO₂ eq	3.80	16.23	32.15	46.85	14.80	-17.3	-44.81	-59.41	-56.26
Total of Waste in %	0.77	3.05	5.85	7.52	2.14	-2.92	-8.13	-10.80	-10.01

10.2 Response to the UNFCCC Review Process

Not all necessary recalculations have been performed for the March submission in 2014. Our main goal is to improve quality, correctness and transparency of the NIR, which is planned for the submission in April 2014.

We have also included as many recommendations as possible from the in-country review in 2013 which was held from September 16 to 21, 2013, in Ljubljana. The draft report has been available to the inventory team on March 31 2014 and the final report was published on May 13 2014.

After careful examination of recommendations from the draft review report we had realised that it is impossible to address all of them due April 15. For this reason and due to the importance of this report, which is the last report for the first commitment period, we had decided to continue with improvements in the NIR and to resubmit the report due May 27. Our work was focused on QA/QC and verification as well as improvement of transparency, while the emissions reported in the CRF tables on April 15 have not change.

Due to the late availability of 2012 review report (it was published in July 2013), most of the recommendations were not addressed in the 2013 annual submission. Therefore, on the following page all recommendations from 2012 and 2013 review are included and information is given where these recommendations have been addressed (green cells) or when they are partly addressed (yellow).

Category		para	Comment from RR	Slovenia's response	Where in the NIR
I. OVERVIEW					
1. Annual submission and other sources of information					
Annual submission		2012, para 10	Estimate emissions from carbon stock changes under the elected KP-LULUCF activities, or make the necessary arrangements to provide verifiable information at the latest for the 2014 annual submission	Have been provided in 2014 submission	NIR 2014, chapter 7
2. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management					
Inventory preparation	Key categories	2012, para 16	Perform and report the key category analysis including a disaggregation of CO2 emissions from stationary combustion by fuel type	Have been implemented for the submission 2014	NIR, chapter 1.5, page 18 CRF, Table 7
		2012, para 18	Further use the key category analysis to select the estimation methods and QA/QC activities	Was used for the submission 2014	NIR, chapter 1.5, page 24
		2013, para 17	Include the results of the KC analysis in the process of planned QA/QC activities to prioritize improvements and report on this results in the NIR.	The results are included in the NIR.	NIR, chapter 1.5, page 24
		2012, para 18	Complete CRF table 7 by reporting the KC both including and excluding LULUCF.	Was completed for the submission 2013	CRF, Table 7
		2013, para 17	Include the qualitative approach in the performed KC analysis	Quantitative approach did not provide additional KC.	NIR, chapter 1.5, page 19
		2013, para 17	Include activities under Article 3, para 3 and 4, in the KC analysis	These activities are included	NIR, chapter 1.5, page 19
		2013, para 17	Include description of the changes in the results of the KC analysis compare with the results in the previous annual submission.	Description is included in the NIR	NIR, chapter 1.5, page 16
Inventory preparation	Uncertainties	2012, para 21	Improve the transparency of the reporting on the expert judgement used to derive the uncertainty estimates	Has been improved in the April submission 2014, but will be further improved for the May resubmission	
	Time-series consistency	2012, para 24	Ensure time-series consistency for all categories	Have been implemented for the submission 2014	
	Verification and QA/QC approaches	2013, para 16	Report on outcome of the action plan and the specific results of all of the QA/QC checks carried out	Was been included in the NIR 2014 – May resubmission	
Inventory management	Archiving	2013, para 18	implement a structured process to regulate where information is archived and implement a file-name system for that information.	The system is under improvement and will be finalized after the May resubmission	

B. ENERGY					
1. Sector overview		2012, para 36	Improve the completeness of the reporting of the reference approach by estimating and reporting the emissions from all fuels (kerosene, lubricants, bitumen, naphtha, refinery feed-stocks and other oil.	All data which are available have been included in the submission 2013.	CRF, Table 1A(b)
		2013, para 25	Update of Annex 4	Annex 4 have been updated	NIR, Annex 4
2. Reference and sectoral approach	Comparison of the RA with the SA and international statistics	2012, para 38	Examine the reasons for the difference in the apparent and total fuel consumption	Have been examined for the submission 2013	
		2012, para 39	Further investigate the reasons for the differences between the reference approach and data from the International Energy Agency	Have been examined for the submission 2013	
		2013, para 26	Use in the reference approach a CO ₂ EF based on plant-specific data	RA have been improved accordingly	CRF, Table 1A(b)
		2013, para 27	Correct the data on jet kerosene used in the international bunkers in the CRF for 2011	CRF table has been correct	NIR, chapter 3.12, page 43 CRF, Table 1C (2011)
	Feedstock and non-energy use of fuels	2012, para 40	Analyse and correct the inconsistencies in the reporting of the information on feed-stocks and non-energy use of fuels	Has been corrected for submission 2014	CRF Tables 1.A(b) and 1.A(d)
		2012, para 41	Verify the consistency of the apparent consumption of petroleum coke reported in the CRF tables	Has been corrected for submission 2013	CRF Table 1.A(d)
		2012, para 42 2013, para 28	Provide information on the allocation of the emissions from non-energy use of diesel oil and liquefied petroleum gas	Has been included in the NIR of March submission	NIR, chapter 3.1.3, page 46
		2012, para 43	Include, in the NIR, information on the use of waste oils to explain the decreasing trend of the fraction of carbon stored in lubricants	Fraction has been changed to 1. Has been improved for the 2013 submission	CRF Table 1.A(d)
3. Key categories	Stationary combustion: solid and liquid fuels – CO ₂	2012, para 44 2013, para 29	Develop country-specific CO ₂ EFs for all fuels with a significant share in the fuel mix	Data for developing CS EF are not available, but verification of EF used is presented in the NIR. in the May resubmission.	NIR, chapter 3.2.7.1
3. Key categories		2012, para 45 2012, para 30	Reallocate the emissions from supporting activities for oil and natural gas extraction to the subcategory manufacture of solid fuels and other energy industries under the energy industries category	Have been reallocated in the submission 2014	NIR, chapter 3.2.5.2 and 3.2.5.3

		2012, para 46 2013, para 31	Provide information on the net calorific values used for liquid fuels	All data with the sources of data are already provided in the NIR	NIR, chapter 3
		2012, para 47 2013, para 33	Improve the description of the methodology and data used to calculate the emission estimates for manufacturing industries and construction	Transparency has been improved	NIR, chapter 3.2.6
	Road transportation: liquid fuels – CO ₂	2012, para 48	Include information on the trend of the CO ₂ IEF for gasoline	Has been included in the NIR of March submission 2014	NIR, Annex 2, Table 1.8
	Road transportation: liquid fuels – CO ₂	2013, para 34	Start collecting information on the types and quantities of fuels most consumed for road transportation, either from local information sources or from neighbouring countries, in order to better reflect its national circumstances.	This activity is included in the improvement plan.	Improvement plan
	Coal mining and handling: solid fuels – CH ₄	2012, para 49 2013, para 35	Include more information on CH ₄ EF for coal mining and handling	Information has been included in the NIR of March submission	NIR, chapter 3.3.1, page 108
		2012, para 51 2013, para 37	Provide an explanation for the differences in mining and post-mining activities in the NIR to ensure the accuracy and time-series consistency of the emission estimates	Explanation has been included in the NIR of March submission	NIR, chapter 3.3.1, page 108
3. Non-key categories	Road transportation: gaseous and biomass fuels – CO ₂ , CH ₄ and N ₂ O	2012, para 53	Include the methodology and background information used to estimate CH ₄ and N ₂ O emissions from biofuel consumption	Information has been included in the NIR of March submission	NIR, chapter page 92
		2012, para 54	Correct the use of the notation keys for CO ₂ , CH ₄ and N ₂ O emissions from gaseous fuels	Have been corrected in the submission 2014	CRF Table 1.A(a) s3
	Other transportation: gaseous fuels – CO ₂ , CH ₄ and N ₂ O	2012, para 55	Reallocate CO ₂ , CH ₄ and N ₂ O emissions associated with fuel used in compressor stations from commercial/institutional to other transportation	Have been reallocated in the submission 2013	CRF Table 1.A(a) s3
	Oil and natural gas: gaseous fuels – CH ₄	2012, para 56	Include background information on the EFs used to estimate emissions from natural gas transmission and distribution	Information has been included in the NIR of March submission	NIR, pages 115, 118
		2013, para 38	Recalculate emissions using new data on length of transport and distribution network.	Recalculations have been performed.	NIR, chapter 3.3.2.2, page 120 CRF, Table 1.B.2
		2013, para 39	Verify the emissions from service and distribution network of pipelines for natural gas, and recalculate emissions, as necessary	Verification have been performed and results are included in the NIR	NIR, chapter 3.3.2.2, page 121
		2012, para 57	Improve the transparency of the reporting of the emission estimates for flaring and natural gas transmission	Has been included in the NIR 2013	NIR 2013, chapter 3.3.2.2,
C. INDUSTRIAL PROCESSES AND SOLVENT AND OTHER PRODUCTS USE					

2. Key categories	Cement production – CO ₂	2013, para 41	Perform category-specific QA/QC for this key category and encourages the Party to explain its importation of clinker	Have been implemented for the submission 2013	NIR 2013, page 167 CRF, Table 4.B
	Limestone and dolomite use - CO ₂	2013, para 42	Undertake a survey that will enable it to complete the emission estimation for this category.	Survey has been done and no other sources have been found.	NIR, chapter 4.3.3, page 132
	Aluminium production – CF ₄ and C ₂ F ₆	2013, para 43	Correctly report the method used to estimate PFC emissions and include an explanation of how EFs are determined in accordance with the IPCC GPG.	Have been included in the 2014 submission	NIR, chapter 4.11.2, page 145
	Consumption of halocarbons and SF ₆ – HFCs, PFCs, and SF ₆	2013, para 45, and 46	Provide information on the implementation and enforcement of the European Union regulation on F-gases in its NIR, including details on the recovery and destruction of F-gases from decommissioned equipment.	Emissions from decommission have been included, using GPG and default factors.	NIR, chapter 4.14.5, page 156, CRF, Table 2.II.Fs1
D. AGRICULTURE					
1. Sector overview		2012, para 72 2013, para 48	Provide correct values in the additional information table of CRF table 4.B(a) for dairy cattle, non-dairy cattle, swine and poultry	Have been corrected in the submission 2014	CRF Table 4.B(a)
2. Key categories	Enteric fermentation – CH ₄	2012, para 73	Revise the EF for enteric fermentation for swine on small family farms, and estimate emissions	Have been implemented for the submission 2013	NIR 2013, page 167 CRF, Table 4.B
	Manure management– CH ₄ and N ₂ O	2012, para 75 2013, para 49	Include information on the AWMS by livestock category together with the data and assumptions used in the NIR	Has been included in the NIR of May submission	NIR, Annex 3
		2012, para 72 2013, para 52	Provide documentation on the suckling cow population and on the time-series of nitrogen excretion values for non-dairy cattle and swine	Has been included in the NIR of May submission	NIR, chapter 6.3.2
		2013, para 50 and 51	Apply the AWMS and other available pasture data for 2010 and interpolate the pasture data for the years 2001-2009, accordingly	Data from the agriculture census 2010 are not appropriate for this purpose . More information has been provided in the May resubmission	NIR, chapter 6.2.2.1
E. LULUCF					
1. Sector overview		2012, para 82, 83	Update the information on land-use and land-use change areas	Have been updated for the 2014 submission	NIR 2014, chapters 7.1, 7.2.1, 7.2.1.1
		2012, para 83	Include information to explain the large inter-annual fluctuations in the emissions and removals from forest land, cropland, grassland and settlements between 2000 and 2001	Have been included in the NIR of March submission	NIR 2014, chapter 7.3.2.1

		2012, para 84	Provide information on the area and emission estimates for organic soils under all relevant land uses and land-use changes, as well as data on liming.	Has been provided in 2014 submission	NIR 2014, chapters 7.4.1, 7.4.2.1, 7.5.1 and 7.5.2.1
		2012, para 85	Provide complete uncertainty estimates and incorporate the associated activities in a QA/QC plan for all reported categories	Has been provided in 2014 submission	NIR 2014, chapters 7.3.3, 7.4.3, 7.5.3
		2012, para 86	Check the application of the notation key "NA" and report the appropriate notation keys	Have been revised in the submission 2014	CRF Tables 5.A, 5.B, 5.C, 5.D, 5.F, 5(V), NIR1
		2013, para 54	Improve the way of using notation keys and resolve the inconsistency between the data reported in the CRF tables and in the NIR.	Have been corrected in the submission 2014	CRF Tables 5(III)B.2.1, 5(III)B.2.2, 5.B.1, 5.C.1
		2013, para 55	Improve the quality of the information reported in the NIR and enhance QA/QC activities for all categories.	Have been improved in the submission 2014	NIR 2014, all chapters
		2013, para 57	Examine whether the country-specific average soil carbon stocks of cropland and grassland are considered suitable as values before or after applying land-use factors and include information on the soil carbon stock values for settlements and other land uses for its estimations in relation to land-use conversion to settlements and other land in the NIR.	Have been updated for the 2014 submission	NIR 2014, chapters 7.4.2.1, 7.5.2.1
2. Key categories	Forest land remaining forest land - CO ₂	2012, para 87	Use a method in accordance with the IPCC <i>Good Practice Guidance for Land Use, Land-Use Change and Forestry</i> to estimate the carbon stock changes in dead wood.	Has been provided in 2014 submission	NIR 2014, chapter 7.3.2.1
		2012, para 88	Apply a higher-tier method to estimate the carbon stock changes in litter and soils	Has been included in the NIR of March submission	NIR 2014, chapter 7.3.2.1
		2013, para 58	Recalculate the estimates for the categories to which the FECS2012 data will apply for the whole time series from 1986 to the most recent year.	Have been provided in 2014 submission	NIR 2014, all chapters
		2013, para 59	Calculate total living biomass carbon stock change for all forest land first using the average growing stock of forest and the total area of forest, then estimate living biomass stock change for forest land remaining forest land by subtracting that for land converted to forest land from the total value for all forest land.	Have been provided in 2014 submission	NIR 2014, chapter 7.3
	Land converted to forest land - CO ₂	2012, para 89	Revise the growth factor and the estimates of losses from living biomass and dead organic matter.	Have been revised in 2014 submission	NIR 2014, chapter 7.3.2.3

		2013, para 60	Include an explanation that conversion to forest land only occurs through a natural regeneration process of abandoned land and that no clearing of living biomass existed in previous land use is assumed to occur in the NIR.	Has been included in 2014 submission	NIR 2014, chapter 7.3.2.3
	Cropland remaining cropland - CO ₂	2012, para 90	Report the conversions between perennial and annual cropland as separate subcategories	Have been reported in 2014 submission	NIR 2014, chapter 7.4.2.1
	Land converted to settlements - CO ₂	2012, para 92	Provide information on the values for carbon stock applied to estimate emissions from the relevant pools under this category	Have been provided in 2014 submission	NIR 2014, chapters 7.3, 7.4, 7.5
3. Non-key categories	Cropland remaining cropland - CO ₂	2013, para 61	Estimate the appropriate carbon stock changes in living biomass and mineral soils under cropland remaining cropland.	Has been partly provided in 2014 submission	NIR 2014, chapter 7.4
	Cropland and grassland - CO ₂	2013, para 62	Estimate CO ₂ emissions from organic soils on cropland and grassland in a manner consistent with the estimation of the use of the area of organic soils under the agriculture sector	Has been provided in 2014 submission	NIR 2014, chapters 7.4.2.1, 7.5.2.1
	N ₂ O emissions from disturbance associated with land-use conversion to cropland .	2012, para 93	Provide information that supports the expert judgement used to derive the carbon: nitrogen ratio	Has been corrected in 2014 submission	NIR 2014, chapter 7.4.2.2
		2013, para 63	Estimate N ₂ O emissions from disturbance associated with land-use conversion to cropland and report thereon.	Has been provided in 2014 submission	CRF, table 5(KP-III)B.2.1, 5(KP-III)B.2.2, NIR 2014, chapter 7.4.2.2.
	Wildfires - CH ₄ and N ₂ O	2013, para 64	Explore the use of methodology that reflects the trend in the parameter "mass of available fuel", or provide information to support the adequacy of using a constant value for this parameter for the entire time series.	Has been provided in 2014 submission	NIR 2014, chapter 7.3.2.2
VI. WASTE					
1. Sector Overview		2012, para 98 2013, para 67	Strengthen QC procedures to avoid inconsistencies	All QA/QC checks have been performed for the May resubmission.	
		2013, para 66	Not enough information in the NIR - improve transparency of descriptions on the methodology used to estimate emissions from waste incineration, on the data source for waste allocation, on the overall situation with waste treatment and the assumptions applied when choosing country-specific values.	Transparency has been improved for the May resubmission	

2. Key categories	Solid waste disposal on land – CH ₄	2012, para 99	Provide more transparent and detailed information on the QA procedures implemented and on how the peer reviews lead to concrete improvements of the inventory	Have been included in the submission 2012	
		2012, para 101 2013, para 69	Include the source of the information used to obtain the quantity of municipal solid waste disposed at solid waste disposal sites and synchronize its use.	Have been included in the NIR 2013	NIR 2013, page 240
		2012, para 102 2013, para 68	Review and update the information on the method used to derive the methane correction factor values	The information is included in the NIR	NIR, chapter 8.1.3, page 255
		2013, para 70	Report the survey data and sampling results.	Data has been provided in the May resubmission	NIR, chapter 8.1.3, Table 8.1.7
3. Non-key categories	Wastewater handling – CH ₄	2013, para 72	Provide the total organic decomposable matter in domestic and commercial wastewater (i.e. BOD) and in industrial wastewater (i.e. COD).	Data have been provided	NIR, chapter 8.2.2., pages 267 and 274
		2013, para 73	Provide more transparent explanations in its NIR of the assumptions made in deriving MCF values.	The information is included in the NIR	NIR, chapter 8.2.2, pages 271
	Waste incineration - CO ₂ and N ₂ O	2012, para 105 2013, para 74	Include, in the NIR, data on the amount of biogenic waste used as fuel and check that corresponding CO ₂ emissions are not included in the total.	Has been included for the submission 2013.	NIR 2013, Chapter 8.3, page 257
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		2012, para 106	Provide AD and emission estimates for organic soils, or provide transparent and verifiable information that they are not a net source	Have been provided in 2014 submission	NIR 2014, chapters 7.4.1, 7.4.2.1, 7.5.1 and 7.5.2.1
		2012, para 109	Provide updated and consistent AD and emission estimates for deforestation and forest management	Have been provided in 2014 submission	NIR 2014, chapter 11.2.2, 11.4.4, 11.5.4
		2012, para 109	Check any inconsistencies within the land-use change matrices and between the matrices and table NIR-2, and provide adjusted AD	Have been checked and corrected in 2014 submission	NIR 2014, chapter 11.2.2,
		2013, para 76	Improve QC - CRF tables and NIR	Have been checked and corrected in 2014 submission	CFR Tables NIR1, NIR2, NIR3

		2013, para 77	Recalculate all relevant carbon stock changes and emissions from deforestation and forest management for all years of the first commitment period, reflecting all relevant improvements that will be made in relation to the LULUCF sector, and provide clear information on how the estimation has improved.	Have been provided in 2014 submission	CRF Table 5(KP-I)A.2, Table 5(KP-I)B.1; NIR 2014, chapters 11.3.1.6, 11.3.1.7, 11.4.4, 11.5.4
		2012, para 110 2013, para 78	Provide complete uncertainty estimates and explain how it will use the information in planning future inventory improvements.	Have been partly provided in 2014 submission	NIR 2014, chapters 7.2.1.1, 7.3.6, 11.2.3, 11.3.1.7, 11.4.1, 11.4.4
		2013, para 79	Implement all of the necessary improvements	Have been provided in 2014 submission	CRF Tables 5(KP-II)3, NIR1, NIR2, NIR3, NIR 2014 chapters 7.4, 7.5
Activities under Article 3, paragraph 3, of the Kyoto Protocol	Deforestation – CO ₂ and N ₂ O	2012, para 111	Explain or revise the inter-annual fluctuations in net CO ₂ emissions for each carbon pool from 2008 to 2009	Have been provided in 2014 submission	CRF Table 5(KP-I)A.2
		2012, para 112	Provide revised estimates for deforestation	Have been revised in 2014 submission	NIR 2014, chapter 11.4.4
		2012, para 113	Revise the reporting in Table 5(KP-I)A.2.	Has been revised in 2014 submission	CRF Table 5(KP-I)A.2.1
		2012, para 114	Provide information on whether the system managed by the Slovenian Forest Service covers the whole deforested land area	Has been included in the NIR of March submission	NIR 2014, chapter 11.2.3
		2013, para 81	Provide, in the NIR, further clarification of the adequacy of the subcategorization under deforestation when information from the forest management plan is used for detecting deforestation.	Have been provided in 2014 submission	NIR 2014, chapter 11.2.3
		2013, para 82	Report N ₂ O emissions from mineralization associated with LU conversions to cropland.	Have been provided in 2014 submission	CRF, Table 5(KP-II)3
		2013, para 83	Clarify the possibility of liming occurring in the area of deforestation used as cropland after the conversion, and either provide information explaining why the reporting of "NO" is appropriate or estimate and report emissions from lime application under deforestation.	Have been provided in 2014 submission	NIR 2014, chapter 7.4.2.1
Activities under Article 3, paragraph 4, of the Kyoto Protocol	Forest management - CO ₂	2012, para 115	Use a higher tier method to estimate the emissions from the litter and soil carbon pools or demonstrate that these pools are not a net source of emissions.	Has been partly included in the NIR of March submission. More information will be given in the April submission.	NIR 2014, chapter 11.3.1.1
		2013, para 84	Improve the reporting on the area of forest management and provide consistent information on and explanation of the reliability of the data on the area of forest management in the NIR.	Have been provided in 2014 submission	CRF, Tables NIR2, 5(KP-I)A.2, 5(KP-I)B.1

		2013, para 85	Elaborate on the information that demonstrates that carbon pools are not net sources of emissions, as required by paragraph 6(e) of the annex to decision 15/CMP.1.	Have been provided in 2014 submission	NIR 2014, chapters 7.3.2.1, 7.3.4
National registry	SEF reporting	2013, para 90	Improve the public availability of the register information	Have been improved	NIR, chapter 13.2, page 309
		2013, para 91	Provide additional information on database structure	Provided in this submission	NIR, Annex 6
Minimization of adverse impacts...		2013, para 92	Report any changes	No changes have occurred	

Legend:

Completely Included in this or in the previous submission
Partly included in this submission or will be 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
Total (Net Emissions)				
1. Energy				
A. Fuel Combustion (Sectoral Approach)				
1. Energy Industries				
2. Manufacturing Ind. And Construction				
3. Transport				
4. Other Sectors				
5. Other				
B. Fugitive Emissions from Fuels				
1. Solid Fuels				
2. Oil and Natural Gas				
2. Industrial Processes				
A. Mineral Products				
B. Chemical Industry				
C. Metal Production				
D. Other Production				
E. Production of Halocarbons and SF6				
F. Consumption of Halocarbons and SF6				
G. Other				
3. Solvent and Other Product Use				
4. Agriculture				
A. Enteric Fermentation				
B. Manure Management				
C. Rice Cultivation				
D. Agricultural Soils				
E. Prescribed Burning of Savannas				
F. Field Burning of Agricultural Residues				
G. Other				
5. Land Use, Land-Use Change and Forestry				
A. Forest Land				
B. Cropland				
C. Grassland				
D. Wetlands				
E. Settlements				
F. Other Land				
G. Other				
6. Waste				
A. Solid Waste Disposal on Land				
B. Waste-water Handling				
C. Waste Incineration				
D. Other				
7. Other (as specified in Summary 1.A)				
Memo Items:				
International Bunkers				
Aviation				
Marine				
Multilateral Operations				
CO2 Emissions from Biomass				
NIR Chapter	DESCRIPTION		REFERENCE	
	Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		If ticked please provide some more detailed information for example reference to pages in the NIR	
Chapter 1.2 Institutional arrangements				
Chapter 1.6 QA/QC plan				

PART II: SUPPLEMENTARY 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 2012 were 221.8 Gg CO₂ eq. The area subjected to D was 6,986.62 kha at the end of the last year of the first commitment period.

Removals from Article 3.4 activity (FM) in 2012 were -6,250.2 Gg CO₂ eq. The area subjected to FM was 1,184.53 kha at the end of the last year of the commitment period.

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*. Also abandoned agricultural land on an area larger than 0.25 ha, which has been abandoned for more than 20 years, with minimal tree height 5.00 m and tree crown cover up to 75 % is defined as forest.

Table 11.1.1: 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 because of methodological differences in data acquirements. Data on forest land areas in forest management plans (data for KP reporting) are updated annually by Slovenia Forest Service for 1/10 of forest management units (10 years period cycle for whole country). Data on forest land areas from land-use map (ALUM) by Ministry of Agriculture and the Environment (data for UNFCCC reporting) represents land uses in a specific year.

All land converted to forest land occurs through process of spontaneous 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 the values used in the reporting to the FAO and FRA forest definition. Differences of definitions are not relevant for final estimation of CO₂ 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, forest management plans are prepared, regardless of ownership, conservation degree or natural conditions. Practically all these forests are also used either for wood harvesting, protecting and protective purposes, recreation and/or, to a greater or lesser 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 data needed for time period 1994 – 2012 is adopted from Slovenia Forest Service (SFS) database. SFS will continue providing data on areas for activities under Articles 3.3. and 3.4.

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11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities and their consistent application in determining land classification

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. Besides, the definition of forest has remained the same irrespective of the data source.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of units of land under Article 3.3

The spatial assessment unit for determining 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 2012.

To current inventory year (2010) From previous inventory year (2009)		Article 3.3 activities		Article 3.4 activities				Other ⁽⁵⁾	Total area at the beginning of the current inventory year ⁽⁶⁾
		Afforestation and Reforestation	Deforestation	Forest Management (if elected)	Cropland Management (if elected)	Grazing Land Management (if elected)	Revegetation (if elected)		
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	0.00	0.00						0.00
	Deforestation		6.57						6.57
Article 3.4 activities	Forest Management (if elected)		0.41	1,184.44					1,184.86
	Cropland Management ⁽⁴⁾ (if elected)	NA	NA		NA	NA	NA		NA
	Grazing Land Management ⁽⁴⁾ (if elected)	NA	NA		NA	NA	NA		NA
	Revegetation ⁽⁴⁾ (if elected)	NA			NA	NA	NA		NA
Other ⁽⁵⁾		NA	NA	0.08	NA	NA	NA	835.79	835.87
Total area at the end of the current inventory year		0.00	6.99	1,184.53	NA	NA	NA	903.98	2,027.30

Annual and total areas under Articles 3.3 and 3.4 for Deforestation (D) and Forest management (FM) were adopted from Slovenia Forest Service (SFS) and Statistical Office of the Republic of Slovenia (SORS). Areas of D were subtracted from areas of FM. Areas of spontaneous expansion of forest were added from Other to FM.

11.2.3 Maps and/or database for identification of geographical locations and system of identification codes for geographical locations

Forestry spatial information system, managed by SFS, is based on stand level inventory for forest management purposes. There are 14 forest management regions, which are further divided into 136 management units. For both management levels forest management plans are prepared for the period of 10 years. Smallest spatial unit for forest management is compartment (2 – 5 ha). All data are georeferenced and can be aggregated to higher levels. Therefore, according to GPG2003, Slovenia uses Reporting Method 1 with national border as geographical boundary to identify the geographical location.

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 (Annual reports on forests). Slovenian legislation forbids clear cutting as forest management practice. Deforestation activities according to SFS occur due to urbanization, infrastructure, agriculture, mining, power industry and other reasons, but in recent years mostly for agricultural purposes. Although SFS records all deforestation activities, there is lack of data on specific purposes within each of the abovementioned category. The areas of the latter were therefore aggregated into two subcategories under deforestation, namely category agriculture to

“Land converted to cropland and urbanization, infrastructure, mining, power industry and other reasons to “Land converted to settlements”. Some of activities in the SFS categories may of course belong to conversions to grassland, wetlands or other land. Due to lack of available data, further subcategorization under deforestation would not be suitable. Yet, the data by SFS on deforestation activities are assumed to be much more accurate than data that are derived from the land use change matrix under the Convention.

Areas of spontaneous expansion of forest are annually documented in forestry spatial information system database for 1/10 of forest management units (10-year 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 estimations 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 N₂O 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 determination of the carbon stocks in all pools prior to and after deforestation event. Biomass carbon stock after deforestation was assumed to be equal to zero. More detailed descriptions of calculations for conversion of forest to other land uses were made in accordance with 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 N₂O emission from biomass burning are presented below.

Carbon stock changes in living biomass

In accordance with the decision tree provided in the GPG2003, 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 (FECS), carried out in years 2007 and 2012, were used for our calculations.

Carbon stock changes in dead organic matter

In accordance with the decision tree provided in the GPG2003, carbon stock changes in dead organic matter in Forest land remaining Forest land are estimated by Tier 2.

For carbon stock changes in litter “a pool is not a source” approach was used. In the latter, 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 relatively stable carbon stocks in litter in Forest land remaining forest land. For additional explanation, please see chapters 7.3.2.1 and 7.3.4 under the Convention.

Carbon stock changes in soils

In accordance with GPG2003, for carbon stock changes in soils “a pool is not a source” approach was applied. Under the latter, 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, carbon stock in mineral soil remains constant as long as the land remains forest. Results of our preliminary expertise for the period 1996 – 2006 (Kobal et al. 2011), show relative stable carbon stocks in forest soils. In the last 20-year period no large fluctuation in forest management regime and no large disturbance event that could affect the soil carbon stock have occurred. Additionally, soil also depends on the climate and bedrock factors depend largely on the source of carbon coming from dead wood and litter. Since those two pools seem to be stable, soil pool is assumed to be stable. For additional explanation, please see chapters 7.3.2.1 and 7.3.4 under the Convention.

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) and estimation of GHGs directly released in fires were used.

More detailed explanation about calculations is 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).

N₂O emissions

Estimations of N₂O emissions due to biomass burning were made using the default emission factor for N₂O from Table 3A.1.16 and Equation 3.2.20 according to GPG2003 default methodology (see chapter 7.3.2.2). For calculating the N₂O emissions in soil of land converted to cropland, the equations 3.3.14 and 3.3.15 were used (GPG2003). See chapter 7.4.2.2 for detailed method description of the latter.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions and removals from activities under Article 3.3 and elected activities under Article 3.4

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 ₂ O	N ₂ O	N ₂ O	CO ₂	CO ₂	CH ₄	N ₂ O
Article 3.3 activities	Afforestation and Reforestation	NO	NO	NO	NO	NO	NO			NO	NO	NO	NO
	Deforestation	R	IE	IE	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
		NA	NA	NA	NA	NA				NA	NA	NA	NA

For calculations of carbon stock changes in litter and soils, “a pool is not a source” approach was used. According to this approach, net emissions/removals from litter and soils are balanced and therefore equal to zero. Results of our preliminary expertise for period 1996 – 2006 (Kobal Simoncic 2011) show relative stable carbon stocks in litter in forest land remaining forest land. Estimates under FM for carbon stock changes in litter and soils were therefore not reported. See also the comments provided in the 7.3.2.1 section (Convention part).

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 dynamic effects of age structure resulting from activities prior to January 1, 1990. The IPCC does 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 this year's (2014) submission may differ from the previous ones.

National forest inventory (FECS) provides data on growing stock, dead organic matter and soils (in forest land). The argument for applying FECS 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.

In 2012 the repetition of the national forest inventory, so called Forest and Forest Ecosystem Condition Survey (FECS 2012), was carried out for the third time. The methodology stayed the same as in the one of 2000, although some improvements were made to ensure consistency over time when reporting the GHS emissions/removals for the first commitment period. A detailed protocol was established for FECS 2012 (see Annex 3).

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 an activity onset, if after 2008.

Forest management (FM) area increases during the first commitment period due to inclusion of new forest area by natural (spontaneous) afforestation of abandoned agricultural land.

According to requirement of paragraph 6(d) of Annex to decision 15/CMP.1, Slovenia declares that new FM area is not accounted (estimated as removals) in previous years during the first commitment period. Therefore, new area of FM is estimated by its removals and accounted under FM only in the years since the area has been recognized as forest.

Additional explanation for the years 2010 and 2011: The area of forest land in the year 2010 is higher for 211.4 ha and in the year 2011 higher for 279.1 ha than reported by Slovenia Forest Service in the Annual reports on forests for 2010 and 2011, respectively. Due to methodology of area presentation, not all areas of *Pinus mugo* stands were included in SFS forest inventory in 2010 and 2011. Because of the implied increase, i.e. sum of net change of FM and D, area cannot be negative. The abovementioned areas were added to FM area at the end of inventory year (2010, 2011) as it was assumed that FM area was underestimated.

11.4 Article 3.3

11.4.1 Information demonstrating that activities under Article 3.3 began on or after January 1, 1990 and before December 31, 2012 and were directly human-induced

All data for areas under Articles 3.3 were adopted from annual reports of SORS and SFS for the period 1990 – 2012.

Deforestation in Slovenia is human induced, because all conversions of forest to other land uses have to be permitted by legal entities. Forest Act (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 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 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 begin as soon as 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 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 that are not yet classified as deforested.

11.4.4 Emissions and Removals from Deforestation

Deforestation was a net source in the whole KP reporting period 2008-2012. The net emissions from carbon stock changes were 162.0 Gg CO₂ eq. (in 2008), 301.5 Gg CO₂ eq. (in 2009), 339.8 Gg CO₂ eq. (in 2010), 272.7 Gg CO₂ eq (in 2011), and 221.8 Gg CO₂ eq (in 2012).

Due to different methodological approaches, area of deforestation under KP is not the same as sum of areas of forest land converted to other land uses reported under Convention,. Land use change matrix assumes higher changes due to the methodology used - also small sliver polygons are still included in land use change matrix, but they do not represent actual deforestation. All deforested areas are spatially located (geo-referenced) and are documented in annual report by Slovenia Forest Service, which is entitled by legislation to approve all conversions from forest (deforestation). In their annual reports, they also include illegally deforested areas.

11.5 Article 3.4

11.5.1 Information demonstrating that activities under Article 3.4 have occurred since January 1990 and are human-induced

All data on areas under Articles 3.4 were adopted from annual reports of SORS and SFS for the period 1990 – 2012. All selected forest areas (for KP reporting) were under FM activities on January 1, 1990, 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 of ownership, conservation degree or natural conditions.

Slovenian forests are a part of sustainable and multipurpose management based on principles of environmental protection and natural values. Our main concerns are: permanent and optimal functioning of forests 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 (FM) was a net sink in the whole KP reporting period 2008-2012. The net removals from carbon stock changes were -6,294.1 Gg CO₂ eq. (in 2008), -6,294.1 Gg CO₂ eq. (in 2009), -6,295.0 Gg CO₂ eq. (in 2010), -6,284.3 Gg CO₂ eq. (in 2011), and -6,250.2 Gg CO₂ eq. (in 2012).

According to the paragraph 9(c) of Annex to decision 15/CMP.1, Slovenia declares that FM removals are not accounted for under activities under Article 3.3 (Deforestation for Slovenia case).

According to paragraph 9(d) of Annex to decision 15/CMP.1, Slovenia declares that 1,297.8 Gg CO₂ removal of sink was used in 2012 to offset the debit incurred under Article 3.3.

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 CO₂ emissions from deforestation (conversion to grassland, to cropland to settlements and to other land) and CO₂ removals due to forest management also represent 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 2013 (SEF_SI_2014_1_8-40-5 10-1-2014.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 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 of 2013 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 2013 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_2014_1_8-40-5 10-1-2014.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 2013 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 2013.</p> <p>Refer to Separate Electronic Attachment "SIAR Reports 2014-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 2013.</p> <p>Refer to Separate Electronic Attachment "SIAR Reports 2014-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 2013. Refer to Separate Electronic Attachment "SIAR Reports 2014-SI v 1.0.xls" Worksheet R4.
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist on December 31, 2013. Refer to Separate Electronic Attachment "SIAR Reports 2014-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 addressing discrepancies occurred in 2013.

12.4 Publicly Accessible Information

The public has access via the national registry website (<http://www.arso.gov.si/>), by the selection "Register emisijskih kuponov" (<http://www.arso.gov.si/podnebne%20spremembe/Register%20emisijskih%20kuponov/>).

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 accounts (Table 12.4.1) are available on the same website under "Javno dostopna poročila"/UNFCCC reports.

Table 12.4.1: Publicly Accessible Information

Annual Submission Item	Report
15/CMP.1 annex I.E Publicly accessible information	Public available information could be accessed via registry website, URL: http://www.arso.gov.si/ by the selection of "Register emisijskih kuponov", under title »Javno dostopna poročila" - UNFCCC reports: http://www.arso.gov.si/podnebne%20spremembe/Register%20emisijskih%20kuponov/Javno%20dostopna%20porocila/ In accordance with the requirements of Annex E to decision 13/CMP.1, all required information for a Party is provided.

12.5 Calculation of the Commitment Period Reserve

The assigned amount is calculated according to Articles 3.7 and 3.8 of the Kyoto Protocol, on the basis of the latest base year inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol.

Slovenia's estimate of its assigned amount is derived from the base year emissions (1986, 1995 for F-gasses), multiplied by the limit implied by the Slovenia's 8% Kyoto target i.e. 0.92, multiplied by 5 representing five years of the first commitment period.

Table 12.5.1: Slovenia's assigned amount

	Emission (Gg CO ₂ eq.)
Emissions (without F-gasses and LUCF) in 1986	20,027.878
Emissions of F-gasses in 1995	326.164
TOTAL Base Year Emission	20,354.042
Kyoto target	-8%
Annual average emissions (2008-2012)	18,725.719
Estimated assigned amount	93,628.593

Slovenia's AA= 20,354.042 x 0.92 x 5 = **93,628.593 Gg CO₂ equivalent**

Slovenia's CPR = 93,628.593 x 0.90 = **84,265.734 Gg CO₂ 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

In the response to the Potential Problems formulated in the course of 2013 UNFCCC in country review the Minister for agriculture and environment has secured the additional administrative resources to carry out the necessary QA/QC activities. He has nominated QA/QC manager as well as a control team of experts with the following main tasks:

- Develop a QA/QC plan in accordance with the IPCC good practice guidance;
- Develop an inventory improvement plan;
- Implement general inventory QC procedures (tier 1) in accordance with the QA/QC plan following the IPCC good practice guidance;
- Collaboration of other members of the team with the inventory experts and QA/QC manager when necessary;
- Regular partial review of QA/QC by sector, scheduled by the team;
- Preparation of expert framework for the elaboration of emission inventories for land use.

13.2 Changes to the Registry

The following changes to the national registry of Slovenia have occurred in 2013.

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	Additional registry administrator was nominated: Mrs. Veronika Tolar Šmid Slovenian Environment Agency Vojkova 1b, SI-1000 Ljubljana Email: veronika.tolar-smid@gov.si Telephone: +386 1478 4487 Fax: +386 14784051
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	An updated diagram of the database structure is attached as Annex A. Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduce changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was carried out in February 2014 and the successful test report has been attached. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reporting period.

Reporting Item	Report
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change of the list of publicly available information occurred during the reporting period. The Slovenian publicly accessible information are available via registry website, URL: http://www.arso.gov.si/ by selection "Register emisijskih kuponov" /Javno dostopna poročila (http://www.arso.gov.si/podnebne%20spremembe/Register%20emisijskih%20kuponov/Javno%20dostopna%20poroc%4%8dila/) The confidential data according to the EU Regulation 389/2013/EU are not published.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the national registry internet address occurred during the reporting period. The internet address of the Slovenian registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/SI/index.xhtml , available from agency registry page named "Register emisijskih kuponov" (http://www.arso.gov.si/podnebne%20spremembe/Register%20emisijskih%20kuponov/) or from EC Climate Action Union Registry page http://ec.europa.eu/clima/policies/ets/registry/links_en.htm
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in February 2014 and the successful test report has been attached.
The previous Annual Review recommendations	At the time of preparation of this submission the draft FCCC/ARR/2013/SVN, dated 31 March 2014, was available. The response is in the Table 13.2.2 below

Table 13.2.2: The response to the previous Annual Review recommendations, for the reporting year 2012.

Reference	Recommendation description	Response
1.3.7 / 1.4.1	Improve the public availability of the register information	Slovenian Environment Agency (SEA) maintains Slovenian publicly accessible information on its website (http://www.arso.gov.si/), on a part of the national registry website, named "Register emisijskih kuponov", which is accessible from main page of SEA, by selection "Register emisijskih kuponov" /Javno dostopna poročila: http://www.arso.gov.si/podnebne%20spremembe/Register%20emisij%20kuponov/Javno%20dostopna%20porocila%20c4%8dila/
2.3.3	Provide additional information on database structure in the NIR (The assessor recommends that following major changes, the party provide a data model which contains all DES required entities complete with descriptions in its annual NIR.)	<p>The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. Since the successful certification of the registry on June 1, 2012, iteration 4 of the registry, introduced in October 2012, added a limited number of new entities, none of them to DES entities.</p> <p>A data model was attached which more clearly shows the relevant entities "RECONCILIATIONS", "NOTIFICATIONS", "RESPONSES", "INTERNAL AUDIT LOG" and "MESSAGE LOG." As specified in DES (Section VII. Data Logging Specifications/E. Message Archive), a copy of messages sent and received is stored in standalone files in one of two managed servers in the hosting environment. For that reason, the Message Archive is not shown in the model. The "MESSAGE LOG" object holds the location of the entire message for each Message_ID.</p> <p>Since the successful certification of the registry on June 1, 2012, there has been no change in the capacity of the registry or change of its infrastructure.</p>
2.3.10	The assessor strongly recommends that the Party test each release thoroughly against the DES as part of each major release cycle and provide the results of such tests in its annual NIR.	<p>The consolidated EU system of registries successfully completed a full certification procedure in June 2012. Notably, this procedure includes connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). This included a full Annex H test. All tests were executed successfully and led to successful certification on June 1, 2012.</p> <p>The October 2012 release (version 4.0) was only a minor iteration and changes were limited to EU ETS functionality and had no impact on Kyoto Protocol functions in the registry. This is reflected by the previously provided test script .</p> <p>However, each major release of the registry is subject to both regression testing and tests related to new functionality. These tests include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production.</p>

14 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 the 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, 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, 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, promotion of energy efficiency and renewable energies and 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 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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