MINISTRY OF ENVIRONMENTAL AND NATURE PROTECTION

CROATIAN ENVIRONMENT AGENCY

NATIONAL INVENTORY REPORT 2012

Submission to the UNFCCC and the Kyoto Protocol

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NATIONAL INVENTORY REPORT 2012

Croatian greenhouse gas inventory
for the period 1990-2010

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LIST OF ABBREVIATIONS

CBS	*- Central Bureau of Statistics*
CFC	*- Chlorofluorocarbons*
COP	*- Conference of Parties*
COPERT	*- Computer Programme to Calculate Emissions from Road Transport*
CORINAIR	*- Core Inventory of Air Emissions in Europe*
CPS Molve	*- Central Gas Station Molve*
CRF	*- Common Reporting Format*
EKONERG	*-Energy Research and Environmental Protection Institute*
EIHP	*- Energy Institute "Hrvoje Požar"*
EMEP	*- Co-operative Programme for Monitoring and Evaluation of the Long Rang Transmission of Air Pollutants in Europe*
ERT	*- Expert Review Team*
FAO	*- Food and Agriculture Organization of the United Nations*
GHG	*- Greenhouse gas*
GWP	*- Global Warming Potential*
HEP	*- Croatian Electricity Utility Company*
HFC	*- Hydrofluorocarbons*
IEA	*- International Energy Agency*
INA	*- Croatian Oil and Gas Company*
IPCC	*- Intergovernmental Panel on Climate Change*
ISWA	*- International Solid Waste Association*
LULUCF	*- Land-use, Land Use Change and Forestry*
MENP	*- Ministry of Environmental and Nature Protection*
NGGIP	*- National Greenhouse Gas Inventories Programme*
NIR	*- National Inventory Report*
NMVOC	*- Non-methane Volatile organic Compounds*
PFC	*- Perfluorocarbons*
SF_6	*- Sulphur hexafluoride*
UNECE	*- United Nations Economic Commission for Europe*
UNFCCC	*- United Nations Framework Convention on Climate Change*
ZGOS	*- Zagreb's Environmental Protection and Waste Management Company*
int.	*- international*
dom.	*- domestic*

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EXECUTIVE SUMMARY

ES.1. BACKGROUND INFORMATION ON GHG INVENTORIES AND CLIMATE CHANGE

The Republic of Croatia became a party to the United Nations Framework Convention on Climate Change (UNFCCC) on 17 January 1996 when the Croatian Parliament passed the law on its ratification (Official Gazette, International Treaties No. 2/96). For the Republic of Croatia the Convention came into force on 7 July 1996. As a country undergoing the process of transition to market economy, Croatia has, pursuant to Article 22, paragraph 3 of the Convention, assumed the commitments of countries included in Annex I. By the amendment that came into force on 13 August 1998 Croatia was listed among Parties included in Annex I to the Convention.

The adoption of the Decision 7/CP.12 by the Conference of Parties was acknowledged by the Croatian Parliament which ratified the Kyoto Protocol on 27 April 2007 (Official Gazette, International Treaties No. 5/07). The Kyoto Protocol has entered into force in Croatia on 28 August 2007. Initial Report of the Republic of Croatia under the Kyoto Protocol[1] was submitted in August 2008.

One of the commitments outlined in Article 4, paragraph 1 of the UNFCCC is that Parties are required to develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties.

Furthermore, Article 5, paragraph 1 of the Kyoto Protocol requires that each Party included in Annex I shall have in place, no later than one year prior to the start of the first commitment period, a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. A national system includes all institutional, legal and procedural arrangements made within a Party included in Annex I for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

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[1] According to decision 13/CMP.1 *Modalities for the accounting of assigned amounts under Article 7, paragraph 4, of the Kyoto Protocol* each Party included in Annex I with a commitment inscribed in Annex B shall submit to the Secretariat, prior to 1 January 2007 or one year after the entry into force of the Kyoto Protocol for that Party, whichever is later, the report referred to in paragraph 6 of the annex of decision 13/CMP.1. Therefore, the Ministry of Environmental and Nature Protection has prepared the Initial Report of the Republic of Croatia in accordance with requirements of paragraph 7 of the annex of decision 13/CMP.1 which specifies the information which shall be provided by the Party.

The Republic of Croatia is also a country which is currently in the process of accession to the EU. Accession is conditioned by the harmonization, adoption and implementation of the entire *acquis communaitaire*, i.e. the body of legislation and rules already implemented in the EU. This process is very complex and requires changes that are systemic in its nature particularly in institutional and legislative sphere. As a future EU member state, Croatia will have to implement legislation concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol, which also stipulates establishment of mechanism for monitoring emissions by sources and removals by sinks of greenhouse gases, evaluating progress towards meeting commitments in respect of these emissions and for implementing the UNFCCC and the Kyoto Protocol, as regards national programmes, inventories, national system and registries.

Taking into consideration abovementioned comprehensive reporting requirements and previous experience in preparation of annual inventory submissions, Ministry of Environmental and Nature Protection as a national focal point has enforced regulation which stipulate institutional and procedural arrangements for greenhouse gas monitoring and reporting in Croatia. The Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia came into force on 2 January 2007 (Official Gazette, No. 1/07). Monitoring of GHG gases is stipulated by Article 75. of the Air Protection Act (Official Gazette No. 130/11).

In this NIR, the inventory of the emissions and removals of the greenhouse gases is reported for the period from 1990 to 2010. The NIR is prepared in accordance with the UNFCCC reporting guidelines on annual Inventories as adopted by the COP by its Decision 18/CP.8. The methodologies used in the calculation of emissions are based on the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines)* and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC Good Practice Guidance)* prepared by the Intergovernmental Panel on Climate Change (IPCC). As recommended by the IPCC Guidelines country specific methods have been used where appropriate and where they provide more accurate emission data. The important part of the inventory preparation is uncertainty assessment of the calculation and verification of the input data and results, all this with the aim to increase the quality and reliability of the calculation.

Furthermore, since the introduction of annual technical reviews of the national inventories by experts review teams (ERT), Croatia has undergone seven reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005, 2006, 2009, 2010 and 2011. Issues recommended by the ERT have been included in this report as far as possible.

The calculation includes the emissions which are the result of anthropogenic activities and these include the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated carbons (HFCs, PFCs) and sulphur hexafluoride (SF_6) and indirect greenhouse gases: carbon monoxide (CO), oxides of nitrogen (NO_x), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2). The greenhouse gases covered by Montreal Protocol on the pollutants related to ozone depletion (freons) are reported in the framework of this protocol and therefore are excluded from this Report.

Greenhouse gas emission sources and sinks are divided into six main sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land Use, Land-Use Change and Forestry and Waste. Generally, the methodology for emission calculation could be described as a product of the particular economic activity (e.g. fuel consumption, cement production, number of animals, increase of wood stock etc.) with corresponding emission factors. The use of specific national emission factors is recommended wherever possible and justified, whereas on the contrary, the methodology gives typical values of emission factors for all relevant activities of the particular sectors.

ES.1.1. INSTITUTIONAL AND ORGANIZATIONAL STRUCTURE OF GREENHOUSE GAS EMISSIONS INVENTORY PREPARATION

Institutional arrangement for inventory preparation in Croatia is regulated in Part II of the Regulation on greenhouse gas emissions monitoring in the Republic of Croatia, entitled National system for the estimation and reporting of anthropogenic greenhouse gas emissions by sources and removals by sinks. Institutional arrangements for inventory management and preparation in Croatia could be characterized as decentralized and out-sourced with clear tasks breakdown between participating institutions including Ministry of Environmental and Nature Protection, Croatian Environment Agency and competent governmental bodies responsible for providing of activity data. The preparation of inventory itself is entrusted to Authorised Institution which is elected for three year period by public tendering.

Ministry of Environmental and Nature Protection (MENP) is a national focal point for the UNFCCC, with overall responsibility for functioning of the National system in a sustainable manner, including:

- mediation and exchange of data on greenhouse gas emissions and removals with international organisations and Parties to the Convention;
- mediation and exchange of data with competent bodies and organisations of the European Union in a manner and within the time limits laid down by legal acts of the European Union;
- control of methodology for emission calculation and greenhouse gas removal in line with good practices and national circumstances;
- consideration and approval of the Greenhouse Gas Inventory Report prior to its formal submission to the Convention Secretariat.

Croatian Environment Agency (CEA) is responsible for the following tasks:

- organisation of greenhouse gas inventory preparation with the aim of meeting the due deadlines referred to in Article 12 of this Regulation;
- collection of activity data referred to in Article 11 the Regulation;
- development of quality assurance and quality control plan (QA/QC plan) related to the greenhouse gas inventory in line with the guidelines on good practices of the Intergovernmental Panel on Climate Change;

- implementation of the quality assurance procedure with regard to the greenhouse gas inventory in line with the quality assurance and quality control plan;
- archiving of activity data on calculation of emissions, emission factors, and of documents used for inventory planning, preparation, quality control and quality assurance;
- maintaining of records and reporting on authorised legal persons participating in the Kyoto Protocol flexible mechanisms;
- reporting on modifications in the National System;
- selection of Authorised Institution (in Croatian: Ovlaštenik) for preparation of the greenhouse gas inventory.
- provide insight into data and documents for the purpose of technical reviews.

Authorised Institution is responsible for preparation of inventory, which include:

- emission calculation of all anthropogenic emissions from sources and removals by greenhouse gas sinks, and calculation of indirect greenhouse gas emissions, in line with the methodology stipulated by the effective guidelines of the Convention, guidelines of the Intergovernmental Panel on Climate Change, Instructions for reporting on greenhouse gas emissions as published on the Ministry's website, and on the basis of the activities data referred to in Article 11 of this Regulation;
- quantitative estimate of the calculation uncertainty referred to in indent 1 of this Article for each category of source and removal of greenhouse gas emissions, as well as for the inventory as a whole, in line with the guidelines of the Intergovernmental Panel on Climate Change;
- identification of key categories of greenhouse gas emission sources and removals;
- recalculation of greenhouse gas emissions and removals in cases of improvement of methodology, emission factors or activity data, inclusion of new categories of sources and sinks, or application of coordination/adjustment methods;
- calculation of greenhouse gas emissions or removal from mandatory and selected activities in the sector of land use, land-use change and forestry;
- reporting on issuance, holding, transfer, acquisition, cancellation and retirement of emission reduction units, certified emission reduction units, assigned amount units and removal units, and carry-over, into the next commitment period, of emission reduction units, certified emission reduction units and assigned amount units, from the Registry in line with the effective decisions and guidelines of the Convention and supporting international treaties;
- implementation of and reporting on quality control procedures in line with the quality control and quality assessment plan;
- preparation of the greenhouse gas inventory report, including also all additional requirements in line with the Convention and supporting international treaties and decisions;
- cooperation with the Secretariat's ERTs for the purpose of technical review and assessment/evaluation of the inventory submissions.

EKONERG – Energy and Environmental Protection Institute was selected as Authorised Institution for preparation of 2012 inventory submission.

ES.1.2. BACKGROUND INFORMATION ON SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL

LULUCF

Since the enforcement of the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia (Official Gazette, No. 1/07) in 2007, which *inter alia* established National system as required by Decision 19/CMP.1, Ministry of Environmental and Nature Protection (MENP), as the UNFCCC focal point, initiated intensive and continuous consultation and knowledge sharing with relevant national institutions responsible for the forestry sector in Croatia. The overall goal of this effort was to establish procedural arrangements necessary for streamlined data flow needed for reporting of information related to accounting of LULUCF activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol.

In Croatia, there is a long tradition of forest management and a comprehensive national system for monitoring, data collection and reporting on the condition and activities in forestry sector. In that respect, main effort was directed in harmonization of current system with the KP-LULUCF requirements. In the beginning of 2010, MENP commissioned a preparation of Action plan for implementation of Article 3, paragraphs 3 and 4 of the Kyoto Protocol which should facilitate the process of data collection and preparation of information related to accounting of LULUCF activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol. Terms of reference for this Action plan includes harmonization of definitions and their appliance to national circumstances, identification of lands subject to activities under Article 3.3 and elected activity under Article 3.4, data collection for estimation of carbon stock change and non-CO_2 greenhouse gas emissions and uncertainty assessment and verification.

The Ministry of Agriculture and the Ministry of Environmental and Nature Protection agreed that preparation of the annual GHG Inventory in respect of LULUCF sector should be based on forest management plans. As for the first Croatian National Forest Inventory (CRONFI), it is still not published and available. Once CRONFI becomes official and published, it could be used to fill the gaps in reporting.

Information on Kyoto units

Until the end of 2011 Croatia did not make any transaction of Kyoto units.

Changes in national system

There were changes in National system in part related to legal arrangements where new Air Protection Act was enacted in November 2011.

Changes in national registry

There were no changes in national registry.

ES.2. SUMMARY OF NATIONAL EMISSION AND REMOVAL RELATED TRENDS

In this chapter the results of the greenhouse gas emission calculation in the Republic of Croatia are presented for the period from 1990 to 2010. The results are presented as total emissions of all greenhouse gases in CO_2 equivalents over sectors and then as emissions for the individual greenhouse gas by sectors. Since the certain greenhouse gases have different irradiation properties, and consequently different contribution to the greenhouse effect, it is necessary to multiply the emission of every gas with proper Global Warming Potential (GWP). The Global Warming Potential is a measure of the impact on greenhouse effect of the certain gas compared to CO_2 impact which is accordingly defined as a referent value. In that case the emission of greenhouse gases is presented as the equivalent emission of carbon dioxide (CO_2-eq). If the removal of greenhouse gases occurs (e.g. the absorption of CO_2 at increase of wood stock in forests) than it refers to sinks of greenhouse gases and the amount is presented as a negative value. Table ES.2-1 shows the global warming potentials for particular gases.

Table ES.2-1: Global warming potentials for certain gases (100- year time horizon)

Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_20)	310
HFC-32	650
HFC-125	2800
HFC-134a	1300
HFC-143a	3800
CF_4	6500
C_2F_6	9200
SF_6	23900

ES.3. OVERVIEW OF SOURCES AND SINK CATEGORY EMISSION ESTIMATES AND TRENDS

Total emission/removal of greenhouse gases for the period 1990-2010 and their trend in sectors is given in table ES.3-1, while the contribution of the individual gases is given in table ES.3-2.

Table ES.3-1: Emissions/removals of GHG by sectors for the period 1990-2010 (Gg CO_2-eq)

Source	Emissions and removals of GHG (Gg CO_2-eq)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
Energy	22,538	17,102	19,332	22,537	22,716	24,045	22,826	21,574	20,880
Industrial Processes	3,822	2,030	2,886	3,284	3,446	3,628	3,577	2,969	3,230
Solvent and Other Product Use	117	109	109	197	224	246	236	151	151
Agriculture	4,381	3,055	3,130	3,478	3,498	3,597	3,478	3,366	3,265
Waste	612	744	656	748	863	892	932	998	1,071
Total emission (excluding net CO_2 from LULUCF)	**31,469**	**23,039**	**26,094**	**30,244**	**30,747**	**32,408**	**31,049**	**29,056**	**28,597**
Removals (LULUCF)	-5,592	-6,664	-1,876	-7,663	-7,752	-7,729	-7,967	-7,753	-8,283
Total emission (including LULUCF)	**25,877**	**16,375**	**24,218**	**22,582**	**22,995**	**24,679**	**23,081**	**21,304**	**20,314**

Table ES.3-2: Emissions/removals of GHG by gases for the period 1990-2010 (Gg CO_2-eq)

Source	Emissions and removals of GHG (Gg CO_2-eq)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
Carbon dioxide (CO_2)	23,093	17,037	19,935	23,336	23,570	24,859	23,660	21,892	21,179
Methane (CH_4)	3,745	2,927	3,756	3,099	3,362	3,601	3,527	3,504	3,617
Nitrous oxide (N_2O)	4,837	3,190	6,883	3,571	3,418	3,700	3,784	3,400	3,450
HFCs, PFCs and SF_6	948	61	183	347	379	419	437	443	480
Total emission (excluding net CO_2 from LULUCF)	**31,469**	**23,039**	**26,094**	**30,244**	**30,747**	**32,408**	**31,049**	**29,056**	**28,597**
Removals (LULUCF)	-5,592	-6,664	-1,876	-7,663	-7,752	-7,729	-7,967	-7,753	-8,283
Total emission (including LULUCF)	**25,877**	**16,375**	**24,218**	**22,582**	**22,995**	**24,679**	**23,081**	**21,304**	**20,314**

Table ES.3-1 represents the contribution of the individual sectors to total emissions and removals of the greenhouse gases. The largest contribution to the greenhouse gas emission in 2010 has the Energy Sector with 73.0 percent, followed by Agriculture with 11.4 percent, Industrial Processes with 11.3 percent, Waste with 9.7 percent and Solvent and Other product Use with 0.5 percent. This structure is with minor changes consistent through all the observed period from 1990 to 2010. In the year 2010, the amount of removed emissions of the greenhouse gases by CO_2 from the forestry sector was 29.0 percent.

Energy sector is the largest contributor to greenhouse gas emissions. In the year 2010, the greenhouse gas emission from Energy sector was 3.2 percent lower in relation to 2009. The total energy consumption in 2010 was 2.6 percent lower than in the previous year. This reduction is the results of decreased consumption of liquid fuels (14.9 percent) and imported electricity (11.8 percent). It is also due to increase in hydro power utilization (by 17.5 percent from the previous year) and larger consumption of fuel wood and other renewables.

Emission of CH_4 and N_2O in the Agricultural sector is conditioned by different agricultural activities. For the emission of CH_4, the most important source is livestock farming (Enteric Fermentation) which makes about 83 percent of total CH_4 emission. The number of cattle showed continuous decrease in the period from 1990 to 2000. As a consequence, this led to CH_4 emission reduction. In the year 2000, the number of cattle has started increasing and this trend was mostly retained until 2006. From 2007 to 2010, cattle number decreased. Compared to 2009, in 2010 CH_4 emission decreased by about 1.2 percent. As for Manure management emissions, both CH_4 and N_2O emission decreased in 2010 compared to 2009 by about 3 percent and 4.1 percent respectively. Emissions from Agricultural soils decreased after 1990 and during the war due to specific national circumstances and limited agricultural practice at that time. Afterwards, the emission trend is mostly influenced by the changes in the direct soil emissions; thus, emission increase can be noticed in 1997, 2001 and 2002 due to increase in mineral fertilizer consumption and crop production, later on also due to the increase of livestock population. However, N_2O emission from Agricultural soils decreased in 2010 compared to 2009 by about 3.7 percent. Overall, in 2010 emission from agriculture sector decreased by about 3 percent compared to 2009.

In Industrial Processes sector the key emission sources are Cement Production, Ammonia Production, Nitric Acid Production and Consumption of HFCs in Refrigeration and Air Conditioning Equipment, which all together contribute with 93 percent in total sectoral emission in 2010. The iron production in blast furnaces and aluminium production were ended in 1992, and ferroalloys production ended in 2003. The cement production in the period from 1997-2008 was constantly increasing. Due to decreasing of economic activity within 2009 and 2010, cement production was decreased by 23 and 26 percent, respectively. The aim of the producer is maximum use of the existing capacities which amounts about 3.2 millions of tons of clinker in total per year, whereas in the year 2010, 2.3 millions of tons of clinker was produced. The ammonia production in 2010 was 17 percent higher in comparison to the previous year. Also, the nitric acid production in 2010 was 29 percent higer in comparison to 2009. The level of emissions from these sub-sectors strongly depends on consumer’s demand for particular type of mineral fertilizer at the market.

CO_2 emission from Solvent and Other Product Use contributes to the total greenhouse gas emission in 2010 with 0.5 percent.

Waste sector includes waste disposal, waste water management and waste incineration, whereas the waste disposal represents dominant CH_4 emission source from that sector in the Republic of Croatia. The emission depends on the amount and composition of municipal solid waste, management practices on-site including implementation of measures for collection and utilization of landfill gas. The First Order Decay (FOD) model was used for CH_4 emission calculation. Although increasing of municipal solid waste amounts as a result of the growth in the living standard, this rise has slightly declined due to effects of measures undertaken to avoid/reduce and recycle waste. Priority is given according avoiding and reducing waste generation and reducing its hazardous properties. These objectives, defined by the *Waste Management Strategy* (Official Gazette No. 130/05) and *Waste Management Plan in the Republic of Croatia* (Official Gazette No. 85/07, 126/10, 31/11) include the assumed time-lags with respect to relevant EU legislation (Landfill Directive). CH_4 that is recovered and burned in a flare or energy recovery device in the period 2005-2010 have been included in emission estimation. It should be emphasized that Solid Waste Disposal on Land contributes with 70.8 percent in total sectoral emission in 2010. Waste sector contributes to total greenhouse gas emissions with 3.7 percent in 2010.

ES.3.1. CARBON DIOXIDE EMISSION (CO_2)

Carbon dioxide is the most significant anthropogenic greenhouse gas. As in the majority of countries, the most significant anthropogenic sources of CO_2 emissions in Croatia are the processes of fossil fuel combustion for electricity or/and heat production, transport and industrial processes (cement and ammonia production). The results of the CO_2 emission calculation in Croatia are presented in table ES.3-3.

Table ES.3-3: CO_2 emission/removal by sectors from 1990-2010 (Gg CO_2)

Sector	1990	1995	2000	2005	2006	2007	2008	2009	2010
Energy	20,977	15,744	17,938	20,927	21,009	22,203	21,080	19,881	19,124
Industrial processes	2,034	1,218	1,923	2,248	2,371	2,444	2,379	1,893	1,935
Solvent and Other Product Use	82	75	74	162	189	211	202	117	120
LULUCF	-6,746	-6,840	-6,538	-7,772	-7,895	-8,197	-8,327	-7,936	-8,413
Total CO_2 emission	***23,093***	***17,037***	***19,935***	***23,336***	***23,570***	***24,859***	***23,660***	***21,892***	***21,179***
Net CO_2 emission	***16,348***	***10,197***	***13,397***	***15,565***	***15,675***	***16,662***	***15,333***	***13,956***	***12,766***

ES.3.1.1. ENERGY SECTOR

This sector covers all activities that involve fuel consumption from stationary and mobile sources, and fugitive emission from fuels. Fugitive emission arises from production, transport, processing, storage and distribution of fossil fuels. The Energy sector is the main source of the anthropogenic greenhouse gas emission with share of 73.0 percent in total greenhouse gas emission (presented as equivalent emission of CO_2). CO_2 emission from fuel combustion makes the largest part of CO_2 emission (88.5 percent). Emission by sub-sectors is presented in table ES.3-4.

Table ES.3-4: CO_2 emission by sub-sectors from 1990-2010 (Gg CO_2)

Source	1990	1995	2000	2005	2006	2007	2008	2009	2010
Energy Industries	7,127	5,262	5,877	6,779	6,628	7,737	6,705	6,373	5,884
Manufacturing Industries & Constr.	5,843	3,541	3,617	4,081	4,181	4,205	4,198	3,379	3,315
Transport	3,986	3,376	4,421	5,509	5,869	6,297	6,186	6,185	5,959
Comm./Inst., Resid., Agr /For./Fish.	3,606	2,826	3,389	3,867	3,630	3,301	3,415	3,428	3,480
Fugitive emissions	416	739	633	691	700	663	576	516	487
Total CO_2 emission	20,977	15,744	17,938	20,927	21,009	22,203	21,080	19,881	19,124

Emission calculation is based on fuel consumption data recorded in annual national energy balance, where the fuel consumption and supply is presented at the sufficient level of detail which enables more detailed calculation by sub-sectors in the framework of the formal IPCC methodology (i.e. Sectoral approach). Furthermore, the simplest method of the calculation was carried out (i.e. Reference approach) which takes into account only the total balance of fuel, without sub-sector analysis. The relative deviation of CO_2 emissions between reference and sectoral approach for Croatia is around 3 percent (table ES.3-5).

Table ES.3-5: CO_2 emission comparison due to fuel combustion (Gg)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Reference appr.	21023.5	15062.2	17773.0	20980.9	20820.0	22208.6	21167.8	19834.6	19110.8
Sectoral appr.	20560.1	15004.0	17305.6	20297.6	20309.5	21540.6	20494.8	19256.7	18637.1
Relative Diff (%)	**2.25**	**0.39**	**2.70**	**3.37**	**2.51**	**3.10**	**3.28**	**3.00**	**2.54**

Two energy most intensive stationary sub-sectors are Energy Industries (electricity and heat production, refineries and oil and gas field combustion) and Manufacturing Industries and Construction. In the framework of the sub-sector Manufacturing Industries and Construction, the largest CO_2 emissions are the result of fuel combustion in industry of construction material and petrochemical production, followed by chemical industry, food and drink production, tobacco production, industry of pulp, paper and print, etc. Furthermore, this sub-sector includes electricity and heat production in manufacturing industry for manufacturing processes.

Transport sector is also one of more important CO_2 emission sources. This sector includes emission from road transport, civil aviation, railways and navigation. In the year 2010, the CO_2 emission from Transport sector contributed with 31.2 percent to the national total CO_2 emission. The largest part of the CO_2 emission from Transport sector arises from road transport (95.2 percent of CO_2 emission from transport sector in 2010) followed by national navigation, railways and domestic civil aviation.

Biomass combustion (fuel wood and waste wood, biodiesel, biogas) also results in greenhouse gas emissions. CO_2 emission from biomass is not included in balance according the Guidelines, due to assumption that life-

cycle CO_2 emitted is formerly absorbed for the growth of biomass. Sinks or CO_2 emissions resulted in change of forest biomass is calculated in sector Land Use, Land-Use Change and Forestry.
Fugitive greenhouse gas emission from coal, liquid fuels and natural gas, resulted from exploration of minerals, production, processing, transport, distribution and activities during mineral use is also included in this sector. Although this emission is not characteristic for CO_2, yet for CH_4, there is a CO_2 emission present during the process of scrubbing of natural gas in Central Gas Station Molve.

ES.3.1.2. INDUSTRIAL PROCESSES

The greenhouse gas emission is a by-product in various industrial processes, where the raw material is chemically transformed into final product. Industrial processes where the contribution to CO_2 emission is identified as relevant are production of cement, lime, ammonia, as well as use of limestone and soda ash in various industrial activities.

General methodology used for emission calculation from industrial processes, recommended by the Convention, includes the product of annual produced or consumed amount of a product or material with appropriate emission factor per unit of this production or consumption. Annual production or consumption data for particular industrial processes are extracted, in most cases, from Annual Industrial Reports published by Central Bureau of Statistics. Certain activity data was collected from survey of manufacturers. The results of the CO_2 emission in industrial processes are shown in table ES.3-6.

Table ES.3-6: CO_2 emission from Industrial Processes for the period from 1990-2010 (Gg CO_2)

Source	1990	1995	2000	2005	2006	2007	2008	2009	2010
Cement production	1,086	629	1,244	1,500	1,588	1,612	1,527	1,224	1,198
Lime production	153	83	136	206	251	261	256	165	152
Limestone and dolomite use	51	17	16	27	24	22	26	30	37
Soda ash production and use	26	14	12	20	18	16	16	17	20
Ammonia production	466	439	498	485	477	522	530	445	501
Ferroalloys production	119	32	12	0	0	0	0	0	0
Aluminium production	1,048	0	0	0	0	0	0	0	0
Iron and steel production	21	4	5	11	13	12	24	11	27
Total CO_2 emission	**3,822**	**2,030**	**2,886**	**3,284**	**3,446**	**3,628**	**3,577**	**2,969**	**3,230**

The most significant CO_2 industrial processes emission sources are production of cement, ammonia and lime. In 2010, cement production contributes in total sectoral CO_2 emission with 37 percent, lime production with 5 percent and ammonia production with 16 percent. Generally, CO_2 emissions from industrial processes declined from 1990 to 1995, due to the decline in industrial activities caused by the war in Croatia, while in the period 1996-2008 emissions slightly increased. Production of iron and aluminium was stopped in 1992. Due to decreasing of economic activity within 2009, which influenced decreasing of cement, lime, ammonia, and steel production, emissions have dropped, but in 2010, although cement production was decreased by 0.05 percent and lime production by 0.08 percent, ammonia production increased by 17 percent and iron and steel production by 124 percent, which resulted in an increase in emissions from industrial processes by 8,8 precent., regarding 2009.

The quantity of the CO_2 emitted during cement production is directly proportional to the lime content of the clinker. Therefore, the CO_2 emissions are calculated using an emission factor, in tonnes of CO_2 released per tonne of clinker produced, to the annual clinker output corrected with the fraction of clinker that is lost from the kiln in the form of Cement Kiln Dust (CKD). The emission factor and correction factor for CKD is determined according to *Revised 1996 IPCC Guidelines and Good Practice Guidance*. Country-specific emission factors were estimated using data from individual plants. The activity data for clinker production were collected from survey of cement manufacturers and cross-checked with cement production data from Annual Industrial Reports published by Central Bureau of Statistics.

In ammonia production, emission of CO_2 from natural gas used as feedstock is stehiometrically determined based on carbon content in natural gas. One part of the CO_2 produced in ammonia production is further used as feedstock in urea production, i.e. mineral fertilizer. Emission of intermediately bound CO_2 occurs during the use of urea as a fertilizer in agriculture. However, according to IPCC methodology this approach is not distinguished.

ES.3.1.3. CO_2 REMOVALS

The *Forest Act* (OG 140/05, 82/06, 129/08, 80/10, 124/10) regulates the growing, protection, usage and management of forests and forest land as a natural resource aimed to maintain biodiversity and ensure management based on principles of economic sustainability, social responsibility and ecological acceptability. Moreover, one of its the most important provisions, in the context of climate protection, is that forests should be managed in conformity with the sustainable management criteria, implying the maintenance and enhancement of forest ecosystems and their contribution to the global carbon cycle. Planning activities in forestry sector in Croatia are also regulated by the *Forest Act* (OG 140/05, 82/06, 129/08, 80/10, 124/10). Forest management plans determine conditions for harmonious usage of forest and forest land and procedures in that area, necessary scope regarding cultivation and forest protection, possible utilization degree and conditions for wildlife management. The Forest Management Area Plan (FMAP) for the Republic of Croatia determines the ecological, economic and social background for forest improvement in terms of biology and for the increase of forest productivity.

According to Forest Management Area Plan of the Republic of Croatia (2006-2015), the forests and the forest land cover 47.5 percent of the total surface area. By its origin, approximately 95 percent of the forests in Croatia were formed by natural regeneration and the 5 percent of the forests are grown artificially. The Plan determines, for 2006, growing stock of about 398 millions of m^3 while its yearly increment amounts around 10.5 millions of m^3. The most frequent species are Common Beech (*Fagus sylvatica*), Pedunculate Oak (*Quercus robur*), Sessile

Oak (*Quercus petrea*), Common Hornbeam (*Carpinus betulus*), Silver Fir (*Abies alba*), Narrow-leafed Ash (*Fraxinus angustifolia*), Spruce (*Picea abies*), Black Alder (*Alnus glutinosa*), Black Locust (*Robinia pseudoacacia*), Turkey Oak (*Quercus cerris*) and other.

Up to now, the Republic of Croatia reported data only for Forest land and Settlements category. For this inventory, data are collected and presented in the CRF databse for all other land use categories under LULUCF sector. Interpretation of the collected data are given in this NIR's resubmission.

The methodology used for CO_2 removal calculation is taken from the IPCC and it is based on data on increment and fellings. The problem of deforestation in Croatia does not exist. According to present data the total forest area has not been reduced in the last 100 years.

Table ES.3-7 shows the CO_2 emission removal trend in the forestry sector. Conversion of forest land to settlements results in CO_2 emission which makes about 0.3% of total national emission in 2009.

Table ES.3-7: Emission trends in LULUCF sector from 1990-2010 (Gg CO_2)

	1990	1995	2000	2005	2008	2009	2010
Removals	-6,746	-6,840	-6,538	-7,772	-8,327	-7,935	-8,413

ES.3.2. METHANE EMISSION (CH_4)

The major sources of methane (CH_4) emission are fugitive emission from production, processing, transportation and activities related with fuel use in Energy sector, Agriculture and Waste Disposal on Land. In table ES.3-8, sectoral and total CH_4 emissions are reported.

Table ES.3-8: CH_4 emission in Croatia in the period from 1990-2010 (Gg CH_4)

Source	1990	1995	2000	2005	2006	2007	2008	2009	2010
Energy	69	61	59	69	76	82	78	75	78
Agriculture	70	44	41	46	48	46	47	47	46
Waste	25	31	27	31	36	38	40	43	46
Total CH_4 emission	***178***	***139***	***179***	***148***	***162***	***171***	***168***	***167***	***172***

Fugitive methane emission is mainly the result of exploration, production, processing, transportation and distribution of natural gas (about 97 percent). The fugitive emission from oil and natural gas accounts with 41.5 percent in total methan emission, and venting and flaring of gas/oil production accounts with approximately 1 percent. In 1999, by closing of the coal mines in Istra, large amount of fugitive emissions arising from the exploration, processing and transportation of coal, were avoided.

In the Agricultural sector there are two significant methane emission sources present: enteric fermentation in the process of digestion of ruminants (dairy cows represent the major source) and different activities related with storage and use of organic fertilizers (manure management). The total methane emission for domestic animals is being calculated as a sum of emission from enteric fermentation and emission related to manure management. The emission trend depends on the livestock population trend.

Methane emission from solid waste disposal sites (SWDSs) is a result of anaerobic decomposition of organic waste by methanogenic bacteria. The amount of methane emitted during the process of decomposition is directly proportional to the fraction of degradable organic carbon (DOC) which is defined as carbon content in different types of organic biodegradable wastes. In Croatia, more than 1.7 million tons of municipal solid waste is produced annually and the average composition of it biodegradable part is: paper and textile (21-22 percent), garden and park waste (18-19 percent), food waste (23-24 percent), wood waste and straw (3 percent). As for the wastewater handling in Croatia, aerobic biological process is used mostly in wastewater treatment. Anaerobic process is applied in some industrial wastewater treatment, which results with CH_4 emissions. Data for 4 industries with the largest potential for wastewater methane emissions were considered. Disposal of domestic and commercial wastewater, particularly in rural areas where systems such as septic tanks are used, are partly anaerobic without flaring, which results with CH_4 emissions.

ES.3.3. NITROUS OXIDE EMISSION (N_2O)

The most important sources of N_2O emissions in Croatia are agricultural activities, nitric acid production, but as well, the N_2O emissions occur in energy sector and waste management. In table ES.3-9 the N_2O emission is reported according to sectors.

Table ES.3-9: N_2O emission in Croatia for the period from 1990-2010 (Gg N_2O)

Source	1990	1995	2000	2005	2006	2007	2008	2009	2010
Energy	0.3	0.2	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Industrial Processes	2.6	2.3	2.4	2.2	2.2	2.4	2.4	2.0	2.6
Solvent and Other Product	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	9.4	6.9	7.3	8.1	8.1	8.5	8.1	7.7	7.4
Waste	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total N_2O emission	***15.6***	***10.3***	***22.2***	***11.5***	***11.4***	***12.9***	***12.2***	***11.0***	***11.1***

In the Agricultural sector, three N_2O emission sources are determined: direct N_2O emission from agricultural soils, direct N_2O emission from livestock farming and indirect N_2O emission induced by agricultural activities. The largest emission is a result of direct emission from agricultural soils which makes about 55.9 percent of total emission from agricultural soils in 2010. According to IPCC methodology, the mineral nitrogen, nitrogen from organic fertilizers, amount of nitrogen in fixing crops, amount of nitrogen which is released from crop residue mineralization and soil nitrogen mineralization due to cultivation of histosols, are separately analyzed.

In Industrial Processes sector, the N_2O emission occurs in nitric acid production, which is used as a raw material in nitrogen mineral fertilizers. In the framework of the N_2O reduction measure analysis, the possibility for application of non-selective catalytic reduction device was considered, whereby the nitric acid production influence on N_2O emissions would be practically eliminated.

In Energy sector the emission was calculated on the basis of fuel consumption and adequate emission factors (IPCC). The N_2O emission increase in Energy sector is the consequence of greater use of three-way catalytic converters in road transport motor vehicles, which have about 30 times greater N_2O emission comparing to vehicles without a catalytic converter.

N_2O emission from the Waste sector indirectly occurs from human sewage. It is calculated on the basis of the total number of inhabitants and annual protein consumption per inhabitant. Data on the annual per capita Protein Intake Value were obtained by the FAOSTAT Statistical Database. Extrapolation method has been used for calculation of insufficient data.

ES.3.4. HALOGENATED CARBONS (HFCS, PFCS) AND SF_6 EMISSIONS

Synthetic greenhouse gases include halogenated carbons (HFCs and PFCs) and sulphur hexafluoride (SF_6). Although on an absolute scale their emissions are not great, due to their high global warming potential (GWP) their contribution to global warming is considerable. Ministry of Environmental and Nature Protection (MENP) is responsible for monitoring of consumption of substitutes and mixture of substitutes for gases that deplete the ozone layer. There is no production of HFCs PFCs and SF_6 in Croatia, therefore, all quantities of these gases are imported. Minor quantities of some substances are exported.
Croatia is an Article 5 country, according to the Montreal protocol, and has a longer period for using CFC, HCFC and halons. Because of that, Croatia started using HFCs 10 years later then other Annex I countries.
According to survey carried out among major agents, users and consumers of these gases, information related to consumption of HFCs, PFCs, and SF6 (provided by the MENP, Croatian Electricity Utility Company - HEP and Končar – Electrical Industries Inc.) was used for emission calculation which is presented in Gg of CO_2-eq and showed in Table ES.3-10.

Table ES.3-10: HFCs, PFCs and SF_6 emission in the period from 1990-2010 (Gg CO_2-eq)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
HFC, PFC and SF_6 emission	11	61	183	347	379	419	436	443	480

ES.4. EMISSION OF INDIRECT GREENHOUSE GASES

The photochemicaly active gases, carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane volatile organic compounds (NMVOCs) indirectly contribute to the greenhouse gas effect. These are generally called indirect greenhouse gases or ozone precursors, because they are involved in creation and degradation of ozone which is also one of the greenhouse gases. Sulphur dioxide (SO_2), as a precursor of sulphate and aerosols, is believed to contribute negatively to the greenhouse effect.

Emissions of indirect GHGs have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

The calculations of aggregated results for the emissions of indirect gases in the period 1990-2010 are given in table ES.4-1.

Table ES.4-1: Emissions of ozone precursors and SO_2 by different sectors (Gg)

Gas	Emissions (Gg)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
NO_x Emission	93.3	64.2	73.7	72.6	72.8	77.2	75.8	68.7	64.8
Energy Industries	17.5	14.5	13.8	12.2	11.3	13.7	11.5	11.5	9.5
Manufacturing Ind. & Construction	16.3	7.6	7.7	9.9	11.0	13.0	14.0	11.1	11.0
Transport	41.0	31.4	35.1	35.0	35.0	35.0	34.3	31.1	29.2
Other Energy (fuel comb.)	15.0	8.1	12.8	13.1	13.2	12.9	13.5	13.3	13.2
Fugitive Em. from Fuels	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.1
Industrial Processes	2.8	2.6	2.8	8.3	9.5	10.1	9.2	7.0	5.8
Agriculture	0.1	NO	NO	NO	NO	NO	NO	NO	NO
LULUCF	0.4	0.1	1.7	0.0	0.1	0.2	0.1	0.1	0.0
CO Emission	**589.5**	**395.3**	**490.1**	**351.8**	**353.5**	**333.8**	**288.8**	**284.7**	**263.3**
Energy Industries	2.4	1.6	1.6	1.1	1.5	2.1	1.5	1.2	1.1
Manufacturing Ind. & Construction.	37.2	38.1	33.6	33.4	34.5	31.6	31.7	30.9	31.8
Transport	237.9	175.3	172.8	111.4	98.8	90.9	80.8	72.4	62.8
Other Energy (fuel comb.)	204.0	116.7	146.4	133.0	133.5	115.6	120.1	126.2	141.8
Fugitive Em. from Fuels	50.1	34.5	54.1	54.4	44.4	53.5	41.6	51.9	24.3
Industrial Processes	41.7	28.4	32.1	19.8	41.8	38.0	12.8	2.3	3.4
Agriculture	4.3	NO	NO	NO	NO	NO	NO	NO	NO
LULUCF	12.7	1.9	51.5	1.1	1.5	5.1	3.9	1.9	1.3

Table ES.4-1: Emissions of ozone precursors and SO_2 by different sectors (Gg), cont.

Gas	Emissions (Gg)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
NMVOC Emission	**114.4**	**78.1**	**89.7**	**102.6**	**111.0**	**114.5**	**108.7**	**77.0**	**75.6**
Energy Industries	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2
Manufacturing Ind. & Construction	1.7	1.3	1.4	1.8	1.9	2.0	2.1	1.7	1.6
Transport	37.9	28.2	31.8	18.9	18.2	16.9	15.2	13.4	11.3
Other Energy (fuel comb.)	12.1	6.9	9.0	8.3	8.4	7.4	7.7	8.0	8.8
Fugitive Em. from Fuels	9.8	9.1	10.0	8.6	7.8	8.2	7.5	8.3	5.0
Industrial Processes	24.0	9.3	7.8	8.7	8.3	6.3	5.9	5.3	5.4
Solvent and Other Product Use	28.1	25.5	25.3	55.2	64.6	72.1	68.8	40.0	40.8
LULUCF	1.3	0.2	5.2	0.1	0.2	0.5	0.4	0.2	0.1
SO_2 Emission	**173.7**	**81.4**	**61.3**	**63.0**	**59.3**	**67.2**	**57.3**	**59.0**	**41.3**
Energy Industries	99.5	54.0	32.9	32.7	30.2	39.0	32.0	36.7	19.7
Manufacturing Ind. & Construction.	39.8	16.7	11.0	9.4	10.6	9.1	8.5	6.0	12.0
Transport	5.9	3.5	6.0	9.1	8.4	9.2	7.5	6.8	2.3
Other Energy (fuel comb.)	23.9	4.7	6.5	6.8	5.8	4.8	4.3	4.5	4.2
Fugitive Em. from Fuels	1.8	1.2	3.1	3.1	2.5	3.2	2.8	3.3	1.8
Industrial Processes	2.6	1.6	2.1	2.1	1.9	2.1	2.4	1.8	1.3

PART 1: ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

1.1. BACKGROUND INFORMATION ON GHG INVENTORIES, CLIMATE CHANGE AND SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL

1.1.1. BACKGROUND INFORMATION ON GHG INVENTORIES AND CLIMATE CHANGE

The Republic of Croatia became a party to the United Nations Framework Convention on Climate Change (UNFCCC) on 17 January 1996 when the Croatian Parliament passed the law on its ratification (Official Gazette, International Treaties No. 2/96). For the Republic of Croatia the Convention came into force on 7 July 1996. As a country undergoing the process of transition to market economy, Croatia has, pursuant to Article 22, paragraph 3 of the Convention, assumed the commitments of countries included in Annex I. By the amendment that came into force on 13 August 1998 Croatia was listed among Parties included in Annex I to the Convention.

The adoption of the Decision 7/CP.12 by the Conference of Parties was acknowledged by the Croatian Parliament which ratified the Kyoto Protocol on 27 April 2007 (Official Gazette, International Treaties No. 5/07). The Kyoto Protocol has entered into force in Croatia on 28 August 2007. Initial Report of the Republic of Croatia under the Kyoto Protocol[2] was submitted in August 2008.

One of the commitments outlined in Article 4, paragraph 1 of the UNFCCC is that Parties are required to develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties.

Furthermore, Article 5, paragraph 1 of the Kyoto Protocol requires that each Party included in Annex I shall have in place, no later than one year prior to the start of the first commitment period, a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. A national system includes all institutional, legal and procedural arrangements made within a Party included in Annex I for estimating anthropogenic emissions by sources and removals by sinks of

[2] According to decision 13/CMP.1 *Modalities for the accounting of assigned amounts under Article 7, paragraph 4, of the Kyoto Protocol* each Party included in Annex I with a commitment inscribed in Annex B shall submit to the Secretariat, prior to 1 January 2007 or one year after the entry into force of the Kyoto Protocol for that Party, whichever is later, the report referred to in paragraph 6 of the annex of decision 13/CMP.1. Therefore, the Ministry of Environmental and Nature Protection has prepared the Initial Report of the Republic of Croatia in accordance with requirements of paragraph 7 of the annex of decision 13/CMP.1 which specifies the information which shall be provided by the Party.

all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

The Republic of Croatia is also a country which is currently in the process of accession to the EU. Accession is conditioned by the harmonization, adoption and implementation of the entire *acquis communaitaire*, i.e. the body of legislation and rules already implemented in the EU. This process is very complex and requires changes that are systemic in its nature particularly in institutional and legislative sphere. As a future EU member state, Croatia will have to implement legislation concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol, which also stipulates establishment of mechanism for monitoring emissions by sources and removals by sinks of greenhouse gases, evaluating progress towards meeting commitments in respect of these emissions and for implementing the UNFCCC and the Kyoto Protocol, as regards national programmes, inventories, national system and registries.

Taking into consideration abovementioned comprehensive reporting requirements and previous experience in preparation of annual inventory submissions, Ministry of Environmental and Nature Protection as a national focal point has enforced regulation which stipulate institutional and procedural arrangements for greenhouse gas monitoring and reporting in Croatia. The Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia came into force on 2 January 2007 (Official Gazette, No. 1/07). Monitoring of GHG gases is stipulated by Article 75. of the Air Protection Act (Official Gazette No. 130/11).

In this NIR, the inventory of the emissions and removals of the greenhouse gases is reported for the period from 1990 to 2010. The NIR is prepared in accordance with the UNFCCC reporting guidelines on annual Inventories as adopted by the COP by its Decision 18/CP.8. The methodologies used in the calculation of emissions are based on the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines)* and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC Good Practice Guidance)* prepared by the Intergovernmental Panel on Climate Change (IPCC). As recommended by the IPCC Guidelines country specific methods have been used where appropriate and where they provide more accurate emission data. The important part of the inventory preparation is uncertainty assessment of the calculation and verification of the input data and results, all this with the aim to increase the quality and reliability of the calculation.

The calculation includes the emissions which are the result of anthropogenic activities and these include the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated carbons (HFCs, PFCs) and sulphur hexafluoride (SF_6) and indirect greenhouse gases: carbon monoxide (CO), oxides of nitrogen (NO_x), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2). The greenhouse gases covered by Montreal Protocol on the pollutants related to ozone depletion (freons) are reported in the framework of this protocol and therefore are excluded from this Report.

Greenhouse gas emission sources and sinks are divided into six main sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land Use, Land-Use Change and Forestry and Waste. Generally, the methodology for emission calculation could be described as a product of the particular economic activity (e.g. fuel consumption, cement production, number of animals, increase of wood stock etc.) with corresponding emission factors. The use of specific national emission factors is recommended wherever possible and justified, whereas on the contrary, the methodology gives typical values of emission factors for all relevant activities of the particular sectors.

1.1.2. BACKGROUND INFORMATION ON SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL

LULUCF

Since the enforcement of the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia (Official Gazette, No. 1/07) in 2007, which *inter alia* established National system as required by Decision 19/CMP.1, Ministry of Environmental and Nature Protection (MENP), as the UNFCCC focal point, initiated intensive and continuous consultation and knowledge sharing with relevant national institutions responsible for the forestry sector in Croatia. The overall goal of this effort was to establish procedural arrangements necessary for streamlined data flow needed for reporting of information related to accounting of LULUCF activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol.

In Croatia, there is a long tradition of forest management and a comprehensive national system for monitoring, data collection and reporting on the condition and activities in forestry sector. In that respect, main effort was directed in harmonization of current system with the KP-LULUCF requirements. In the beginning of 2010, MENP commissioned a preparation of Action plan for implementation of Article 3, paragraphs 3 and 4 of the Kyoto Protocol which should facilitate the process of data collection and preparation of information related to accounting of LULUCF activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol. Terms of reference for this Action plan includes harmonization of definitions and their appliance to national circumstances, identification of lands subject to activities under Article 3.3 and elected activity under Article 3.4, data collection for estimation of carbon stock change and non-CO_2 greenhouse gas emissions and uncertainty assessment and verification.

The Ministry of Agriculture and the Ministry of Environmental and Nature Protection agreed that preparation of the annual GHG Inventory in respect of LULUCF sector should be based on forest management plans. As for the first Croatian National Forest Inventory (CRONFI), it is still not published and available. Once CRONFI becomes official and published, it could be used to fill the gaps in reporting.

Information on Kyoto units

Until the end of 2011 Croatia did not make any transaction of Kyoto units.

Changes in national system
There were changes in National system in part related to legal arrangements where new Air Protection Act was enacted in November 2011.

Changes in national registry
There were no changes in national registry.

1.2. BRIEF DESCRIPTION OF THE INSTITUTIONAL ARRANGEMENT FOR INVENTORY PREPARATION

Institutional arrangement for inventory preparation in Croatia is regulated in Part II. of the Regulation on greenhouse gas emissions monitoring in the Republic of Croatia, entitled National system for the estimation and reporting of anthropogenic greenhouse gas emissions by sources and removals by sinks. Institutional arrangements for inventory management and preparation in Croatia could be characterized as decentralized and out-sourced with clear tasks breakdown between participating institutions including Ministry of Environmental and Nature Protection, Croatian Environment Agency and competent governmental bodies responsible for providing of activity data. The preparation of inventory itself is entrusted to Authorised Institution which is elected for three year period by public tendering.
Ministry of Environmental and Nature Protection (MENP) is a national focal point for the UNFCCC, with overall responsibility for functioning of the National system in a sustainable manner, including:

- mediation and exchange of data on greenhouse gas emissions and removals with international organisations and Parties to the Convention;
- mediation and exchange of data with competent bodies and organisations of the European Union in a manner and within the time limits laid down by legal acts of the European Union;
- control of methodology for emission calculation and greenhouse gas removal in line with good practices and national circumstances;
- consideration and approval of the Greenhouse Gas Inventory Report prior to its formal submission to the Convention Secretariat.

Croatian Environment Agency (CEA) is responsible for the following tasks:

- organisation of greenhouse gas inventory preparation with the aim of meeting the due deadlines referred to in Article 12 of this Regulation;
- collection of activity data referred to in Article 11 the Regulation;
- development of quality assurance and quality control plan (QA/QC plan) related to the greenhouse gas inventory in line with the guidelines on good practices of the Intergovernmental Panel on Climate Change;
- implementation of the quality assurance procedure with regard to the greenhouse gas inventory in line with the quality assurance and quality control plan;

- archiving of activity data on calculation of emissions, emission factors, and of documents used for inventory planning, preparation, quality control and quality assurance;
- maintaining of records and reporting on authorised legal persons participating in the Kyoto Protocol flexible mechanisms;
- reporting on modifications in the National System;
- selection of Authorised Institution (in Croatian: Ovlaštenik) for preparation of the greenhouse gas inventory.
- provide insight into data and documents for the purpose of technical reviews

Authorised Institution is responsible for preparation of inventory, which include:

- emission calculation of all anthropogenic emissions from sources and removals by greenhouse gas sinks, and calculation of indirect greenhouse gas emissions, in line with the methodology stipulated by the effective guidelines of the Convention, guidelines of the Intergovernmental Panel on Climate Change, Instructions for reporting on greenhouse gas emissions as published on the Ministry's website, and on the basis of the activities data referred to in Article 11 of this Regulation;
- quantitative estimate of the calculation uncertainty referred to in indent 1 of this Article for each category of source and removal of greenhouse gas emissions, as well as for the inventory as a whole, in line with the guidelines of the Intergovernmental Panel on Climate Change;
- identification of main categories of greenhouse gas emission sources and removals;
- recalculation of greenhouse gas emissions and removals in cases of improvement of methodology, emission factors or activity data, inclusion of new categories of sources and sinks, or application of coordination/adjustment methods;
- calculation of greenhouse gas emissions or removal from mandatory and selected activities in the sector of land use, land-use change and forestry;
- reporting on issuance, holding, transfer, acquisition, cancellation and retirement of emission reduction units, certified emission reduction units, assigned amount units and removal units, and carry-over, into the next commitment period, of emission reduction units, certified emission reduction units and assigned amount units, from the Registry in line with the effective decisions and guidelines of the Convention and supporting international treaties;
- implementation of and reporting on quality control procedures in line with the quality control and quality assessment plan;
- preparation of the greenhouse gas inventory report, including also all additional requirements in line with the Convention and supporting international treaties and decisions;
- cooperation with the Secretariat's ERTs for the purpose of technical review and assessment/evaluation of the inventory submissions.

EKONERG – Energy and Environmental Protection Institute was selected as Authorised Institution for preparation of 2012 inventory submission.

1.2.1. OVERVIEW OF INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS FOR COMPILING SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL

Since the enforcement of the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia (Official Gazette, No. 1/07) in 2007, which *inter alia* established National system as required by Decision 19/CMP.1, Ministry of Environmental and Nature Protection (MENP), as the UNFCCC focal point, initiated intensive and continuous consultation and knowledge sharing with relevant national institutions responsible for the forestry sector in Croatia. The overall goal of this effort was to establish procedural arrangements necessary for streamlined data flow needed for reporting of information related to accounting of LULUCF activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol.

1.3. BRIEF DESCRIPTION OF THE PROCESS OF INVENTORY PREPARATION

Process of inventory preparation encompasses several steps starting with activity data collection and followed by emissions estimation and recalculations in accordance with the IPCC methodology and recommendations for improvements from the ERT review reports, compilation of inventory including the NIR and the CRF and in parallel implementation of general and source-category specific quality control procedures.

Activity data collection is under responsibility of Croatian Environment Agency which represents a hub between governmental and public institutions responsible for providing activity data and Authorised Institution responsible for inventory preparation. The scope and due dates for delivering activity data to CEA are prescribed by the Regulation. In addition several operators from energy and industrial sector were directly approached by the CEA and EKONERG for more detailed activity data since higher tier methods have been applied (see table 1.4-1 for details).

After activity data are collected and processed, inventory team performed emission estimations and recalculation in accordance with the IPCC methodology and taking into consideration recommendations for inventory improvements. Results are checked against quality control procedures in order to ensure data integrity, correctness and completeness.

It is important to emphasize that process of inventory preparation has been improved in recent submissions mainly as a result of activities carried out under the framework of two capacity building projects, i.e.:

- UNDP/GEF regional project “Capacity building for improving the quality of GHG inventories” in which following inventory related documents were prepared:
    - National GHG Inventory Improvement Strategy
    - National QA/QC plan
    - National QA/QC guidance
    - Manuals of procedures for compiling, archiving, updating and managing GHG Inventory

- Description of inventory archives
- Description of awareness-raising campaign
- Improvement of GHG emission calculation from road transport
- Improvement of methane emission calculations from waste disposal

- EC LIFE Third Countries project "Capacity building for implementation of the UNFCCC and the Kyoto Protocol in the Republic of Croatia" in which following inventory related documents were prepared:
    - Draft of National implementation strategy and action plan
    - Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia

Furthermore, since the introduction of annual technical reviews of the national inventories by experts review teams (ERT), Croatia has undergone seven reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005, 2006, 2009, 2010 and 2011. Issues recommended by the ERT have been included in this report as far as possible.

1.4. BRIEF DESCRIPTION OF METHODOLOGIES AND DATA SOURCES USED

The methodologies from *Revised 1996 IPCC Guidelines for National GHG Inventories* and *Good Practice Guidance and Uncertainty Management in National GHG Inventories, recommended by the UNFCCC* were used for emission estimations of greenhouse gases which are result of anthropogenic activities, i.e. CO_2, CH_4, N_2O, HFCs, PFCs, SF_6. Emissions of indirect GHGs have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are principal greenhouse gases and though they occur naturally in the atmosphere, their recent atmospheric build-up appears to be largely the result of human activities. Synthetic gases such as halogenated hydrocarbons (PFCs, HFCs) and sulphur hexafluoride (SF_6) are also considered as greenhouse gases and they are solely the result of human activities. The methodology does not include the CFCs which are the subject of the Montreal Protocol. In addition, there are other photochemically active gases such as carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane volatile organic compounds (NMVOCs) that, although not considered as greenhouse gases, contribute indirectly to the greenhouse effect in the atmosphere. These are generally referred to as ozone precursors, because they participate in the creation and destruction of tropospheric and stratospheric ozone (which is also GHG). Sulphur dioxide (SO_2), as a precursor of sulphate and aerosols, is believed to exacerbate the greenhouse effect because the creation of aerosols removes heat from the environment.

Generally, methodology applied to estimate emissions includes the product of activity data (e.g. fuel consumption, cement production, wood stock increment and so forth) and associated emission factor. The use of country-specific emission factors, if available, is recommended but these cases should be based on well-documented research. Otherwise, the *Revised 1996 IPCC Guidelines* provides methodology with default emission factors for different tiers. The emission estimates are divided into following sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land Use, Land-Use Change and Forestry and Waste. Detailed description of the applied methodologies is described in sector specific chapters of the NIR from 3 to 9 and overview is given in the CRF tables Summary 3s1 - Summary 3s2.

The 2008 reporting cycle represents a transition from voluntary to in principal mandatory activity data collection system stipulated by the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia. Activity data sources for inventory preparation are presented in the Table 1.4-1, but more detailed information is given in sectoral chapters.

Table 1.4-1: Data sources for GHG inventory preparation

CRF Sector/Sub-sector	Type of data	Source of data
Energy	Energy balance	Ministry of Economy with assistance of Energy Institute Hrvoje Požar
	Registered motor vehicles database	Ministry of Interior
	Fuel consumption and fuel characteristic data for thermal power plants	Pollution Emission Register Voluntary survey of HEP - Croatian Power Utility Company
	Fuel characteristic data	Voluntary survey of INA - Oil and Gas Company
	Natural gas processed (scrubbed), CO_2 content before scrubbing and CO_2 emission	Voluntary survey of INA - Central Gas Station MOLVE
Industrial Processes	Activity data on production/consumption of material for particular industrial process	Central Bureau of Statistics, Department of Manufacturing and Mining Croatian Environment Agency
	Activity data on production/consumption of halogenated hydrocarbons (PFCs, HFCs) and sulphur hexafluoride (SF6)	Ministry of Environmental and Nature Protection
	Data on consumption and composition of natural gas in ammonia production Data on cement and lime production	Survey of ammonia manufacturer (Petrokemija Fertilizer Company Kutina) Survey of cement and lime manufacturers
Solvent and Other Product Use	Activity data on production for particular source category and number of inhabitants	Central Bureau of Statistics, Department of Manufacturing and Mining
Agriculture	Livestock number	Central Bureau of Statistics, Croatian Horse breeding Centre
	Production of N-fixing crops and non N-fixing crops	Central Bureau of Statistics
	Area of histosols	Faculty of Agriculture
	Activity data on mineral fertilisers applied in Croatia	Voluntary survey of Petrokemija Fertilizer Company Kutina, Fertilizer Company Adriatica Dunav, Fertzilizer Company Genera
LULUCF	Activity data on areas of different land use categories, annual increment and annual cut, fuel wood and wildfires	Ministry of Agriculture with assistance of public company "Hrvatske šume"
Waste	Activity data on municipal solid waste disposed to different types of SWDSs	Ministry of Environmental and Nature Protection; Croatian Environment Agency
	Activity data on wastewater handling	State company Croatian Water (Hrvatske vode)
	Activity data on waste incineration	Croatian Environment Agency

1.5. BRIEF DESCRIPTION OF KEY CATEGORIES

According to the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, key categories are those which represent 95% (Tier 1) or 90% (Tier 2) of the total annual emissions in the last reported year or belonging to the total trend, when ranked from contributing the largest to smallest share in annual total and in the trend. Results of Key categories analysis are presented in Annex 1, Table A1.2-2 – Table A1.2-19.

Tier 1 level assessment uses emissions and removals from each category directly and Tier 2 level assessment analyzes the emissions and removals of each category, multiplied by the uncertainty (Annex 5, Table A5.2-1, Table A5.2-2).

The purpose of trend assessment is to identify categories that may not be large enough to be identified by level assessment, but whose trend is significantly different from the trend of the overall inventory, and should therefore receive particular attention. Tier 2 trend assessment is calculated multiplying the Tier 1 trend assessment with uncertainty of each category (Annex 5, Table A5.2-1, Table A5.2-2).

The analysis is based on the contribution of CO_2 equivalents from different sources and sinks on the sectoral level. The recommended IPCC categories as well as the categories recommended in *Good Practice Guidance for Land Use, Land-Use Change and Forestry* to be assessed in the key category analysis are presented in Table A1-1 of the Annex 1. Furthermore, Croatian experts determined certain sub-categories which are particularly significant, such as CO_2 Emission from Natural Gas Scrubbing (also shown in Table A1-1 of the Annex 1).

The results of the Approach 1 Level Assessment including/excluding LULUCF for 1990 and 2010 are shown in Tables A1.2-1 to A1.2-4 respectively, with the key categories shaded.
The results of the Approach 2 Level Assessment including/excluding LULUCF for 1990 and 2010 are shown in Tables A1.2-7 to A1.2-10 respectively, with the key categories shaded.
The key categories are sorted in descending order of magnitude and the cumulative total is included in the final column of the table.

The results of the Approach 1 Trend Assessment including/excluding LULUCF are shown in Tables A1.2-5 to A1.2-6, with the key categories shaded.
The results of the Approach 2 Trend Assessment including/excluding LULUCF are shown in Tables A1.2-11 to A1.2-12, with the key categories shaded.
The key categories are sorted in descending order of magnitude, and the cumulative total is shown in the final column of the table.

The results of the Key Category Analysis including/excluding LULUCF are summarized by sector and gas in Table A1-18 and A1-19 respectively. The tables indicate whether the key category arises from the level assessment or the trend assessment or both level and trend assessment for 1990 and 2010 using Approach 1 and Approach 2. Some changes in the Key Categories based on the level and trend of emission occurred in NIR 2012 in relation to NIR 2011. These changes are shown in Table A1.2-17.

1.6. INFORMATION ON THE QA/QC PLAN INCLUDING VERIFICATION AND TREATMENT OF CONFIDENTIALITY ISSUES

1.6.1. QA/QC PLAN

According to Article 8, paragraph 1 of the Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia, within the competence of Croatian Environment Agency is the preparation of quality assurance and quality control plan regarding greenhouse gas inventory (hereinafter QA/QC plan), implementation of the quality assurance procedures in accordance with the QA/QC plan and archiving activity data for emission calculation, emission factors and documents used for planning, preparing, controlling and assuring Inventory quality. QA/QC plan is a part of quality assurance and quality control system (QA/QC system), stipulated by Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol. Implementation of QA/QC system is based on following documents: QA/QC programme, Quality objectives document, QA/QC plan and Category-specific QC checklist.

QA/QC programme describes: overall responsibilities and roles of institutions involved in inventory planning, preparation and management, general timetable of activities for data collection, inventory preparation, inventory submission, annual review and reporting on GHG registry and general and specific QA/QC procedures.

Quality objectives document defines general and specific short-term (< 1 year) and medium-term (1-3 years) objectives related to the improvement of National system in regard to inventory planning, preparation and management. This document takes into account results of uncertainty analysis, key category analysis and recommendations outlined in the Annual review report. This document is prepared annually.

QA/QC plan follows the proposed cycle of activities and responsibilities:

activity	**responsibility**
Preparation of QA/QC plan •Making decisions regarding method selection, procedures and/or national system supplements •Documentation revision and supplement	QA/QC coordinator CEA, MENP, Authorized Institution
Approval of QA/QC plan	CEA, MENP
Implementation of QC procedures •Internal audit •Corrective and preventive activities •Reporting on performed internal audit	QA/QC coordinator, Authorized Institution's sectoral experts QA/QC coordinator, Project leader in NIR preparation Authorized Institution's sectoral experts QA/QC coordinator
Reporting on QC procedures	Authorized Institution
Implementation of QA procedures	CEA, MENP - National System Committee

Quality control activities are focused on following elements of inventory preparation and submission process:

- Activity data collection and archiving;
- Preparation of inventory report;
- Submission of inventory report;
- Review activities;
- Reporting on GHG registry.

For the purposes of transparency of the emission calculation and archiving of data, inventory team has continued with the good practice in preparation of Inventory Data Record Sheets which were introduced in 2001 submission and which contain details of the person and/or organization responsible for an emission estimate, the primary or secondary sources of activity data and emission factors used, the methodology applied, data gaps, ways to cross-check, suggestion for future improvement in the estimates and relevant bibliographic references. The information provided in Inventory Data Record Sheets is available for each source category and for the entire time-series. An example of Inventory Data Record Sheet for 2008 in Waste sector is presented in Annex 6, Table A6-1. All data in the form of Inventory Data Record Sheets are also archived at Croatian Environment Agency.

During the preparation of the NIR a number of checks were carried out by sector experts related to completeness, consistency, comparability, recalculation and uncertainty of activity data, emission factors and emission estimates. The details on these issues are elaborated in the NIR by each sector, subsector and corresponding CRF tables.

Finally, before the Authorized Institution submits the NIR to Croatian Environment Agency, QA/QC manager carried out an audit which covers selected IPCC source categories, as outlined in the QA/QC plan, with purpose to check which quality control elements, both general (Tier 1) and specific (Tier 2), as defined in the *IPCC Good Practice Guidance*, are already implemented by sector experts and which improvements and corrective actions should be carried out in the future submissions. CRF tables for each sector are reviewed in accordance with the Quality Management Standard (ISO 9001) and Environmental Management Standard (ISO 14001) implemented within the Agency and the authorized institution. Audit results are registered in control lists as well as performed correction activities.

Quality assurance activities are accomplished in a way that Croatian Environment Agency submits complete Inventory and CRF tables to the Ministry of Environmental and Nature Protection, which, upon receipt, approves the latter. National System Committee is included in the approval process; its members who have not been included in the Inventory preparation provide their opinion on certain parts of the Inventory within the frame of their speciality. Members of the National System Committee are nominated by the authorized Ministries upon the request of the Ministry of Environmental and Nature Protection. QA/QC coordinator documents all Committee results/findings.

1.6.2. VERIFICATION AND CONFIDENTIALITY ISSUES

The verification process of calculation is aimed at the improvement of the input quality and identification of the calculation reliability. The *IPCC Guidelines* recommend that inventories should be verified through the use of a set of simple checks for completeness and accuracy, such as checks for arithmetic errors, checks of country estimates against independently published estimates, checks of national activity data against international statistics and checks of CO_2 emissions from fuel combustion calculated using sectoral methods with the IPCC Reference Approach. Further verification checks may be done through comparison with other national inventory calculation data.

In the development of the Croatian inventory, certain steps and some of these checks were performed:

- Comparison with the national inventory data of other countries was conducted by comparing CRF tables or through a direct communication;
- Activity data were compared using different sources such as Croatian Bureau of Statistics and individual emission sources;
- The CO_2 emissions from fossil fuel combustion, within the framework of IPCC methodology, are estimated using two approaches: (1) Reference Approach and (2) Sectoral Approach (Tier 1).

1.7. GENERAL UNCERTAINTY EVALUATION

The uncertainties associated with both annual estimates of emissions and emission trends over time are reported according to the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. The uncertainties are estimated using Tier 1 and Tier 2 (Monte Carlo analysis) methods described by the IPCC, which provide estimates of uncertainties by pollutant. The uncertainties are estimated for both excluding LULUCF and including LULUCF due to the *Good Practice Guidance for Land Use, Land-Use Change and Forestry*.

According to the Tier 1 uncertainty analysis the total uncertainty excluding LULUCF is 16.84%, while the total uncertainty including LULUCF is 25.3%.

According to the Tier 2 Monte Carlo uncertainty analysis the total uncertainty excluding LULUCF for all key source activities is 17.1%, while the total uncertainty including LULUCF is 26.1%.

According to the Tier 1, the uncertainty introduced into the trend in total national emissions excluding LULUCF is estimated to be 20.84% and including LULUCF 28.11%.

According to the Tier 2 (Monte Carlo analysis), the uncertainty introduced into the trend for all key source activities excluding LULUCF is estimated to be from -17.57% to +20.31% and including LULUCF is estimated to be from -22.482% to +27.02%.

The results of the Tier 1 approach are shown in Table A5.2-1 and A5.2-2 and results of the Tier 2 approach are shown in Table A5.1-2 and A5.1-3 (Annex 5).

Comparison of result uncertainties in total emission and uncertainty of trend from the Error Propagation model and Monte Carlo model are described and explained in Annex 5, Chapter A.5.3.

1.8. GENERAL ASSESSMENT OF THE COMPLETENESS

Croatian inventory consists of the emission estimates for the period from 1990-2010.

The completeness is evaluated following the IPCC methodology and appropriate use of the following notation keys: *NO* (not occurred); *NE* (not estimated); *NA* (not applicable); *IE* (included elsewhere); *C* (confidential). Detailed description by activities and gases of the status of the emission calculation is given in corresponding CRF tables.

Generally, the objective of the completeness is achieved in compliance with the capabilities of the Republic of Croatia in collecting adequate and acceptable activity data. The issues related with lack of activity data are described in sectoral chapters where necessary. The aim of the Croatian inventory is to include all anthropogenic sources of GHGs in the future.

The summary of the "not estimated" sources/sinks is given in Annex 4 – Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded, Table A4-1.

2. TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 BRIEF DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR AGGREGATED GREENHOUSE GAS EMISSIONS

The total GHG emissions in 2010, excluding removals by sinks, amounted to 28.597 mil. t CO_2-eq (equivalent CO_2 emissions), which represents 9.1 percent emission reduction compared to GHG emission in the year 1990.

Overall decline of economic activities and energy consumption in the period 1991-1994, which was mainly the consequence of the war in Croatia, had directly caused the decline in total emissions of greenhouse gases in that period. With the entire national economy in transition process, some energy intensive industries reduced their activities or phased out certain productions (e.g. blast furnaces in Sisak, primary aluminium production in Šibenik, coke plant in Bakar), which was considerably reflected in GHG emissions reduction. Emissions have started to increase in the 1995 at an average rate of 3 percent per year, till 2008. Due to decreasing of economic activity within 2009 and 2010, emission has been reduced by 6.4 percent in 2009 and 7.9 in 2010, regarding 2008.

The main reasons of GHG emission increase in the period 1995-2008 was Energy (Public electricity and Heat production and Transport), Industrial processes (Cement production, Lime production, Ammonia production, Nitric acid production and Consumption of HFCs) and Waste. Increase in Public electricity and Heat production sector is mostly due to higher consumption of liquid fuels (7.5%). Lately, cement, lime, ammonia and nitric acid producers reached their highest producing capacity which has reflected on emission levels. Waste disposal on land, as well as Wastewater handling, have the greatest impact on emission increase in Waste sector.

The main reasons of GHG emission decrease in 2010 are favourable hydrological conditions which leaded to increase in hydro power utilisation by 17.4 percent and decrease in liquid fuels consumption in energy industries (2.5 times).
Due to decreasing of economic activity within 2009, which influenced decreasing of cement, lime, ammonia, and steel production, emissions have dropped by 17 percent average, regarding 2008. In 2010, cement production was decreased by 0.05 percent and lime production by 0.08 percent, regarding 2009. On the other side, in 2010 ammonia production increased by 17 percent and iron and steel production by 124 percent, regarding 2009. Consequently, in 2010 emissions from industrial processes were increased by 8.8 precent, regarding 2009.

2.2 BRIEF DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS BY GAS

The shares of GHG emission have not significantly changed during the entire period. The CO_2 is the largest anthropogenic contributor to total national GHG emissions. In 2010, the shares of GHG emissions were as follows: 74.1 percent CO_2, 12.6 percent CH_4, 11.7 percent N_2O, 1.6 percent HFCs and 0.05 percent SF_6. The trend of aggregated emissions/removals, divided by gasses, is shown in the Table 2.2-1 and Figure 2.2-1.

Table 2.2-1: Aggregated emissions and removals of GHG by gases (1990-2010)

Gas	Emissions and removals of GHG (Gg CO_2-eq)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO_2	23,093	17,037	19,935	23,336	23,570	24,859	23,660	21,892	21,179
CH_4 as CO_2-eq	3,745	2,927	3,756	3,099	3,412	3,601	3,527	3,504	3,617
N_2O as CO_2-eq	4,837	3,190	6,883	3,571	3,530	3,700	3,784	3,400	3,450
HFCs as CO_2-eq	0	49	171	334	365	405	423	429	466
PFCs as CO_2-eq	937	0	0	0	0	0	0	0	0
SF_6 as CO_2-eq	11	12	12	14	14	14	14	14	14
Total GHG emission	**31,469**	**23,039**	**26,094**	**30,244**	**30,747**	**32,408**	**31,049**	**29,056**	**28,597**
Removals (CO_2)	-5,592	-6,664	-1,876	-7,663	-7,752	-7,729	-7,967	-7,753	-8,283
Total emission (including LULUCF)	**25,877**	**16,375**	**24,218**	**22,582**	**22,995**	**24,679**	**23,081**	**21,304**	**20,314**

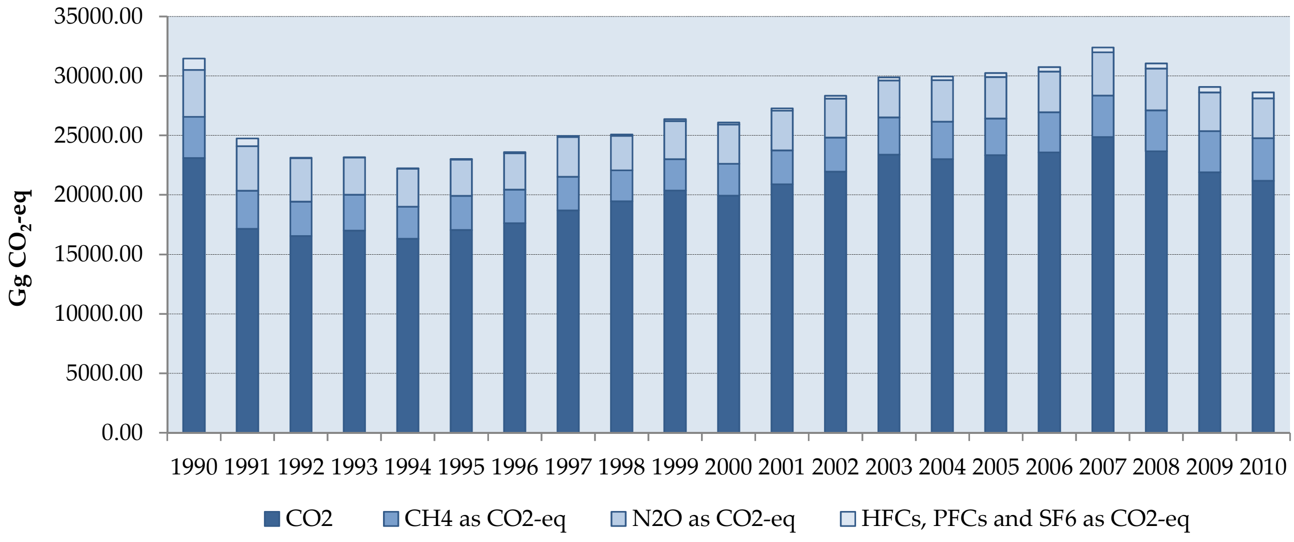

Figure 2.2-1: Trend of GHG emissions, by gases

2.2.1. CARBON DIOXIDE – CO_2

The most significant anthropogenic greenhouse gas is carbon dioxide (CO_2). In 2010, CO_2 emission was 8.3 percent lower than in 1990. CO_2 removals by sinks were almost 48 percent larger than removals in 1990. The largest CO_2 emission decrease was in Energy sector (Public Electricity and Heat Production) and Industrial processes. In addition, there was a permanent increase in mobility (number of road vehicles) and therefore increase in motor fuel consumption. The largest CO_2 emission growth in Industrial Processes is in Chemical industry (Ammonia and Nitric acid production).

2.2.2. METHANE – CH_4

The CH_4 emission in 2010 was 3.7 percent lower than in 1990, largely due to emission trend in Agriculture.

2.2.3. NITROUS OXIDE – N_2O

The N_2O emission in 2010 was 15.1 percent lower than emission in 1990. Decrease of emission was in Energy sector (Manufacturing industries and construction and Transport sectors), Industrial processes (Nitric acid production) and Agriculture (N_2O emission from Agricultural soils).

2.2.4. FLUOROCARBONS – HFCs AND PFCs

PFCs emissions were generated in the production of primary aluminium. The Croatian aluminium industry was still operational in 1990/1991, but production was stopped in 1992. HFCs and PFCs were used as substitutes for cooling gases that deplete the ozone layer, in refrigerating and air-conditioning systems, foam blowing, fire extinguishers and aerosols/metered dose inhalers According to provided calculations, the contribution of F-gases in total national GHG emission in 2010 was approximately 1.7 percent.

2.2.5. SULPHUR HEXAFLUORIDE SF_6

Total emissions of SF_6 used in GIS application and high voltage circuit-breakers have been estimated using data on total charge of SF_6 contained in the existing stock of equipment and leakage and maintenance losses as a fixed percentage of the total charge. According to provided calculations, the contribution of SF_6 in total national GHG emission in 2010 was approximately 0.05 percent.

2.3. BRIEF DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS BY CATEGORY

According to the UNFCCC reporting guidelines and IPCC methodological guidelines, total national emission are divided into six sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land Use, Land-Use Change and Forestry and Waste. The total national GHG emissions and removals, divided by sectors, are presented in the Table 2.3-1 and Figure 2.3-1.

Table 2.3-1: Aggregated emissions and removals of GHG by sectors (1990-2010)

Source	Emissions and removals of GHG (Gg CO_2-eq)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
Energy	22,538	17,102	19,332	22,537	22,716	24,045	22,826	21,574	20,880
Industrial Processes	3,822	2,030	2,886	3,284	3,446	3,628	3,577	2,969	3,230
Solvent and Other Product Use	117	109	109	197	224	246	236	151	151
Agriculture	4,381	3,055	3,130	3,478	3,498	3,597	3,478	3,366	3,265
Waste	612	744	656	748	863	892	932	998	1,071
Total GHG emission	**31,469**	**23,039**	**26,094**	**30,244**	**30,747**	**32,408**	**31,049**	**29,056**	**28,597**
Removals (LULUCF)	-5,592	-6,664	-1,876	-7,663	-7,752	-7,729	-7,967	-7,753	-8,283
Total emission (including LULUCF)	**25,877**	**16,375**	**24,218**	**22,582**	**22,995**	**24,679**	**23,081**	**21,304**	**20,314**

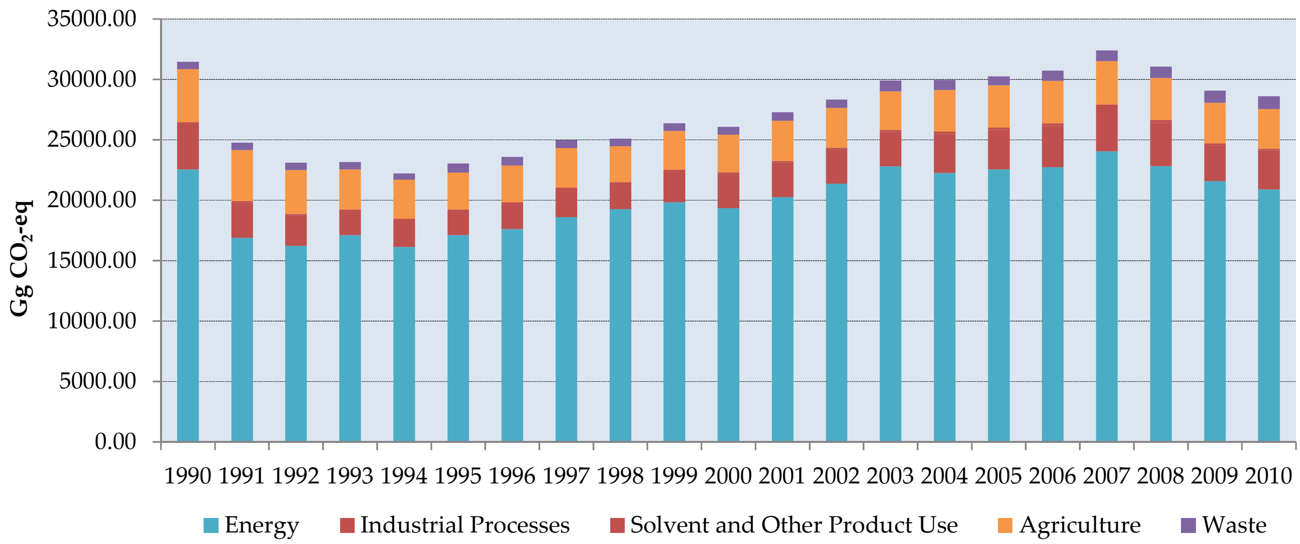

Figure 2.3-1: Trend of GHG emissions, by sectors

2.3.1.ENERGY

The most important IPCC sector in Croatia is Energy sector. The Energy sector accounted for some 73.0 percent of the total national GHG emissions (presented as equivalent emission of CO_2). In 2010, the GHG emission from Energy sector was 7.4 percent smaller than emission in 1990.

The main reasons of GHG emission decrease in 2010 were favourable hydrological conditions which leaded to increase in hydro power utilisation by 17.5 percent and decrease in consumption of liquid fuels (for 14.9 percent in relation to 2009). In addition, because of the economic crisis, there was decrease in industrial production and consequently, decrease in fuel consumption, and it was contributed to the GHG emission decrease

2.3.2.INDUSTRIAL PROCESSES

Industrial Processes contributes to total GHG emission with approximately 10 percent, depending on the year. Due to decreasing of economic activity within 2009, which influenced decreasing of cement, lime, ammonia, and steel production, emissions have dropped by 17 percent average, regarding 2008. In 2010, cement production was decreased by 0.05 percent and lime production by 0.08 percent, regarding 2009. On the other side, in 2010 ammonia production increased by 17 percent and iron and steel production by 124 percent, regarding 2009. Consequently, in 2010 emissions from industrial processes were increased by 8.8 precent, regarding 2009.

2.3.3.SOLVENT AND OTHER PRODUCT USE

Solvent and Other Product Use contributes to total GHG emission with some 0.5 percent of the total national GHG emissions (presented as equivalent emission of CO_2). The GHG emission in 2010 was 29 percent larger than emission in 1990 since new activity data, regarding Other use of solvent, were included in the emission calculation.

2.3.4.AGRICULTURE

The GHG emissions from Agriculture have been decreasing from 2006. The GHG emission in 2010 was about 25.5 percent lower in comparison with 1990 emission. According to estimation of Croatian experts for agriculture, approximately 11.4 percent of total GHG emissions belong to Agriculture.

2.3.5.WASTE

Emissions from Waste sector have been constantly increasing in the period 1990-2010. Increasing emissions are a consequence of greater quantities of waste, activities in wastewater handling and waste incineration. The GHG emission in 2010 was 75 percent larger in comparison with 1990 emission. Contribution of waste sector to the total GHG emission is 3.7 percent.

2.4. BRIEF DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR INDIRECT GREENHOUSE GASSES AND SO_2

Although they are not considered as greenhouse gases, photochemical active gases such as carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane volatile organic compounds (NMVOCs) indirectly contribute to the greenhouse effect. These are generally referred to as indirect greenhouse gases or ozone precursors because they take effect in the creation and degradation of O_3 as one of the GHGs. Sulphur dioxide (SO_2), as a precursor of sulphate and aerosols, is believed to contribute negatively to the greenhouse effect.

Emissions of indirect GHGs have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2009* Submission to the Convention on Long-range Transboundary Air Pollution'.

The emissions of ozone precursors and SO_2 are shown in the Table 2.4-1.

Table 2.4-1: Emissions of ozone precursors and SO_2 by different sectors (Gg)

Gas	Emissions (Gg)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
NO_x Emission	93.3	64.2	73.7	72.6	72.8	77.2	75.8	68.7	64.8
Energy Industries	17.5	14.5	13.8	12.2	11.3	13.7	11.5	11.5	9.5
Manufacturing Ind. & Construction	16.3	7.6	7.7	9.9	11.0	13.0	14.0	11.1	11.0
Transport	41.0	31.4	35.1	35.0	35.0	35.0	34.3	31.1	29.2
Other Energy (fuel comb.)	15.0	8.1	12.8	13.1	13.2	12.9	13.5	13.3	13.2
Fugitive Em. from Fuels	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.1
Industrial Processes	2.8	2.6	2.8	8.3	9.5	10.1	9.2	7.0	5.8
Agriculture	0.1	NO	NO	NO	NO	NO	NO	NO	NO
LULUCF	0.4	0.1	1.7	0.0	0.1	0.2	0.1	0.1	0.0
CO Emission	**589.5**	**395.3**	**490.1**	**351.8**	**353.5**	**333.8**	**288.8**	**284.7**	**263.3**
Energy Industries	2.4	1.6	1.6	1.1	1.5	2.1	1.5	1.2	1.1
Manufacturing Ind. & Construction.	37.2	38.1	33.6	33.4	34.5	31.6	31.7	30.9	31.8
Transport	237.9	175.3	172.8	111.4	98.8	90.9	80.8	72.4	62.8
Other Energy (fuel comb.)	204.0	116.7	146.4	133.0	133.5	115.6	120.1	126.2	141.8
Fugitive Em. from Fuels	50.1	34.5	54.1	54.4	44.4	53.5	41.6	51.9	24.3
Industrial Processes	41.7	28.4	32.1	19.8	41.8	38.0	12.8	2.3	3.4
Agriculture	4.3	NO	NO	NO	NO	NO	NO	NO	NO
LULUCF	12.7	1.9	51.5	1.1	1.5	5.1	3.9	1.9	1.3

Table 2.4-1: Emissions of ozone precursors and SO_2 by different sectors (Gg), cont.

Gas	Emissions (Gg)								
	1990	1995	2000	2005	2006	2007	2008	2009	2010
NMVOC Emission	**114.4**	**78.1**	**89.7**	**102.6**	**111.0**	**114.5**	**108.7**	**77.0**	**75.6**
Energy Industries	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2
Manufacturing Ind. & Construction	1.7	1.3	1.4	1.8	1.9	2.0	2.1	1.7	1.6
Transport	37.9	28.2	31.8	18.9	18.2	16.9	15.2	13.4	11.3
Other Energy (fuel comb.)	12.1	6.9	9.0	8.3	8.4	7.4	7.7	8.0	8.8
Fugitive Em. from Fuels	9.8	9.1	10.0	8.6	7.8	8.2	7.5	8.3	5.0
Industrial Processes	24.0	9.3	7.8	8.7	8.3	6.3	5.9	5.3	5.4
Solvent and Other Product Use	28.1	25.5	25.3	55.2	64.6	72.1	68.8	40.0	40.8
LULUCF	1.3	0.2	5.2	0.1	0.2	0.5	0.4	0.2	0.1
SO_2 Emission	**173.7**	**81.4**	**61.3**	**63.0**	**59.3**	**67.2**	**57.3**	**59.0**	**41.3**
Energy Industries	99.5	54.0	32.9	32.7	30.2	39.0	32.0	36.7	19.7
Manufacturing Ind. & Construction.	39.8	16.7	11.0	9.4	10.6	9.1	8.5	6.0	12.0
Transport	5.9	3.5	6.0	9.1	8.4	9.2	7.5	6.8	2.3
Other Energy (fuel comb.)	23.9	4.7	6.5	6.8	5.8	4.8	4.3	4.5	4.2
Fugitive Em. from Fuels	1.8	1.2	3.1	3.1	2.5	3.2	2.8	3.3	1.8
Industrial Processes	2.6	1.6	2.1	2.1	1.9	2.1	2.4	1.8	1.3

3 ENERGY (CRF sector 1)

3.1. OVERVIEW

3.1.1.OVERVIEW OF THE ENERGY SITUATION

Primary sources of energy that are produced in Croatia are coal (production stopped in 2000), fuel wood, crude oil, natural gas, renewables and hydro power. Primary energy production for the 1990, 1995, 2000 and period from 2005 to 2010 is presented in the Table 3.1-1.

Table 3.1-1: Primary energy production

PJ	1990	1995	2000	2005	2006	2007	2008	2009	2010
Coal and coke	4.21	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel wood	22.68	13.52	15.64	14.77	17.18	15.11	16.58	17.97	19.96
Crude oil	104.54	62.81	51.35	40.11	38.90	37.27	35.42	33.07	30.69
Natural gas	74.27	69.12	59.4	79.76	94.27	100.12	94.05	93.50	93.88
Hydro power	38.55	51.75	56.93	62.40	58.18	42.21	50.19	65.77	79.71
Heat	-	-	-	0.61	0.64	1.01	1.25	1.48	1.71
Renewables	0.00	0.00	0.00	0.20	0.24	0.71	1.03	1.34	2.63
Total	**244.25**	**199.16**	**183.32**	**197.24**	**208.77**	**195.42**	**197.28**	**211.64**	**228.57**

Figure 3.1-1 presents the trends in the primary energy production from 1990 to 2010.

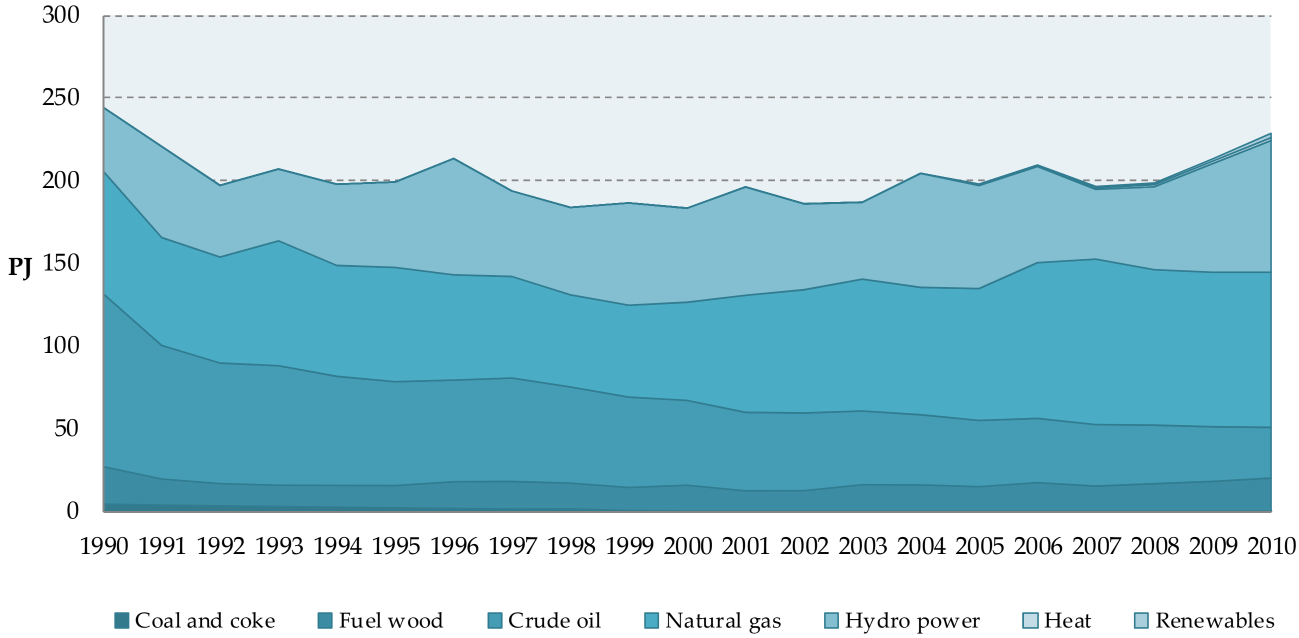

Figure 3.1-1: Trends in primary energy production for the period from 1990 to 2010

In 1990 primary energy production was about 244 PJ, which is 6,4% higher comparing to 2010. In 2010, the total primary energy production increased by 7.3% with relation to the 2009. Comparing to 2009, the energy production from renewable sources increased 2 times in 2010. The production of natural gas increased 0.4% as well as production of fuel wood by 11.1%, while production of crude oil decreased (7.2%). Hydro power utilization increased by 21.2%.

While in 1990 the share of crude oil in primary energy production was the highest one with 42.8%, in 2010 its' share was only 13.4%. In 2010, the share of natural gas (41.1%) was the highest one. It was followed by hydro power with the share of 34.9%. The comparison of shares in primary energy productions for the 1990 and 2010 are presented in Figure 3.1-2.

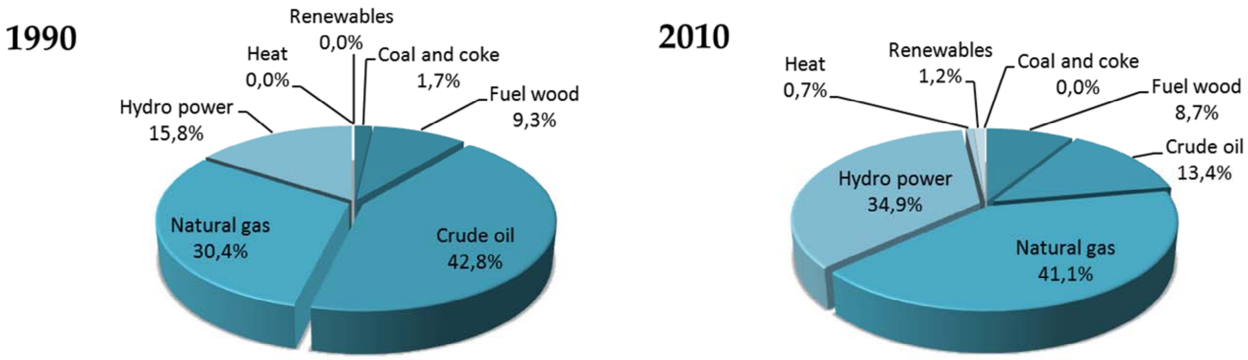

Figure 3.1-2: Shares of individual energy forms in the total production for the 1990 and 2010

<u>Primary energy supply</u>

Total primary energy supply is determined by adding the import and subtracting the export of all primary and transformed energy forms to the total primary energy supply. Primary energy supply for the 1990, 1995, 2000 and period from 2005 to 2009 is presented in the Table 3.1-2.

Table 3.1-2: Primary energy supply

PJ	1990	1995	2000	2005	2006	2007	2008	2009	2010
Coal and coke	34.07	7.42	17.15	32.95	31.61	33.74	34.65	24.66	30.92
Fuel wood	22.68	13.52	15.64	14.77	15.28	13.31	13.38	14.42	16.05
Liquid fuels	192.6	146.03	160.52	181.88	185.15	189.70	180.15	178.04	152.54
Natural gas	98.22	82.77	94.98	101.06	99.86	114.22	110.22	102.15	111.37
Hydro power	38.55	51.75	56.93	62.40	58.18	42.21	50.19	65.77	79.71
Electricity	25.42	12.59	14.4	18.41	20.24	22.90	23.68	20.46	17.15
Heat				0.61	0.64	1.01	1.25	1.48	1.71
Renewables	0.00	0.00	0.00	0.20	0.24	0.69	0.97	1.43	2.24
Total	**411.54**	**314.08**	**359.62**	**411.67**	**410.56**	**416.77**	**413.24**	**406.92**	**411.69**

Figure 3.1-3 presents the trends in the primary energy supply from 1990 to 2010.

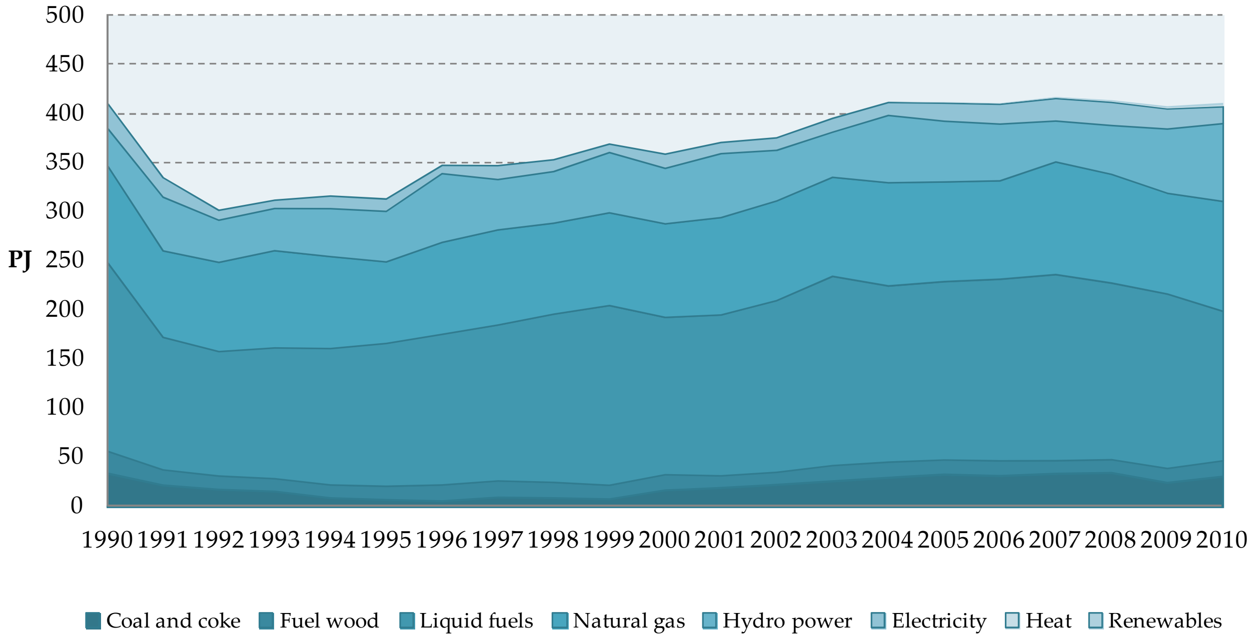

Figure 3.1-3: Trends in primary energy supply for the period from 1990 to 2010

In 1990 primary energy supply was about 412 PJ, which is 0,04% lower comparing to 2010. In 2010, the total primary energy supply increased by 1.2% with relation to the previous year. There was an increase in fuel wood, renewable energy sources, coal and coke, natural gas, while consumption of liquid fuels and electricity decreased. Due to good hydrology conditions, hydro power energy supply increased by 56.9% with relation to the 2009. Figure 3.1-4 presents comparison of the shares of individual energy forms in the total primary energy supply for the 1990 and 2010.

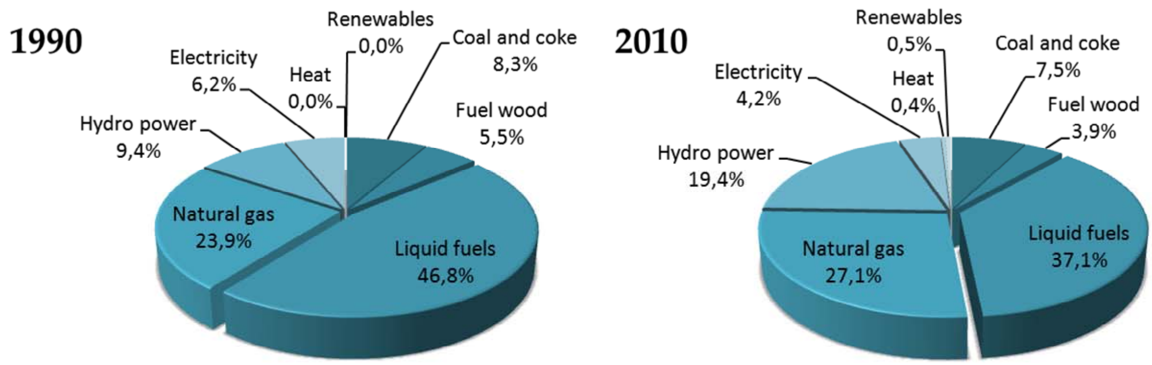

Figure 3.1-4: Comparison of the shares of individual energy forms for the 1990 and 2010

Liquid fuels had the largest share in total primary energy supply in 1990 as well as in 2010 (approximately 45%). It was followed by the natural gas with the share of approximately 25%. The Figure 3.1-5 presents difference between total primary energy production (P) given in Table 3.1-1 and total primary energy supply (S) given in Table 3.1-2.

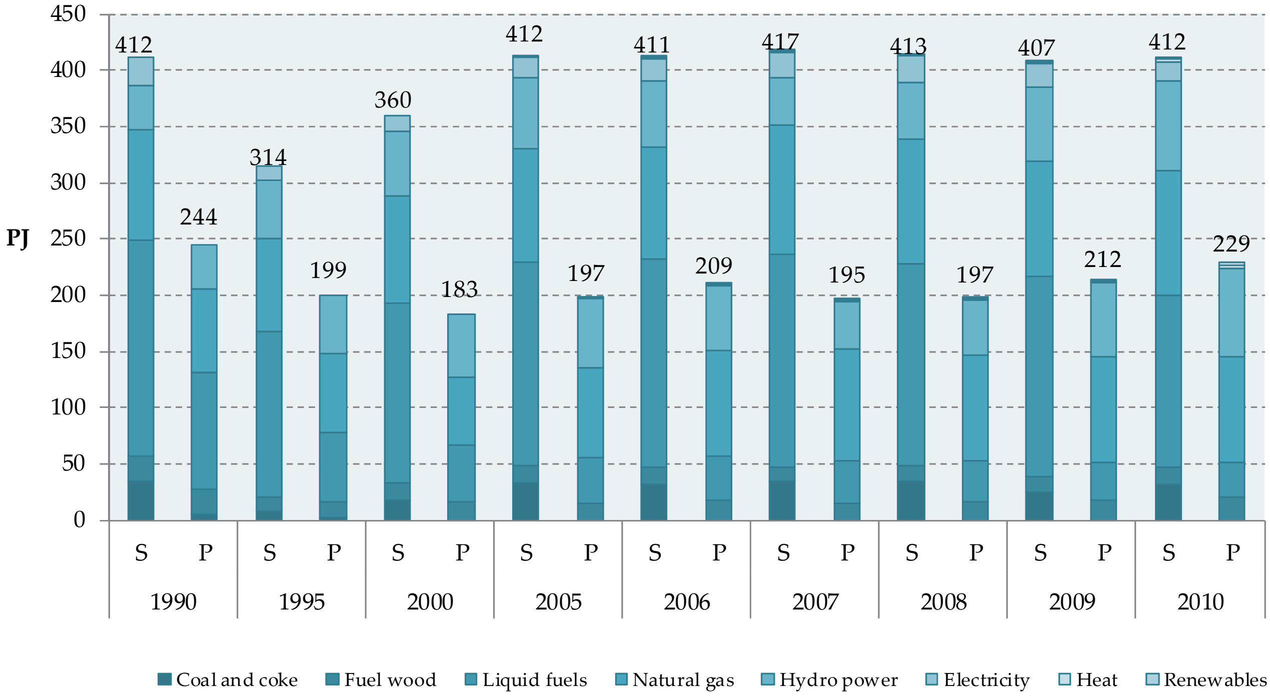

Figure 3.1-5: Total primary energy supply (S) and production (P)

The difference between the supply and the production presents the balance of energy export and import to Croatia. The relation between the produced and consumed energy constitutes own supply which in 2010 amounted 55.5%. Total hydro power and fuel wood supply were fully covered from the territory of Croatia. Own natural gas supply in 2009 amounted 84.3% while own oil supply amounted 20.1%. The production of solid fuels stopped in 2000, thus all needs for coke and coal were satisfied from export.

The basis for estimating the GHG emissions from Energy sector is the national energy balance. Data on production, imports, exports, stock change and consumption of fuels are reported both in natural units (kg or m^3) and energy units (PJ). National energy balance for 2010 is presented in Annex 3.

For easier comparison of data from energy balance the natural units are transformed to energy units using appropriate national net calorific values (Table 3.1-3).

Table 3.1-3: National net calorific values, CO_2 emission factors and oxidation factors for 1990 and 2010

Fuel	Net Caloric Value			Carbon emission factor[3] (t C/TJ)	CO_2 emission factor (t CO_2/TJ) (without OF)	Oxidation factor (OF)
	Unit	1990	2010			
SOLID FUELS						
Anthracite	TJ/Gg	29.29	29.31	26.8	98.27	0.98
Other Bituminous Coal	TJ/Gg	25.14	24,77	25.8	94.60	0.98
Sub-Bituminous Coal	TJ/Gg	16.74	17.6	26.2	96.07	0.98
Lignite	TJ/Gg	10.90	11.6	27.6	101.20	0.98
Brown Coal Briquettes	TJ/Gg	16.74	-	26.6	97.53	0.98
Coke oven Coke	TJ/Gg	29.31	29.31	29.5	108.17	0.98
LIQUID FUELS						
Motor gasoline	TJ/Gg	44.60	44.60	18.9	69.30	0.99
Aviation gasoline	TJ/Gg	44.60	44.60	18.9	69.30	0.99
Jet Kerosene	TJ/Gg	44.00	44.00	19.5	71.50	0.99
Gas/Diesel oil	TJ/Gg	42.71	42.71	20.2	74.07	0.99
Residual Fuel Oil	TJ/Gg	40.19	40.19	21.1	77.37	0.99
Liquefied Petroleum Gases	TJ/Gg	46.89	46.89	17.2	63.07	0.99
Petroleum Coke	TJ/Gg	29.31	31.0	27.5	100.83	0.99
Petroleum	TJ/Gg	44.00	44.00	19.6	71.87	0.99
Lubricants	TJ/Gg	33.57	33.50	20.0	73.33	0.99
GASEOUS FUELS						
Natural Gas	TJ/10^6m^3	34.00	34.0	15.3	56.10	0.995
Gas Works Gas	TJ/10^6m^3	15.82	17.2	13.0	47.67	0.995
Coke Oven Gas	TJ/10^6m^3	17.90	-	13.0	47.67	0.995
BIOMASS FUELS						
Wood biomass	TJ/Gg	-	9.0	29.9	109.63	0.98
Industrial waste	TJ/Gg	-	-	29.9	109.63	0.98

The structure of energy consumption of fossil fuels from 1990 to 2010 is shown in Figure 3.1-6.

[3] IPCC default (from "*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook*")

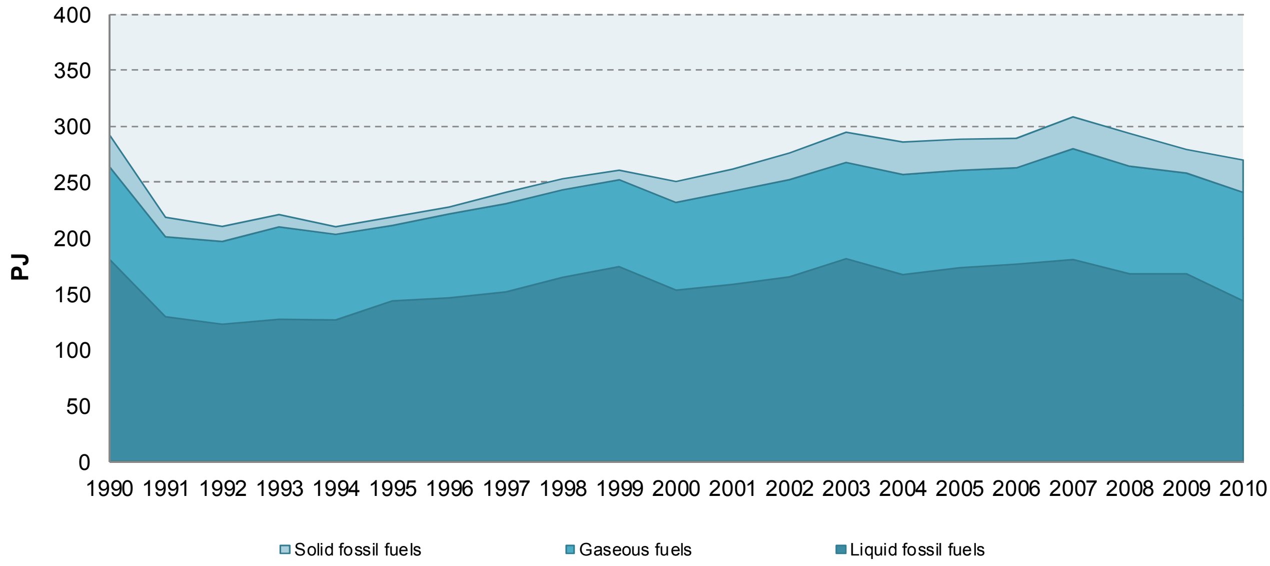

Figure 3.1-6: Structure of energy consumption

Liquid fossil fuels are mainly used with share between 60 to 70 percent, and natural gas with approximately 30 percent, while share of solid fossil fuels is between 3 to 11 percent. Fuel woods and biomass-based fuels are neutral regarding CO_2 emission, therefore are not shown in the Figure 3.1-6.

3.1.2.OVERVIEW OF EMISSIONS

Energy sector covers all activities that involve fuel combustion from stationary and mobile sources, and fugitive emission from fuels.

The Energy sector is the main cause for anthropogenic emission of greenhouse gases. It accounts approximately 75 percent of the total emission of all greenhouse gases presented as equivalent emission of CO_2. Looking at its contribution to total emission of carbon dioxide (CO_2), the energy sector accounts for about 90 percent. The contribution of energy in methane (CH_4) emission is substantially smaller (46 percent) while the contribution of nitrous oxide (N_2O) is quite small (about 3 percent).

During complete combustion, the carbon contained in fuel oxidizes and transforms into CO_2, while through the incomplete combustion the small amounts of CH_4, CO and NMVOC emissions also appear. The CO_2 is the most important greenhouse gas from fuel combustion. The emission of CO_2 depends on the quantity and type of the fuel used. The specific emission is the highest during combustion of coal, then oil and natural gas. A rough ratio of specific emission during combustion of the stated fossil fuels is 1 : 0.75 : 0.55 (coal : oil : gas).

There are some other gases generated from fuel combustion such as methane (CH_4) and nitrous oxide (N_2O), and indirect greenhouse gases such as nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC). The indirect greenhouse gases participate in the process of creation and destruction of ozone, which is one of the GHGs. In the framework of the IPCC methodology, the calculation of sulphur dioxide (SO_2) emission is also recommended. The sulphur dioxide as a precursor of sulphate and aerosols has a negative impact on the greenhouse effect because the creation of aerosols removes heat from the atmosphere.

The fuel fugitive emission which is generated during production, transport, processing, storing and distribution of fossil fuels, is also estimated. These activities produce mainly the emission of CH_4, and smaller quantities of NMVOC, CO and NO_x.

Emissions from fossil fuel combustion comprise the majority (more then 90 percent) of energy-related emissions. Contribution of individual subsectors to emission of greenhouse gases, for the last estimated year (2010), is presented in the Table 3.1-4 while contribution of individual subsectors to GHG emission for the period 1990-2010 is presented in Figure 3.1-7.

Table 3.1-4: Contribution of individual subsectors to emission of greenhouse gases, for 2010

GHG categories	Gg			Total	
	CO_2	CH_4	N_2O	CO_2-eq (Gg)	%
ENERGY	19,124.32	78.39	0.35	20,879.01	100.00
A. Fuel combustion activities	18,637.06	5.71	0.35	18,865.47	90.36
1. Energy industries	5,883.79	0.21	0.05	5,903.70	28.28
a) Electricity and heat production	3,955.65	0.15	0.04	3,971.20	19.02
b) Petroleum refining	1,474.74	0.06	0.01	1,479.10	7.08
c) Manufacture of solid fuels	453.40	0.01	0.00	453.61	2.17
2. Manufacturing ind. and constr.	3,314.66	0.32	0.03	3,330.68	15.95
3. Transport	5,958.90	0.69	0.20	6,035.39	28.91
a) Civil aviation	81.10	0.00	0.00	81.10	0.39
b) Road transport	5,673.40	0.68	0.19	5,746.58	27.52
c) Railways	89.25	0.01	0.00	89.46	0.43
d) Navigation (domestic)	115.14	0.01	0.00	115.35	0.55
4. Other sectors	3,479.71	4.49	0.07	3,595.70	17.22
5. Other	NO	NO	NO	-	-
B. Fugitive emissions from fuels	487.26	72.68	NO	2,013.54	9.64
1. Solid fuels	NO	NO	NO	-	-
2. Oil and natural gas	487.26	72.68	NO	2,013.54	9.64

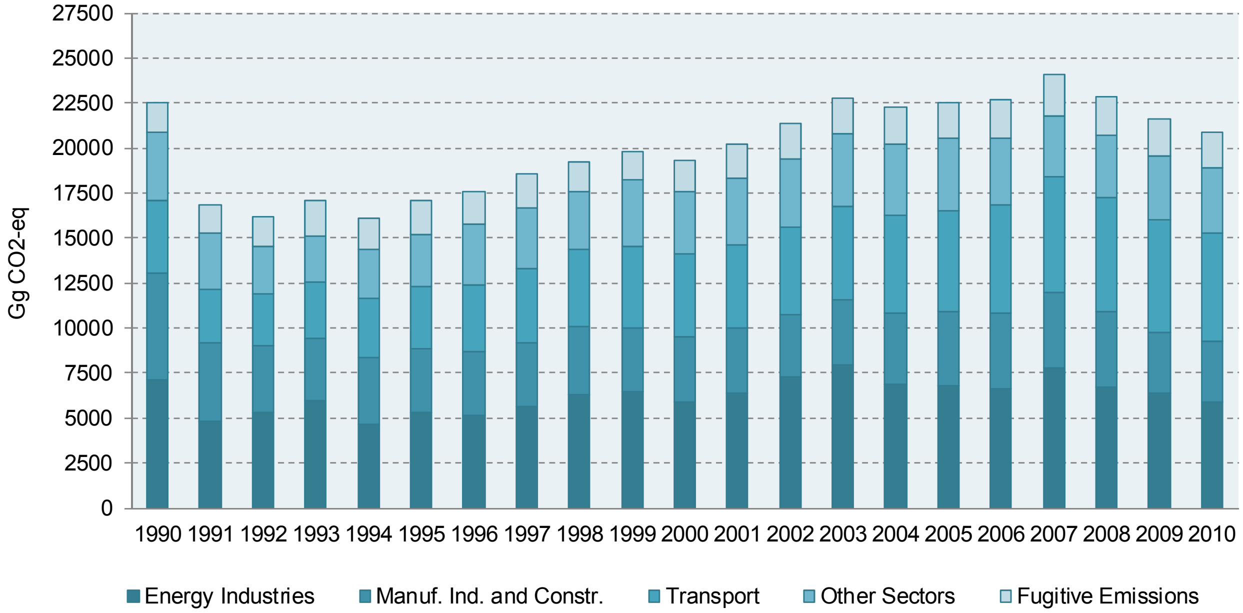

Figure 3.1-7: CO_2-eq emissions from Energy sector by subsectors in 1990-2010

The largest part (29 to 29 percent) of the emissions are a consequence of fuel combustion in Transport, then the combustion in Energy industries with increasing trend (28 percent in 2010) and the combustion in Manufacturing Industries and Construction with decreasing trend (25 percent in 1990; 16 percent in 2010). Small stationary energy sources, such as Commercial/Institutional, Residential and Agriculture/Forestry/Fishing, contribute to total emission from Energy sector with 16 to 20 percent, while Fugitive Emissions from Fuels contribute with about 10 percent. The majority of energy-related GHG emissions belong to CO_2 (91 to 93 percent), then follows CH_4 (6 to 9 percent) and N_2O (less than 1 percent).

Greenhouse gases are also generated during combustion of biomass and biomass-based fuels. The CO_2 emission from biomass, in line with IPCC guidelines, is not included into the national emission totals because emitted CO_2 had been previously absorbed from the atmosphere for growth and development of biomass. Removal or emission of CO_2 due to the changes in the forest biomass is estimated in the Land Use, Land-use Change and Forestry sector.

The emission from fuel combustion in international air and waterborne transport is reported separately and it has not been included in the national emission totals.

In Energy sector, ten source categories represent key source category regardless of LULUCF (detailed in Table 3.1-5).

Table 3.1-5: Key categories in Energy sector based on the level and trend assessment in 2010[4]

IPCC Source Categories	Direct GHG	Criteria for Identification			
		Level		Trend	
		excl. LULUCF	incl. LULUCF	excl. LULUCF	incl. LULUCF
ENERGY SECTOR					
CO_2 Emissions from Stationary Combustion - Coal	CO_2	L1e	L1i	T1e	T1i
CO_2 Emissions from Stationary Combustion - Oil	CO_2	L1e,L2e	L1i,L2i	T1e,T2e	T1i,T2i
CO_2 Emissions from Stationary Combustion - Gas	CO_2	L1e,L2e	L1i,L2i	T1e	T1i
Mobile Combustion - Road Vehicles	CO_2	L1e, L2e	L1i,L2i	T1e,T2e	T1i,T2i
Mobile Combustion - Road Vehicles	N_2O			T2e	T2i
Mobile Combustion: Aircraft	CO_2			T1e	
Combustion: Agriculture/Forestry/Fishing	CO_2	L1e	L1i		T1i
Fugitive Emissions from Coal Mining and Handling	CH_4			T2e	T2i
Fugitive Emissions from Oil and Gas Operations	CH_4	L1e,L2e	L1i,L2i	T1e,T2e	T1i,T2i
CO_2 Emissions from Natural Gas Scrubbing	CO_2	L1e	L1i	T1e	T1i

L1e - Level excluding LULUCF Tier 1
L1i - Level including LULUCF Tier 1
T1e - Trend excluding LULUCF Tier 1
T1i - Trend including LULUCF Tier 1
L2e - Level excluding LULUCF Tier 2
L2i - Level including LULUCF Tier 2
T2e - Trend excluding LULUCF Tier 2
T2i - Trend including LULUCF Tier 2

[4] Data on key categories are taken from Annex 1 Key categories (Tier 1 and Tier 2)

3.2. FUEL COMBUSTION ACTIVITIES (CRF 1.A.)

3.2.1.COMPARISON OF THE SECTORAL WITH THE REFERENCE APPROACH

The methodology used for estimating CO_2 emissions follows the *Revised 1996 IPCC Guidelines*. The emission of CO_2 is calculated using two different approaches: Reference approach and Sectoral approach. Sectoral emission estimates are based on fuel consumption data given in National Energy Balance, where energy demand and supply is given at sufficiently detailed level, what allows emissions estimation by sectors and subsectors. In Reference approach the input data are production, import, export, international bunkers and stock change for primary and secondary fuel. Comparison between these approaches was made and presented in Annex 3. The total differences in fuel consumption and CO_2 emissions for chosen years are given in Table 3.2-1.

Table 3.2-1: The fuel consumption and CO_2 emissions from fuel combustion (Reference & Sectoral approach)

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Fuel cons. (PJ)									
Reference appr.	302.45	216.57	250.46	292.28	290.60	311.37	298.61	280,60	143.19
Sectoral appr.	292.76	218.44	250.16	288.63	288.76	307.97	293.33	277.67	143.46
Relative Dif. (%)	**3.31**	**-0.85**	**0.12**	**1.26**	**0.64**	**1.10**	**1.80**	**1.06**	**1.03**
CO_2 Emission (Gg)									
Reference appr.	21,023.5	15,062.2	17,773.0	20,980.9	20,820.0	22,208.6	21,167.8	19,834.6	10,576.1
Sectoral appr.	20,560.1	15,004.0	17,305.6	20,297.6	20,309.5	21,540.6	20,494.8	19,256.7	10,523.2
Relative Dif (%)	**2.25**	**0.39**	**2.70**	**3.37**	**2.51**	**3.10**	**3.28**	**3.00**	**2.54**

The CO_2 emission calculated by Reference approach is higher in comparison to Sectoral approach. The reason is that CO_2 emission from feedstock and non-energy fuel consumption is calculated under Reference approach while it is not accounted for under Sectoral approach.

In the whole period from 1990 to 2010 the total differences in fuel consumption and CO_2 emissions were increased because of recalculations as follows:

- Reference Approach – Gas works gas
  - Gas works gas as a secondary fuel is excluded from the production column of the Reference Approach.
- Manufacturing Industries and Construction, Petrochemical Production (1.A.2.f)
  - CO_2 emissions from natural gas which used as fuel in ammonia production. – Recalculation is carried out adding only natural gas which used as fuel in Petrochemical Production (1.A.2.f).
- Feedstock and non-energy use (1.A.d) – Natural gas
  - CO_2 emission from natural gas which used as a feedstock in ammonia production. – Recalculation is carried out adding only natural gas which used as feedstock in 1.A.d.

These recalculations were performed as recommended by ERT (2010).

3.2.2.INTERNATIONAL BUNKER FUELS

The CO_2 emissions from the consumption of fossil fuels for aviation and marine international transport activities, as required by the IPCC methodology, are reported separately and not included in national emission totals. The fuel consumption (PJ) and CO_2-eq emissions for International Aviation and Marine Bunkers and GHG emissions for observed period is shown in the Table 3.2-2.

Total CO_2-eq from the international bunker in 2010 amounted to 266.14 Gg which is 5.2% higher than in 2009 as a result of higher fuel consumption especially in the Aviation bunkers (6.6%).

In comparison with 1990, the emission of CO_2-eq in 2010 was for a 41.6% lower as a result of reduced fuel consumption especially in the Marine bunkers (-82.1%), but also in Aviation bunkers (-10.1%).

International marine bunkers are included in national energy balance for the period from 1994 to 2010, as separate data. Until the year 1994, international marine bunkers are based on expert estimation. According to suggestion of review team the disaggregation of fuel between international and domestic aviation was calculated using drivers such as ratio of domestic/international passengers, taking into account average km traveled for passengers on domestic/international routes.

Table 3.2-2: Fuel consumption and CO_2-eq emissions for sector International aviation and marine bunkers, from 1990 to 2010

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Fuel combustion (PJ)									
Aviation bunkers	4.85	2.64	2.39	3.19	3.25	3.35	3.75	3.21	3.42
Marine bunkers	1.44	1.36	0.76	1.05	0.81	1.00	0.87	0.28	0.25
Total bunkers	**6.29**	**4.00**	**3.15**	**4.24**	**4.05**	**4.35**	**4.62**	**3.49**	**3.68**
CO_2-eq emission (Gg)									
Aviation bunkers	346.35	188.42	170.91	228.16	231.87	240.51	270.37	231.31	246.63
Marine bunkers	108.96	102.40	57.24	79.29	61.22	75.94	67.05	21.71	19.50
Total bunkers	**455.31**	**290.82**	**228.15**	**307.45**	**293.09**	**316.45**	**337.42**	**253.02**	**266.14**

3.2.3.FEEDSTOCK AND NON-ENERGY USE OF FUELS

Non-energy fuel consumptions (fuels used as feedstock) and appropriate emissions, where one part or even the whole carbon is stored in product for a longer time and the other part oxidizes and goes to atmosphere, are described here. The feedstock use of energy carriers occurs in chemical industry (natural gas consumption for ammonia production, production of naphtha, ethane, paraffin, and wax), construction industry (bitumen production), and other products such as motor oil, industrial oil, grease etc. As a result of non-energy use of bitumen in construction industry there is no CO_2 emission because all carbon is bound to the product.

3.2.4. CO_2 CAPTURE FROM FLUE GASES AND SUBSEQUENT CO_2 STORAGE

There are no plants in operation for recovery and storage of CO_2 in Croatia, although there are plans for storage of CO_2 in two oil fields in central part of Croatia as part of EOR project conducted by INA - Oil Company. Natural gas produced in Croatian gas fields contains a large amount of CO_2, more than 15 percent, and before coming to commercial pipeline has to be cleaned (scrubbed), but CO_2 is emitted without capture and storage. The CO_2 emission from gas scrubbing in Central Gas Station Molve, estimated by material balance method, is described in the Chapter 3.3.1.2.

3.2.5. SOURCE CATEGORY DESCRIPTION

3.2.5.1. Energy industries (CRF 1.A.1.)

This subsector comprises emission from fuel combustion in public electricity and heat production plants, petroleum refining plants, solid transformation plants, oil and gas extraction and coal mining. The total GHG emission from Energy Industries is given in the Table 3.2-3 and Figure 3.2-1. The GHG emissions from thermal power plants and public cogeneration plants in the period from 1990-2010, were calculated using more detailed Tier 2 approach while emissions from Petroleum Refining and Other Energy Industries were calculated using Tier 1 approach.

Table 3.2-3: The CO_2-eq emissions (Gg) from Energy Industries

CO_2-eq emission (Gg)	1990	1995	2000	2005	2006	2007	2008	2009	2010
Public El. and Heat Prod.	3693.5	2988.1	3809.2	4640.4	4670.2	5531.1	5039.0	4307.6	3971.3
Petroleum Refining	2574.8	1892.1	1792.4	1810.5	1670.7	1867.9	1441.7	1706.0	1479.6
Other Energy Industries	875.5	394.7	293.4	350.7	308.8	361.7	245.6	378.6	453.8
Total Energy Industries	7143.8	5275.0	5895.0	6801.6	6649.7	7760.7	6726.3	6392.2	5904.7

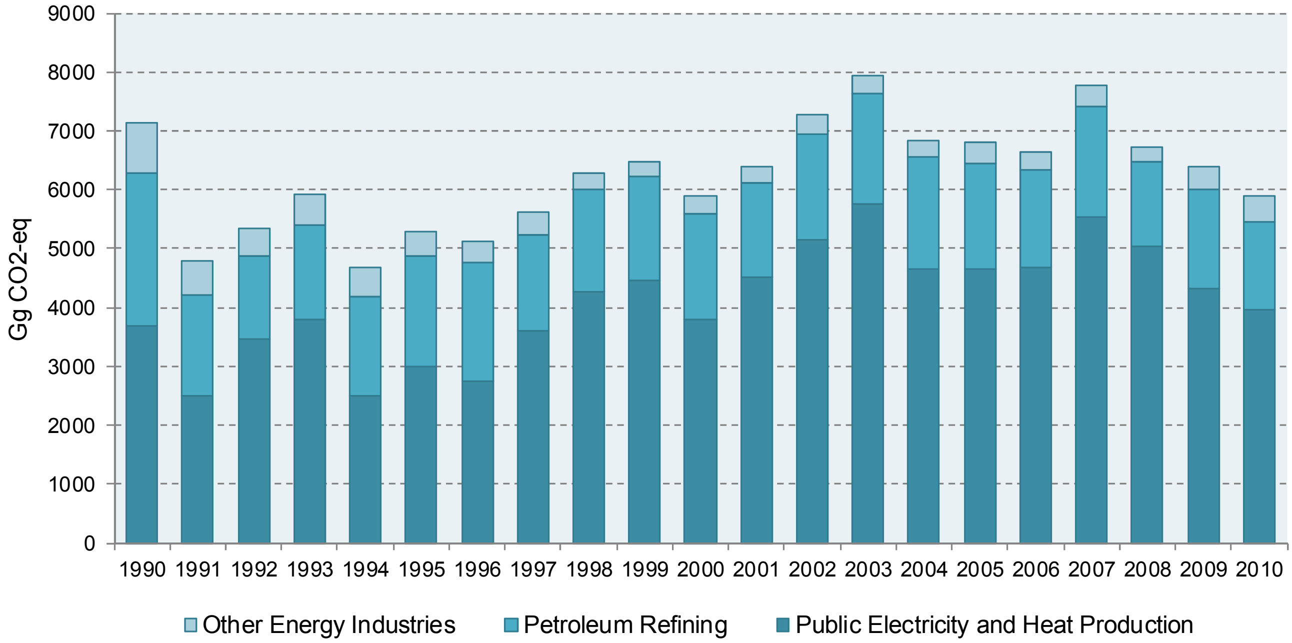

Figure 3.2-1: CO_2-eq emissions from Energy Industries

It should be stressed out that approximately 53 percent of the electricity is generated in hydro power plants; therefore the emission from Energy Industries sector is relatively small, 29-36 percent of emission from total Energy sector. The largest part (52-75 percent) of the emission is a consequence of fuel combustion in thermal power plants, then the combustion in oil refineries 21-40 percent. The remaining combustion in oil and gas fields, coal mines and the coke plant accounts for some 4-12 percent.

Public Electricity and Heat Production (CRF 1.A.1.a)

The installed electricity generating capacities in the Republic of Croatia include power plants owned by the HEP Group (Croatian Power Company), a certain number of industrial power plants and a few privately owned power plants (wind power plants, small hydro power plants).

Total capacities serving the needs of the Croatian electric power system amount to 3,817.56 MW (including TPP Plomin and excluding NPP Krško). Total capacities serving the needs of the Croatian electric power system amount to 4,117 MW (with 50% of Krško capacities). Out of this amount, 1,681 MW is placed in thermal power plant, 2,136.56 MW in hydro power plant and 348 MW in the nuclear unit Krško (50% of total available capacity). These capacities do not include generating units in other countries from which the Croatian electric power system has the right to withdrow electricity on the basis of capacity lease and share-ownership arrangements. Generating capacities of HPPs, TPPs and NPP Krško are presented in the Table 3.2-4.

Table 3.2-4: Generating capacities of HPPs, TPPs and NPP Krško

	Available Power (MW) Net Output	Fuel
HPPs	2,088	-
NPP Krško*	348	uranium oxide (UO_2)
TPP Plomin 1	110	coal
TPP Plomin 2**	192	coal
TPP Rijeka	303	fuel oil
TPP Sisak	396	fuel oil / natural gas
CHP Zagreb (east)	422	fuel oil / natural gas / extra light oil
CHP Zagreb (west)	90	fuel oil / natural gas / extra light oil
CPP Osijek	90	fuel oil / natural gas / extra light oil
CCGT Jertovec	78	natural gas / extra light oil
Total (HPPs+NPP+TPPs)	**4,117**	

* 50% of NPP Krško is owned by HEP
** TPP Plomin 2 Ltd. (HEP and RWE Power Co-ownership – share 50% : 50%)

During the observed period between 1990 and 2010 in Croatia only 14 to 32 percent of Croatian electricity demands were covered by thermal power plants. The largest contribution to electricity production in Croatia had hydro power plants 36 to 69 percent. Nuclear power plant Krško delivered 50 percent of its electricity to Croatian power system until 1998 after which was a four year period of non-delivery. The delivery of electricity from NPP Krško started again in 2003. The past few years the electricity demand was compensated with import. Therefore, in 2000 the electricity import was larger than production in all Croatian thermal power plants (TPPs). In 2010, the import of electricity was about 35 percent of total electricity consumption in Croatia. Electricity supply for the period from 1990 to 2010 is presented in Figure 3.2-2.

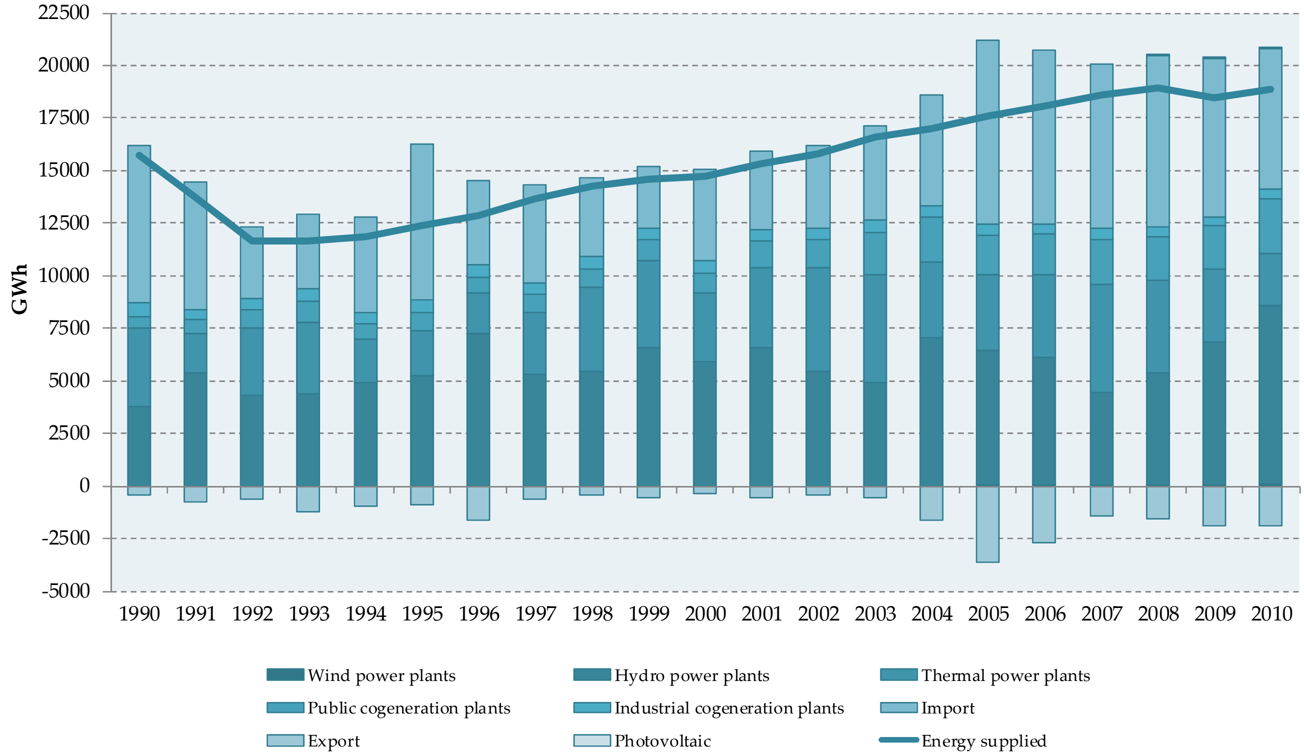

Figure 3.2-2: Electricity supply for the period from 1990 to 2010

In this subsector there are few types of plants:

- Thermal Power Plants (TPPs), which produce only electricity
- Public Cogeneration Plants (PCPs), which produce combined heat and electricity
- Public Heating Plants (PHPs), which produce only heat

TPP Plomin 2, which started to operate in 2002, has installation for flue gasses cleaning. By-product from process which cleans flue gasses from sulphur (SO_2 scrubbing process) is CO_2. CO_2 emission is calculated from amount of $CaCO_3$ used for cleaning. Amounts of produced $CaCO_3$ as well as emitted CO_2 emission are presented in Industry sector (Limestone and dolomite use).

The CO_2-eq emission from public electricity and heat production are presented in Figure 3.2-3 for the whole period from 1990 to 2010.

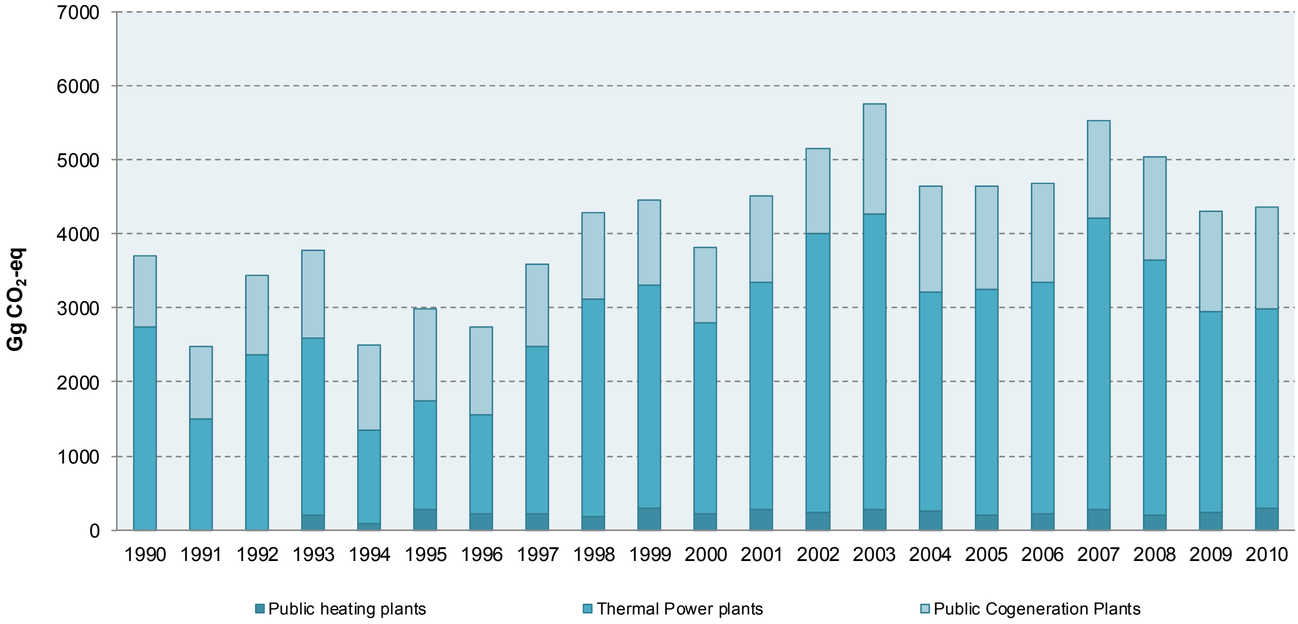

Figure 3.2-3: CO_2-eq emissions from Public Electricity and Heat Production subsector's

Production of electricity has increasing trend trough the years, from 8 TWh (1990) to 14 TWh (2010) but CO_2 emission does not follow this trend. Approximately 53 percent of electricity is generated in hydro power plants (HPP), but this percent depends on hydrological conditions during the year. If hydrological conditions are unfavourable the lack of electricity must be supplemented by stronger engagement of thermal power plants, which consequently leads to large GHG emissions. Domestic production of electricity by sources for the period from 1990 to 2010 is presented in Figure 3.2-4. In 2010, the total electricity production was 9.8 percent higher than in the former year. Decrease in energy consumption from Thermal power plants and public cogeneration plants is mostly due to favourable hydrological conditions which leaded to increase in electricity production from hydro power by 19.2 percent (Table 3.2-5).

Table 3.2-5: Differences between electricity production in 2009 and 2010

ENERGY BALANCE	Electricity, GWh		Difference 2010-2009	Difference %
	2009	2010		
Production	12,777.1	14,104.9	1327.8	9.4
Hydro power plants	6,814.4	8,435.2	1620.8	19.2
Wind power plants	54.2	139.1	84.9	61.0
Photovoltaic	0.1	0.0	-0.1	-150.0
Thermal power plants	3,422.2	2,494.8	-927.4	-37.2
Public cogeneration plants	2,085.3	2,589.0	503.7	19.5
Industrial cogeneration plants	400.9	446.8	45.9	10.3
Import	7,580.7	6,682.4	-898.3	-13.4
Export	-1,898.6	-1,917.4	-18.8	1.0
TOTAL CONSUMPTION	18,459.2	18,869.9	410.7	2.2

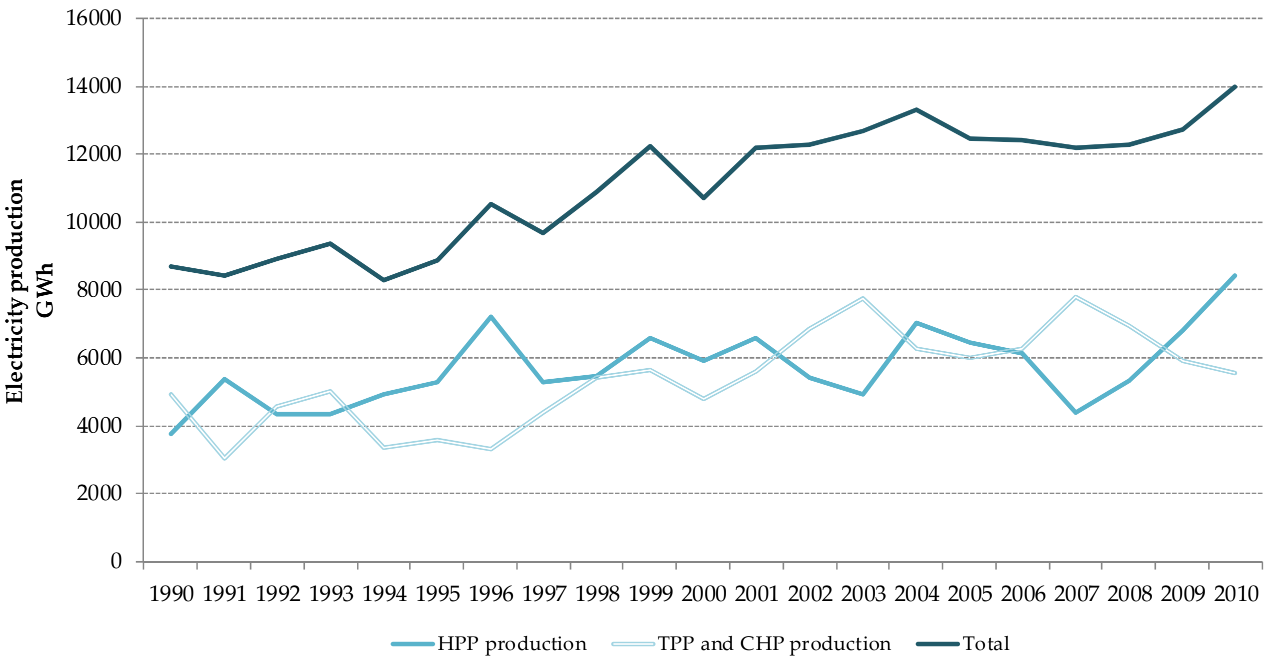

Figure 3.2-4: Domestic production of electricity by sources for the period from 1990 to 2010

Electricity and heat production, fuel consumption and GHG emissions for the years 1990, 1995 and 2000-2010 are presented in Tables A2-1 to A2-2 of the Annex 2.

Petroleum Refining (CRF 1.A.1.b)

Croatia has two oil refineries in Rijeka and Sisak, while lubricants are produced in Rijeka and Zagreb. Crude oil is produced from 34 oil fields and gas condensation products from 8 gas-condensations fields, which covers about 35 percent of the total domestic demand. Processing capacities of the Croatian refineries, which belong to INA – oil and gas company, are shown in the Table 3.2-6.

Table 3.2-6: Processing Capacities of Oil & Lube Refineries

PROCESSING CAPACITIES	INSTALLED (1000 t/year)
Oil Refinery Rijeka (Urinj)	
atmospheric distillation	5000
reforming	730
fluidized-bed catalytic cracking (FCC)	1000
visbreaking	600
isomerisation	250
hydrodesulphurisation (HDS)	1040
mild hidrocracking (MHC)	560
Lube Refinery Rijeka (Mlaka)	
vacuum distillation	630
deasphalting	110
furfural extraction	220
deparaffination	140
ferofining	200
deoiling	30
bitumen	250
Oil Refinery Sisak	
atmospheric distillation	4000
reforming	720
fluidized-bed catalytic cracking (FCC)	500
coking	240
vacuum distillation	800
bitumen	350
Lube Refinery Zagreb	
atmospheric distillation	-
lubricants	60

In the refineries, there are two types of fuel combustion – for heating and/or cogeneration and for own use of energy for production processes. Emissions from both types of fuel combustion were calculated in this sector and presented in Figure 3.2-5.

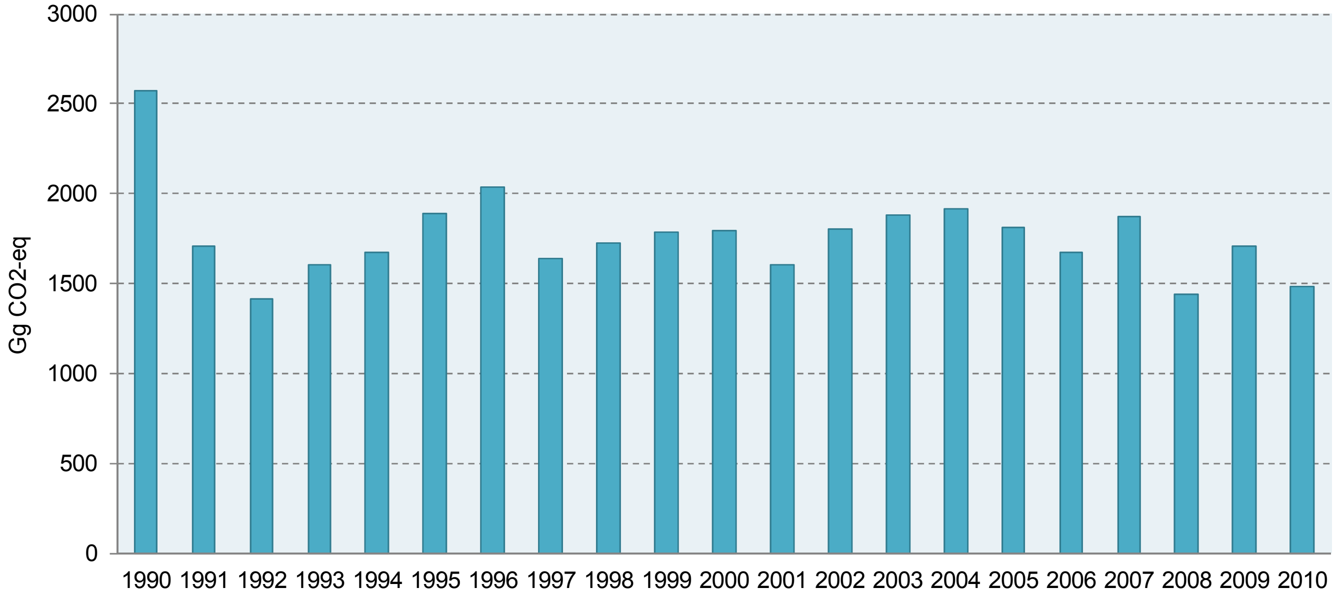

Figure 3.2-5: CO_2-eq emissions from Petroleum Refining subsector for the period from 1990 to 2010

Fuel consumption and GHG emissions from Petroleum Refining are presented in Table A2-5 of the Annex 2.

Manufacturing of Solid Fuels and Other Energy Industries (CRF 1.A.1.c)

In Croatia the coal production in the period 1990-1998 was rather low. Last coal mines in Istria were closed in 1999. Coke-oven plant in Bakar, nearby Rijeka, was also closed in 1994.

Natural gas is produced from 17 on-shore gas fields and 6 off-shore gas fields, which covers about 64.2 percent of total domestic demand in 2009. The largest share of gas is coming from fields Molve and Kalinovac. They include the units for processing and preparation of gas for transportation – Central Gas Stations (CGS) Molve I, II and III. Their capacities are:

- 1 mill. m^3/day for Molve I
- 3 mill. m^3/day for Molve II
- 5 mill. m^3/day for Molve III

The underground gas storage Okoli was designed with the nominal capacity of 558 million m^3. Maximum injection capacity is 3.8 million m^3/day and maximal withdrawal capacity is 5.8 million m^3/day.

CO_2-eq emissions from this subsector for the whole period from 1990 to 2010 are presented in Figure 3.2-6.

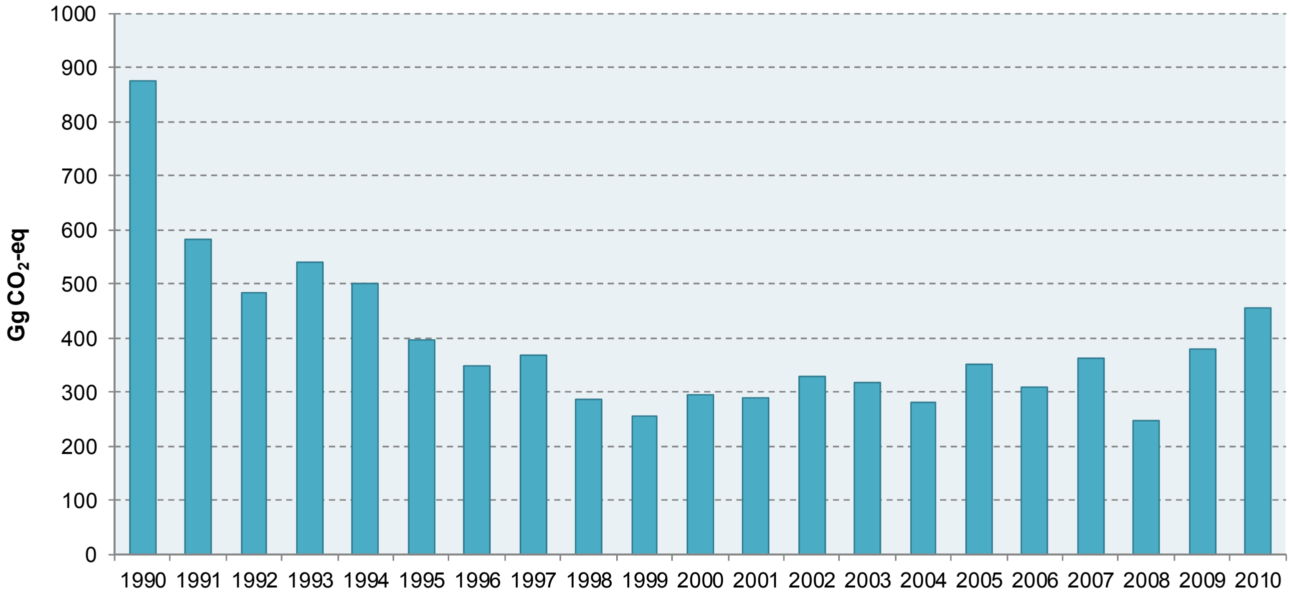

Figure 3.2-6: CO_2-eq emissions from Manufacturing of Solid Fuels and Other Energy Industries for the period from 1990 to 2010

Fuel consumption and GHG emissions from Manufacturing of Solid Fuels and Other Energy Industries are presented in the Table A2-6 of the Annex 2.

3.2.5.2.Manufacturing Industries and Construction (CRF 1.A.2.)

Manufacturing Industries and Construction includes emissions from fuel combustion in different industries, such as iron and steel industries, industries of non-ferrous metals, chemicals, pulp and paper, food processing, beverages and tobacco, construction and building material industries, petrochemical industries. This sector also includes the emissions from fuel used for the generation of electricity and heat in industry (industrial cogeneration plants and industrial heating plants). In national energy balance fuel consumed in industrial heating plants and cogenerations were not divided by appropriate industrial branches, so in addition to national energy balance so called 'Industry analysis balance' was created, but only for the period from 2001 to 2009. The total GHG emission from Manufacturing Industries and Construction is given in the Table 3.2-7 and Figure 3.2-7.

Table 3.2-7: The CO_2-eq emissions (Gg) from Manufacturing Industries and Construction

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Iron and Steel Industry	IE	IE	IE	89	102	104	98	79	93
Non-Ferrous Metals	IE	IE	IE	21	18	21	21	18	14
Chemicals	IE	IE	IE	578	670	625	568	501	448
Pulp, Paper and Print	IE	IE	IE	174	181	171	153	148	161
Food Proc. Bev. & Tob.	IE	IE	IE	589	588	539	639	490	511
Other	IE	IE	IE	2,647	2,640	2,762	2,736	2,158	2,103
Total Manuf. Ind. & Cons.	**5,872**	**3,524**	**3,632**	**4,098**	**4,200**	**4,223**	**4,215**	**3,394**	**3,330**

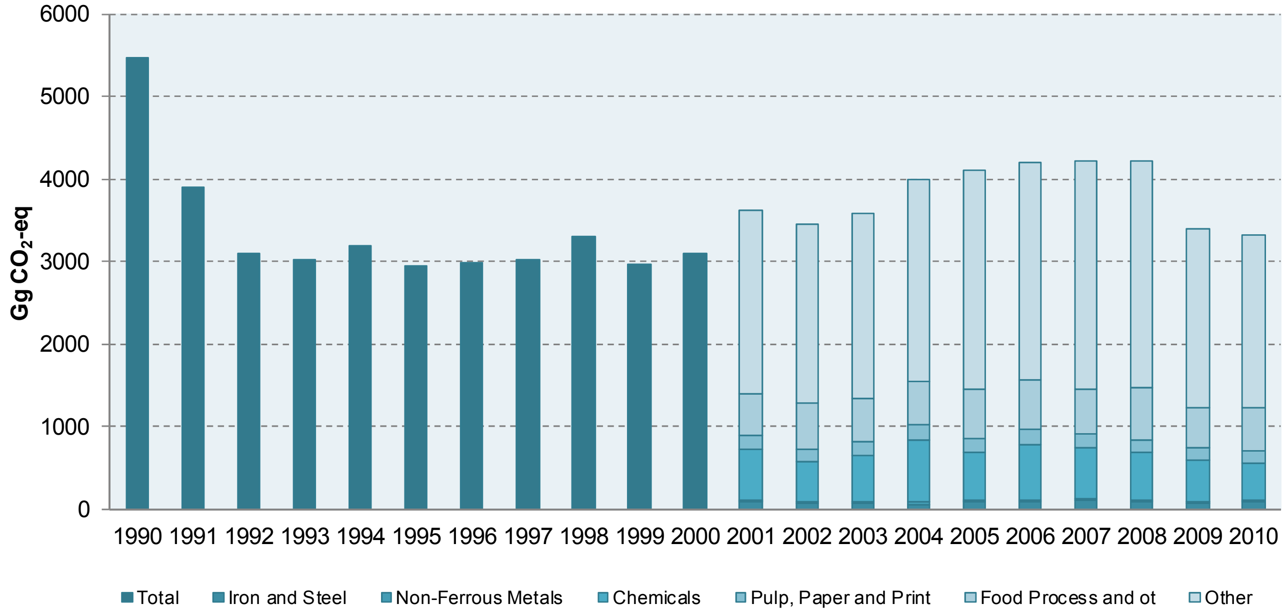

Figure 3.2-7: CO_2-eq emissions from Manufacturing Industries and Construction

The emission from this sector contributes 16-27 percent of the total emission from Energy sector. In national energy balance the fuel combustion in industrial cogeneration and heating plants is not divided on appropriate industrial branches, for which electricity and/or thermal energy is produced. The fuel consumed in industrial cogeneration and heating plants is divided by industrial subsectors for the period 2001-2010 (Industry analysis balance). The largest contributor to emissions is fuel combustion in industry of construction materials and petrochemical production (subsector: Other in Figure 3.2-7), followed by chemical industry, food processing industry, paper industry, iron and steel industry and non-ferrous metal industry.

The GHG emissions from Manufacturing Industries and Construction by fuels are shown in Tables A2-7, A2-8 and A2-9 of the Annex 2.

3.2.5.3. Transport (CRF 1.A.3.)

The emission from combustion and evaporation of fuel for all transport activities is included in this sector. In addition to road transport, this sector includes the emission from air, rail and marine transport as well. The total GHG emission from Transport sector is given in the Table 3.2-8 and Figure 3.2-8.

Table 3.2-8: The CO_2-eq emissions (Gg) from sector Transport

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Civil Aviation	156.1	79.4	55.4	67.2	73.9	76.7	89.0	78.1	81.8
Road Transport	3,634.1	3,151.6	4,327.5	5,373.2	5,674.4	6,097.8	5,948.0	5,954.8	5,748.0
Railways	138.7	106.8	85.8	95.9	101.6	102.5	101.6	89.6	90.0
National Navigation	133.5	98.7	86.1	100.0	104.1	108.2	131.3	145.9	115.6
Total Transport	**4,062.4**	**3,436.4**	**4,554.8**	**5,636.3**	**5,953.9**	**6,385.1**	**6,269.9**	**6,268.4**	**6,035.4**

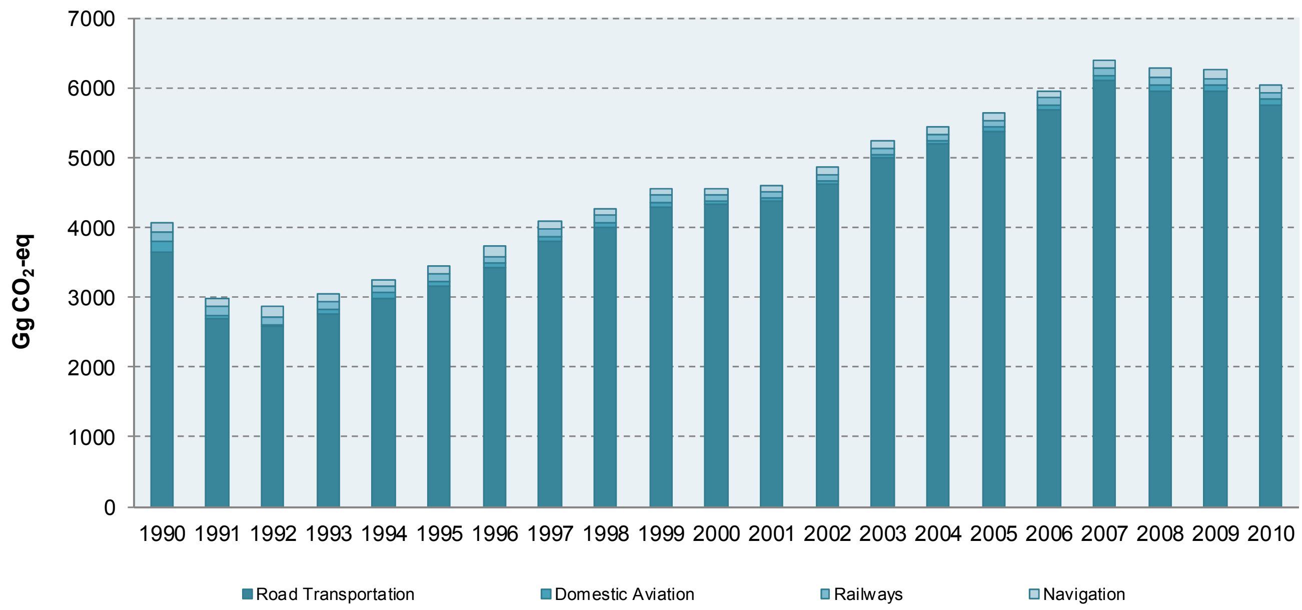

Figure 3.2-8: The CO_2-eq emissions from Transport

The contribution from Transport sector to the total CO_2-eq emissions from Energy sector in 2010 was 29%.

CO_2-eq emissions from the transport sector in 2010 amounted to 6,035.4 Gg, which is 3.9% less than in 2009 as a result of less fuel consumption in road transport. Specifically, the emission of CO_2-eq emissions from sector Road transport (CRF 1AA3B) was dominant one in the transport sector (CRF 1AA3) in 2010 and contributed to the CO_2-eq emissions from the transport sector with 95.2%. In 2010, the sector Civil aviation (domestic) was contributed to the CO_2-eq emissions from the transport sector with 1.4%, Railways with 1.5% and Navigation with 1.9% (Figure 2.3-8).

In comparison with 1990, CO_2-eq emissions from the transport sector were increased by 51.4% as a result of increasing the number of vehicles and also increase of annual millage.

Civil aviation (CRF 1AA3A)

The CO_2-eq emission from the sub-sector domestic civil aviation in 2010 was amounted to 81.8 Gg, which is 4.8% higher than in 2009 as a result of increase of fuel jet kerosene consumption. In comparison with 1990, CO_2-eq emission was by 47.6% lower as a result of decrease of fuel consumption.

Emissions from domestic aviation estimate by using drivers such as ratio of domestic/international passengers, taking into account average km traveled for passengers on domestic/international routes. So, total jet kerosene consumption from Energy balance was divided to domestic and international aviation according to average km traveled per passenger on domestic/international routes (Table 3.2-9).

Table 3.2-9: Estimation of civil aviation drivers

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total jet kerosene (10^3 t)	160.0	85.0	72.0	93.0	96.3	99.6	112.7	96.9	103.3
Passangers carried - Total (10^3)		679.0	1,072.0	2,099.0	2,148.0	2,288.0	2,329.0	2,053.0	1861.0
Passangers carried – intern. (10^3)		346.0	712.0	1,633.0	1,698.0	1,796.0	1,775.0	1,561.0	1418.0
Passangers carried – domastic (10^3)		333.0	360.0	466.0	450.0	492.0	554.0	492.0	443.0
Passangers kilometers- total (10^6)		444.0	763.0	1,989.0	1,959.0	2,055.0	1,945.0	1,636.0	1510.0
Passangers kilometers-inter. (10^6)		317.0	656.0	1,842.0	1,813.0	1,896.0	1,768.0	1,483.0	1370.0
Passangers kilometers-dom. (10^6)		127.0	107.0	147.0	146.0	159.0	177.0	153.0	140.0
Passangers domestic/km		381.4	297.2	315.5	324.4	323.2	319.5	311.0	316.0
Passangers international/km		916.2	921.3	1,128.0	1,067.7	1,055.7	996.1	950.0	966.1
Passangers intern.+domastic		1,297.6	1,218.1	1,443.4	1,392.2	1,378.9	1,315.6	1,261.0	1,282.2
share domestic	0.311	0.294	0.244	0.219	0.233	0.234	0.243	0.247	0.246
Jet kerosene in domestic aviation	**49.68**	**24.98**	**17.56**	**20.32**	**22.44**	**23.34**	**27.37**	**23.90**	**25.46**
Jet kerosene in international	**110.32**	**60.02**	**54.44**	**72.68**	**73.86**	**76.26**	**85.33**	**73.00**	**77.84**

Data for the period from 1991 to 2006 were obtained from Statistical yearbooks (1994, 1997 and 2008) of Republic of Croatia. Since average km traveled per passenger on domestic/international routes for 1990 is not included in available Croatian statistical publications, this value was estimated using linear extrapolation from the period 1991-2006 (Figure 3.2-9).

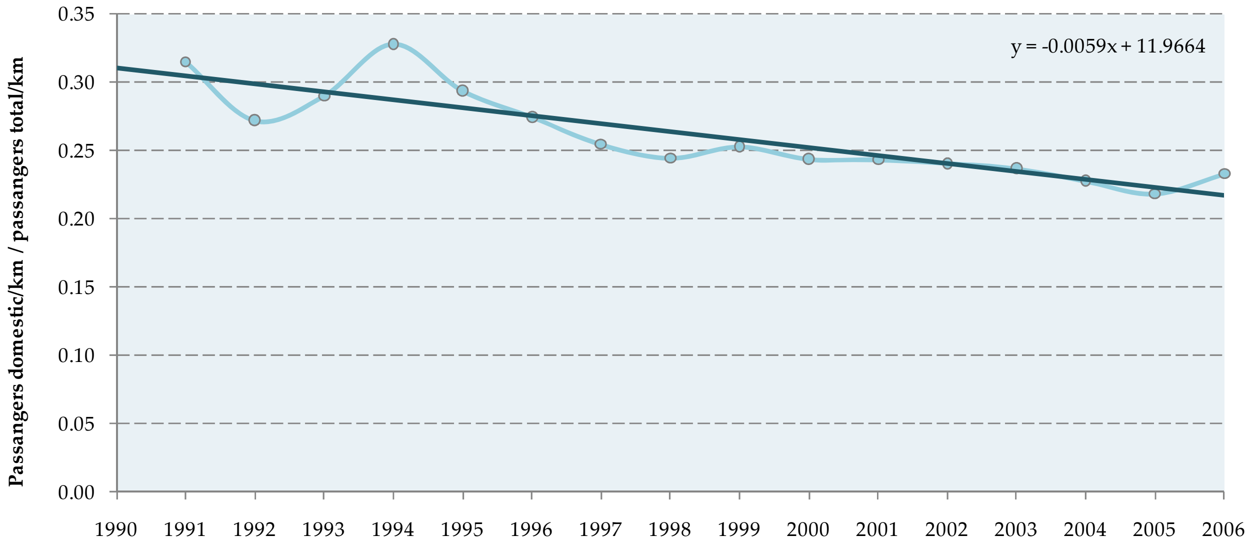

Figure 3.2-9: The average km traveled per passenger on domestic/international routes for the period 1991-2006

The GHG emissions were calculated using Tier 1 approach based on jet fuel consumption and aviation kerosene (calculated as previously explained) provided by national energy balance and default IPCC emission factors. Fosill fuel consumption, their net calorific values, appropriate GHG emission factors and GHG emissions for sub-sector Civil aviation for years 1990, 1995, 2000 and 2005 - 2009 are shown in Table A2-12 Annex 2

Road Transport (CRF 1AA3B)

The COPERT 4 ver 9.0 software package (Tier 2/3 method) was used for CO_2, CH_4 and N_2O emission calculation for the period from 1990 to 2010, with the usage of COPERT 4 emission factors per fuel types.

Corresponding to the COPERT 4 fleet classification all vehicles are grouped into vehicle classes and subclasses as is shown in Table 3.2-10.

Table 3.2.10: Vehicle classes and sub-classes, trip speed and driving share

Class	Subclass	Trip speed (km/h)			Driving share		
		Urban	Rural	Highway	Urban	Rural	Highway
Passenger Cars	Gasoline <1,4 l	30	60	110	40	35	25
	Gasoline 1,4 - 2,0 l	30	60	110	40	35	25
	Gasoline >2,0 l	30	60	110	40	35	25
	Diesel <2,0 l	30	60	110	40	35	25
	LPG	30	60	110	40	35	25
Light Duty Vehicles	Gasoline <3,5t	30	60	100	30	50	20
	Diesel <3,5 t	30	60	100	30	50	20
Heavy Duty Vehicles	Gasoline >3,5 t	30	50	80	30	55	15
	Rigid <=7,5 t	30	50	80	30	55	15
	Rigid 7,5 - 12 t	30	50	80	30	55	15
	Rigid 12 - 14 t	30	50	80	30	55	15
	Rigid 14 - 20 t	30	50	80	30	55	15
	Rigid 20 - 26 t	30	50	80	30	55	15
	Rigid 26 - 28 t	30	50	80	30	55	15
	Rigid 28 - 32 t	30	50	80	30	55	15
	Rigid >32 t	30	50	80	30	55	15
	Articulated 14 - 20 t	30	50	80	30	55	15
	Articulated 20 - 28 t	30	50	80	30	55	15
	Articulated 28 - 34 t	30	50	80	30	55	15
	Articulated 34 - 40 t	30	50	80	30	55	15
	Articulated 40 - 50 t	30	50	80	30	55	15
	Articulated 50 - 60 t	30	50	80	30	55	15
Buses	Urban Midi <=15 t	30	50	0	90	10	0
	Urban Standard 15-18 t	30	50	0	90	10	0
	Urban Articulated >18 t	30	50	0	90	10	0
	Coaches Standard <=18 t	30	50	90	25	65	10
	Coaches Articulated >18 t	30	50	90	25	65	10
Mopeds	<50 cmł	30	50	0	70	30	0
Motorcycles	2-stroke >50 cmł	30	50	0	60	40	0
	4-stroke <250 cmł	30	50	70	48	50	2
	4-stroke 250 - 750 cmł	30	50	80	45	51	4
	4-stroke >750 cmł	30	50	90	35	60	5

The aggregate numbers of road motor vehicles and mileage per vehicle type for year 1990, 2000, and 2005 – 2010 are presented in the Table A2-10 of the Annex 2 while the vehicle numbers per sub-classes are shown in Figure 3.2-10.

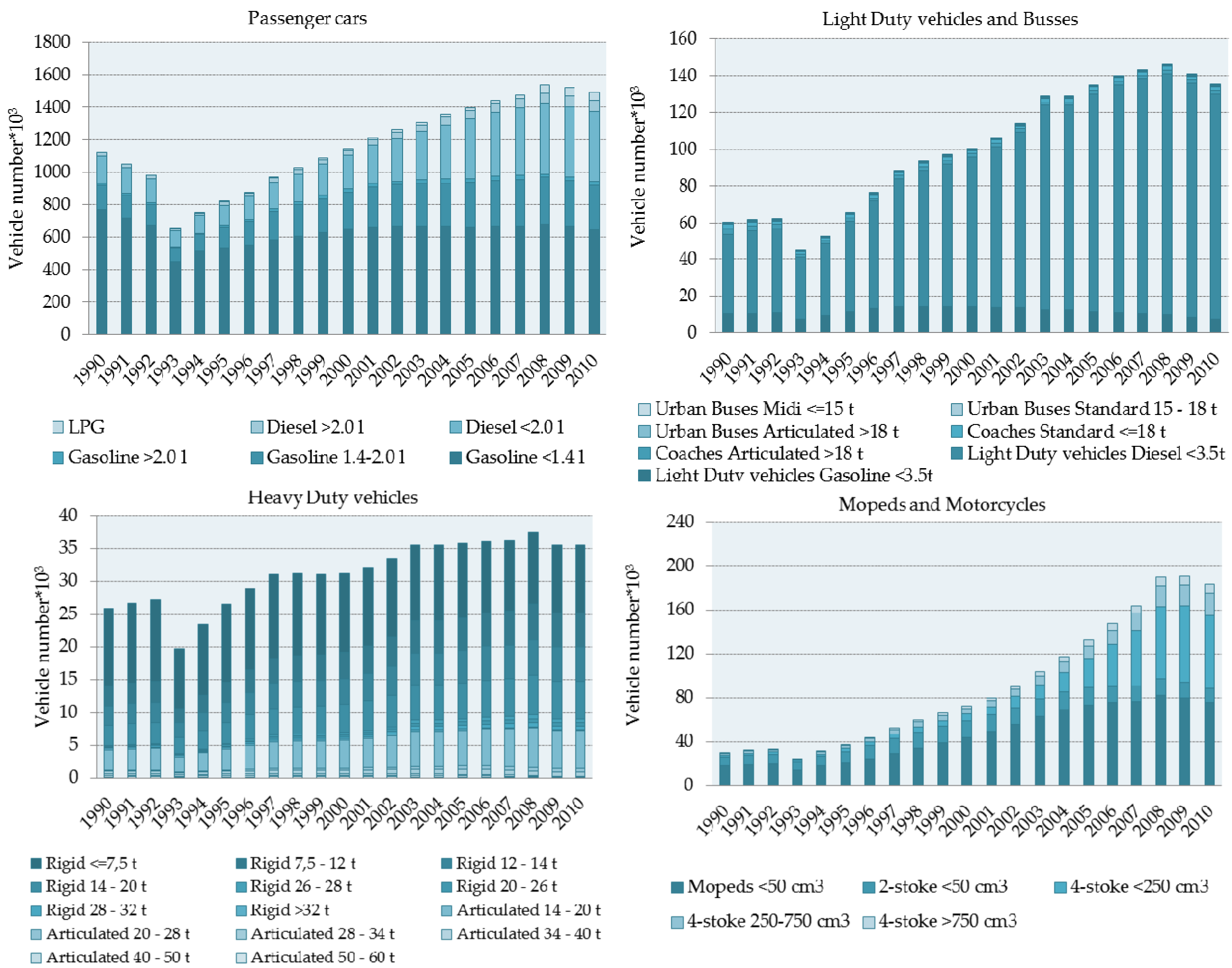

Figure 3.2-10: Number of vehicles in sub-classes in the period from 1990 to 2010

Comparing the total number of vehicles in 2010 with the number of vehicles in 1990 it can be notice the increase by 49.0% (Table A2-10 Annex 2). The increase was largely the result of increase in the number of passenger cars by 33.2%, constituting 76.0% of the total number of road vehicles in 2010. Other classes of vehicles were also increased in this period: the number of Light Duty vehicles increased by 2.4 times, Heavy Duty vehicles by 1.3 times, motorcycles and mopedsby 6.0 times. In the period 1990 - 2010 only the number of buses was increased by 22.5%.

The number of passenger cars was increased from 1990 to 2010 due to the increase in the number of diesel cars with engine size <2.0 L (2.6 times) and gasoline cars with engine size between 1.4 to 2.0 L (70.0%). At the same time the number of gasoline cars with engine size <1.4 l decreased by 17.4%.

The total number of duty vehicles in the period from 1990 to 2010 was increased by 2.1 times as a result of increasing the number of diesel light duty vehicles with engine size <3.5 t (64.4.0% increase in comparison to the overall duty vehicles (light, heavy, and buses).
The number of mopeds and motorcycles was increased in the period from 1990 to 2010 due to increase in the number of mopeds engine size <50 cm³ (+53.1%) and motorcycle engine size <250 cm³ (33.7 times).

The trends in vehicle numbers per layer are shown in Figure 3.2-11. The figure shows how vehicles complying with the EU emission levels (EURO I, II, III etc.) which have been introduced into the Croatian motor fleet.

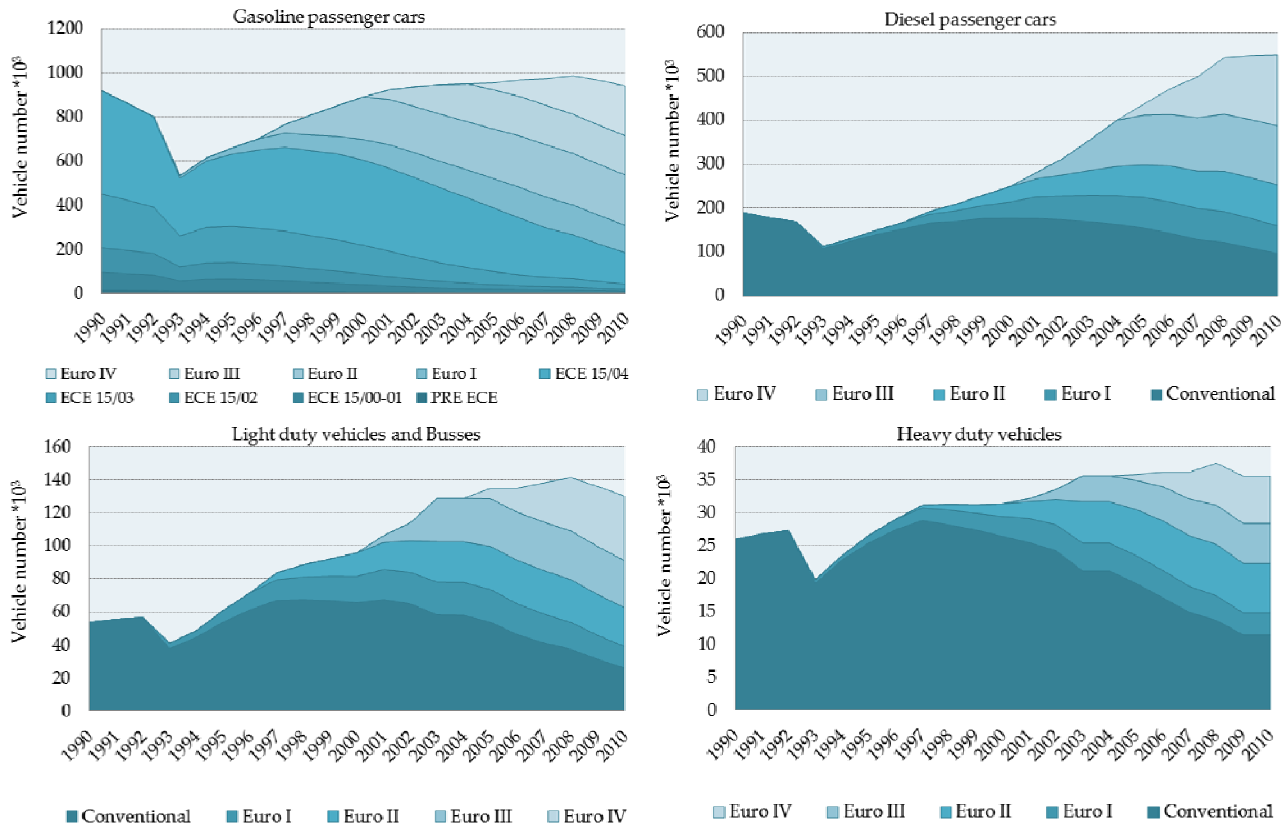

Figure 3.2-11: Layer distribution of vehicle numbers per vehicle type for the period from 1990 to 2010

The GHG emissions for the period from1990 to 2010 were calculated using COPERT 4 ver 9.0 model, taking into account two assumptions:

- Motor fuel tanked (filled in vehicle reservoir) abroad and consumed in Croatia is equal with fuel tanked in Croatia and consumed abroad
- Fuel consumption calculated by COPERT multiplying number of vehicles and annual average vehicle mileage should be equal to consumption of fossil fuels from the national energy balance (the difference should not be greater than 1%).

Quantities of fossil fuel consumed, their net calorific values and appropriate GHG emission factors and GHG emissions in the sub-sector Road transport for the years 1990, 1995, 2000 and 2005 - 2010 are shown in Table A2-11 Annex 2.
The CO_2-eq from the sub-sectors Road transport in 2010 amounted to 5,748.0 Gg, which is 3.6% less than in 2009 as a result of decrease in fuel consumption. In comparison with 1990, CO_2-eq was increased by 58.2% as a result of grow in diesel fuel consumption (by 3.0 times compared to 1990). At the same time gasoline consumption was decreased by 17.7%.

Trends of CO_2-eq emissions for fossil fuel type consumed in road transport for the period from 1990 to 2010 are shown in Figure 3.2-12.

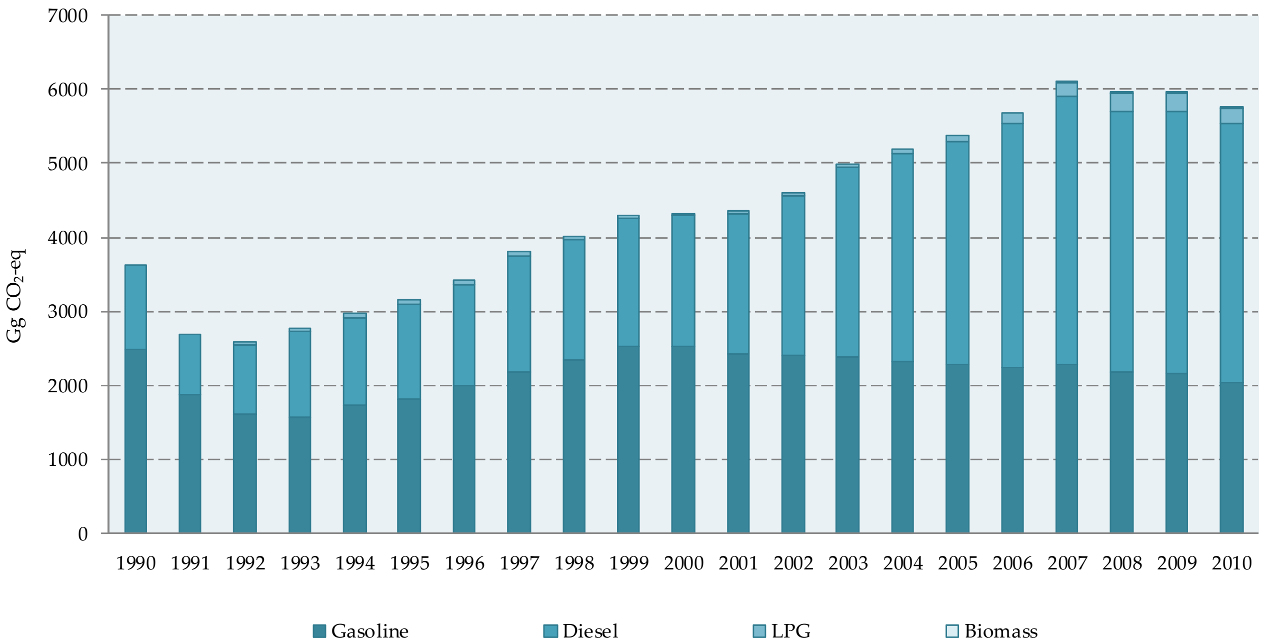

Figure 3.2-12: The CO_2-eq emission from Road transport sub-sector by fossil fuel type for the period from 1990 to 2010

Railways (CRF 1AA3C)

The GHG emissions calculation from sub-sector Railways were calculated using Tier 1 approach based on fossil fuel consumption data (from national energy balance) and default IPCC emission factors.

Quantities of fossil fuel consumed their net calorific values and appropriate GHG emission factor and GHG emissions in the sub-sector Railways for the years 1990, 1995, 2000 and 2005 - 2010 are shown in the Table A2-14 of the Annex 2.

The CO_2-eq from the sub-sectors Railways in 2010 was amounted to 89.61 Gg, which is the same as emission in in 2009 as a result of same fuel consumption in both years. In comparison with 1990, CO_2-eq was decreased by 34.42% as a result of decrease in railways transportation and consequently decreases in fuel consumption.

Navigation (CRF 1AA3D)

The GHG emissions calculation from Navigation sub sector were calculated using Tier 1 approach, based on fossil fuel consumption data (from national energy balance) and default IPCC emission factors.

Quantities of fossil fuel consumed their net calorific values and appropriate GHG emission factor and GHG emissions in the sub-sector Navigation for the years 1990, 1995, 2000 and 2005 - 2010 are shown in the Table A2-13 of the Annex 2.

The CO_2-eq from the sub-sectors Navigation in 2010 was amounted to 115.6 Gg, that is for 20.8% lower than in 2009 as a result of decrease in fuel consumption. In comparison with 1990, CO_2-eq was decreased by 13.4% as a result of decrease in navigation traffic and consequently decreases in fuel consumption.

3.2.5.4.Small Stationary Energy Sources (CRF 1.A.4.)

This sector includes emissions from fuel combustion in commercial and institutional buildings, residential sector and agriculture, forestry and fishing.

The total GHG emissions from abovementioned Small Stationary Energy Sources are shown in the Table 3.2-11 and Figure 3.2-13.

Table 3.2-11: The CO_2-eq emissions (Gg) from Small Stationary Energy Sources

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Commerc./Institutional	775	652	638	786	723	611	626	627	669
Residential	2,176	1,688	2,008	2,481	2,286	2,060	2,116	2,166	2,209
Agric./Forestry/Fishing	843	583	861	712	732	725	771	738	718
Total	**3,794**	**2,923**	**3,507**	**3,979**	**3,741**	**3,396**	**3,513**	**3,531**	**3,596**

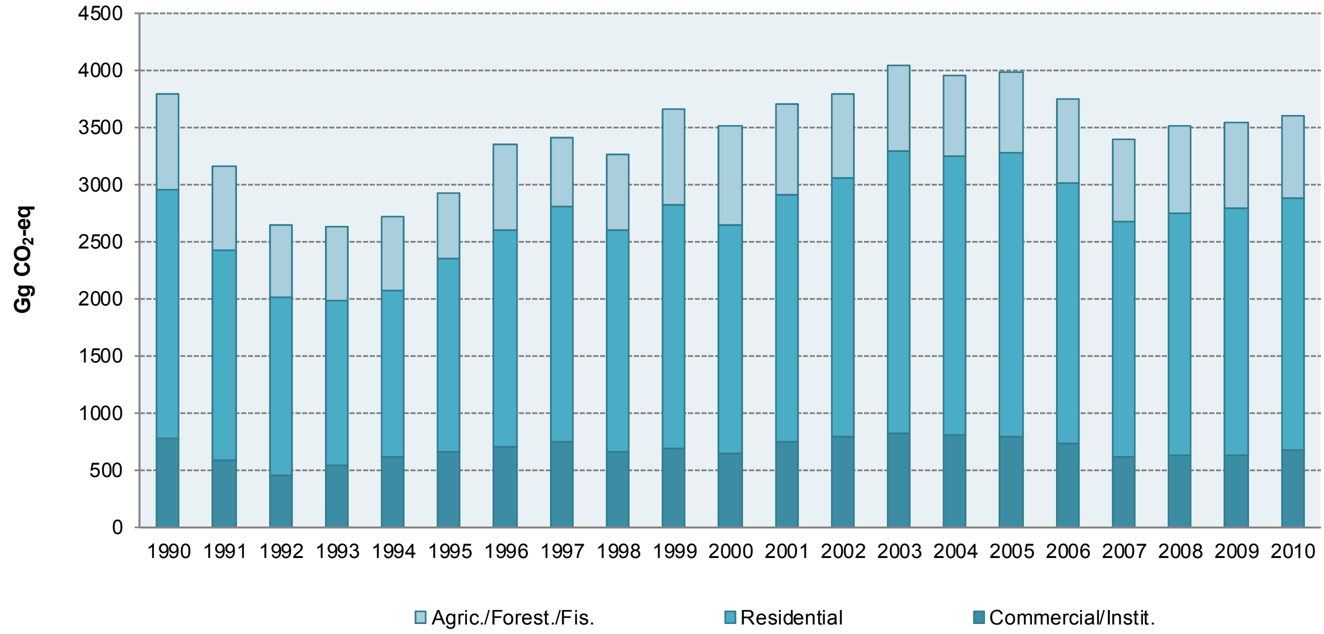

Figure 3.2-13: The CO_2-eq emissions from Small Stationary Energy Sources

The CO_2-eq emissions from these subsectors were about 16-20 percent of the total emissions from Energy sector. The most of the emission comes from small household furnaces and boiler rooms (55-62 percent), then from service sector (17-21 percent), while the combustion of fuel in agriculture, forestry and fishing accounts for 18 to 25 percent.

The GHG emissions from these subsectors were calculated using Tier 1 approach, based on fuel consumption data (national energy balance) and default IPCC emission factors. The fuel consumption and GHG emissions for Commercial/Institutional, Residential and Agriculture/Forestry/Fishing are presented in Tables A2-15, A2-16 and A2-17 of the Annex 2.

3.2.5.5.Ozone Precursors and SO_2 Emissions

The emissions of indirect greenhouse gases (NO_x, CO and NMVOC) and SO_2 are described in this chapter. Ozone precursors are cause of greenhouse gas - tropospheric ozone, whereas SO_2 was added to a list of pollutants first time in Revised 1996 IPCC Guidelines for National GHG Inventories due to the importance of this gas from the position of acidification and eutrophication. Emissions of indirect GHGs for whole time period, from 1990 to 2010 was set up according to the EMEP/CORINAIR methodology. Emissions were obtained from the emission inventory report 'Republic of Croatia Informative Inventory Report to LRTAP Convention for the Year 2010 Submission to the Convention on Long-range Transboundary Air Pollution' which is Croatia's obligation in the framework of the Long-range Transboundary Air Pollution (LRTAP) Convention according to the Act on Air Protection (OG 178/04, 60/08).

NO_X emissions

The NO_X emission encompasses nitrogen monoxide and nitrogen dioxide emissions. The emissions are expressed as equivalents of NO_2. NO_X is a pollutant that causes acidification and eutrophication. Together with volatile organic compounds and other reactive gases in atmosphere, and in presence of solar radiation, NO_X takes part in ground ozone formation.

The emission of NO_X from Energy sector (Fuel Combustion Activities) in 2010 was 62.9 Gg which is 6.0 percent lower than the year before and 30.0 percent lower compared to 1990. The NO_X emissions from Energy sector contribute with 97.6 percent to national total NO_X emission. The structure of NO_X emission in Energy sector has not changed significantly in the period from 1990 to 2010 (Figure 3.2-14). The main source of NO_X emission is transport (53.5 percent of total emission). Small stationary energy sources accounted for 18 percent to national total NO_X emission and emission from industry sectors accounted for 15 percent to the national total.

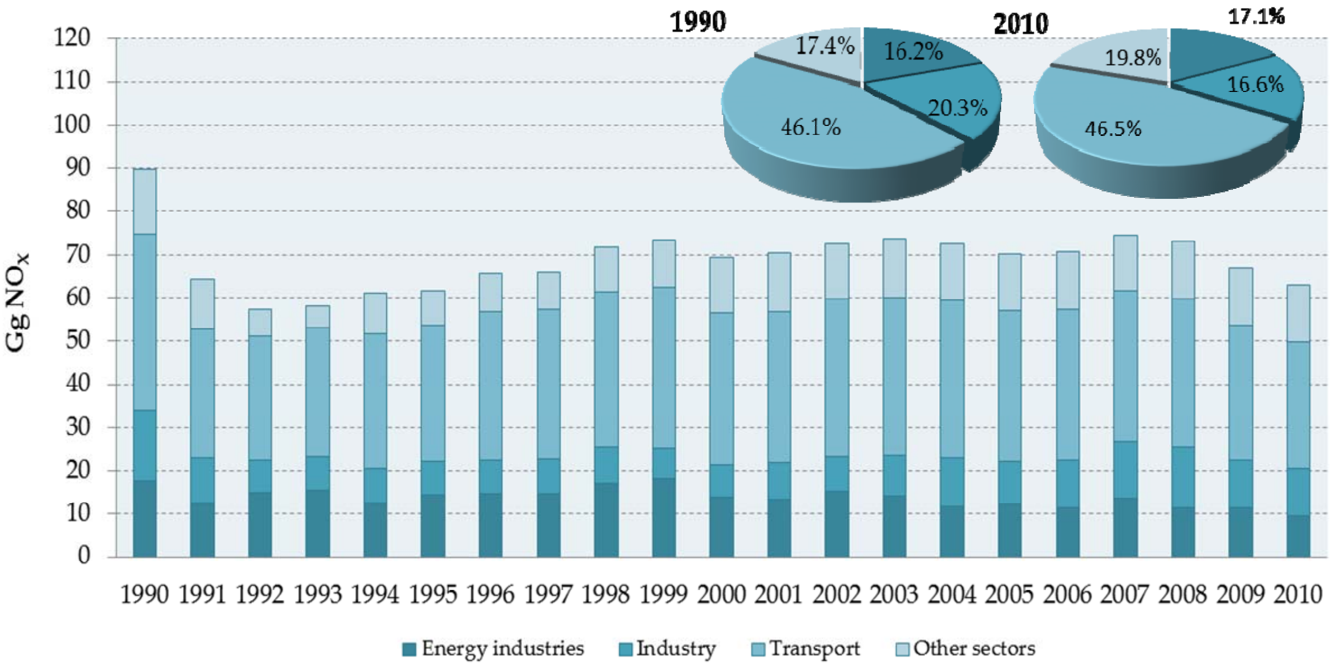

Figure 3.2-14: NO_X emissions from Energy sector in the period 1990-2010

CO emissions

In 2010, the emission of CO from Fuel Combustion Activities was 237.5 Gg which is 2.9 percent higher than in the year before and 50.7 percent lower compared to 1990, the year with maximum emission (481.5 Gg) of CO in the observed period. The CO emissions from Energy sector in 2010 contribute with 81.7 percent to national total CO emission. 26.5 percent of CO emission in Energy sector in 2010 was the result of incomplete fossil fuel combustion in Road transport sector and 59.7 percent in Commercial and Residential sector (Figure 3.2-15). Large combustion plants have automatic regulation of air throughput and combustion control, so CO emissions are low (about 0.3% of national total emission).

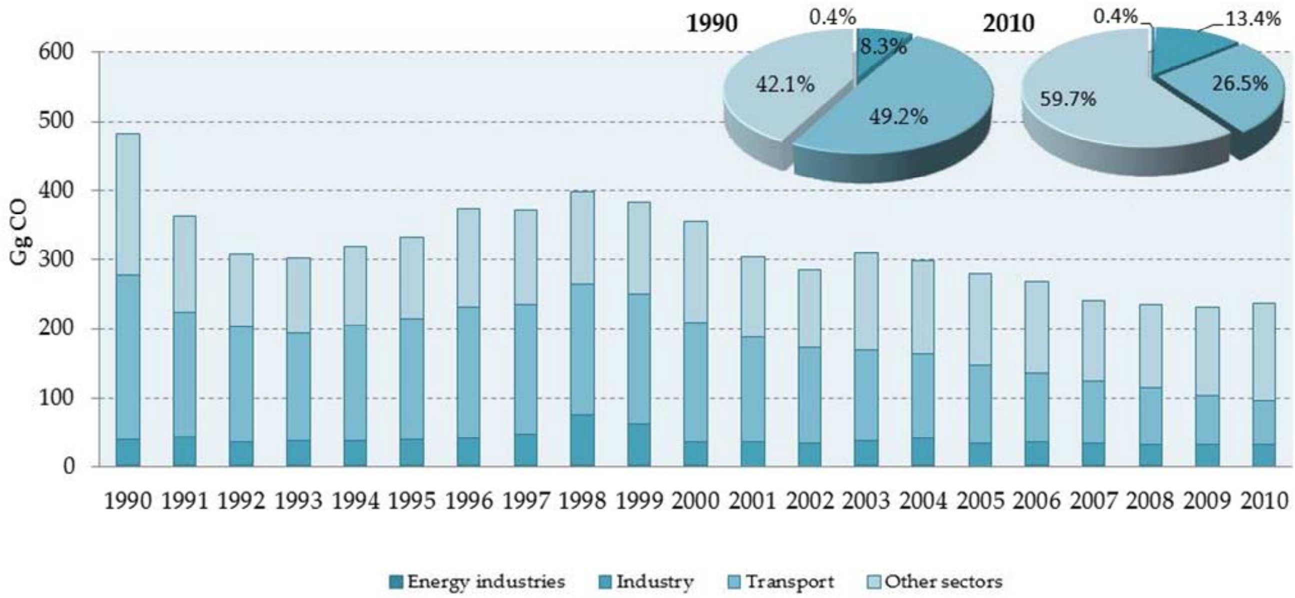

Figure 3.2-15: CO emissions from Energy sector in the period 1990-2010

NMVOC emissions

Non methane volatile organic compounds are important because they are precursors in formation of tropospheric ozone. Some of them may have undesirable ecotoxicological properties, for example benzene and xylene. Anthropogenic NMVOCs emissions from Energy sector (Fuel Combustion Activities) were 21.9 Gg in 2010 which was 6.3 percent lower than the year before and 58.0 percent lower than 1990. The NMVOC emissions from Energy sector contribute with 33.4 percent to national total NMVOC emission.

The structure of NMVOC emission from Energy sector has not changed significantly in the period from 1990 to 2010 (Figure 3.2-16). The main source of NMVOC emission is transport sources sector (51.5 percent of total emission of Energy sector). Emission of NMVOC from stationary combustion sectors accounted with 8.3 percent to the national total, mainly from the Commercial and Residential sector (40.2 percent).

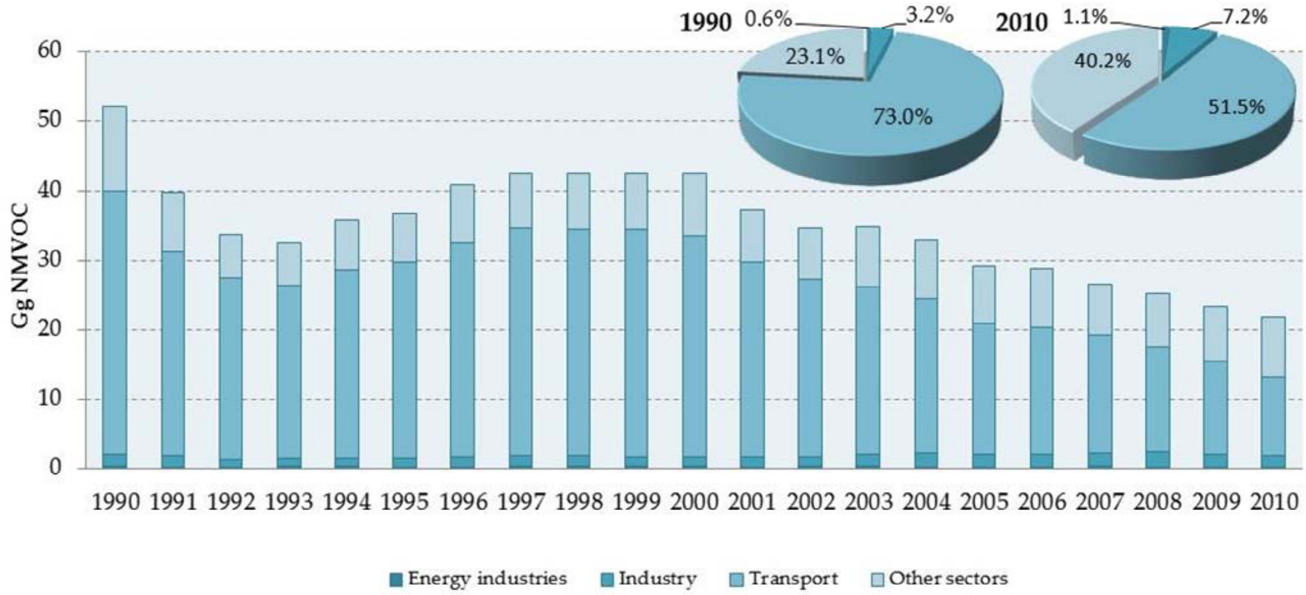

Figure 3.2-16: NMVOC emissions from Energy sector in the period 1990-2010

SO_2 emissions

In accordance with the calculated results, the level of SO_2 emission from Fuel Combustion Activities in 2010 reached 38.2 Gg which is 92.7% of total national SO_2 emission. The trend shows that emissions of SO_2 have increased by 29.2 percent compared to the emission in 2009 and decreased by 77.4 percent since 1990. Since 1990, SO_2 emission has the overall decreasing trend due to consumption of fossil fuel with lower sulphur content. The outstanding high level of SO_2 emission in 1990 is a result of fossil fuel consumption with high sulphur content in Energy Industries and Manufacturing Industries and Construction sectors. In years ahead, emissions from these two sectors were reduced by 50%.

During the period from 1990 to 2010, the decrease of SO_2 emissions was achieved in almost all sectors and the greatest decrease of SO_2 emission was in Energy Industries sector (-80.2%). Emission trend for SO_2 in the period of 1990 to 2010 as well as the share of the particular sectors in total emission of SO_2 in Energy sector 1990 and 2010 is presented in Figure 3.2-17.

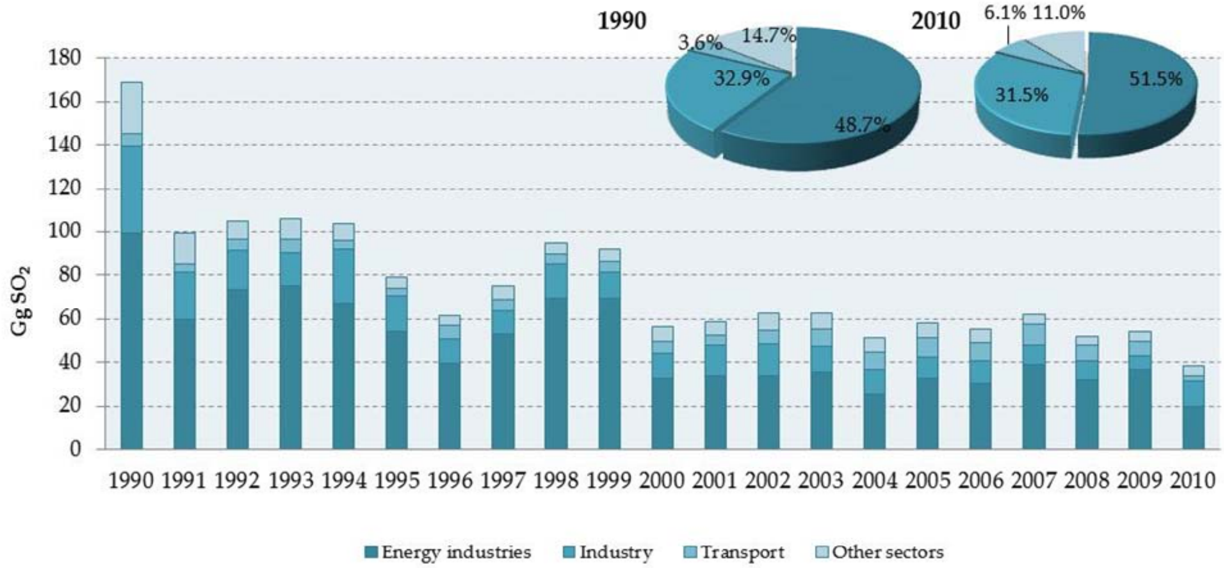

Figure 3.2-17: SO_2 emissions from Energy sector in the period 1990-2010

The emissions of ozone precursors and SO_2 are shown in the Table 3.2-12.

Table 3.2-12: Emissions of ozone precursors and SO_2 from Fuel Combustion sector (Gg)

Emission (Gg)	1990	1995	2000	2005	2006	2007	2008	2009	2010
NO_x Emission	**89.872**	**61.632**	**69.399**	**70.268**	**70.600**	**74.568**	**73.260**	**66.944**	**62.903**
Energy Industries	17.534	14.480	13.755	12.188	11.323	13.679	11.477	11.470	9.484
Manuf. Ind. & Cons.	16.330	7.573	7.732	9.901	11.043	13.034	13.997	11.084	11.017
Transport	40.974	31.448	35.066	35.033	34.992	34.996	34.279	31.103	29.225
Other Sectors	15.034	8.132	12.846	13.146	13.243	12.858	13.508	13.286	13.176
CO Emission	**481.453**	**331.640**	**354.351**	**278.918**	**268.343**	**240.188**	**234.008**	**230.655**	**237.459**
Energy Industries	2.395	1.558	1.621	1.149	1.528	2.086	1.450	1.177	1.068
Manuf. Ind. & Cons.	37.226	38.102	33.564	33.357	34.513	31.576	31.706	30.918	31.797
Transport	237.881	175.297	172.776	111.450	98.829	90.943	80.794	72.409	62.824
Other Sectors	203.951	116.683	146.389	132.962	133.474	115.583	120.058	126.151	141.770
NMVOC Emission	**52.081**	**36.712**	**42.454**	**29.254**	**28.739**	**26.567**	**25.295**	**23.372**	**21.896**
Energy Industries	0.352	0.255	0.293	0.263	0.264	0.309	0.280	0.263	0.249
Manuf. Ind. & Cons.	1.660	1.336	1.398	1.760	1.885	1.994	2.097	1.733	1.575
Transport	37.924	28.213	31.753	18.938	18.218	16.852	15.199	13.368	11.277
Other Sectors	12.144	6.909	9.011	8.292	8.372	7.411	7.718	8.009	8.796
SO_2 Emission	**169.040**	**78.829**	**56.393**	**58.037**	**55.132**	**62.184**	**52.190**	**53.994**	**38.209**
Energy Industries	99.526	53.981	32.929	32.732	30.228	39.029	31.959	36.737	19.668
Manuf. Ind. & Cons.	39.753	16.657	10.986	9.380	10.639	9.089	8.470	5.957	12.041
Transport	5.888	3.536	5.974	9.150	8.450	9.216	7.490	6.785	2.316
Other Sectors	23.874	4.655	6.505	6.775	5.816	4.849	4.272	4.514	4.185

3.2.6.COUNTRY-SPECIFIC ISSUES

There are also a few technical country-specific issues, which are connected to GHG emission calculation in Energy sector:

- The methodology for estimating CO_2 emission from natural gas scrubbing is not given in the IPCC Guidelines. The CO_2 emission is determined on the base of differences in CO_2 content before and after scrubbing units and quantity of scrubbed natural gas (material balance method). The data for estimating CO_2 emission is given from gas field Molve.
- Country-specific net calorific values (NCV) obtained from national energy balance are used in GHG emission calculation (Annex 2).

3.2.7. METHODOLOGICAL ISSUES

The GHG emission calculation is mainly provided using Tier 1 approach. There are two exceptions, as follows:

- Thermal power plants and public cogeneration plants (Energy Industries, CRF 1.A.1.a)
- Road transport (Transport, CRF 1.A.3.b)

Tier 1 Approach

<u>CO_2 emissions</u>

The CO_2 emission is estimated by two approaches: (1) Reference approach and (2) Sectoral approach. Inputs in the Reference approach are production, import, export, international bunkers and stock change for primary and secondary fuels. The Sectoral approach is used to identify the emission by means of fuel consumption for each group of sources (sectors). Data from the national energy balance were recalculated from natural units into energy units by means of its net calorific values for each fuel. Calorific values are also taken from the energy balance. The emission factors used for calculation are taken from *IPCC Guidelines* (*Revised 1996 IPCC Guidelines for National GHG Inventories,* Workbook, Page 1.6).

Since the combustion processes are not 100 percent efficient, the part of carbon stored is not emitted to the atmosphere so it occurs as soot, ash and other by-products of inefficient combustion. Therefore, it is necessary to know the fraction of carbon which oxidizes. This value was taken from *Revised 1996 IPCC Guidelines* as recommended (Workbook, Page 1.8).

Non-energy uses of fossil fuels can result in storage (in products) of some or all of the carbon contained in the fuel for a certain period of time, depending on the end-use. The fraction of carbon stored in products is suggested in *Revised 1996 IPCC Guidelines* (Workbook, auxiliary worksheet 1-1. page 1.37).

According to guidelines the emissions from international transport activities were not included in national totals.

Emissions of CH_4, N_2O

Emissions of CH_4 and N_2O have been identified by Tier 1 method in such a way that the fuel used in each sector is multiplied by the emission factor suggested in Revised 1996 IPCC Guidelines for National GHG Inventories (Reference Manual, page 1.33-1.42). The basis for the estimate is the fuel used in different energy sectors. The used fuel is grouped into basic fossil fuels categories according to its aggregate condition: coal, natural gas and oil, and biomass-based fuel. Data about quantities of the fuel used are taken from the national energy balance.

Emissions of indirect greenhouse gases

Emissions of indirect GHGs was set up according to the EMEP/CORINAIR methodology. Emissions were obtained from the emission inventory report 'Republic of Croatia Informative Inventory Report to LRTAP Convention for the Year 2010 Submission to the Convention on Long-range Transboundary Air Pollution' which is Croatia's obligation in the framework of the Long-range Transboundary Air Pollution (LRTAP) Convention according to the Act on Air Protection (Official Gazette 178/04, 60/08).

Tier 2/3 Approach

Thermal power plants and public cogeneration plants (CRF 1.A.1.a)

The GHG emissions from thermal power plants and public cogeneration plants in the period from 1990 to 2010, were calculated using more detailed Tier 2 approach. Tier 2 approach is based on bottom-up fuel consumption data from every boiler or gas turbine in plant. There were available data about yearly fuel consumption and detailed fuel characteristics data (net calorific value,…). For estimation of CO_2 emissions, default IPCC emission factors were used, while implied emission factors for CH_4 and N_2O are based on technology type and configuration (Tier 2).

Road transport (CRF 1.A.3.b)

The COPERT IV package (Tier 2/3 method) was used for air emission calculation from road transport emission in the period from 1990 to 2010 for CO_2, CH_4 and N_2O emissions.

Very detailed set of input data is necessary for COPERT implementation. In Croatian case, main data provider is Ministry of Interior, which is responsible for compilation of detailed motor vehicle database. The database assures the following information about:

- type of vehicles (passenger cars, light duty vehicles, heavy duty vehicles, buses, mopeds, motorcycles)

- type of motor (gasoline four-stroke, gasoline two-stroke, diesel, rotation motor and electromotor)
- cylinder capacity (<1.4L, 1.4-2.0L, >2.0L)
- weight class (<3.5 t, 3.5-7.5 t, 7.5-16 t, 16-32 t, >32 t) and
- age of vehicles (distribution of vehicles per ECE categories according to EC directives)

Weight class of heavy duty vehicles (HDV) and the buses is distributed in accordance with the detailed recommendations of the COPERT 4 team and the propossed conversion matrix. Thus, the current heavy-duty vehicles - diesel vehicles distributed on heavy duty vehicles - "Rigid" and heavy duty vehicles - "Articulated", and a new detailed weight classes are listed in Table 3.2-10.

Besides above mentioned activity data, the fuel consumption data (from national energy balance) and average month temperature (statistical yearbooks) are also necessary for GHG emissions calculation from road transport using COPERT software.

Additional data, like highway, rural and urban transport mileage, average speed of different kind of vehicles and different road types, average daily trip distance and beta value (the fraction of the monthly mileage driven before the engine and any exhaust components have reached their nominal operation temperature) are estimated or COPERT default data are used.

The COPERT calculates emission factors according to driving conditions data (the average speed per vehicle type and per road tipe), fuel variables and climate conditions (average monthly temperatures data).

3.2.8. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

3.2.8.1.Uncertainty of CO_2 emissions

The CO_2 emission, from the fossil fuel combustion, depends on amount of fuel consumed (from energy balance), net calorific values (from energy balance), carbon emission factors (IPCC), the fraction of carbon stored (IPCC) and the fraction of carbon oxidised (IPCC).

The national energy balance is based on data from different available sources. The data from Central Bureau of Statistics about production, usage of raw material and consumption of fuels in all industrial facilities in Croatia are used. The data from questionnaires about monthly use of natural gas in certain sectors from all distributive companies in Croatia, about annual consumption of coal in certain sectors and the data from Customs Administration about export and import of fossil fuels are also used. The data from these sources and other necessary data are organised in related database. The estimated uncertainty of data from energy balance is below 4 percent.

The accuracy of data on net calorific values, which are also taken from national energy balance, is high.

There are more uncertainties in data on international marine and aviation bunkers. Nevertheless, possible errors in estimated values do not significant affect on the accuracy of data of national emission, as marine and aviation transport have relatively small influence. The estimated CO_2 emissions for International Marine and Aviation Transport are not included in nationals totals.

The other data needed for calculation, such as, carbon emission factors, the fraction of carbon stored for non-energy uses of fuel and the fraction of carbon oxidized, are taken from *Revised 1996 IPCC Guidelines for National GHG Inventories*. Experts believe that CO_2 emission factors for fuels are generally well determined within 5 percent, as they are primarily dependent on the carbon content of the fuel.

For example, for the same primary fuel type (e.g. coal), the amount of carbon contained in the fuel per unit of useful energy can vary. Non-energy uses of the fuel can also create situations where the carbon is not emitted to the atmosphere (e.g. plastics, asphalt, etc.) or is emitted at a much-delayed rate. Additionally, inefficiencies in the combustion process, which can result in ash or soot remaining unoxidized for long periods, were also assumed. These factors all contribute to the uncertainty in the CO_2 estimates. However, these uncertainties are believed to be relatively small. Overall uncertainty for CO_2 emission estimates from the fossil fuel combustion are considered accurate within 3 percent.

3.2.8.2.Uncertainty of CH_4, N_2O and indirect greenhouse gases emissions

Estimates of CH_4, N_2O and ozone precursor emissions are based on fuel (coal, natural gas, oil and bio-fuels) and aggregate emission factors for different sectors. Uncertainties in estimates are due to the fact that emissions are estimated on the base of emission factors representing only a limited subset of combustion conditions.

Using the aggregate emission factors for each sector, the differences between various types of coal and especially liquid fuel are not included, nor are the differences in the technology and the contribution of equipment for emission reduction. Therefore, the uncertainties associated with emission estimates of these gases are greater than estimates of CO_2 emissions from the fossil fuel combustion.

The uncertainty of CH_4 emission is estimated to ±40 percent; while the uncertainty of N_2O emission is estimated to factor 2 (the emission could be twice larger or smaller than the estimated one). The largest part of uncertainty refers to the emission factor applied while the fuel consumption data (national energy balance) are rather good. Implementation of Tier 2/3 approach for estimation of CH_4 and N_2O emissions from Thermal power plants and public cogeneration plants (CRF 1.A.1.a) and Road transport (CRF 1.A.3.b) lead to certain uncertainty reduction.

3.2.8.3.Time-series consistency

Activity data, emission factors and methodology implied for GHG emission calculation from fuel combustion activities is very consistent for entire period. Negligible inconsistency is a consequence of implementation more detailed approach (Tier 2/3) in Energy Industries sector.

3.2.9. SOURCE-SPECIFIC QA/QC

Quality control activities were divided in two phases according to the QA/QC plan, first phase included activities during the inventory preparation performed by sector expert, and the second phase included audit conducted by the designated QA/QC manager after the preparation of final draft of the NIR.

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of activity data and emission estimates and on proper use of notation keys in the CRF tables. Also, several checks have been carried out in order to ensure correct aggregation from lower to higher reporting level and correct use of conversion factors.

The basis for emission estimates in Energy sector is Energy balance prepared by Energy Institute "Hrvoje Požar" and usage of mainly default emission factors provided by the IPCC guidelines. Background information and assumptions for entire time-series are transparently recorded in Inventory Data Record Sheets which allow third party to evaluate quality of estimates in this sector.

After preparation of final draft of this chapter an audit was carried out to check selected activities from Tier 1 General inventory level QC procedures and Tier 2 source-specific QC procedures according to QA/QC plan.

Regarding to QC Tier 2 activities, activity data were checked for key source categories. In Energy industries, Public Electricity and Heat Production a more detailed Tier 2 methodology was applied for the whole period from 1990 to 2009, due to availability of detail information on fuel consumption in the facilities. Activity data from energy balance were compared with data provided by individual facilities. Results of this comparison showed that there is no significant difference between these two sets of data. These bottom up data are still not available for other sub-categories therefore Tier 1 methodology was applied.

Also, inventory team used country-specific fuel net calorific values for emission estimates. Calorific values from energy balance were compared with data from the IPCC Guidelines. Results of this comparison showed that there is no significant difference between these two sets of data.

In Mobile combustion – Road, a COPERT IV model was used for the whole period (1990-2009). This model requires a very detailed set of input data and could be considered as a Tier 3 methodology. Activity data for vehicle fleet were obtained from three different sources: Ministry of Interior, Central Bureau of Statistics and

Centre for Vehicles. It was decided that database from Ministry of Interior is relevant because it contains the complete data set on each registered vehicle in Croatia. In Mobile combustion – Domestic and International Aviation, a data from Central Bureau of Statistics was used in order to reduce trend inconsistency, but it was point out that uncertainty of international bunkers is relatively higher comparing to other data.

3.2.10. SOURCE-SPECIFIC RECALCULATIONS

Public Electricity and Heat Production (1.A.1.a.)

Some inconsistencies in data occurred because two different approaches were used for emission calculation (bottom up for large point sources and top down for the rest of the sector). Recalculations are carried out to reconcile these two approaches for emission calculation. Fuel consumption from CHP and TPP plants (tier 2) were compared to same subsector in national energy balance. The differences which occurred were added to consumption of PHP plants. In such way total consumption of this sector is equal to total consumption in national energy balance. This approach assures that neither double-counting nor omissions occur. Recalculation was performed for the whole period of time (1993-2009).

Table 3.2-13 gives an overview of the differences in emissions before and after recalculation in Energy industries sector.

Table 3.2-13: Differences in emissions before and after recalculation in Energy industries sector

Energy industries	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2, %	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.02	0.00	0.00
CH_4, %	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00
N_2O, %	0.00	0.00	0.00	0.00	0.13	0.00	-0.01	0.04	0.07	0.01	-0.01

Energy industries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2, %	0.00	-0.28	-0.04	0.16	-1.34	-0.01	0.06	0.06	0.07	0.00
CH_4, %	0.00	-0.10	-0.01	0.05	-0.38	0.00	0.00	0.01	0.00	0.00
N_2O, %	0.00	-0.58	-0.08	0.32	-2.48	-0.03	-0.01	0.04	-0.01	0.00

Road transport (1.A.3.b.)

Emission of this sector have been recalculated for the sequence 1990-2009. The reason of recalculation is the usage of new version of COPERT 4 for calculating the pollutant emissions from the road traffic, COPERT 4 ver9.0. Using the new version is the recommendations of the European Commission because they bring improvement in traffic emissions calculation, and eliminate existing bugs in the software package.

As a result of introduction of newer version, there was a minor changes in CO_2 emissions due to updated emission factors, bugs fixed (corrected CH4, N2O emissions calculation), increase in fuel consumption due to usage of air conditioning system that are now installed in almost 95% of all new passenger cars, the NO2/NOx ratios have been completed for some vehicle technologies for which no values were available in the older COPERT 4 versions, the default O:C, H:C ratios for biodiesel have changed to 0.11 and 1.94, respectively, assuming a typical biodiesel ester molecule containing 18 C atoms, 2 O atoms, and one double bond.

Table 3.2-13 gives an overview of the differences in emissions before and after recalculation in Road Transport sector.

Table 3.2-13: Differences in emissions before and after recalculation in Road Transport sector

Road Transport	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, %	0.02	0.00	-0.02	0.00	-0.34	0.03	0.01	0.00	0.01	0.02
CH_4, %	3.50	3.06	3.60	4.56	3.56	3.85	4.58	4.76	4.43	4.85
N_2O, %	4.17	6.67	8.45	32.11	32.05	7.37	71.86	72.31	5.77	90.01

Road Transport	2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2, %	0.00	0.01	0.03	0.00	0.00	0.01	0.00	0.41	0.00
CH_4, %	5.49	5.74	6.67	7.63	0.00	7.56	7.27	8.31	5.49
N_2O, %	2.67	6.08	5.24	2.82	0.00	4.44	3.81	4.39	2.67

Road Transport	2009
CO_2, %	1.88
CH_4, %	7.95
N_2O, %	4.61

Agriculture/Forestry/Fisheries (1.A.4.c)

In 2008. Wrong Net calorific value is used for emission calculacion. In this submission error is corrected.

Table 3.2-14: Differences in emissions before and after recalculation in Agriculture/Forestry/Fisheries sector

	2008
CO_2, %	-2.18
CH_4, %	-2.11
N_2O, %	-2.17

3.2.11.SOURCE-SPECIFIC PLANNED IMPROVEMENTS

For the purpose of GHG inventory improvement, missing data should be collected and also quality of existing data, emission factors and methods should be improved. Implementation of well-documented country specific emission factors and appropriate detailed methods are recommended. Consequently, the main objectives of the GHG inventory improvement plan are:

- data gaps reduction,
- data collection improvement,
- activity data and emission factors uncertainties reduction,
- activities on improvement methodologies and emission factors, documentation and description of inventory system.

Short-term and long-term goals for GHG inventory improvement are:

Short-term goals (< 1 years)

Usage of more source-specific QA/QC procedures will improve the quality of GHG inventory in Energy sector.

Long-term goals (> 1 years)

The project on national level (Development of software for web based energy data collection), which will contribute to data collection improvement, is in progress.

The changes from Tier 1 to Tier 2/3 estimation methodologies for Energy key sources, as much as possible, are recommended. The priority should be the key sources with high uncertainties of emission estimation. But, significant constrains are availability of activity data, especially for the beginning years of concerned period. Consequently, implementation of more detailed methodology approach (Tier 2/3) for key sources, for entire period, will be very difficult.

In addition, the extensive use of plant-specific data which will be collected in the Register of Environmental Pollution is highly recommended ("bottom up" approach).

3.3. FUGITIVE EMISSIONS FROM FUELS (CRF 1.B.)

3.3.1. SOURCE CATEGORY DESCRIPTION

This section describes fugitive emission of greenhouse gases from coal, oil and natural gas activities. This category includes all emissions from mining, production, processing, transportation and use of fossil fuels. During all stages from the extraction of fossil fuels to their final use, the escape or release of gaseous fuels or volatile components may occur.

3.3.1.1. Solid fuels (CRF 1.B.1.)

All underground and opencast coal mines release methane during their regular operation. The amount of methane generated during mining is primarily a function of the coal rank and mining depth, as well as other factors such as moisture. After coal has been mined, small amounts of methane retained in coal are released during post-mining activities, such as coal processing, transportation and utilization.

In Croatia, the coal production was steadily decreasing in the period 1990-1999. Until 1999 only underground coal mines in Istria were in operation (Tupljak, Ripenda and Koromačno) and they produced some 0.015 to 0.174 mill. tons of coal. Global Average Method (Tier 1) was used for the methane emission estimation and the estimated emission was 0.2 to 2.3 Gg. The emissions of methane from mining and post-mining activities are showed in the Figure 3.3-1 and Table A2-18, Annex 2.

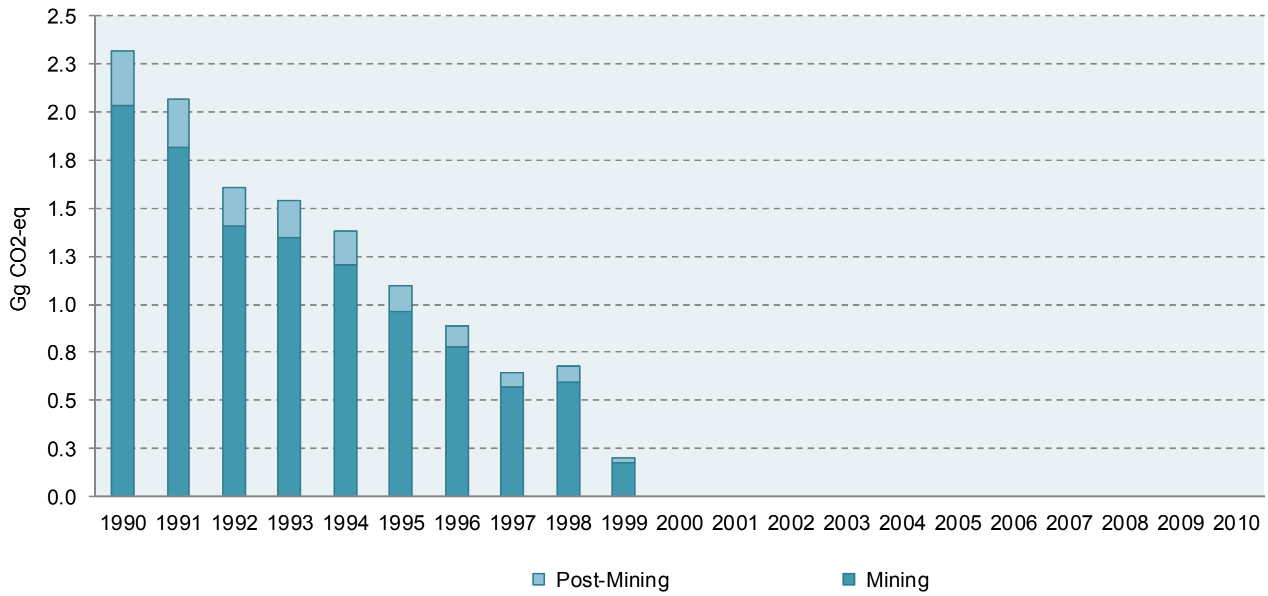

Figure 3.3-1: The fugitive emissions of methane from coal mines

3.3.1.2.Oil and natural gas (CRF 1.B.2.)

The fugitive emission of methane is inevitable during all the activities involving oil and natural gas. This category includes the fugitive emission from production, refining, transportation, processing and distribution of crude oil or oil products and gas. The fugitive emission also includes the emission of methane, which is the result of incomplete combustion of gas during flaring, and the emission from venting during oil and gas production.

The most significant fugitive emissions after methane among the activities relating to oil and gas are the emissions of non-methane volatile organic compounds (NMVOCs). They are produced by evaporation when fuel oil gets in contact with air during refining, transportation, and distribution of oil products. In addition to NMVOCs there are fugitive emissions of NOx, CO and SO_2 during various processes in oil refineries.

Fugitive emission of methane

For estimating the fugitive emission of methane the simplest procedure has been used (Tier 1), which is based on production, unloading, processing and consumption of oil and gas.

According to the IPCC, all countries are divided into regions with relatively homogenous characteristics of oil and gas systems. Croatia is included in the region that covers the countries of Central & East Europe and former Soviet Union. For this region higher emission factors are provided, especially for the gas system. In the absence of better data, average emission factors provided for the region are used for estimating the fugitive emission of methane. Estimated results are given in Figure 3.3-2 and Table A2-19, Annex 2.

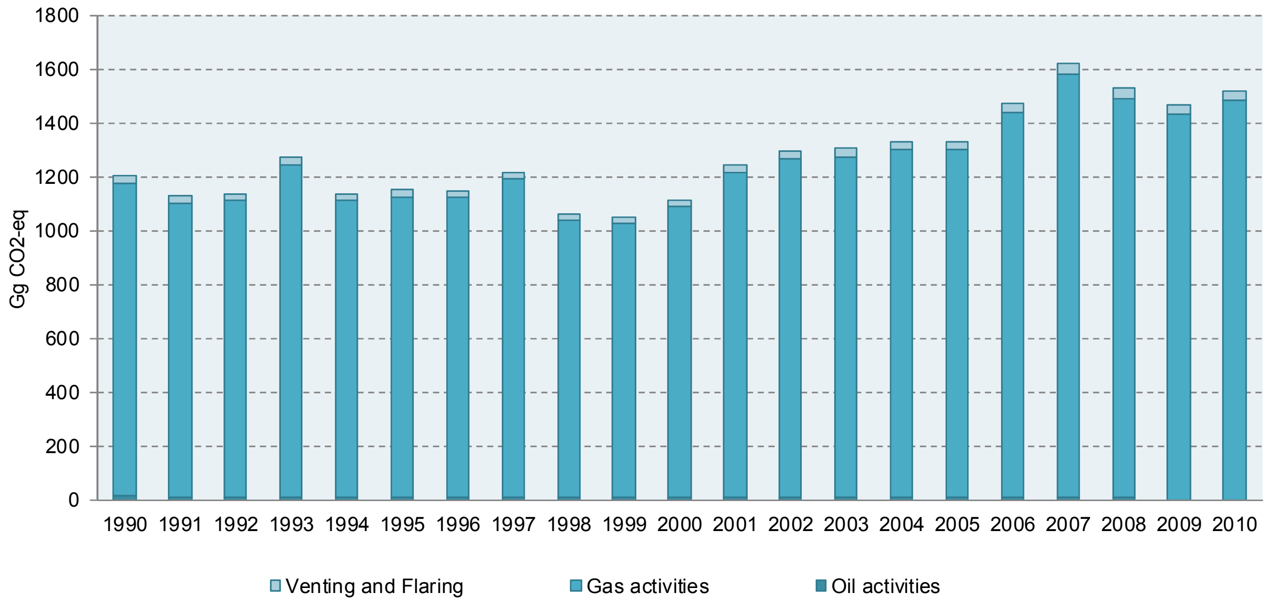

Figure 3.3-2: The fugitive emissions of methane from oil and gas activities

The fugitive emission of methane is mainly (about 97 percent) consequence of production, transmission and distribution of natural gas. The fugitive emission from oil accounts for about 1 percent and venting and flaring of gas/oil production accounts for approximately 2 percent.

Fugitive emission of ozone precursors and SO_2

Emissions of indirect GHGs for whole time period (1990-2009) was set up according to the EMEP/CORINAIR methodology. Emissions were taken from the emission inventory report 'Republic of Croatia Informative Inventory Report to LRTAP Convention for the Year 2010 Submission to the Convention on Long-range Transboundary Air Pollution' which is Croatia's obligation in the framework of the Long Range Transboundary Air Pollution (LRTAP) Convention according to the Act on Air Protection (Official Gazette 178/04, 60/08).

A simplified Tier 1 procedure was used for fugitive emission estimates of ozone precursors and SO_2 from oil refineries, for the entire period from 1990 to 2009. The simplified procedure is based on the quantity of crude oil processed in oil refineries. Default emission factors were used for the estimation. A summary of estimated results of the fugitive emissions of CO, NOx and NMVOC and SO_2 are illustrated in the Table 3.3-1 and Figure 3.3-3.

Table 3.3-1: The fugitive emissions of ozone precursors and SO_2 from oil refining

Emissions (Gg)	1990	1995	2000	2005	2006	2007	2008	2009	2010
CO emission	50.06	34.51	54.07	54.42	44.43	53.47	41.61	51.91	24.34
NO_x emission	0.49	0.30	0.30	0.30	0.25	0.30	0.24	0.29	0.13
NMVOC emission	9.76	9.14	10.04	8.61	7.85	8.17	7.55	8.31	5.02
SO_2 emission	1.80	1.24	3.11	3.10	2.54	3.17	2.83	3.27	1.77

Figure 3.3-3: The fugitive emissions of CO, NO_X, NMVOC and SO_2

<u>CO_2 emission from natural gas scrubbing</u>

Fugitive emission of greenhouse gases from coal, oil and natural gas, due to mining, production, processing, transportation and use of fossil fuels is also part of Energy sector. Although these emission sources are not characteristic in respect of CO_2 emission, specifically in Croatia emission of CO_2 from natural gas scrubbing in Central Gas Station Molve, which is assigned here. IPCC doesn't offer methodology for estimating CO_2 emission scrubbed from natural gas and subsequently emitted into atmosphere.

Natural gas produced in Croatian gas fields (Molve and Kalinovac) contains a large amount of CO_2, more than 15 percent, and before coming to commercial pipeline has to be cleaned (scrubbed). Since the maximum volume content of CO_2 in commercial natural gas is 3 percent, it is necessary to clean the natural gas before transporting through pipeline to end-users. Because of that, the Scrubbing Units exist at largest Croatian gas field. The estimated CO_2 emissions, by the material balance method, are presented in Table 3.3-2.

Table 3.3-2: The CO_2 emissions (Gg) from natural gas scrubbing in CGS Molve

CO_2 emission (Gg)	1990	1995	2000	2005	2006	2007	2008	2009	2010
Central Gas Station MOLVE	416	739	633	691	700	663	576	516	487

3.3.2.METHODOLOGICAL ISSUES

The fugitive emission of methane from coal, oil, and gas has been identified by Tier 1 method with average emission factors given in *Revised 1996 IPCC Guidelines for National GHG Inventories, Workbook* (page 1.26 and 1.30). Data about quantities of the mined coal and production, unloading, transportation, processing, storing and consumption of oil and gas are taken from the national balance.

The methodology for estimating CO_2 emission from natural gas scrubbing is not given in IPCC Guidelines. The CO_2 emission is determined on the base of differences in CO_2 content before and after scrubbing units and quantity of scrubbed natural gas.

3.3.3.UNCERTAINTIES AND TIME SERIES CONSISTENCY

3.3.3.1.Uncertainty

The fugitive emission of methane from coal mining and handling is determined by use of Global Average Method (Tier 1), which is based on multiplication of coal produced and emission factor. The amount of coal produced is taken from energy balance and that value is very accurate. The main uncertainty of calculation depends on accuracy of used emission factor. The arithmetic average value of emission factor has been chosen from IPCC Guidelines for the region to which Croatia belongs. The estimated uncertainty of methane emissions, for underground mining may be as a high as a factor of 2 and for post-mining activities a factor of 3.

The Production-Based Average Emission Factors Approach is used to determine fugitive emission from oil and natural gas activities. This approach is based on activity data (production, transport, refining and storage of fossil fuels) and average emission factors. Due to the complexity of the oil and gas industry, it is difficult to quantify the uncertainties. The uncertainty of calculation is linked mostly to the emission factor, just like the determination of fugitive emission of methane from coal mining and handling. The expert estimated that accuracy of calculation of fugitive emission from oil is better than from fugitive emission from gas, but the uncertainty of both estimations is pretty high. Similarly, the uncertainty of calculation of emission of ozone precursors and SO_2 is also very high.

The CO_2 emission from scrubbing of natural gas is also shown here. The calculation is based on material balance which gives much better accuracy (±10 percent).

3.3.3.2.Time-series consistency

Activity data, emission factors and methodology implied for fugitive emission from fuels is consistent for entire period.

3.3.4. SOURCE-SPECIFIC QA/QC

For Fugitive emissions from oil and gas operations a Tier 1 method was applied and emission factor is a mean value of the range proposed in the IPCC Manual. The CO_2 emission from natural gas scrubbing in CPS Molve was estimated using country specific methodology since IPCC Guidelines does not provide methodology for this source category.

In this subsector QA/QC plan for 2011 does not prescribe source-specific quality control procedures since it is county specific issue and comparison with other similar cases in other countries is not possible. Only general (Tier 1) quality control procedures were applied.

3.3.5. SOURCE-SPECIFIC RECALCULATIONS

In this sector one recalculation was performed:

- CO_2 emission from Natural gas scrubbing (1.B.2.b.ii)
    - New official and verified data were obtained from CPS Molve

Table 3.3-3 gives an overview of the difference in emissions before and after recalculation in Fugitive Emissions from Oil, Natural Gas and Other Sources.

Table 3.3-3: Difference in emissions before and after recalculation in Fugitive Emissions from fuels

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2, %	0.00	0.00	0.00	0.00	0.00	5.73	10.10	10.10	0.00	9.33	0.00

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2, %	0.00	5.24	-4.03	-0.06	0.04	5.32	-0.25	-15.66	0.00	0.00

3.3.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

For estimation of fugitive emissions from oil and natural gas operations a Tier 1 method was applied. Used emission factors are an average value of the range proposed in the *IPCC Guidelines*. However, fugitive emission from natural gas is key source and implementation of rigorous source-specific evaluations approach (Tier 3) is necessary. The Tier 3 approach will generally involve compiling the following types of information:

- detailed inventories of the amount and types of process infrastructure (e.g. wells, field installations and production/processing facilities),
- production disposition analyses of oil and gas production, vented, flared and reinjected volumes of gas and fuel gas consumption,
- accidental releases (i.e. well blow-outs and pipeline ruptures),

- typical design and operating practices and their impact on the overall level of emission control.

Additional technical and financial resources are necessary for implementation the Tier 3 approach. As a first step in order to implementation source-specific evaluations approach the workshop for determining fugitive emission from oil and natural gas system was held. The aim of the workshop was to identify the data needed to improve estimate of fugitive emission.

3.4. REFERENCES

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4 INDUSTRIAL PROCESSES (CRF sector 2)

4.1OVERVIEW OF SECTOR

Greenhouse gas emissions are produced as by-products of non-energy industrial processes in which raw materials are chemically transformed to final products. During these processes different greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4) or nitrous oxide (N_2O) are released in the atmosphere.

Industrial processes whose contribution to CO_2 emissions was identified as significant are production of cement, lime, ammonia, as well as use of limestone and soda ash in different industrial activities. Nitric acid production is a source of N_2O emissions. Emissions of CH_4 appear in production of other chemicals, as well as carbon black and ethylene.

Consumption of halocarbons (HFCs) and perfluorocarbons (PFCs), which are used as substitution gases in refrigeration and air conditioning systems, foam blowing, fire extinguishers and aerosols/metered dose inhalers, is a source of emissions of fluorinated compounds. SF_6 is used as an insulation medium in high voltage electrical equipment. During SF_6 manipulation and testing of high voltage apparatus, leakage and maintenance losses of the total charge can be present.

Some industrial processes, particularly petrochemical, generate emissions of short-lived ozone and aerosol precursor gases such as carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). These gases indirectly contribute to the greenhouse effect.

The general methodology applied to estimate emissions associated with each industrial process, as recommended by *Revised 1996 IPCC Guidelines* and *Good Practice Guidance and Uncertainty Management in National GHG Inventories*, involves the product of amount of material produced or consumed, and an associated emission factor per unit of production/consumption.

The activity data on production/consumption for particular industrial process were extracted from Annual Industrial Reports, which cover industrial activities according to prescribed national classification of activities and are published by Central Bureau of Statistics, Department of Manufacturing and Mining, or from surveys of individual manufacturers.

Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official Gazette No. 1/07) prescribes obligation and procedure for emissions monitoring, which comprise estimation and/or reporting of all anthropogenic emissions and removals. According to requirement, sources of abovementioned greenhouse gases are responsible to report required activity data for more accurate emissions estimation.

Emission factors used for calculation of emissions are, in most cases, default emission factors according to *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, and *Good Practice Guidance and Uncertainty Management in National GHG Inventories*, mainly due to a lack of plant-specific emission factors. Country-specific emission factors for cement and lime production as well as ammonia and nitric acid production were estimated by collecting the actual data from individual plants.

Uncertainty estimates associated with emission factors for some industrial processes are well reported in *Good Practice Guidance*, while those associated with activity data are based on expert judgements since statistics and manufacturers have not particularly assessed the uncertainties.

Generally, CO_2 emissions from industrial processes declined from 1990 to 1995, due to a decline in industrial activities caused by the war in Croatia, while during the period 1996-2008 emissions slightly increased. Decreasing of economic activity in 2009 influenced a decrease in emissions, which again started to slightly increase in 2010.

The total annual emissions of GHGs, expressed in Gg CO_2-eq, from Industrial Processes in the period 1990-2010 are presented in the Figure 4.1-1.

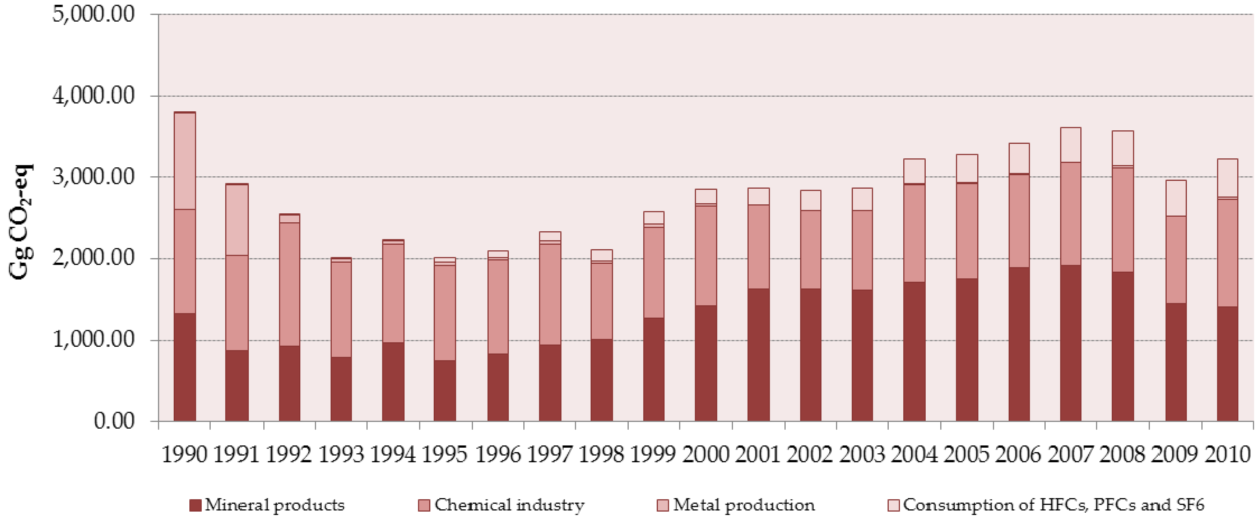

Figure 4.1-1: Emissions of GHGs from Industrial Processes (1990-2010)

In Industrial processes, seven source categories represent key source category regardless of LULUCF (detailed in Table 4.1-1):

Table 4.1-1: Key categories in Industrial processes sector based on the level and trend assessment in 2010[5]

IPCC Source Categories	Direct GHG	Criteria for Identification			
		Level		Trend	
		excl. LULUCF	incl. LULUCF	excl. LULUCF	incl. LULUCF
INDUSTRIAL PROCESSES					
CO_2 Emissions from Cement Production	CO_2	L1e	L1i	T1e	T1i
CO_2 Emissions from Ammonia Production	CO_2	L1e	L1i	T1e	
CO_2 Emissions from Ferroalloys Production	CO_2			T1e	T1i, T2i
CO_2 Emissions from Aluminium Production	CO_2			T1e	T1i
N_2O Emissions from Nitric Acid Production	N_2O	L1e, L2e	L1i, L2i	T1e	T2i
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	L1e, L2e	L1i, L2i	T1e, T2e	T1i, T2i
PFC Emissions from Aluminium Production	PFC		T1e, T2e		T1i, T2i

L1e - Level excluding LULUCF Tier 1
L1i - Level including LULUCF Tier 1
T1e - Trend excluding LULUCF Tier 1
T1i - Trend including LULUCF Tier 1
L2e - Level excluding LULUCF Tier 2
L2i - Level including LULUCF Tier 2
T2e - Trend excluding LULUCF Tier 2
T2i - Trend including LULUCF Tier 2

[5] Data on key categories are taken from Annex 1 Key categories (Tier 1 and Tier 2)

4.2 MINERAL PRODUCTS (CRF 2.A.)

4.2.1.CEMENT PRODUCTION

4.2.1.1.Source category description

During cement production, calcium carbonate ($CaCO_3$) is heated in a cement kiln at high temperatures to form lime (i.e. calcium oxide, CaO) and CO_2 in a process known as calcination or calcining:

$$CaCO_3 + Heat \rightarrow CaO + CO_2\uparrow$$

Lime is combined with silica-containing materials (e.g. clay) to form dicalcium and tricalcium silicates which are the main constituents of cement clinker, with the earlier CO_2 being released in the atmosphere as a by-product. The clinker is then removed from the cement kiln, cooled, pulverized and mixed with small amount of gypsum to form final product called Portland cement.

There are four manufacturers of cement in Croatia, producing mostly Portland cement. There is production of Aluminate cement in the minor quantities. CO_2 emitted during the cement production process represents the most important source of non-energy industrial process of total CO_2 emissions. Different row materials are used for Portland cement and Aluminate cement production. The quantity of the CO_2 emitted during Portland cement production is directly proportional to the lime content of the clinker. Emissions of SO_2 (non-combustion emissions) in the cement production originate from sulphur in the raw clay material.

4.2.1.2.Methodological issues

Estimation of CO_2 emissions is accomplished by applying an emission factor, in tonnes of CO_2 released per tonne of clinker produced, to the annual clinker output corrected with the fraction of clinker that is lost from the kiln in the form of Cement Kiln Dust (CKD), (Tier 2 method, *Good Practice Guidance*).

Country-specific emission factor for Portland and Aluminate cement was estimated by using data on CaO and MgO content of clinker produced from individual plants. CO_2 from Cement Kiln Dust (CKD) leaving the kiln system was calculated using the default CF_{ckd} (2 percent of the CO_2 calculated for the clinker) due to the absence of plant-specific data for the whole time series.

The activity data for clinker production, data on the CaO and MgO content of the clinker, information on the CKD collection and recycling practices and likewise on the calcination fraction of the CKD were collected by survey of cement manufacturers. The data were cross-checked with cement production data from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining. The data on clinker production and emission factors are presented in Table 4.2-1. The quantity of clinker imported has not been considered in the emission estimations.

Table 4.2-1: Clinker production and emission factors (1990 - 2010)

Year	Clinker production *Portland cement* (tonnes)[1]	Clinker production *Aluminate cement* (tonnes)[1]	Actual clinker production (tonnes)[2]	Emission factor *Portland cement* (t CO_2/t clinker)	Emission factor *Aluminate cement* (t CO_2/t clinker)
1990	2,017,840	44,585	2,103,674	0.521	0.319
1991	1,296,146	40,974	1,363,862	0.521	0.327
1992	1,538,923	27,378	1,597,627	0.521	0.307
1993	1,264,565	40,511	1,331,178	0.523	0.312
1994	1,548,980	34,702	1,615,356	0.526	0.317
1995	1,148,756	48,854	1,221,562	0.523	0.317
1996	1,245,692	60,570	1,332,387	0.524	0.312
1997	1,470,234	63,541	1,564,451	0.515	0.314
1998	1,571,767	77,344	1,682,093	0.517	0.309
1999	2,063,838	87,175	2,194,033	0.517	0.311
2000	2,308,148	73,999	2,429,790	0.518	0.312
2001	2,645,180	94,065	2,794,030	0.517	0.306
2002	2,627,934	70,667	2,752,573	0.511	0.315
2003	2,609,349	82,741	2,745,932	0.510	0.307
2004	2,764,331	87,911	2,909,287	0.512	0.307
2005	2,827,258	99,320	2,985,110	0.510	0.299
2006	3,007,818	96,549	3,166,454	0.508	0.314
2007	3,046,209	114,311	3,223,730	0.507	0.310
2008	2,883,266	111,787	3,054,954	0.507	0.311
2009	2,355,148	83,911	2,487,840	0.499	0.310
2010	2,229,152	91,332	2,366,894	0.515	0.309

[1] Clinker production according to survey of cement manufacturers

[2] Actual clinker productions calculated as a product of clinker production and CF_{ckd}.

Import/export quantities of clinker are presented in Table 4.2-2.

Table 4.2-2: Import/export quantities of clinker (1990 - 2010)

Year	Clinker import / tonnes		Clinker export / tonnes		Change in clinker stocks* / tonnes	
	Portland	Aluminate	Portland	Aluminate	Portland	Aluminate
1990	0	0	0	0	9,484	-113
1991	0	0	0	0	-35,932	7,790
1992	0	0	4,376	0	51,763	-3,154
1993	0	0	0	0	-25,265	-3,616
1994	0	0	0	2,200	-16,847	1,003
1995	52,500	0	0	5,504	10,313	3,619
1996	0	0	32,715	5,500	10,521	3,416
1997	57,973	0	63,529	5,000	16,034	-824

Table 4.2-2: Import/export quantities of clinker (1990 - 2010), cont.

Year	Clinker import / tonnes		Clinker export / tonnes		Change in clinker stocks* / tonnes	
	Portland	Aluminate	Portland	Aluminate	Portland	Aluminate
1998	116,397	0	82,451	14	-22,552	8,827
1999	0	0	114,868	287	-13,736	7,145
2000	0	0	111,226	576	-15,574	-9,775
2001	0	100	131,565	519	47,038	8,999
2002	0	0	5,029	2,987	-12,673	-8,991
2003	112,467	0	0	285	-16,320	690
2004	51,791	0	53,387	157	33,581	-1,643
2005	0	0	195,888	238	-88,696	-1,151
2006	0	0	243,708	438	-32,078	-1,710
2007	24,000	1,632	309,431	1,115	4,442	4,467
2008	0	153	234,849	626	-21,949	2,602
2009	0	0	169,356	536	43,281	958
2010	67	0	124,675	297	-19,944	-2,865

* During the period 2002-2005, Portland clinker was sent off in one plant which didn't produce clinker (only cement), in the following quantities: 153,138 tonnes (2002), 159,321 tonnes (2003), 172,020 tonnes (2004); 56,459 tonnes (2005).

The resulting emissions of CO_2 from Cement Production in the period 1990-2010 are presented in the Figure 4.2-1.

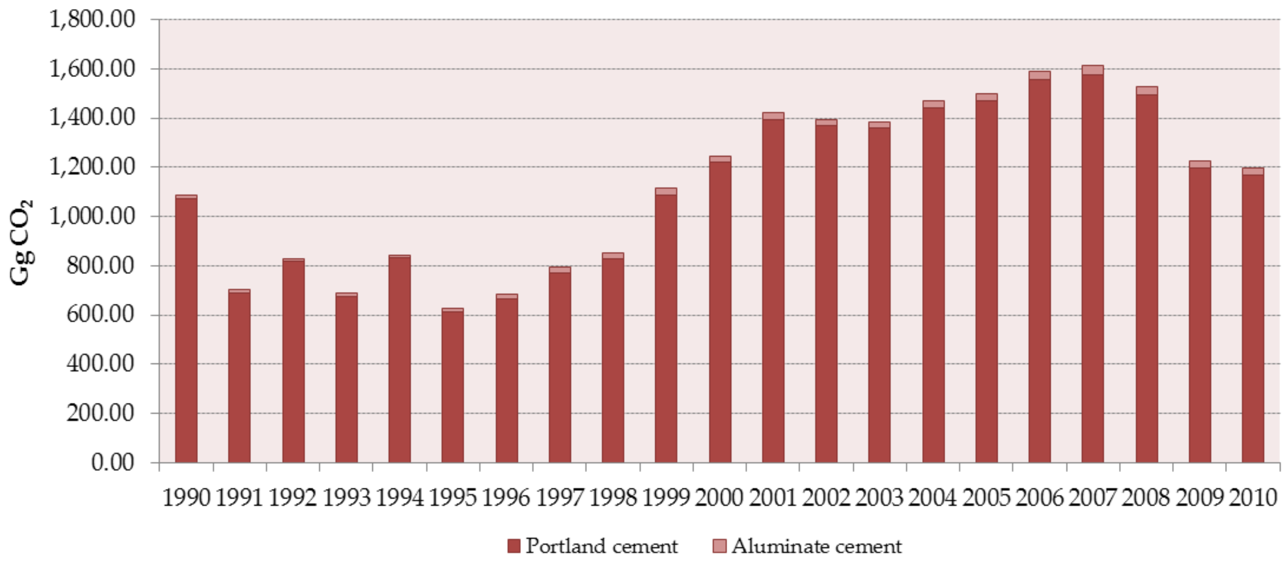

Figure 4.2-1: Emissions of CO_2 from Cement Production (1990-2010)

CO_2 emissions from cement production declined from 1990 to 1995, due to the decline in industrial activities caused by the war in Croatia, while in the period 1996-2008 emissions slightly increased. Due to decreasing of economic activity within 2009 and 2010, which influenced decreasing of cement production by 23 percent in 2009 and 26 percent in 2010, while emissions decreased by 20 percent in 2009 and 22 percent in 2010, regarding the year 2008.

The activity data for cement production (see Table 4.2-3) were collected by survey of cement manufacturers and cross-checked with cement production data from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

Table 4.2-3: Cement production (1990-2010)

Year	Cement production / tonnes	
	Portland	Aluminate
1990	2,598,066	44,698
1991	1,702,589	33,184
1992	1,810,780	30,532
1993	1,596,244	36,895
1994	2,049,140	31,499
1995	1,571,415	39,731
1996	1,643,049	51,654
1997	1,906,133	59,365
1998	2,161,827	68,503
1999	2,549,726	79,743
2000	2,909,466	83,388
2001	3,152,805	84,655
2002	3,415,011	76,737
2003	3,607,840	81,860
2004	3,553,985	89,563
2005	3,528,544	100,509
2006	3,657,889	98,041
2007	3,613,548	111,624
2008	3,671,826	108,891
2009	2,847,053	80,945
2010	2,687,535	93,128

SO_2 emissions originate from sulphur in the fuel and in the clay raw material. The fuel emissions are counted as energy emissions (these emissions are presented in the chapter on emissions from energy sources). SO_2 emissions from the clay are counted as process emissions and calculated on the basis of produced quantities of cement. About 70-95 percent of the SO_2 generated in the process is absorbed in the produced alkaline clinker.

Emissions of SO_2, CO, NO_x and NMVOC have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of SO_2, CO, NO_x and NMVOC from Cement Production in the period 1990-2010 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.2.1.3.Uncertainties and time-series consistency

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 3 percent (1 to 5 percent), based on expert judgements. Uncertainty estimate associated with emission factors amounts 3 percent, accordingly to values (1 to 5 percent) reported in *Good Practice Guidance* (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Cement Production have been calculated using the same method and data sets for every year in the time series.

4.2.1.4.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to source specific quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Cement Production is one of the key source categories in Industrial Processes. Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories. CO_2 emissions from cement production were estimated using Tier 2 method which is a *good practice.* Basic activity data from Annual Industrial Reports were compared with data provided by individual plants. Results of this comparison showed that there is no significant difference between these two sets of data. Country-specific emission factors for Portland cement were compared with IPCC default emission factor. Difference between these two data sets is caused by difference in CaO/MgO content in raw materials and clinker.

4.2.1.5.Source–specific recalculations

A mistake in data input made in the previous report for 2009 was corrected.

4.2.1.6.Source–specific planned improvements

Detailed activity data have been collected from individual plants and there is no need for further improvements.

4.2.2.LIME PRODUCTION

4.2.2.1.Source category description

The production of lime involves a series of steps which include qurrying the raw material, crushing and sizing, calcination and hydration. CO_2 is generated during the calcination stage, when limestone ($CaCO_3$) or dolomite ($CaCO_3*MgCO_3$) are burned at high temperature (900-1,200 °C) in a kiln to produce quicklime (CaO) or dolomitic lime (CaO*MgO) and CO_2 which is released in the atmosphere:

$$CaCO_3 \text{ (limestone)} + \text{Heat} \rightarrow CaO \text{ (quicklime)} + CO_2\uparrow$$
$$CaCO_3*MgCO_3 \text{ (dolomite)} + \text{Heat} \rightarrow CaO*MgO \text{ (dolomitic lime)} + 2CO_2\uparrow$$

There are four manufacturers of lime in Croatia, with one of them producing both quicklime and dolomitic lime and the others producing only quicklime. Total seven kilns are used, among four are parallel-flow regenerative shaft kilns, two are annular shaft kilns and one is long rotary kiln.

In addition, for the purpose of improving the completeness of the inventory, emissions from the production of sugar, where a certain amount of quicklime is produced, have been included in this sub-sector.

4.2.2.2.Methodological issues

Calculation of CO_2 emissions from lime production is accomplished by applying an emission factor in tonnes of CO_2 released per tonne of quicklime or dolomitic lime produced, to the annual lime output. The emission factors were derived on the basis of calcination reaction depending on the type of raw material used in the process.

Country-specific emission factor for quicklime was estimated by using data on CaO content of the lime and stoichiometric ratio between CO_2 and CaO from individual plants. Country-specific emission factor for dolomitic lime was estimated by using data on CaO*MgO content of the lime and stoichiometric ratio between CO_2 and CaO*MgO from one plant. Vertical shaft kilns, which are mostly used, generate relatively small amounts of Lime Kiln Dust (LKD). It is judged that a correction factor for LKD from vertical shaft kilns would be negligible and do not need to be estimated.

The data for quicklime and dolomitic lime production, data on the CaO and CaO*MgO content of the lime and stoichiometric ratio between CO_2 and CaO and CaO*MgO were collected by survey of lime and sugar manufacturers. The data for quicklime and dolomitic lime production were cross-checked with lime production data from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining. Also, certain amounts of quicklime were produced in the blast furnace processes, during 1990 and 1991.

A part of the data needed for the calculation of emissions from sugar production has been estimated based on the available data, therefore, for the purpose of additional analysis of reliability and correctness, these data will be checked and more accurate calculations will be performed.

The data on lime production and emission factors are presented in Table 4.2-4.

Table 4.2-4: Lime production and emission factors (1990-2010)

Year	Quicklime		Dolomitic lime	
	Production (tonnes)	EF (t CO_2/t lime)	Production (tonnes)	EF (t CO_2/t lime)
1990	224,830	0.654	7,474	0.869
1991	155,258	0.732	0	-
1992	119,422	0.629	0	-
1993	131,811	0.634	0	-
1994	133,124	0.642	0	-
1995	128,164	0.646	0	-
1996	125,991	0.636	38,070	0.862
1997	119,763	0.634	55,171	0.850
1998	130,386	0.661	53,367	0.874
1999	114,028	0.660	52,704	0.870
2000	114,608	0.658	68,572	0.887
2001	137,563	0.671	84,838	0.887
2002	153,068	0.669	94,378	0.892
2003	138,634	0.670	96,191	0.879
2004	205,806	0.682	56,689	0.895
2005	206,622	0.672	76,351	0.875
2006	233,491	0.669	105,653	0.895
2007	231,511	0.679	115,315	0.899
2008	223,849	0.658	120,680	0.900
2009	141,066	0.631	87,789	0.861
2010	102,867	0.660	92,574	0.903

The resulting emissions of CO_2 from Lime Production in the period 1990-2010 are presented in the Figure 4.2-2.

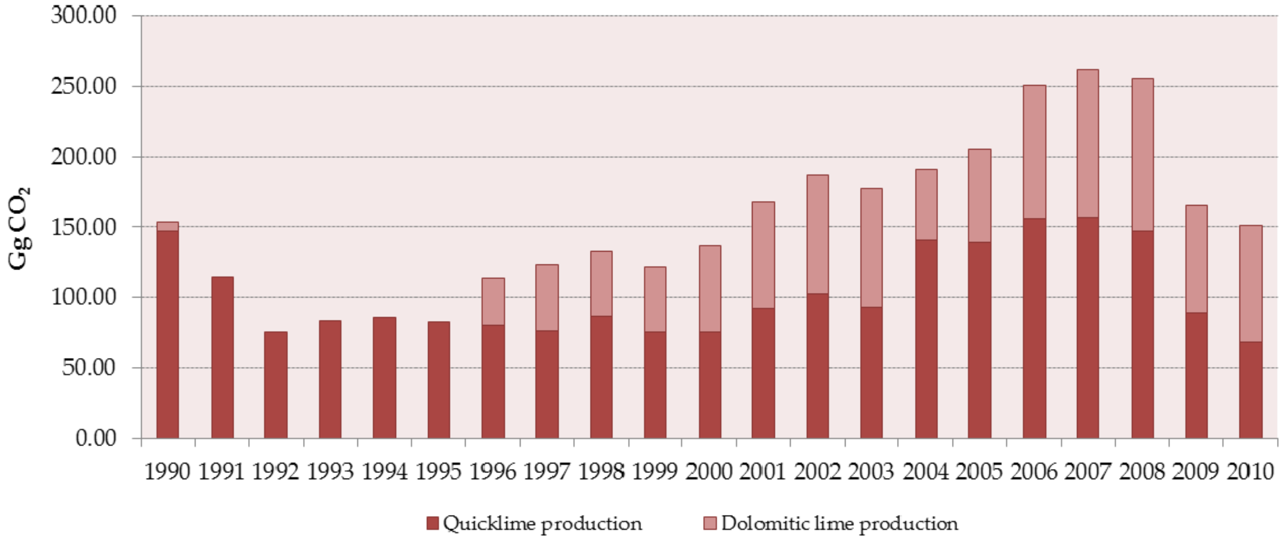

Figure 4.2-2: Emissions of CO_2 from Lime Production (1990-2010)

CO_2 emissions from lime production declined from 1990 to 1995, due to the decline in industrial activities caused by the war in Croatia, while in the period 1996-2008 emissions slightly increased. Due to decreasing of economic activity within 2009, which influenced decreasing of lime production by 34 percent in 2009 and by 43 percent in 2010, while emissions were decreased by 36 percent in 2009 and by 41 percent in 2010, regarding the year 2008.

The methodology for calculation of SO_2 emissions from Lime Production is not available in *Revised 1996 IPCC Guidelines*. Process (non-combustion) SO_2 emissions depend on the sulphur content and mineralogical form of the stone feed, the quality of the lime produced and the type of kiln.

Emissions of CO have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of CO from Lime Production in the period 1990-2010 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.2.2.3.Uncertainties and time-series consistency

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 2.1 percent (1 to 5 percent), based on expert judgements. Uncertainty estimate associated with emission factors amounts 2.2 percent, accordingly to values (1 to 5 percent) reported in *Good Practice Guidance* (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Lime Production have been calculated using the same method and data sets for every year in the time series.

4.2.2.4.Source specific QA/QC and verification

During the preparation of the inventory submission activities related to source specific quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.2.2.5.Source specific recalculations

New data collected from sugar manufacturers have been included in calculations. Consequently, recalculations of emissions from this sub-sector have been performed for the entire calculation period.

4.2.2.6.Source–specific planned improvements

For this report, additional data received from sugar manufacturers, which were prior not included in emissions from this sub-sector, were collected. Due to a need for additional analysis of reliability of these data, they will be checked and more accurate calculations will be performed, which is planned for the next submission.

4.2.3. LIMESTONE AND DOLOMITE USE

4.2.3.1.Source category description

Limestone ($CaCO_3$) and dolomite ($CaCO_3*MgCO_3$) are basic raw materials having commercial applications in a number of industries including metal production, glass, brick and ceramic manufacture, refractory materials manufacture, chemical, agriculture, construction and environmental pollution control. For some of these applications carbonates are sufficiently heated to high temperature as part of the process to generate CO_2 as a by-product. The major utilization of dolomite in Croatia is in glass, brick, ceramic and refractory materials manufacture as well as the limestone use in the pig iron production (during 1990 and 1991). Data for the period from 2000-2010 also include limestone use in desulphurization process in Thermal Power Plant (TPP) Plomin 2[6].

For the purpose of improving the completeness of the inventory, emissions from the use of lithium carbonate (Li_2CO_3) in glass production during 2010, have been included in this sub-sector.

[6] TPP Plomin 2 is a thermal power plant that uses hard coal as a fuel, with sulphur content between 0.3 and 1.4%. In Plomin 2, emission of sulphur dioxide is reduced by utilization of wet limestone-based desulphurization process.

4.2.3.2.Methodological issues

Emissions of CO_2 arising from limestone and dolomite use have been calculated by multiplying annual consumption of raw material in processes (limestone/dolomite) by emission factors, which are based on a ratio between CO_2 and limestone/dolomite used in a particular process. Emissions of CO_2 from the use of limestone have been estimated by using emission factor which equals 440 kg CO_2/tonne limestone. Emissions of CO_2 from the use of dolomite have been estimated by using emission factor which equals 477 kg CO_2/tonne dolomite. Emissions from the use of lithium carbonate were calculated by using emission factor which equals 596 kg CO_2/tonne carbonate[7]. A 100 percent purity of raw material was assumed for the purpose of calculations (*Revised 1996 IPCC Guidelines*).

The activity data for limestone use in the production of pig iron (for the 1990 and 1991), cast iron, glass, brick and ceramics, and for the use in desulphurization process in TPP Plomin 2 were collected by survey of manufacturers.

The activity data for dolomite use in glass, brick, ceramic and refractory materials manufacture for the period 1990-1996 were extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining. After this period, national classification of activities did not distinguish dolomite use in abovementioned activities and because of that, AD was collected by survey of manufacturers. Some of these activities (from the period 1990-1996) were halted in the meantime.

The activity data for the use of lithium carbonate was collected by a survey of glass manufacturers.

Data for the use of limestone, dolomite and other carbonates are shown in Table 4.2-5.

[7] Source: 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 (Annex IX, table 1)

Table 4.2-5: Limestone, dolomite and other carbonates use (1990-2010)

Year	Limestone use (tonnes)	Dolomite and other carbonates* use (tonnes)
1990	60,618	52,031
1991	30,507	40,452
1992	9,950	21,505
1993	9,589	20,134
1994	13,704	32,504
1995	14,085	23,461
1996	12,947	25,063
1997	11,012	14,762
1998	13,412	19,546
1999	12,160	18,396
2000	18,887	15,992
2001	22,526	18,596
2002	38,212	18,415
2003	31,292	21,928
2004	33,369	24,088
2005	33,281	25,275
2006	30,849	22,350
2007	27,802	20,018
2008	32,768	23,582
2009	30,700	35,544
2010	43,728	36,690

* Li_2CO_3 from glass production, used in 2010

The resulting emissions of CO_2 from Limestone and Dolomite Use in the period 1990-2010 are presented in the Figure 4.2-3.

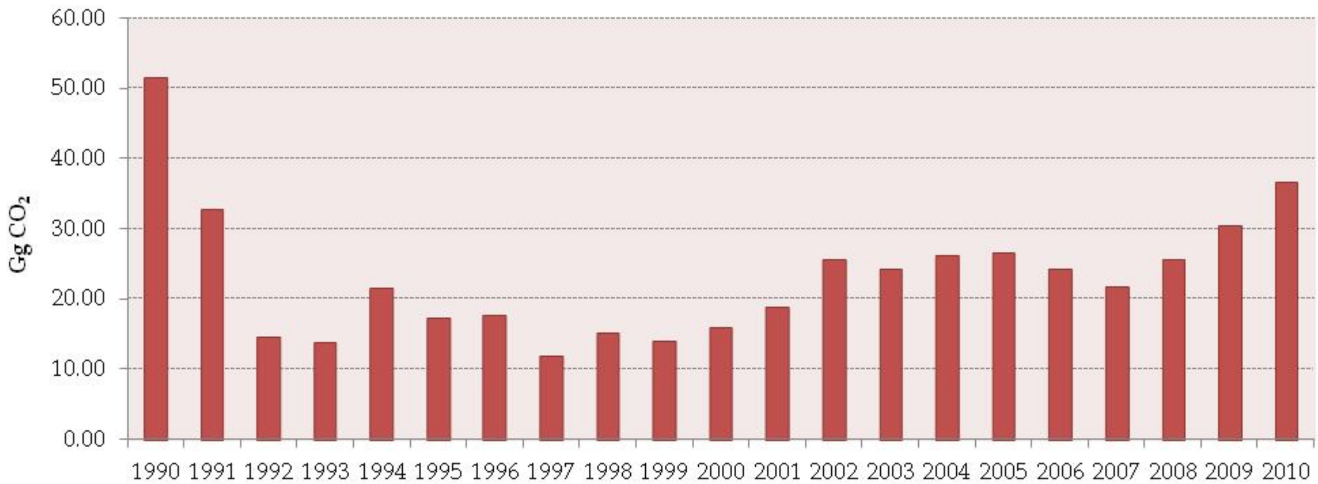

Figure 4.2-3: Emissions of CO_2 from Limestone and Dolomite Use (1990-2010)

4.2.3.3.Uncertainties and time-series consistency

Uncertainties in CO_2 estimates are related to possible variations in the chemical composition of limestone and dolomite (carbonates may contain smaller amounts of impurities i.e. magnesia, silica, and sulphur). Uncertainties contained in these estimates are due to provided default emission factor which assume 100 percent purity of raw material.

Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements. Uncertainty estimate associated with default emission factors amounts 30 percent, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Limestone and Dolomite Use have been calculated using the same method for every year in the time series. Data sets are different for the period 1990-1996 in relation to the period 1997-2010. As abovementioned, in the period 1990-1996 national classification of activities distinguished dolomite use in glass, brick, ceramic and refractory materials manufacture. After this period, national classification of activities did not distinguish dolomite use in abovementioned activities and because of that, AD was collected by survey of manufacturers. Data for 2010 are more detailed than data for the previous years and therefore discrepancy has occurred concerning the whole time-series. So far, detailed data for the entire calculation period has not been collected. Some of the activities (from the period 1990-1996) were halted in the meantime and there is no possibility to collect AD by the same data sets, for entire period.

4.2.3.4.Source specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.2.3.5. Source specific recalculations

In this sub-sector, emission recalculations were made for the entire period by adding new data collected from manufacturers.

4.2.3.6. Source–specific planned improvements

In regards to the previous report, more detailed activity data have been collected from individual plants but this in most part refers only to years 2009 and 2010. Therefore, gathering of data for entire time-series should be performed to avoid potential inconsistency.

4.2.4.SODA ASH PRODUCTION AND USE

4.2.4.1.Source category description

Soda ash (sodium carbonate, Na_2CO_3) is used as a raw material in a large number of industrial processes including the manufacture of glass, ceramic, soap and detergents, pulp and paper production and water treatment methods.

According to Department of Manufacturing and Mining (Central Bureau of Statistics) there was not any significant production, both natural and synthetic, of soda ash in Croatia in the period 1990-2010. Therefore, only CO_2 emissions arising in soda ash consumption in glass and ceramic manufacture, and in the production of soap and detergents, have been estimated.

4.2.4.2.Methodological issues

Emissions of CO_2 from the soda ash use have been calculated by multiplying annual consumption of soda ash by emission factor, which is based on a ratio between CO_2 and soda ash used. Default emission factor equals 415 kg CO_2/tonne soda ash has been used (*Revised 1996 IPCC Guidelines*).

The activity data for soda ash use in glass and ceramic manufacture, and in the production of soap and detergents in the period 1990-1996, were extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining. National classification of activities distinguished soda ash use in glass and ceramic manufacture and in the production of soap and detergents in that period. After this period national classification of activities did not distinguish soda ash use in abovementioned activities and because of that, AD was collected by survey of manufacturers (see Table 4.2-6). Missing data from one manufacturer for the year 2003, were estimated by interpolation.

Table 4.2-6: Soda ash use (1990-2010)

Year	Soda ash use (tonnes)
1990	62,024
1991	52,415
1992	30,739
1993	30,228
1994	36,659
1995	34,668
1996	33,400
1997	27,298
1998	30,622
1999	29,103
2000	28,389
2001	35,108

Table 4.2-6: Soda ash use (1990-2010), cont.

Year	Soda ash use (tonnes)
2002	33,778
2003	39,971
2004	43,962
2005	47,111
2006	42,479
2007	38,611
2008	39,473
2009	42,041
2010	48,061

The resulting emissions of CO_2 from Soda Ash Use in the period 1990-2010 are presented in the Figure 4.2-4.

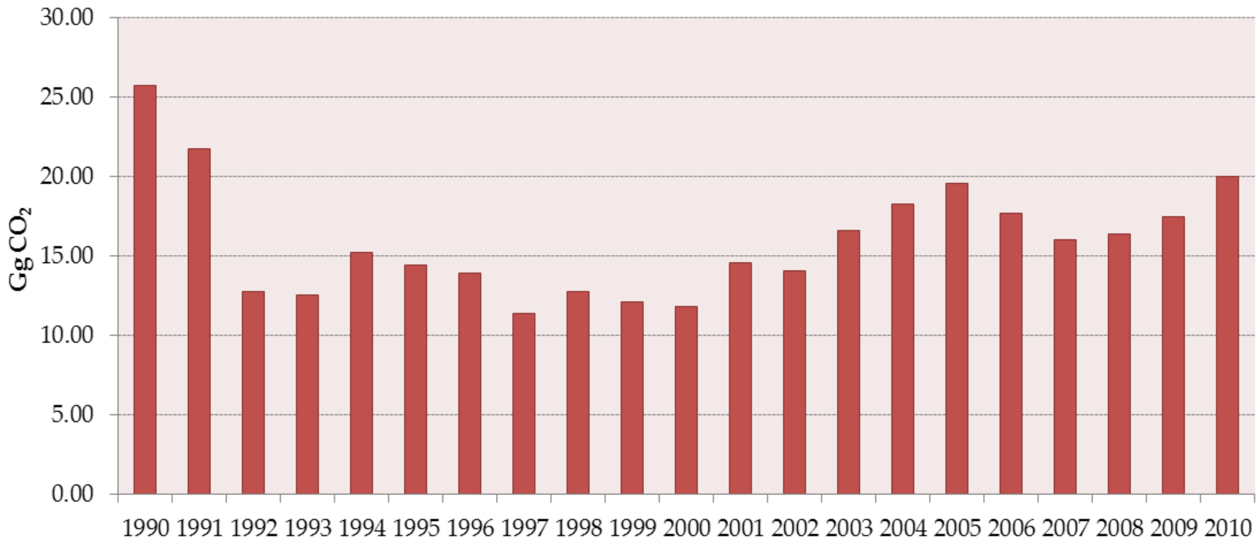

Figure 4.2-4: Emissions of CO_2 from Soda Ash Use (1990-2010)

4.2.4.3.Uncertainties and time-series consistency

Emissions of CO_2 from soda ash use are dependent upon a type of end-use processes involved. Specific information characterizing the emissions from particular end-use process is not available. Therefore, uncertainties are related primarily to the accuracy of the emission factor.

Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements. Uncertainty estimate associated with default emission factors amounts 30 percent, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Soda Ash Use have been calculated using the same method for every year in the time series. Data sets are different for the period 1990-1996 in relation to the period 1997-2010. As abovementioned, in the period 1990-1996 national classification of activities distinguished soda ash use in glass and ceramic manufacture and in the production of soap and detergents. After this period national classification of activities did not distinguish soda ash use in abovementioned activities and because of that, AD was collected by survey of manufacturers. Some of the activities (from the period 1990-1996) were halted in the meantime and there is no possibility to collect AD by the same data sets, for entire period. Also, input data collected from one manufacturer of soaps and detergents encompass only the period from 2001-2010 because there is no data archive prior to 2000 and there is no possibility for obtaining those activity data.

4.2.4.4.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.2.4.5.Source specific recalculations

Recalculations were made for the period 1997-1999 and 2001-2009 because new data collected from manufacturers have been added.

4.2.4.6.Source–specific planned improvements

There are no plans for additional improvements of emission calculations.

4.2.5. PRODUCTION AND USE OF MISCELLANEOUS MINERAL PRODUCTS

4.2.5.1.Source category description

There are several mineral production processes which caused emissions of indirect GHGs: Asphalt Roofing Production, Road Paving with Asphalt and Glass Manufacturing.

4.2.5.2. Methodological issues

Emissions of NMVOC and CO have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of indirect GHGs from Production and Use of Miscellaneous Mineral Products in the period 1990-2010 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.2.5.3.Uncertainties and time-series consistency

Uncertainties associated with emission factors and activity data were not estimated for Production and Use of Miscellaneous Mineral Products.

Emissions from Production and Use of Miscellaneous Mineral Products have been calculated using the same method and data sets for every year in the time series.

4.2.5.4.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.2.5.5.Source specific recalculations

There are no source-specific recalculations because only NMVOC and CO emissions are calculated in abovementioned activities.

4.2.5.6.Source–specific planned improvements

Investigation of specific information related to type of asphalt roofing production processes and type of asphalt as well as amounts of diluents which are used in asphalt production plans to achieve.

4.3 CHEMICAL INDUSTRY (CRF 2.B.)

4.3.1. AMMONIA PRODUCTION

4.3.1.1Source category description

Ammonia is produced by catalytic steam reforming of natural gas in which hydrogen is chemically separated from the natural gas and combined with nitrogen to produce ammonia (NH_3). Carbon dioxide which is formed from carbon monoxide in CO shift converter is removed by using two methods: monoethanolamine scrubbing and hot potassium scrubbing. After absorbing the CO_2, the amine solution is preheated and regenerated which results in removing the CO_2 by steam stripping and then by heating. The CO_2 is either vented to the atmosphere or used as a feedstock in other parts of the plant complex (for production of UREA or dry ice).

4.3.1.2Methodological issues

In ammonia production natural gas provides both feedstock and fuel. Emissions of CO_2 from natural gas used as feedstock have been calculated by means of multiplying annual consumption of natural gas by carbon content of natural gas and molecular weight ratio between CO_2 and carbon (Tier 1a, *Revised 1996 IPCC Guidelines*).

Data on consumption and composition of natural gas (see Table 4.3-1) used as a feedstock were collected by survey of ammonia manufacturer (Petrokemija Fertilizer Company Kutina) and cross-checked with ammonia production data from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

Carbon content of gas (kg C/m^3) has been estimated from volume fraction of CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}, CO_2 and N_2 in natural gas. Measurements were performed at the standard condition (1 atm, 15°C). Therefore, molar volume were corrected ($V = R*T/p = 23.64$ dm^3). Natural gas composition is determined by an accredited chromatographic "in house" method COMPOSITION OF NATURAL GAS. CALCULATION OF LOWER CALORIFIC VALUE AND DENSITY. CHROMATOGRAPHIC METHOD NR. 69-08-2-5-9-830/0307. Calculation of lower heating value is done according to norm HRN ISO 6976:2008 Natural gas – Calculation of heating values, density, relative density and Wobbe index from composition.

Table 4.3-1: Consumption and composition of natural gas in Ammonia Production (1990-2010)

Year	Natural gas consumption (m^3)	Carbon content of gas
	Feedstock	(kg C/m^3)
1990	242,905,233	0.5232
1991	230,492,226	0.5289
1992	299,567,927	0.5237
1993	238,269,046	0.5114
1994	239,717,137	0.5120
1995	232,773,362	0.5141
1996	254,116,356	0.5115
1997	277,311,935	0.5093
1998	207,973,360	0.5094
1999	262,772,017	0.5108
2000	266,433,375	0.5097
2001	214,441,408	0.5134
2002	193,045,364	0.5139
2003	216,859,822	0.5148
2004	264,367,950	0.5111
2005	259,004,302	0.5103
2006	253,861,433	0.5128
2007	280,232,850	0.5075
2008	284,633,920	0.5082
2009	238,983,580	0.5080
2010	267,670,049	0.5108

The resulting emissions of CO_2 from Ammonia Production in the period 1990-2010 are presented in the Figure 4.3-1.

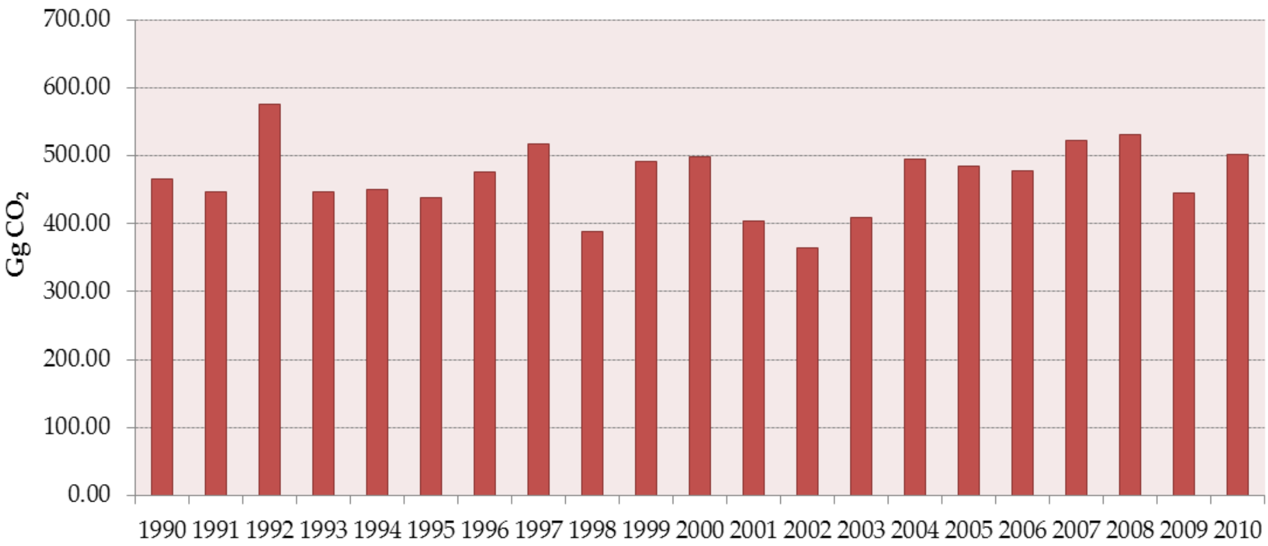

Figure 4.3-1: Emissions of CO_2 from Ammonia Production (1990-2010)

4.3.1.3 Uncertainties and time-series consistency

According to *Revised 1996 IPCC Guidelines* the most accurate method of emissions estimation from natural gas as feedstock is based on the consumption and composition of natural gas in the process. There are some uncertainties concerning to use of CO_2 as a feedstock in downstream manufacturing processes, in the production of urea, dry ice and fertilizer. According to *Revised 1996 IPCC Guidelines* no account should consequently be taken for intermediate binding of CO_2 in production of urea, dry ice and fertilizer. Also, emissions estimation from natural gas as fuel is based on the consumption of natural gas and default emission factors.

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 3 percent (1 to 5 percent), based on expert judgements. Uncertainty estimate associated with emission factors amounts 5 percent, accordingly to value recommended in *Good Practice Guidance* (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Ammonia Production have been calculated using the same methods and data sets for every year in the time series.

4.3.1.4 Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Ammonia Production is one of the key source categories in Industrial Processes. Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories. Emissions of CO_2 from consumption of natural gas (both feedstock and fuel) were estimated using Tier 1a method which could be considered as a *good practice*. Emissions of CH_4 and N_2O from consumption of natural gas as fuel were estimated using Tier 1 method. Basic activity data from Annual Industrial Reports were compared with data provided by plant. Results of this comparison showed that there is no significant difference between these two sets of data.

4.3.1.5Source–specific recalculations

There are no recalculations in this sub-sector.

4.3.1.6Source–specific planned improvements

Since Ammonia Production is a key source category more detailed information about use of CO_2 as a feedstock in downstream manufacturing processes, are planned to investigate.

4.3.2. NITRIC ACID PRODUCTION

4.3.2.1.Source category description

There is one manufacturer of nitric acid in Croatia, with dual pressure type of production process, according to the pressure used in the oxidation and absorption stages. Ammonia, which is used as a feedstock, is vaporized, mixed with air and burned over a platinum/rhodium alloy catalyst. Nitrogen monoxide is formed and oxidized to nitrogen dioxide at medium pressures and absorbed in water at high pressure to give nitric acid. During oxidation stage, nitrogen and nitrous oxide are formed as a by-product and released from reactor vents into the atmosphere. There is no abatement technology installed at the plant. Nitric acid is used in the manufacture of fertilizers.

4.3.2.2.Methodological issues

Emissions of N_2O from nitric acid production have been calculated by multiplying annual nitric acid production by plant-specific EF of 7.8 kg N_2O/tonne nitric acid. This plant-specific EF is in accordance with BAT document.
Data on nitric acid production (see Table 4.3-3) were collected by survey of nitric acid manufacturer (Petrokemija Fertilizer Company Kutina) and cross-checked with nitric acid production data from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

Table 4.3-3: Nitric acid production (1990-2010)

Year	Nitric acid production
1990	332,459
1991	291,997
1992	381,797
1993	287,805
1994	311,236
1995	299,297
1996	278,683
1997	292,892
1998	220,509
1999	260,198
2000	306,201
2001	257,534
2002	249,992
2003	235,645
2004	287,567
2005	280,746
2006	277,590
2007	306,619
2008	312,928
2009	261,478
2010	336,795

The resulting emissions of N_2O from Nitric Acid Production in the period 1990-2010 are presented in the Figure 4.3-2.

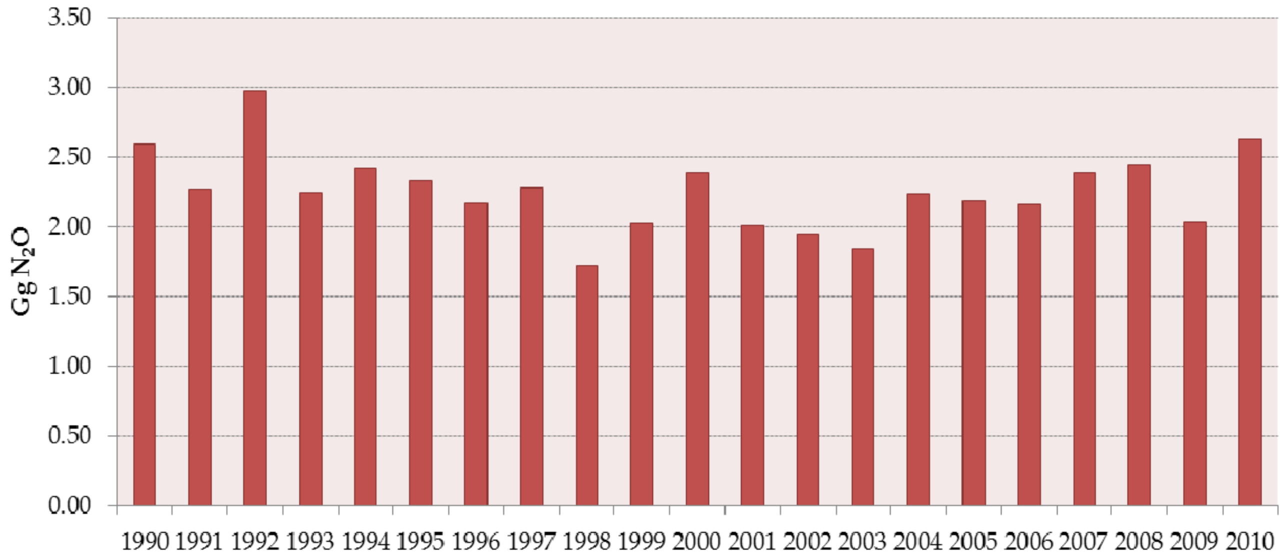

Figure 4.3-2: Emissions of N_2O from Nitric Acid Production (1990-2010)

4.3.2.3.Uncertainties and time-series consistency

The main uncertainties concerning the emissions of N_2O from nitric acid production are due to applied emission factor. This plant-specific EF does not completely outline the real value, because Petrokemija Fertilizer Company does not continuously measure N_2O emissions. In the future Petrokemija will perform continuously measurement of N_2O emissions.

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 3 percent (1 to 5 percent), based on expert judgements. Uncertainty estimate associated with default emission factors amounts 30 percent, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Nitric Acid Production have been calculated using the same method and data sets for every year in the time series.

4.3.2.4.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Nitric Acid Production is one of the key source categories in Industrial Processes. Emissions of N_2O from nitric acid production were based on plant-specific emission factor and annual amount of nitric acid production. It is a *good practice* to use direct emission measurement for national emission factor calculation. Basic activity data from Annual Industrial Reports were compared with data provided by individual plant. Results of this comparison showed that there is no significant difference between these two sets of data.

4.3.2.5.Source–specific recalculations

There are no source-specific recalculations in this report.

4.3.2.6.Source–specific planned improvements

Since Nitric Acid Production is a key source category, more detailed information about using of direct emission measurement for calculation of national emission factor are planned to investigate. Furthermore, this data are not available since CEM system is not installed and manufacturer is not obliged yet to conduct spot measurement according to relevant regulation. In the future, Petrokemija will perform continuous measurement of N_2O emissions.

4.3.3.PRODUCTION OF OTHER CHEMICALS

4.3.3.1.Source category description

The production of other chemicals such as carbon black, coke, and some petrochemicals (ethylene, dichlorethylene, styrene) can be sources of CH_4 emissions. Although most CH_4 sources from industrial processes individually are small, collectively they may be significant.

4.3.3.2.Methodological issues

Emissions of CH_4 from the production of other chemicals have been calculated by multiplying an annual production of each chemical with related emission factor provided by *Revised 1996 IPCC Guidelines*. The annual production of chemicals (see Table 4.3-4) was extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

The resulting emissions of CH_4 from Production of Other Chemicals in the period 1990-2010 are reported in Table 4.3-5.

Table 4.3-4: Production of Other chemicals (1990-2010)

Year	Carbon black (tonnes)	Ethylene (tonnes)	Dichloroethylene (tonnes)	Styrene (tonnes)	Coke (tonnes)
1990	30,624	72,631	72,653	8,923	556,084
1991	18,783	66,871	68,325	6,376	441,584
1992	13,479	68,318	92,089	1,381	409,371
1993	17,123	68,634	79,608	0	420,676
1994	21,468	65,285	97,528	0	276,854
1995	27,185	67,547	84,374	0	0
1996	26,735	64,782	48,630	0	0
1997	24,214	63,554	26,264	0	0
1998	22,165	60,148	31,308	0	0
1999	17,589	60,295	47,686	0	0
2000	20,029	38,918	71,364	0	0
2001	21,180	46,632	64,442	0	0
2002	19,385	43,554	0	0	0
2003	21,497	41,252	0	0	0
2004	20,271	49,886	0	0	0
2005	18,498	50,263	0	0	0
2006	26,264	48,824	0	0	0
2007	23,724	45,438	0	0	0
2008	16,903	43,045	0	0	0
2009	3,976	38,797	0	0	0
2010	0	36,271	0	0	0

Table 4.3-5: Emissions of CH_4 from Production of Other Chemicals (1990-2010)

Year	Emissions of CH_4 from production of other chemicals (Gg)				
	Carbon black	Ethylene	Dichloro-ethylene	Styrene	Coke
1990	0.34	0.07	0.03	0.04	0.28
1991	0.21	0.07	0.03	0.03	0.22
1992	0.15	0.07	0.04	0.01	0.20
1993	0.19	0.07	0.03	0	0.21
1994	0.24	0.07	0.04	0	0.14
1995	0.30	0.07	0.03	0	0
1996	0.29	0.06	0.02	0	0
1997	0.27	0.06	0.01	0	0
1998	0.24	0.06	0.01	0	0
1999	0.19	0.06	0.02	0	0
2000	0.22	0.04	0.03	0	0
2001	0.23	0.05	0.03	0	0
2002	0.21	0.04	0	0	0
2003	0.24	0.04	0	0	0
2004	0.22	0.05	0	0	0
2005	0.20	0.05	0	0	0
2006	0.29	0.05	0	0	0
2007	0.26	0.05	0	0	0
2008	0.19	0.04	0	0	0
2009	0.04	0.04	0	0	0
2010	0	0.04	0	0	0

The emissions of indirect GHGs from Production of Other Chemicals for the period 1990-2010 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.3.3.3.Uncertainties and time-series consistency

Uncertainty estimate associated with activity data for CH_4 emissions amounts 7.5 percent (5 to 10 percent), based on expert judgements. Uncertainty estimate associated with default emission factor for CH_4 emissions amounts 30 percent, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Production from Other Chemicals have been calculated using the same method and data sets for every year in the time series.

Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.3.3.4.Source–specific recalculations

Recalculation of data from production of polyvinylchloride was made for the period 1994-2000, and also for the production of polystyrene for the period 2004-2009 according to the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

4.3.3.5.Source–specific planned improvements

For the purpose of accurate emission calculations, Croatia plans to analyze specific chemical production processes.

4.4. METAL PRODUCTION (CRF 2.C.)

4.4.1. IRON AND STEEL PRODUCTION

4.4.1.1. Source category description

Primary production of pig iron in blast furnace was halted in 1992.

Steel production in electric arc furnaces (EAF) are used to produce carbon and alloy steel. The input material to EAFs is 100 percent scrap. Cylindrical lined EAFs are equipped with carbon electrodes. Alloying agents and fluxing materials (limestone) are added. Electric current of opposite polarity electrodes generates heat between the electrodes and through the scrap. The operations which generate emissions during the EAF steelmaking process are melting, refining, charging scrap, tapping steel and dumping slag. During the melting phase carbon electrodes are kept above the steel melt and the electrical arc oxidises the carbon to CO or CO_2.

4.4.1.2. Methodological issues

Pig Iron Production

Emissions of CO_2 have been calculated by multiplying annual production of pig iron by the emission factor proposed by *Revised 1996 IPCC Guidelines* (1.6 tonnes CO_2/tonne pig iron produced).

The activity data for pig iron were extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining and cross-checked with iron and steel manufacturer[8].

The resulting emission of CO_2 from Pig Iron Production in 1990 was amounted 335,000 tonnes. In 1991 about 111,000 tonnes of CO_2 was emitted. CO_2 emissions are not included in Metal Production to avoid double-counting. These emissions are included in Energy sector because Coke Oven Coke used in blast furnace is given in energy balance.

Steel Production

There are two steel manufacturers in Croatia. In 2009 steel production by one manufacturer was halted. A method based on annual consumption of carbon donors in EAFs has been used for CO_2 emission calculation for each manufacturer. Methodology proposed by the Guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC has been used. For 2005-2010 CO_2 emissions (which are just underway of verifying because Croatia is not in EU ETS yet) have been taken for the inventory.

[8] It should be noticed that blast furnaces were closed at the end of 1991 mainly due to war activities near the location of iron and steel plant.

The same methodology has been used for the entire time series. Calculation of CO_2 emissions is accomplished by applying an emission factor in tonnes of CO_2 released per tonne of carbon donors (input material) to the consumed quantity of the input material. The carbon emission factor is based on carbon loss from carbon donors. Total CO_2 emission has been calculated as follows:

CO_2 emission (t CO_2) $=\sum$ (activity $data_{input}$ * emission $factor_{input}$) - $\sum$ (activity $data_{output}$ * emission $factor_{output}$)

The activity data for main carbon donors (scrap iron, steel scrap, EAF carbon electrodes, EAF charge carbon and petroleum coke), which were collected by bottom up analysis from two steel manufacturers, are presented in Table 4.4-1. The other carbon donors were used in minor quantity. Within installations natural gas, diesel oil and liquefied petroleum gases were used as reducing agents (see Table 4.4-2).

Table 4.4-1: Consumption of main carbon donors (input materials) in EAFs (1990-2010)

Year	Scrap iron (tonnes)	Steel scrap (tonnes)	EAF carbon electrodes (tonnes)	EAF charge carbon (tonnes)	Petroleum coke (tonnes)
1990	2,500	173,588	1,180	121	0
1991	13,221	119,396	982	106	600
1992	17,866	96,221	927	88	327
1993	23,557	60,799	627	63	253
1994	14,892	56,777	550	122	68
1995	10,559	41,661	346	27	0
1996	12,858	38,966	312	12	191
1997	18,233	61,114	468	7	369
1998	31,968	84,281	698	100	246
1999	11,743	72,647	557	78	127
2000	7,845	70,363	462	67	58
2001	7,003	55,100	375	60	118
2002	5,324	29,121	213	292	115
2003	15,934	29,777	223	240	215
2004	20,409	76,594	417	737	274
2005	7,818	77,641	286	745	99
2006	5,510	87,978	331	886	177
2007	4,523	85,054	351	967	97
2008	31,421	130,815	713	1,418	399
2009	25,531	26,293	333	4	376
2010	82,659	38,797	649	283	1,550

Table 4.4-2: Consumption of other carbon donors (input materials) and reducing fuels in EAFs (1990-2010)

Year	Lime (tonnes)	Other carbon donors* (tonnes)	Natural gas (m^3)	Diesel oil (tonnes)	Liquefied petroleum gases (tonnes)
1990	2,970	603	8,470,000	1,624	0
1991	2,095	262	5,310,000	960	0
1992	1,484	256	1,331,000	756	0
1993	2,737	286	1,547,000	379	0
1994	1,530	629	1,242,000	444	0
1995	848	235	687,000	398	0
1996	1,322	496	908,000	252	0
1997	1,729	695	1,119,000	429	0
1998	2,606	1,103	2,032,000	617	0
1999	1,468	518	1,976,000	495	0
2000	861	530	1,146,000	509	0
2001	1,047	449	1,264,000	334	0
2002	670	280	570,000	0	438
2003	1,226	500	1,505,000	0	371
2004	1,641	564	1,818,000	0	1,221
2005	555	289	1,036,000	0	1,392
2006	592	315	1,446,000	0	1,642
2007	386	180	1,033,000	0	1,661
2008	2,559	366	2,311,000	0	2,041
2009	2,327	317	2,839,000	0	0

* other carbon donors include alloys Fe-Cr, Fe-Mo, Fe-V, Fe-Si, Fe-Si-Mn and fluorite

Default emission factors for main carbon donors[9] (Table 4.4-3) and reducing fuels[10] (Table 4.4-4) have been used.

Table 4.4-3: EF for carbon donors (input materials) in EAFs (1990-2010)

Carbon donors	EF (t CO_2/t)
Scrap iron	0.15
Steel scrap	0.008
EAF carbon electrodes	3.00
EAF charge carbon	3.04
Petroleum coke	3.19

Table 4.4-4: EF and net calorific values for reducing fuel in EAFs (1990-2010)

Reducing fuels	EF (t CO_2/TJ)	NCV (TJ/Gg)
Natural gas	56.1	34.00
Gas/Diesel oil	74.07	42.71
Liquefied petroleum gases	63.07	46.89

[9] See 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 4.3 - EF expressed in t C/t multiplied with a CO_2/C conversion factor of 3.664

[10] see Annex 8 (oxidation factor OF = 1 is used)

The activity data for steel production (see Table 4.4-5) were collected by bottom up analysis from two steel manufacturers.

Table 4.4-5: Steel production (1990-2010)

Year	Steel production (tonnes)
1990	171,148
1991	119,734
1992	101,944
1993	74,082
1994	63,355
1995	45,370
1996	45,754
1997	69,895
1998	103,204
1999	75,877
2000	69,641
2001	56,169
2002	32,789
2003	40,942
2004	86,105
2005	73,640
2006	80,517
2007	76,252
2008	138,865
2009	46,264
2010	103,427

The resulting emissions of CO_2 from Steel Production in the period 1990-2010 are presented in the Figure 4.4-1.

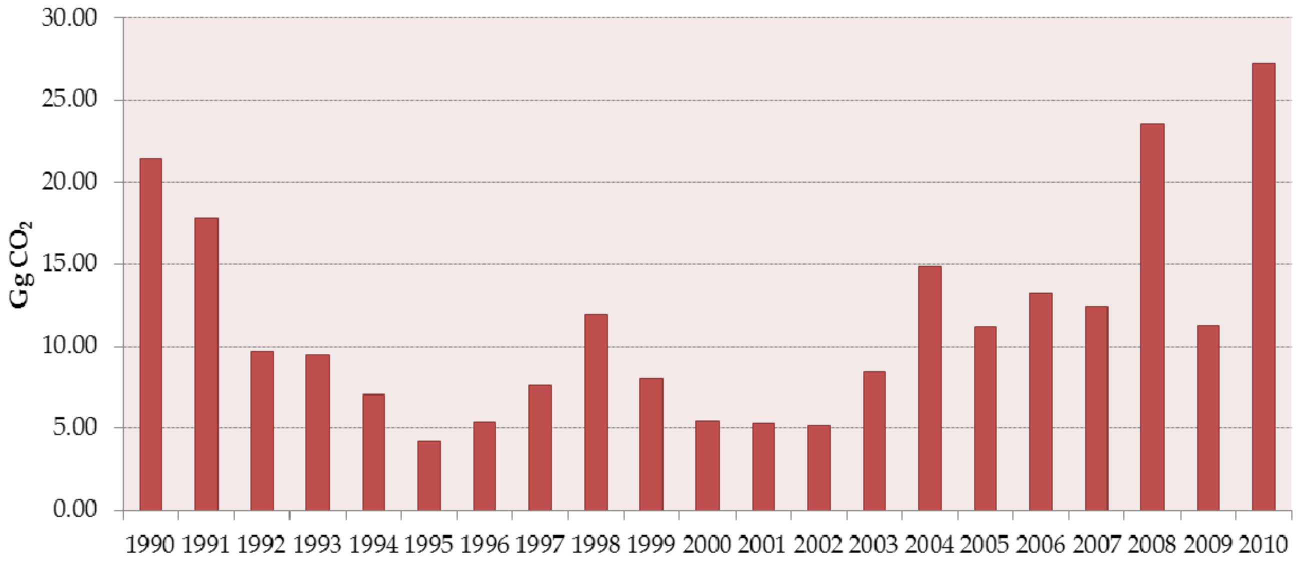

Figure 4.4-1: Emissions of CO_2 from Steel Production (1990-2010)

CO_2 emissions fluctuated over the period. It is mainly a result of discontinuous operation which requires increasing consumption of input materials.

4.4.1.3. Uncertainties and time-series consistency

Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements. The main uncertainties concerning the emission of CO_2 from steel production are due to applied emission factor. Uncertainty estimate associated with emission factors amounts 30 percent, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Steel Production have been calculated using the same method and data sets for every year in the time series.

4.4.1.4. Source specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.4.1.5. Source–specific recalculations

There are no recalculations for this sub-sector.

4.4.1.6. Source–specific planned improvements

There is no need for further improvements because steel production is not a key category.

4.4.2.FERROALLOYS PRODUCTION

4.4.2.1.Source category description

Ferroalloys are alloys of iron and metals such as silicon, manganese and chromium. Similar to emissions from the production of iron and steel, CO_2 is emitted when metallurgical coke is oxidized during a high-temperature reaction with iron and the selected alloying element. Ferroalloys production was halted in 2003.

4.4.2.2.Methodological issues

A higher tier method based on reducing agents has been used for CO_2 emissions calculation. Applying a higher tier method enables avoiding of possible double counting of CO_2 emissions that are already accounted for in the energy sector. Reducing agents that are not accounted for in the energy sector are included here.

Emissions of CO_2 have been calculated by multiplying annual data on reducing agents (see Table 4.4-6) by default emission factor (3.1 tonne CO_2/tonne coke from coal and 3.6 tonne CO_2/tonne coal electrodes). Reducing agent were collected from statistical database 'Inputs of raw and material in industrial production'. Interpolation method has been used for calculation of insufficient data for coke from coal for the period 1994-1996 and 1999-2001. Ferroalloys production fluctuated over the period. It is mainly a result of discontinuous operation, caused by the war in Croatia. Ferroalloys production was halted in 2003.

Table 4.4-6: Reducing agents (1990-2003)

Year	Coke from coal (tonnes)	Coal electrodes (tonnes)
1990	36,216	1,824
1991	41,981	2,533
1992	25,619	1,645
1993	8,519	799
1994	8,566	988
1995	9,529	650
1996	3,860	266
1997	11,867	818
1995	9,529	650
1996	3,860	266
1997	11,867	818
1998	5,166	356
1999	6,054	417
2000	3,624	250
2001	1,195	82
2002	4	0.28
2003	13	0.9

The resulting emissions of CO_2 from Ferroalloys Production in the period 1990-2010 are presented in the Figure 4.4-2.

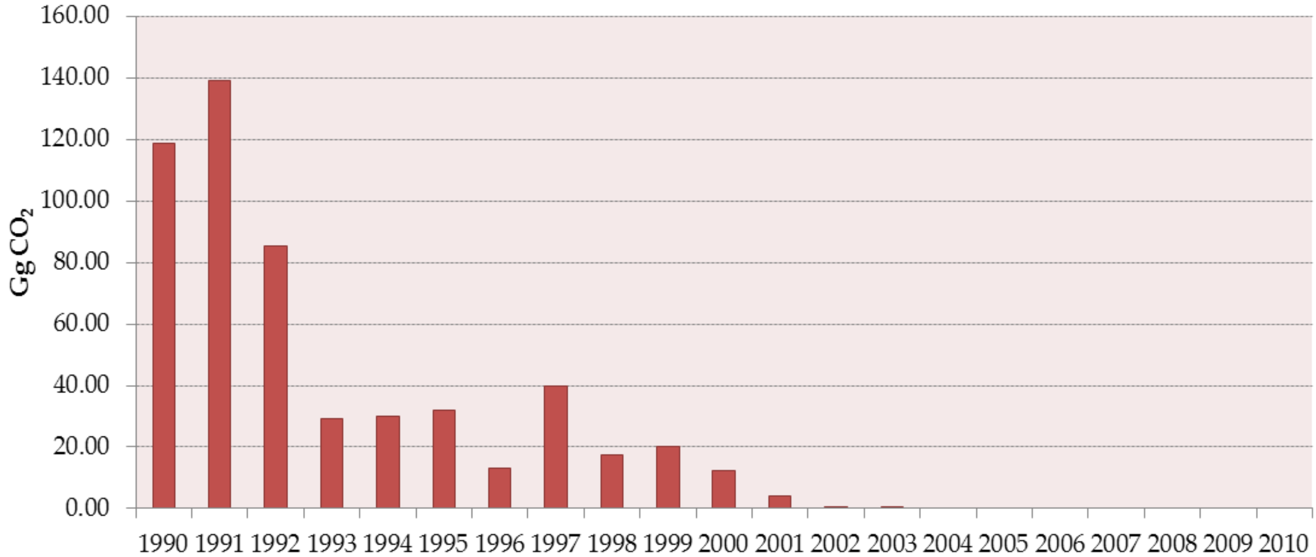

Figure 4.4-2: Emissions of CO_2 from Ferroalloys Production (1990-2010)

4.4.2.3.Uncertainties and time-series consistency

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements. Uncertainty estimate associated with default emission factors amounts 30 percent, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Ferroalloys Production have been calculated using the same method and data sets for every year in the time series, except insufficient data which were obtained by interpolation method. Fluctuations in ferroalloys production over the period caused high uncertainty of data which was assessed by interpolation.

4.4.2.4.Source specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.4.2.5. Source–specific recalculations

There are no source-specific recalculations in this report.

4.4.3.ALUMINIUM PRODUCTION

4.4.3.1.Source category description

Primary aluminium is produced in two steps. First bauxite ore is ground, purified and calcined to produce alumina (Al_2O_3). Following this, the alumina is electrically reduced to aluminium by smelting in large pots. This process results in emission of several greenhouse gases including CO_2, and two PFCs: CF_4 and C_2F_6.

Primary aluminium production in Croatia was halted in 1991. There were used two types of furnaces – open and closed type. Open furnaces were older and represent majority of production furnaces. Alusuisse technology was used, with total 208 open furnaces with prebaked anodes, side feed, without computer controlled process. At the end of 1990 (in September) 10 new closed furnaces started to work (Peciney technology), with central feed and computer controlled process.

4.4.3.2.Methodological issues

The quantity of CO_2 released was estimated from the production of primary aluminium and the specific consumption of carbon which is oxidized to CO_2 in the process. During alumina reduction using prebaked anodes approximately 1.5 tonnes of CO_2 is emitted for each tonne of primary aluminium produced.
Data on primary aluminium production were collected by survey of aluminium manufacturer[11] .

The resulting emission of CO_2 from Aluminium Production in 1990 was amounted about 111 Gg CO_2. In 1991 about 76 Gg CO_2 was emitted.

PFCs emissions from Aluminium Production could represent a significant source of emissions due to high GWP values. Since only aluminium production statistics were available, emissions of CF_4 and C_2F_6 were estimated by multiplying annual primary aluminium production with default emission factors provided by *Good Practice Guidance*. Default emission factors equal 1.7 kg/tonne Al for CF_4 and 0.17 kg/tonne Al for C_2F_6 (Side Worked Prebaked Anodes). 820 Gg CO_2-eq of CF_4 and 116 Gg CO_2-eq of C_2F_6 were emitted in 1990. 563 Gg CO_2-eq of CF_4 and 80 Gg CO_2-eq of C_2F_6 were emitted in 1991.

Occasionally, sulphur hexafluoride (SF_6) is also used by the aluminium industry as a cover gas for special foundry products. There are no available data on SF_6 consumption in aluminium industry.

4.4.3.3.Uncertainties and time-series consistency

Uncertainties related to calculation of CO_2 emissions are primarily due to applied emission factor. A less uncertain method to calculate CO_2 emissions would be based upon the amount of reducing agent, i.e. amount of prebaked anodes used in a process but this information was not available. Nevertheless, it is very likely that use of the technology-specific emission factor, provided by *Revised 1996 IPCC Guidelines*, along with the correct production data produce accurate estimates.

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data for CO_2 emissions amounts 3 percent (1 to 5 percent), based on expert judgements. Uncertainty estimate associated with default emission factor for CO_2 emissions amounts 30 percent, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

More uncertainties are related to calculation of PFCs emissions because continuous emission monitoring was not carried out, and smelter-specific operating parameters were not available. Default emission factors were therefore applied to calculate PFCs emissions. Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis.

[11] It should be noticed that primary aluminium production (electrolysis) were closed at the end of 1991 mainly due to war activities near the location of aluminium plant.

Uncertainty estimate associated with activity data for PFCs emissions amounts 30 percent, based on expert judgements. Uncertainty estimate associated with default emission factor for PFCs emissions amounts 50 percent, based on expert judgements.

Emissions from Aluminium Production have been calculated using the same method and data sets for every year in the time series.

4.4.3.4.Source specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.5. OTHER PRODUCTION (CRF 2.D.)

4.5.1.PULP AND PAPER

4.5.1.1.Source category description

Kraft (sulphate) pulping, acid sulphite pulping and neutral sulphite semi-chemical process are three types of paper production processes. Kraft pulping was used in 1990 and acid sulphite pulping was used until 1994 for paper production. After that, only neutral sulphite semi-chemical process has been used for paper production.

4.5.1.2.Methodological issues

Emissions of indirect GHGs have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of indirect GHGs from Pulp and Paper in the period 1990-2010 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.5.1.3.Uncertainties and time-series consistency

Uncertainties associated with emission factors and activity data were not estimated for Pulp and Paper.

Emissions from Pulp and Paper have been calculated using the same method and data sets for every year in the time series.

4.5.1.4.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.5.1.5.Source specific recalculations

There are no source-specific recalculations because emissions of indirect GHGs are calculated.

4.5.2. FOOD AND DRINK

4.5.2.1.Source category description

Emissions of NMVOC from following types of Food and Drink production processes have been calculated: bread, wine, beer, spirit.

4.5.2.2.Methodological issues

Emissions of NMVOC have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of NMVOC from Food and Drink in the period 1990-2010 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.5.2.3.Uncertainties and time-series consistency

Uncertainties associated with emission factors and activity data were not estimated for Food and Drink.

Emissions from Food and Drink have been calculated using the same method and data sets for every year in the time series.

4.5.2.4.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.5.2.5.Source specific recalculations

There are no source-specific recalculations in this report.

4.6. CONSUMPTION OF HALOCARBONS AND SF6 (CRF 2.F.)

Ministry of Environmental and Nature Protection is responsible for monitoring of consumption of substitutes and mixture of substitutes for gases that deplete the ozone layer. According to requirement of Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official Gazette No. 1/07), all sources of HFCs, PFCs and SF_6 emissions should report required activity data. Regulation on controls of ozone-depleting substances (Official Gazette No.120/05) prescribes control of import and export of these gases and providing of register to the Ministry of Environmental and Nature Protection. There is no production of HFCs PFCs and SF_6 in Croatia, therefore, all quantities of these gases are imported. Minor quantities of some substances are exported.

Croatia is an Article 5 country, according to the Montreal protocol, and has a longer period for using CFC, HCFC and halons. Because of that, Croatia started using HFCs 10 years later then other Annex I countries.

The resulting HFCs, PFCs and SF_6 emissions (Gg CO_2-eq) from Consumption of Halocarbons and SF_6 in the period 1990-2010 are presented in the Figure 4.6-1. Shown are actual emissions of gases HFC-32, HFC-125, HFC-134a and HFC-143a, and potential emissions of gases HFC-23, PFC-14 and PFC-218, used in Refrigeration and Air Conditioning Equipment; actual emissions of gases HFC-227ea and HFC-125, and potential emissions of HFC-236fa used in Fire Extinguishers; actual emission of HFC-134a used in Aerosols/Metered Dose Inhalers; potential emission of HFC-152a used in Foam Blowing and actual emission of SF_6 used in Electrical Equipment.

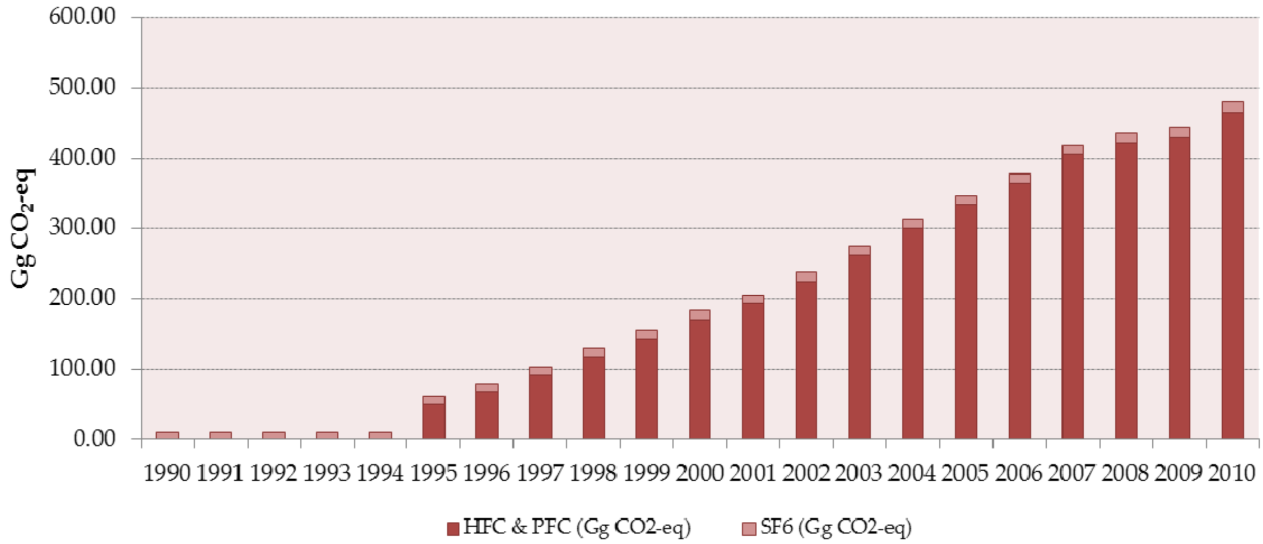

Figure 4.6-1: Emissions of HFCs and SF_6 (Gg CO_2-eq) from Consumption of Halocarbons and SF_6 (1990-2010)

4.6.1. REFRIGERATION AND AIR CONDITIONING EQUIPMENT

4.6.1.1.Source category description

Emissions are released by consumption of synthetic greenhouse gases, HFCs (HFC-23, HFC-32, HFC-125, HFC-134a and HFC-143a), which are used as substitutes for cooling gases in refrigerating and air-conditioning systems that deplete the ozone layer. Refrigerants used are R-404A, R-407C, R-410A, R-413A, R-417A, R-422A, R-422D, R-437A, R-507A and RMO-89. There is no production of HFCs and PFCs in Croatia, therefore, all quantities of these gases are imported. Minor quantities of some substances are exported.

4.6.1.2.Methodological issues

Actual and potential emissions of HFCs used in Refrigeration and Air Conditioning Equipment have been calculated for the period 1995-2010. Potential emission of PFCs used in Refrigeration and Air Conditioning Equipment has been calculated for the period after 2009, when the use of these gas started.

Actual emissions of HFCs have been calculated by data on amount of HFCs in operating system (average annual stocks) for Domestic Refrigeration (HFC-134a), Commercial Refrigeration (HFC-125, HFC-134a, HFC-143a), Transport Refrigeration (HFC-134a), Industrial Refrigeration (HFC-125, HFC-134a, HFC-32), Stationary-Air Conditioning (HFC-125, HFC-134a, HFC-32) and Mobile Air-Conditioning (HFC-134a). Data for the period 1995-2010 have been compiled by the Ministry of Environmental and Nature Protection.

According to available data, decommissioning and disposal have not been occurred so far because all of equipment is still functioning and in use. Default emission factors proposed by *Revised 1996 IPCC Guidelines* have been used for actual emission calculation.

Data on import and export (consumption) of HFCs and PFCs, which were used for calculation of potential emissions, have been compiled by the Ministry of Environmental and Nature Protection. Potential emissions of HFCs and PFCs from Refrigeration and Air Conditioning Equipment were calculated (Tier 1a method, *Revised 1996 IPCC Guidelines*) for the period 1996-2010.

Cluster analysis of countries with similar circumstances was used for the period 1990-1995 (HFCs and PFCs emissions are identified as not occurred).

Actual emissions of HFCs used in Refrigeration and Air Conditioning Equipment in the period 1995-2010 are reported in Table 4.6-1.

Table 4.6-1: Emissions of HFCs (Gg CO_2-eq) (1990 – 2010)

Source/Gas	1995	1996	1997	1998	1999	2000	2001	2002
2.F.1. Refrigeration and Air Conditioning Equipment								
Domestic Refrigeration								
HFC-134a	0.03	0.06	0.14	0.18	0.20	0.23	0.27	0.29
Commercial Refrigeration								
HFC-125	1.41	2.38	2.90	4.31	4.58	5.28	5.54	6.60
HFC-134a	0.13	0.22	0.26	0.39	0.42	0.48	0.50	0.60
HFC-143a	1.66	2.81	3.43	5.10	5.41	6.24	6.55	7.80
Transport Refrigeration								
HFC-134a	24.38	26.33	29.90	32.50	39.00	44.85	55.58	66.95
Industrial Refrigeration								
HFC-125	0.56	0.68	0.92	1.24	1.52	2.00	2.32	2.48
HFC-134a	0.33	0.42	0.58	0.92	1.00	1.16	1.66	1.83
HFC-32	0.55	0.66	0.90	1.20	1.48	1.96	2.26	2.41
Stationary Air-Conditioning								
HFC-125	0.31	0.51	0.99	1.28	1.71	2.08	2.40	2.56
HFC-134a	0.29	0.44	0.81	0.99	1.22	1.51	1.82	1.90
HFC-32	0.30	0.50	0.96	1.24	1.67	2.02	2.33	2.49
Mobile Air-Conditioning								
HFC-134a	2.40	8.40	16.80	25.05	33.60	42.60	45.30	51.15

Table 4.6-1: Emissions of HFCs (Gg CO_2-eq) (1990 – 2010), cont.

Source/Gas	2003	2004	2005	2006	2007	2008	2009	2010
2.F.1. Refrigeration and Air Conditioning Equipment								
Domestic Refrigeration								
HFC-134a	0.33	0.42	0.45	0.41	0.32	0.30	0.29	0.29
Commercial Refrigeration								
HFC-125	7.13	8.18	8.80	9.33	10.38	10.56	10.65	11.62
HFC-134a	0.65	0.74	0.80	0.85	0.94	0.96	0.97	1.06
HFC-143a	8.42	9.67	10.40	11.02	12.27	12.48	12.58	13.73
Transport Refrigeration								
HFC-134a	80.93	93.93	105.30	113.75	124.80	133.25	134.88	144.30
Industrial Refrigeration								
HFC-125	2.60	3.08	3.68	3.92	4.08	4.20	4.48	4.84
HFC-134a	1.91	2.25	2.66	2.83	2.83	2.91	3.00	3.41
HFC-32	2.53	2.99	3.58	3.81	3.97	4.09	4.36	4.71
Stationary Air-Conditioning								
HFC-125	2.80	3.23	3.60	3.94	4.20	4.31	4.34	4.45
HFC-134a	2.18	2.39	2.55	2.73	2.86	2.99	2.99	3.12
HFC-32	2.72	3.13	3.50	3.83	4.09	4.20	4.22	4.33
Mobile Air-Conditioning								
HFC-134a	54.90	61.50	68.40	80.85	89.25	97.20	97.50	107.40

Comparison of actual and potential emissions of gases HFC-32, HFC-125, HFC-134a and HFC-143a used in Refrigeration and Air Conditioning Equipment in the period 1990-2010 is reported in Table 4.6-2 and Figure 4.6-2.

Table 4.6-2: Actual (A) and potential (P) emissions of HFCs in Refrigeration and Air Conditioning Equipment (Gg CO_2-eq) (1990 – 2010)

Year	HFC-32		HFC-125		HFC-134a		HFC-143a		Total (Gg CO_2-eq)	
	A	P	A	P	A	P	A	P	A	P
1990	NO	NO	NO	NO	NO	NO	NO	NO	**NO**	**NO**
1991	NO	NO	NO	NO	NO	NO	NO	NO	**NO**	**NO**
1992	NO	NO	NO	NO	NO	NO	NO	NO	**NO**	**NO**
1993	NO	NO	NO	NO	NO	NO	NO	NO	**NO**	**NO**
1994	NO	NO	NO	NO	NO	NO	NO	NO	**NO**	**NO**
1995	0.55	1.42	6.39	21.08	35.99	14.35	6.32	23.71	**49.25**	**60.57**
1996	0.75	3.32	9.99	34.41	46.79	19.86	10.67	31.62	**68.20**	**89.21**
1997	1.21	3.47	13.47	38.81	63.04	24.60	13.04	37.54	**90.76**	**104.42**
1998	1.59	4.27	19.12	48.47	78.01	26.83	19.36	47.42	**118.07**	**126.99**
1999	2.05	4.12	21.86	51.46	98.04	28.91	20.55	53.35	**142.50**	**137.85**
2000	2.58	5.22	26.19	60.06	118.07	33.70	23.71	59.28	**170.56**	**158.26**
2001	2.98	4.24	28.74	57.09	136.62	40.25	24.90	61.26	**193.24**	**162.84**
2002	3.18	5.54	32.60	63.92	159.51	44.20	29.64	63.23	**224.93**	**176.90**
2003	3.41	7.27	35.08	80.25	183.17	51.84	32.01	77.06	**253.66**	**216.42**
2004	3.98	8.37	40.57	92.54	209.71	60.68	36.75	88.92	**291.02**	**250.51**
2005	4.60	5.74	45.02	117.01	234.00	110.24	39.52	145.54	**323.15**	**378.53**
2006	4.97	7.34	48.12	125.69	261.91	101.30	41.89	148.43	**356.89**	**382.76**
2007	5.24	9.04	52.26	140.73	287.34	106.39	46.63	160.51	**391.47**	**416.66**
2008	5.39	14.83	53.40	183.10	308.65	131.82	47.42	187.46	**414.86**	**517.22**
2009	5.58	13.23	54.50	183.51	311.51	134.00	47.82	198.48	**419.41**	**529.22**
2010	5.88	7.65	58.54	155.93	337.44	121.86	52.17	191.75	**454.02**	**477.20**

There is an inconsistent trend of potential emissions for the period 1999-2004 (actual emissions exceed potential emissions). The reason for that is in the higher uncertainty of data for calculation of potential emission compiled by the Ministry of Environmental and Nature Protection. National Classification of Activities used by Central Bureau of Statistics, in the same manner, does not particularly mark HFCs. Customs Departments Tariff Number does not precisely distinguish these compounds from other fluorinated chemicals which are controlled with Montreal Protocol.

Only data for potential emission calculation for PFCs are available so far. Actual emissions of PFCs are not calculated. Potential emission of PFCs is added to the total actual emission of HFCs.

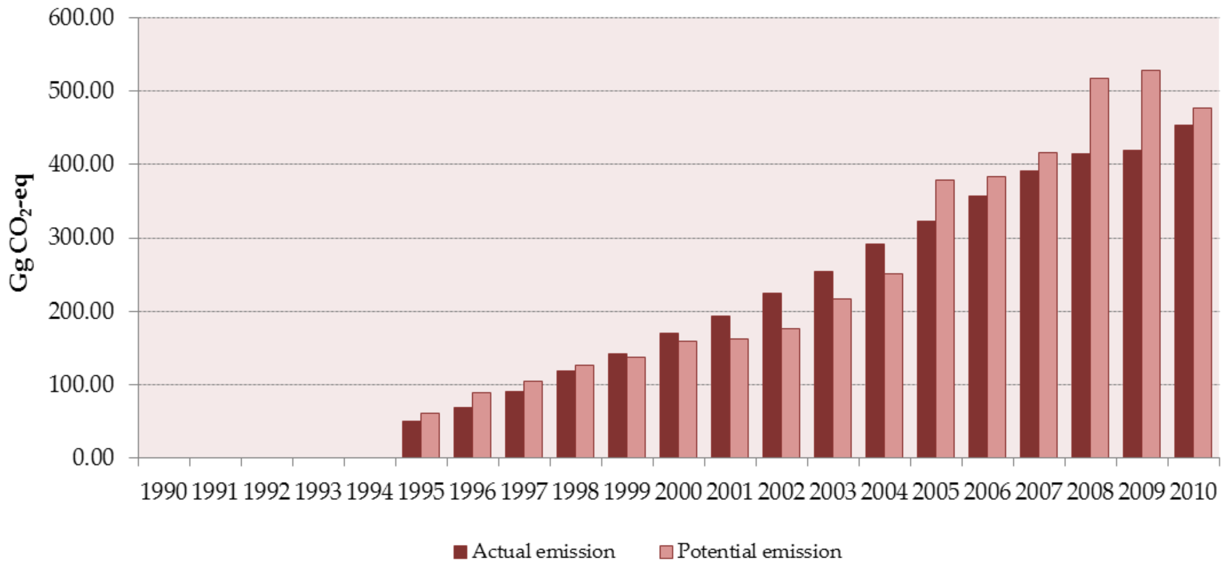

Figure 4.6-2: Actual and potential emission of HFCs in Refrigeration and Air Conditioning Equipment (Gg CO_2-eq) (1990-2010)

4.6.1.3.Uncertainties and time-series consistency

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with estimation of actual emissions of HFC-32, HFC-125, HFC-134a and HFC-143a amounts 50 percent for activity data and 50 percent for emission factor, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions (actual and potential) from Consumption of HFCs in Refrigeration and Air Conditioning Equipment have been calculated using the same methods and data sets for every year in the time series.

4.6.1.4.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Consumption of HFCs in Refrigeration and Air Conditioning Equipment is one of the key source categories in Industrial Processes. Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories. Due to incompleteness of data set, QA/QC plan does not prescribes source specific quality control procedures at this moment, but it recommends improvements which should be implemented in short-term period (see Chapter 4.6.1.6).

4.6.1.5.Source–specific recalculations

New data have been compiled by the Ministry of Environmental and Nature Protection. Accordingly, potential emissions from Refrigeration and Air Conditioning Equipment for the period 1995-2009 have been recalculated.

A mistake was detected in the calculation of potential emissions of gas HFC-125 for the year 2004 and gas HFC-143a for 1998. These mistakes were corrected for this report.

4.6.1.6.Source–specific planned improvements

For the purpose of accurate emission calculations it is essential to adjust National Classification of Activities used by Central Bureau of Statistics in order to particularly mark HFCs, PFCs and SF_6 and Customs Departments Tariff Number to distinguish these compounds from other fluorinated chemicals which are controlled with Montreal Protocol.

Actual and potential emissions of HFCs and PFC were calculated with data compiled by the Ministry of Environmental and Nature Protection. Actual emissions were calculated by using data on annual stocks of HFCs in operating systems. Decommissioning and disposal have not been occurred so far because all of equipment is still functioning and in use.

Potential emissions were calculated by using annual data on the amount of consumed gases. There is inconsequent trend of potential emissions for the period 1999-2004 (actual emissions exceed potential emissions) because data compiled by the Ministry of Environmental and Nature Protection for calculation of potential emission have higher uncertainty. Accordingly, potential emission trend need to be additionally investigated.

4.6.2. OTHER CONSUMPTION OF HFCS, PFCS AND SF_6

4.6.2.1.Source category description

HFC-152a in Foam Blowing, HFC-134a in Aerosols/Metered Dose Inhalers and SF_6 in GIS application and high voltage circuit-breakers. There is no production of HFCs and SF_6 in Croatia; therefore, all quantities of these gases are imported. Minor quantities of some substances are exported. All data on HFCs and PFCs have been compiled by the Ministry of Environmental and Nature Protection.

Methodological issues

Actual emissions of HFC-227ea used in Fire Extinguishers have been calculated for the period 1995-2010. Actual emissions of HFC-125 used in Fire Extinguishers and HFC-134a used in Aerosols/Metered Dose Inhalers have been calculated for the period 2003-2010, when these gases started to use. Potential emissions of HFC-236fa used in Fire Extinguishers and HFC-152a used in Foam Blowing were calculated for the period 2006-2010.

Actual emissions of HFCs have been calculated by data on amount of HFCs in operating system (average annual stocks) for Fire Extinguishers (HFC-227ea, HFC-125) and Aerosols/Metered Dose Inhalers (HFC-134a). Data on HFC-236fa used in Fire Extinguishers and HFC-152a used in Foam Blowing, which are needed for calculation of actual emissions are not available for the period 1995-2010.

According to available data, decommissioning and disposal have not been occurred so far because all of equipment is still functioning and in use.

Default emission factors proposed by *Revised 1996 IPCC Guidelines* have been used for actual emission calculation. Potential emissions (Tier 1a method, *Revised 1996 IPCC Guidelines*) from Foam Blowing and Fire Extinguishers have been calculated for the period 2006-2010. Insufficient data on HFC-152a used in Foam Blowig for 2007 are assessed according to data for 2006. Insufficient data on HFC-227ea used in Fire Extinguishers for 2007 and 2008 been assessed by interpolation method. Data on the consumption of HFC-125 used in Fire Extinguishers are so far available only for 2006.

Potential emissions from Aerosols/Metered Dose Inhalers have been calculated for the period 2003-2010. There was no use of HFCs in Metered Dose Inhalers before that period. It has been determined that HFCs have not been used as solvents in the period 1995-2010.

Actual emissions of HFCs used in Fire Extinguishers and Aerosols/Metered Dose Inhalers in the period 1995-2010 are reported in Table 4.6-3.

Table 4.6-3: Actual emissions of HFCs used Fire Extinguishers and Aerosols/Metered Dose Inhalers, by gas (Gg CO_2-eq) (1990 – 2010)

Source/Gas	1995	1996	1997	1998	1999	2000	2001	2002
2.F.2 Foam Blowing								
Hard Foam	NO	NO	NO	NO	NO	NO	NO	NO
Soft Foam	NO	NO	NO	NO	NO	NO	NO	NO
2.F.3 Fire Extinguishers								
HFC-227ea	0.12	0.12	0.12	0.12	0.12	0.12	0.17	0.17
HFC-125	NO	NO	NO	NO	NO	NO	NO	NO
2.F.4 Aerosols/Metered Dose Inhalers								
HFC-134a	NO	NO	NO	NO	NO	NO	NO	NO

Table 4.6-3: Actual emissions of HFCs used Fire Extinguishers and Aerosols/Metered Dose Inhalers, by gas (Gg CO_2-eq) (1990 – 2010), cont.

Source/Gas	2003	2004	2005	2006	2007	2008	2009	2010
2.F.2 Foam Blowing								
Hard Foam	NO	NO	NO	NE	NE	NE	NE	NE
Soft Foam	NO	NO	NO	NO	NO	NO	NO	NO
2.F.3 Fire Extinguishers								
HFC-227ea	0.17	0.17	0.20	0.44	0.93	0.21	1.38	1.62
HFC-125	0.022	0.022	0.022	0.022	0.022	0.022	0.056	0.112
2.F.4 Aerosols/Metered Dose Inhalers								
HFC-134a	9.17	8.89	10.06	7.61	12.65	7.16	7.89	10.15

Potential emissions of HFC-152-a used in Foam Blowing, HFC-125, HFC-227ea and HFC-236fa used in Fire Extinguishers and HFC-134a used in Aerosols/Metered Dose Inhalers are presented in Table 4.6.4.

Table 4.6-4: Potential emissions of HFCs used in Foam Blowing, Fire Extinguishers and Aerosols/Metered Dose Inhalers (Gg CO_2-eq) (1990 – 2010)

Source/Gas	1995	1996	1997	1998	1999	2000	2001	2002
2.F.2 Foam Blowing								
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO
2.F.3 Fire Extinguishers								
HFC-227ea	NE	NE	NE	NE	NE	NE	NE	NE
HFC-125	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO
2.F.4 Aerosols/Metered Dose Inhalers								
HFC-134a	NO	NO	NO	NO	NO	NO	NO	NO

Table 4.6-4: Potential emissions of HFCs used in Foam Blowing, Fire Extinguishers and Aerosols/Metered Dose Inhalers (Gg CO_2-eq) (1990 – 2010), cont.

Source/Gas	2003	2004	2005	2006	2007	2008	2009	2010
2.F.2 Foam Blowing								
Hard Foam	NO	NO	NO	0.0001	0.0001	0.0001	6.41	5.05
2.F.3 Fire Extinguishers								
HFC-227ea	NE	NE	NE	5.80	2.90	0.44	2.76	15.17
HFC-125	NO	NE	NE	3.55	NE	NE	NE	NE
HFC-236fa	NO	NO	NO	6.30	12.60	18.90	NO	NO
2.F.4 Aerosols/Metered Dose Inhalers								
HFC-134a	9.17	8.89	10.06	7.61	12.65	7.16	7.89	10.15

A certain amount of SF_6 is contained in electrical equipment used in Croatian National Electricity (HEP) and KONCAR Electrical Industries Inc. Total quantity of SF_6 is imported and used as an insulation medium in high voltage electrical equipment – gas insulated switchgear (GIS) and circuit-breakers. There is no production of SF_6 in Croatia.

Actual emissions of SF_6 have been calculated using data on total charge of SF_6 contained in the existing stock of equipment and leakage and maintenance losses as a fixed percentage of the total charge provided by Croatian Electricity Utility Company (Hrvatska elektroprivreda, HEP) and Končar – Electrical Industries Inc. Data on total charge of SF_6 contained in the gas insulated switchgear and circuit-breakers and leakage/maintenance losses of the total charge, as well as losses during SF_6 manipulation and testing of high voltage circuit-breakers and apparatus before delivery, have been provided by:

- HEP Proizvodnja (limited liability company licensed to perform electricity production for tariff customers and production of heat energy for the district heating systems in the cities of Zagreb, Osijek and Sisak);
- HEP OPS (The Sole Transmission System Operator licensed to carry out electricity transmission as a public service – a member of HEP Group);
- HEP ODS (Distribution System Operator licensed to carry out the activity of electricity distribution and the electricity supply for tariff customers - a member of HEP Group);
- Končar Group - High Voltage Switchgear
- Končar Group - Switching Apparatus and Switchgear

Missing data for the year 2010 were estimated on the basis of data for 2009.

Potential emissions of SF_6 used in GIS application and high voltage circuit-breakers have been calculated only for the period 2006-2010, because data for potential emission calculation for the previous period are not available. Data on the amount of consumed gas for the period 2006-2010 have been compiled by the Ministry of Environmental and Nature Protection.

Actual emissions of SF_6 expressed in Gg CO_2-eq for the period 1990-2010 are presented in the Table 4.6-5.

Table 4.6-5: Emissions of SF_6 (Gg CO_2-eq) (1990 – 2010)

Year	Emission of SF_6 (Gg CO_2-eq)
1990	10.95
1991	10.83
1992	10.92
1993	11.04
1994	11.16
1995	11.66
1996	12.13
1997	11.98
1998	12.57
1999	12.57
2000	12.18
2001	12.26
2002	12.59
2003	12.87
2004	13.17
2005	13.66
2006	13.64
2007	13.68
2008	13.71
2009	14.11
2010	14.11

4.6.2.2.Uncertainties and time-series consistency

The main uncertainties of HFCs and SF_6 emissions calculation is related to activity data. Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with estimation of actual and potential emissions of HFC-152a, HFC-125, HFC-227ea, HFC-236fa and SF_6 amounts 50 percent for activity data and 50 percent for emission factor, based on expert judgements (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Consumption of HFCs in Fire Extinguishers and Aerosols/Metered Dose Inhalers have been calculated using the same methods for every year in the time series. Emissions from consumption of SF_6 have been calculated using the same method and data sets for every year in the time series.

4.6.2.3.Source-specific QA/QC and verification

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

4.6.2.4.Source–specific recalculations

A mistake in data input made in the previous report regarding potential emissions of HFC-227a from Fire Extinguishers for 2007 and 2008 was corrected.

A mistake was noticed in calculation of actual emissions of SF_6 for 2008 and was corrected in this report.

4.6.2.5.Source–specific planned improvements

For the purpose of accurate emission calculations it is essential to adjust National Classification of Activities used by Central Bureau of Statistics in order to particularly mark HFCs, PFCs and SF_6 and Customs Departments Tariff Number to distinguish these compounds from other fluorinated chemicals which are controlled with Montreal Protocol.

Actual and potential emissions of HFCs and PFCs were calculated with data compiled by the Ministry of Environmental and Nature Protection. Actual emissions were calculated by using data on annual stocks of HFCs and SF_6 in operating systems. Actual emission trend needs to be additionally investigated.

Potential emissions from Foam Blowing and Fire Extinguishers for the period 1995-2005, and Aerosols/Metered Dose Inhalers for the period 1995-2002 were not calculated due to the lack of required data. There are insufficient data for the period 2006-2009, while compiled data have high uncertainty. Accordingly, potential emission trend needs to be additionally investigated.

4.7. NON - ENERGY USE (CRF 2.G.)

4.7.1.SOURCE CATEGORY DESCRIPTION

Non-energy fuel consumptions (fuels used as feedstock) cause appropriate emissions, where one part or even the whole carbon is stored in product for a longer time and the other part oxidizes and goes to atmosphere. The feedstock use of energy carriers occurs in chemical industry (naphta, lubricants, ethane and other), construction industry (bitumen production), and other products such as motor oil, industrial oil, grease etc.

4.7.2.METHODOLOGICAL ISSUES

According to ERT recommendation during the in-country review, CO_2 emissions from non-energy use of naphtha, lubricants, ethane and other have been removed from inventory, because there is no available information or supporting documentation on the oxidation or use of these substances.

4.8. EMISSION OVERVIEW

4.8.1. GHG EMISSIONS

Emissions of GHGs from Industrial Processes in the period 1990-2010 are presented in Table 4.8-1.

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2010)

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Cement production	1990	CO_2	1,085.79	1	1,085.79	28.56	3.45
	1991		702.56		702.56	24.04	2.84
	1992		826.23		826.23	32.49	3.58
	1993		687.13		687.13	34.35	2.97
	1994		841.87		841.87	37.84	3.79
	1995		628.67		628.67	31.26	2.73
	1996		684.69		684.69	32.82	2.90
	1997		792.26		792.26	34.12	3.17
	1998		852.93		852.93	40.58	3.40
	1999		1,115.06		1,115.06	43.34	4.23
	2000		1,243.59		1,243.59	43.60	4.77
	2001		1,423.55		1,423.55	49.56	5.22
	2002		1,392.12		1,392.12	49.11	4.92
	2003		1,383.62		1,383.62	48.19	4.63
	2004		1,470.38		1,470.38	45.51	4.91
	2005		1,499.86		1,499.86	45.74	4.96
	2006		1,588.04		1,588.04	46.32	5.17
	2007		1,611.88		1,611.88	44.64	4.98
	2008		1,526.87		1,526.87	42.70	4.92
	2009		1,224.17		1,224.17	41.22	4.21
	2010		1,198.26		1,198.26	37.08	4.19
Lime production	1990	CO_2	153.44	1	153.44	4.04	0.49
	1991		113.60		113.60	3.89	0.46
	1992		75.12		75.12	2.95	0.33
	1993		83.60		83.60	4.18	0.36
	1994		85.49		85.49	3.84	0.39
	1995		82.79		82.79	4.12	0.36
	1996		112.92		112.92	5.41	0.48
	1997		122.85		122.85	5.29	0.49
	1998		132.79		132.79	6.32	0.53
	1999		121.12		121.12	4.71	0.46
	2000		136.29		136.29	4.78	0.52
	2001		167.54		167.54	5.83	0.61
	2002		186.67		186.67	6.58	0.66
	2003		177.40		177.40	6.18	0.59
	2004		191.10		191.10	5.92	0.64

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2010), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Lime production	2005	CO_2	205.68	1	205.68	6.27	0.68
	2006		250.68		250.68	7.31	0.82
	2007		260.81		260.81	7.22	0.81
	2008		255.93		255.93	7.16	0.82
	2009		164.55		164.55	5.54	0.57
	2010		151.53		151.53	4.69	0.53
Limestone and dolomite use	1990	CO_2	51.49	1	51.49	1.35	0.16
	1991		32.72		32.72	1.12	0.13
	1992		14.64		14.64	0.58	0.06
	1993		13.82		13.82	0.69	0.06
	1994		21.53		21.53	0.97	0.10
	1995		17.39		17.39	0.86	0.08
	1996		17.65		17.65	0.85	0.07
	1997		11.89		11.89	0.51	0.05
	1998		15.22		15.22	0.72	0.06
	1999		14.13		14.13	0.55	0.05
	2000		15.94		15.94	0.56	0.06
	2001		18.78		18.78	0.65	0.07
	2002		25.60		25.60	0.90	0.09
	2003		24.23		24.23	0.84	0.08
	2004		26.17		26.17	0.81	0.09
	2005		26.70		26.70	0.81	0.09
	2006		24.23		24.23	0.71	0.08
	2007		21.78		21.78	0.60	0.07
	2008		25.67		25.67	0.72	0.08
	2009		30.46		30.46	1.03	0.10
	2010		36.76		36.76	1.14	0.13
Soda ash production and use	1990	CO_2	25.74	1	25.74	0.68	0.08
	1991		21.75		21.75	0.74	0.09
	1992		12.76		12.76	0.50	0.06
	1993		12.54		12.54	0.63	0.05
	1994		15.21		15.21	0.68	0.07
	1995		14.39		14.39	0.72	0.06
	1996		13.86		13.86	0.66	0.06
	1997		11.33		11.33	0.49	0.05
	1998		12.71		12.71	0.60	0.05
	1999		12.08		12.08	0.47	0.05
	2000		11.78		11.78	0.41	0.05
	2001		14.57		14.57	0.51	0.05
	2002		14.02		14.02	0.49	0.05
	2003		16.59		16.59	0.58	0.06
	2004		18.24		18.24	0.56	0.06
	2005		19.55		19.55	0.68	0.06

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2010), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Soda ash production and use	2006	CO_2	17.63	1	17.63	0.60	0.06
	2007		16.02		16.02	0.51	0.05
	2008		16.38		16.38	0.44	0.05
	2009		17.45		17.45	0.46	0.06
	2010		19.95		19.95	0.59	0.07
Ammonia production	1990	CO_2	466.01	1	466.01	12.26	1.48
	1991		447.00		447.00	15.30	1.81
	1992		575.22		575.22	22.62	2.49
	1993		446.83		446.83	22.34	1.93
	1994		450.03		450.03	20.23	2.03
	1995		438.77		438.77	21.82	1.91
	1996		476.59		476.59	22.84	2.02
	1997		517.83		517.83	22.30	2.07
	1998		388.43		388.43	18.48	1.55
	1999		492.14		492.14	19.13	1.87
	2000		497.96		497.96	17.46	1.91
	2001		403.70		403.70	14.06	1.48
	2002		363.78		363.78	12.83	1.28
	2003		409.38		409.38	14.26	1.37
	2004		495.43		495.43	15.34	1.65
	2005		484.65		484.65	14.78	1.60
	2006		477.34		477.34	13.92	1.55
	2007		521.51		521.51	14.44	1.61
	2008		530.39		530.39	14.83	1.71
	2009		445.19		445.19	14.99	1.53
	2010		501.33		501.33	15.52	1.75
Nitric acid production	1990	N_2O	2.59	310	803.89	21.15	2.56
	1991		2.28		706.05	24.16	2.85
	1992		2.98		923.19	36.31	4.00
	1993		2.24		695.91	34.79	3.01
	1994		2.43		752.57	33.82	3.39
	1995		2.33		723.70	35.98	3.14
	1996		2.17		673.86	32.30	2.86
	1997		2.28		708.21	30.50	2.84
	1998		1.72		533.19	25.37	2.13
	1999		2.03		629.16	24.45	2.39
	2000		2.39		740.39	25.96	2.84
	2001		2.01		622.72	21.68	2.28
	2002		1.95		604.48	21.32	2.14
	2003		1.84		569.79	19.84	1.91
	2004		2.24		695.34	21.52	2.32
	2005		2.19		678.84	20.70	2.24
	2006		2.17		671.21	19.58	2.18

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2010), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Nitric acid production	2007	N_2O	2.39	310	741.40	20.53	2.29
	2008		2.44		756.66	21.16	2.44
	2009		2.04		632.25	21.29	2.18
	2010		2.63		814.37	25.20	2.85
Production of other chemicals	1990	CH_4	0.75	21	15.80	0.42	0.05
	1991		0.55		11.49	0.39	0.05
	1992		0.46		9.74	0.38	0.04
	1993		0.50		10.48	0.52	0.05
	1994		0.48		10.06	0.45	0.05
	1995		0.40		8.41	0.42	0.04
	1996		0.38		7.94	0.38	0.03
	1997		0.34		7.15	0.31	0.03
	1998		0.32		6.65	0.32	0.03
	1999		0.27		5.73	0.22	0.02
	2000		0.29		6.04	0.21	0.02
	2001		0.31		6.41	0.22	0.02
	2002		0.26		5.39	0.19	0.02
	2003		0.28		5.83	0.20	0.02
	2004		0.27		5.73	0.18	0.02
	2005		0.25		5.33	0.16	0.02
	2006		0.34		7.09	0.21	0.02
	2007		0.31		6.43	0.18	0.02
	2008		0.23		4.81	0.13	0.02
	2009		0.08		1.73	0.06	0.01
	2010		0.08		1.68	0.05	0.01
Steel production	1990	CO_2	21.45	1	21.45	0.56	0.07
	1991		17.86		17.86	0.61	0.07
	1992		9.65		9.65	0.38	0.04
	1993		9.46		9.46	0.47	0.04
	1994		7.06		7.06	0.32	0.03
	1995		4.24		4.24	0.21	0.02
	1996		5.36		5.36	0.26	0.02
	1997		7.64		7.64	0.33	0.03
	1998		11.96		11.96	0.57	0.05
	1999		8.06		8.06	0.31	0.03
	2000		5.43		5.43	0.19	0.02
	2001		5.27		5.27	0.18	0.02
	2002		5.14		5.14	0.18	0.02
	2003		8.47		8.47	0.29	0.03
	2004		14.89		14.89	0.46	0.05
	2005		11.24		11.24	0.34	0.04
	2006		13.25		13.25	0.39	0.04
	2007		12.42		12.42	0.34	0.04

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2010), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Steel production	2008	CO_2	23.51	1	23.51	0.66	0.08
	2009		11.30		11.30	0.38	0.04
	2010		27.27		27.27	0.84	0.10
Ferroalloys production	1990	CO_2	118.84	1	118.84	3.13	0.38
	1991		139.26		139.26	4.77	0.56
	1992		85.34		85.34	3.35	0.37
	1993		29.29		29.29	1.46	0.13
	1994		30.11		30.11	1.35	0.14
	1995		31.88		31.88	1.58	0.14
	1996		12.92		12.92	0.62	0.05
	1997		36.79		36.79	1.71	0.16
	1998		16.01		16.01	0.83	0.07
	1999		18.77		18.77	0.79	0.08
	2000		11.24		11.24	0.43	0.05
	2001		3.70		3.70	0.14	0.01
	2002		0.01		0.01	0.00	0.000047
	2003		0.04		0.04	0.00	0.00015
	2004-2010		-		-	-	-
Aluminium production	1990	CO_2	111.37	1	111.37	2.93	0.35
	1991		76.40		76.40	2.61	0.31
	1992-2010		-		-	-	-
	1990	CF_4	0.13	6500	820.44	21.58	2.61
	1991		0.09		562.79	19.26	2.27
	1992-2010		-		-	-	-
	1990	C_2F_6	0.013	9200	116.12	3.05	0.37
	1991		0.009		79.66	2.73	0.32
	1992-2010		-		-	-	-
Consumption of HFCs, PFCs and SF_6	1990	HFC PFC SF_6	[2]	[2]	10.95	0.29	0.03
	1991				10.83	0.37	0.04
	1992				10.92	0.43	0.05
	1993				11.04	0.55	0.05
	1994				11.16	0.50	0.05
	1995				61.02	3.03	0.27
	1996				80.45	3.86	0.34
	1997				102.85	4.43	0.41
	1998				130.76	6.22	0.52
	1999				155.19	6.03	0.59
	2000				182.86	6.41	0.70
	2001				205.67	7.16	0.75

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2010), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Consumption of HFCs, PFCs and SF_6	2002	HFC PFC SF_6	[2]	[2]	237.70	8.38	0.84
	2003				275.90	9.61	0.92
	2004				313.28	9.70	1.05
	2005				347.09	10.59	1.15
	2006				378.60	11.04	1.23
	2007				418.75	11.60	1.29
	2008				435.96	12.19	1.40
	2009				443.05	14.92	1.52
	2010				480.05	14.86	1.68

[1] Time horizon chosen for GWP values is 100 years

[3] HFC-32 (GWP=650); HFC-125 (GWP=2,800); HFC-134a (GWP=1,300); HFC-143a (GWP=3,800); HFC-152a (GWP=130); HFC-227ea (GWP=2,900); HFC-236fa (GWP=6,300); PFC-218 (GWP=7000); SF_6 (GWP=23,900)

- total actual emissions of HFCs and SF_6 and potential emission PFC are presented

4.8.2. INDIRECT GHG EMISSIONS

Many non-energy industrial processes generate emissions of ozone and aerosol precursor gases including carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2) (see Table 4.8-2).

Emissions of indirect GHGs have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'.

Table 4.8-2: Gases generated from different non-energy industrial process

Gas	Industrial Process
SO_2	Cement Production
	Production of other chemicals
	Pulp and paper production
NO_x	Nitric acid production
	Production of other chemicals
	Pulp and paper production
CO	Asphalt Roofing Production
	Ammonia production
	Production of other chemicals
	Pulp and paper production
NMVOC	Asphalt Roofing Production
	Road paving with asphalt
	Glass production
	Production of other chemicals
	Pulp and paper production
	Alcoholic beverage production
	Bread and other food production

Total annual emissions of indirect GHGs in the period 1990-2010 are reported in table 4.8-3.

Table 4.8-3: Emissions of indirect GHGs from Industrial Processes (1990-2010)

Year	SO_2 (Gg)	NO_x (Gg)	CO (Gg)	NMVOC (Gg)
1990	2.57	2.76	41.71	24.01
1991	1.75	2.42	26.30	20.85
1992	1.54	2.82	14.87	13.21
1993	1.42	2.32	18.35	11.92
1994	1.82	2.48	22.94	9.00
1995	1.63	2.62	28.35	9.32
1996	1.58	2.53	27.98	10.56
1997	1.65	2.64	25.67	8.88
1998	1.48	2.24	25.76	8.41
1999	1.87	2.44	22.48	8.41
2000	2.05	2.78	32.10	7.78
2001	2.04	2.09	26.26	6.94
2002	2.17	2.17	29.17	7.61
2003	1.86	2.41	30.96	7.22
2004	2.07	2.77	20.35	7.78
2005	2.07	8.30	19.79	8.73
2006	1.90	9.49	41.81	8.34
2007	2.05	10.05	37.99	6.25
2008	2.41	9.21	12.75	5.94
2009	1.77	6.96	2.34	5.27
2010	1.30	5.76	3.42	5.42

4.9. REFERENCES

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5 SOLVENT AND OTHER PRODUCT USE (CRF sector 3)

5.1 SOLVENT AND OTHER PRODUCT USE

5.1.1. SOURCE CATEGORY DESCRIPTION

The use of solvents is the cause of less than 15 percent of anthropogenic national emissions of non-methane volatile organic compounds (NMVOCs). The emissions of NMVOC is caused by use of solvent based paint and varnish, degreasing of metal and dry cleaning, in production of chemicals, in printing industry, by use of glue, by use of solvents in households and by all other activities where solvents are used.

NMVOC emissions oxidize in the atmosphere and CO_2 emissions are generated as a consequence of this oxidation.

N_2O emissions are caused by medical uses of N_2O (for anaesthesia) and other possible sources emissions (aerosol cans).

NMVOC, CO_2 and N_2O emissions are included in emissions estimates in this sector.

5.1.2. METHODOLOGICAL ISSUES

__NMVOC emissions__

Estimation of NMVOC emissions from Solvent and Other Product Use (provided by *EMEP-CORINAIR Emission Inventory Guidebook*) has been carried out by estimating the amount of solvent containing products consumed. Emissions of NMVOC have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'. The NMVOC emissions have been calculated by using simpler methodology. Default emission factor (*EMEP-CORINAIR Emission Inventory Guidebook*) has been applied for each source category. For several source categories (degreasing and dry cleaning, pharmaceutical products manufacturing and domestic solvent use) the NMVOC emissions calculation is based on population data. The activity data for the other sources were extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

Activity data and average emission factors are shown in the Table 5.1-1.

Table 5.1-1: Activity data for NMVOC emissions from Solvent and Other Product Use (1990-2010)

Source and Sink Categories	Activity Data, tonne (1000 capita*)																					EF, kg/t (cap)
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	1990-2010
Paint application																						
Paint application	21,955	13,872	9,145	9,066	10,797	11,083	13,934	15,003	15,472	15,193	15,107	16,793	15,172	15,331	15,857	16,393	17,318	20,097	19,716	15,186	16,395	500
Degreasing, dry cleaning and electronics																						
Metal degreasing *	4,778	4,513	4,470	4,641	4,649	4,669	4,494	4,572	4,501	4,554	4,381	4,437	4,443	4,442	4,439	4,442	4,440	4,436	4,434	4,429	4,418	0.85
Dry cleaning *	4,778	4,513	4,470	4,641	4,649	4,669	4,494	4,572	4,501	4,554	4,381	4,437	4,443	4,442	4,439	4,442	4,440	4,436	4,434	4,429	4,418	0.25
Chemical products manufacturing or processing																						
Polyester	6,047	4,159	3,523	2,570	2,546	2,225	3,367	7,022	8,258	5,609	12,848	9,661	14,693	9,704	10,948	10,886	14,112	16,548	16,548	13,989	7,268	40
Polyvinylchloride	30,718	20,341	19,977	15,147	5,508	5,346	5,335	5,214	4,164	2,898	1,462	1,036	8,387	8,387	10,064	9,396	8,045	8,607	9,341	6,815	4,670	40
Polyurethane	3,763	2,798	1,676	2,046	2,462	2,909	1,822	1,754	1,829	1,830	1,860	2,750	5,611	2,925	2,484	2,919	2,360	1,873	1,873	1,026	780	15
Polystyrene	39,069	26,383	57,045	57,666	58,215	49,356	56,513	50,894	54,240	53,047	16,518	47,146	45,439	46,361	34,311	52,933	47,755	54,069	6,111	5,078	5,078	15
Rubber	5,739	5,442	2,439	2,477	2,338	2,285	1,279	26	17	20	21	21	15	6	11	4	4	0	0	0	0	15
Pharmaceutical products manufac.*	4,778	4,513	4,470	4,641	4,649	4,669	4,494	4,572	4,501	4,554	4,381	4,437	4,443	4,442	4,439	4,442	4,440	4,436	4,434	4,429	4,418	0.014
Paints manufacturing	21,956	13,827	9,493	9,064	10,797	10,773	13,933	15,002	15,473	15,194	15,107	16,794	15,174	15,332	14,984	16,393	17,318	20,097	19,716	15,186	16394	15
Inks manufacturing	4,713	3,652	1,365	1,048	1,481	1,417	1,470	1,453	1,087	806	924	828	870	792	878	669	690	915	935	616	345	30
Glues manufacturing	5,139	13,451	7,151	10,910	11,166	10,076	17,197	10,874	10,379	8,206	10,355	12,385	25,851	30,873	46,119	56,573	71,330	81,768	77,701	33,821	35,507	20
Other use of solvents and related activities																						
Printing industry	4,672	3,626	1,343	985	1,416	1,367	1,420	1,430	1,071	797	916	822	863	789	870	665	684	910	929	612	341	800
Application of glues and adhesives	5,139	13,451	7,151	10,910	11,166	10,076	17,197	10,874	10,379	8,206	10,355	12,385	25,851	30,873	46,119	56,573	71,330	81,768	77,701	33,849	35,507	600
Domestic solvent use*	4,778	4,513	4,470	4,641	4,649	4,669	4,494	45,720	4,501	4,554	4,381	4,437	4,443	4,442	4,439	4,442	4,440	4,436	4,434	4,429	4,418	2

* Activity data is number of inhabitants in Croatia (1,000 capita)

The contribution of group of activities to NMVOC emissions is given in the Figure 5.1-1.

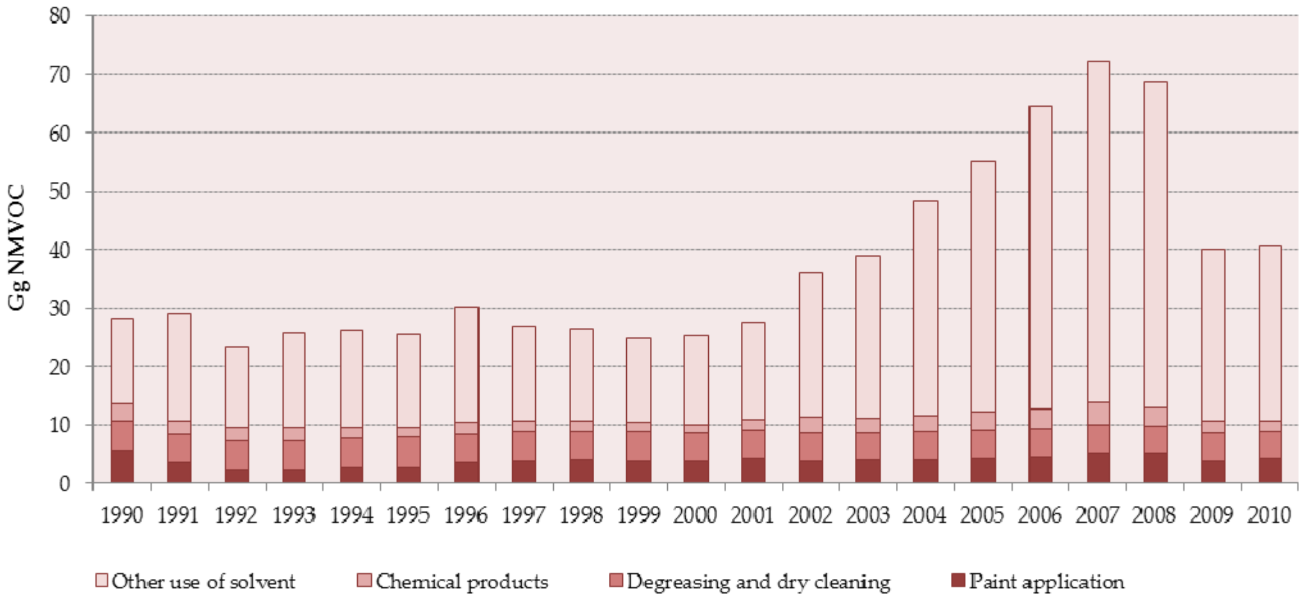

Figure 5.1-1: Emissions of NMVOC from Solvent and Other Product Use (1990-2010)

<u>CO_2 emissions</u>

IPCC Guidelines do not provide methodology for calculation of CO_2 emissions from Solvent and Other Product Use. CO_2 emissions are calculated using conversion factor which contains ratio C/NMVOC = 0.8 and recalculation ratio of C to CO_2 equal to 44/12. The overall conversion factor has value of 2.93.

C/NMVOC conversion factor has been assessed using cluster analysis. The results of investigations performed in other countries were used. Investigation of conversion factor C/NMVOC in Croatia need to be performed during the next period (long-term goals), with purpose of accurate CO_2 emission calculation.

<u>N_2O emissions</u>

N_2O emissions have been calculated by multiplying annual quantity of N_2O used for anaesthesia and aerosol cans and default emission factor. Activity data were obtained by producers and distributors of N_2O in Croatia.

It is assumed that none of the N_2O is chemically changed by the body or reacted during the process and all of the N_2O is emitted to the atmosphere, which resulting in an emission factor of 1.0 for these sources.

The resulting emissions of CO_2 and N_2O (Gg CO_2-eq) from Solvent and Other Product Use in the period 1990-2010 are presented in the Figure 5.1-2.

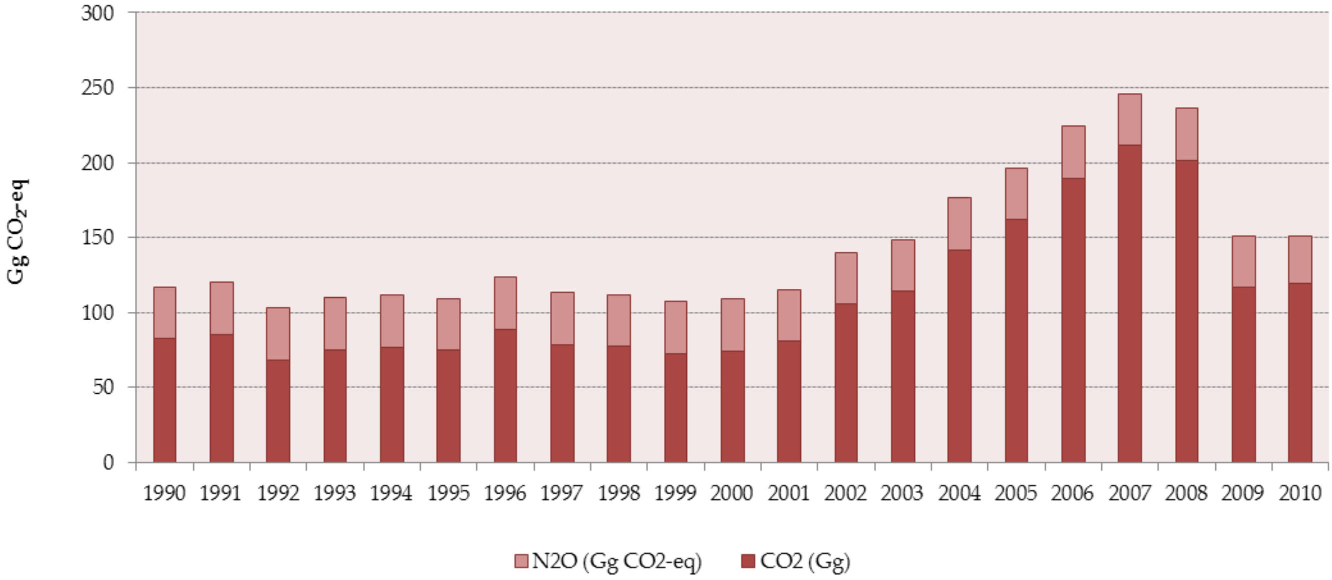

Figure 5.1-2: Emissions of CO_2 and N_2O from Solvent and Other Product Use (1990-2010)

5.1.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Uncertainties in CO_2 emissions estimates are mainly due to the accuracy of used conversion factor (C/NMVOC) and reliability of calculation is very low. Uncertainties in N_2O emissions estimates are caused by relatively high uncertainties of activity data.

Uncertainty estimates are based on expert judgement. Uncertainty estimate associated with activity data amounts 50 percent. Uncertainty estimate associated with emission factors amounts 50 percent (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Solvent and Other Product Use have been calculated using the same method and data sets for every year in the time series.

5.1.4. SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

5.1.5. SOURCE–SPECIFIC RECALCULATIONS

Activity data for NMVOC emission calculation for the whole period 1990-2009 has been updated according to the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'. Therefore, CO_2 emissions have been recalculated for the period 1990-2009 in this report.

5.1.6.SOURCE–SPECIFIC PLANNED IMPROVEMENTS

For the purpose of accurate emission calculations, Croatia plans to investigate source category degreasing and dry cleaning, pharmaceutical products manufacturing and domestic solvent use. The NMVOC emissions calculation in these categories is based on population data.

Investigation of conversion factor C/NMVOC need to be performed during the next period (long-term goals), with purpose of accurate CO_2 emission calculation.

N_2O emissions from medical uses and other possible sources are estimated using constant value for activity data, which is assessment of producer and distributor of N_2O in Croatia. More detailed data are needed for accurate emission calculation.

According to requirement of Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official Gazette No. 1/07) each sources of CO_2 emissions from Solvent and Other Product Use should report required activity data for more accurate emissions estimation.

5.2. REFERENCES

Central Bureau of Statistics, Department of Manufacturing and Mining, *Annual Industrial Reports (1990 – 2010),* Zagreb

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Croatian Environment Agency (2012) Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution, EKONERG Ltd., Zagreb

EMEP/CORINAIR (1996) *Atmospheric Emission Inventory Guidebook*, European Environmental Agency, Denmark

FCC/IRR/2008/HRV *Report of the review of the initial report of Croatia*, 26 August 2009

FCC/ARR/2008/HRV *Report of the initial review of the greenhouse gas inventories of Croatia submitted in 2007 and 2008*, 5 November 2009, *1 March 2010*

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FCCC/ARR/20010/HRV *Report of the individual review of the individual review of the annual submission of Croatia submitted in 2010, 12 April 2011*

Ministry of Environmental and Nature Protection (2011) *National Inventory Report 2011, Croatian greenhouse gas inventory for the period 1990 – 2009*, EKONERG Ltd., Zagreb

Ministry of Environmental and Nature Protection (2010) *Fifth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)*, Zagreb

6. AGRICULTURE (CRF SECTOR 4)

6.1. OVERVIEW OF SECTOR

The agricultural activities contribute directly to the emission of greenhouse gases through various processes. The following sources have been identified to make a more complete break down in the emission calculation:

- Livestock: enteric fermentation (CH_4) and manure management (CH_4, N_2O)
- Agricultural soils (N_2O)

The total emission in 2010 caused by agricultural activities was 3,316.88 Gg CO_2-eq, which represents about 11.42 percent of the total inventory emission. Methane (CH_4) and nitrous oxide (N_2O) are primary greenhouse gases discharged as a consequence of agricultural activities (Figure 6.1-1). Of all the ruminants, dairy cattle are the largest source of methane (CH_4) emission. The result of agricultural soil management, manure management and agricultural engineering in cultivation of some crops are relatively high emission of nitrous oxide (N_2O). Emission generated by burning agricultural residues was not included in the calculation because this activity is prohibited by Croatian regulations. There are no ecosystems in the Republic of Croatia that could be considered natural savannas or rice fields; therefore, no greenhouse gas emissions exist for this sub-category.

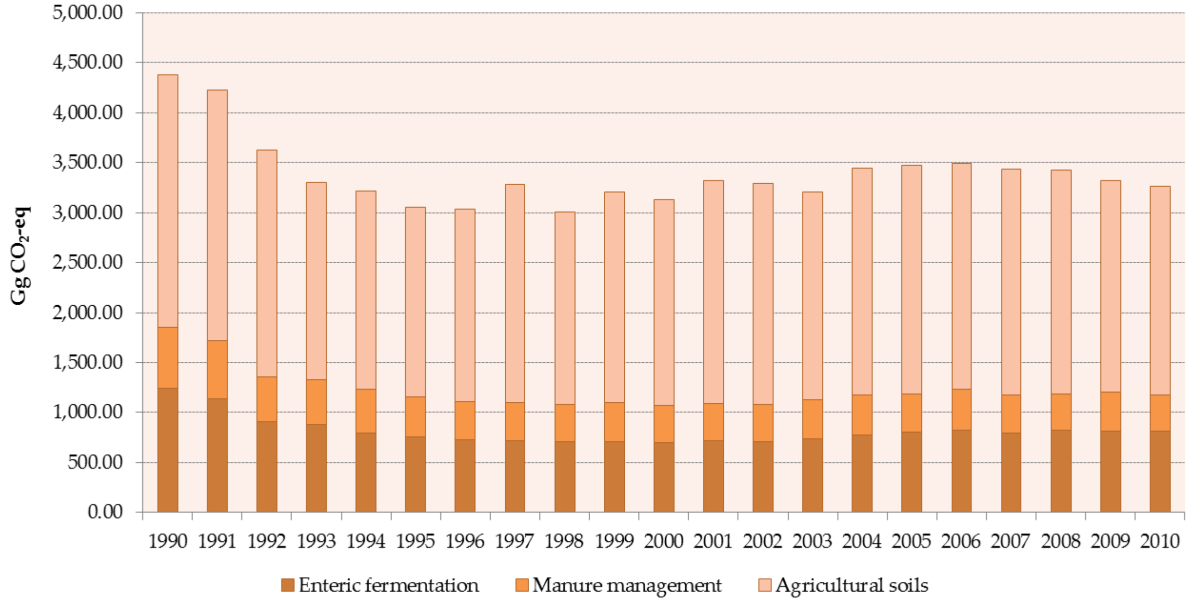

Figure 6.1-1: Agriculture emission trend

Greenhouse gas emission decreased from 1990-1996 due to the war which highly influenced the animal population, crop production, consumption of mineral fertilizers and the overall agricultural practice in Croatia. Afterwards, the sector began to revitalize and emission slightly increased due to better national circumstances for agricultural production. Table 6.1-1 and Table 6.1-2 show the total emission from Agriculture by gases and by emission sources for the period 1990-2010.

Table 6.1-1: Emission of greenhouse gases from agriculture

Year	Methane emission / Gg CH_4			Nitrous oxide emission / Gg N_2O		
	Enteric fermentation	Manure management	Total	Manure management	Agricultural soils	Total
1990	59.14	10.89	**70.03**	1.23	8.15	**9.39**
1991	54.23	10.69	**64.92**	1.15	8.09	**9.23**
1992	43.08	8.09	**51.17**	0.91	7.32	**8.23**
1993	41.96	8.32	**50.27**	0.89	6.34	**7.23**
1994	37.94	8.35	**46.29**	0.83	6.42	**7.25**
1995	36.53	7.52	**44.05**	0.78	6.11	**6.89**
1996	34.82	7.41	**42.24**	0.73	6.23	**6.96**
1997	34.63	7.28	**41.91**	0.72	7.04	**7.76**
1998	34.14	7.17	**41.31**	0.70	6.21	**6.91**
1999	33.97	7.94	**41.92**	0.72	6.80	**7.52**
2000	33.42	7.38	**40.79**	0.70	6.65	**7.35**
2001	34.25	7.42	**41.67**	0.70	7.20	**7.90**
2002	33.79	7.53	**41.32**	0.69	7.14	**7.83**
2003	35.34	7.89	**43.23**	0.72	6.69	**7.41**
2004	36.75	8.51	**45.25**	0.73	7.32	**8.05**
2005	38.37	7.41	**45.78**	0.72	7.40	**8.12**
2006	39.09	8.57	**47.65**	0.75	7.31	**8.05**
2007	37.70	7.93	**45.62**	0.72	7.29	**8.00**
2008	39.05	7.59	**46.65**	0.68	7.22	**7.90**
2009	38.82	8.21	**47.03**	0.68	6.83	**7.51**
2010	38.48	7.96	**46.45**	0.68	6.83	**7.51**

Table 6.1-2: Emission of greenhouse gases from agriculture

Year	Methane emission / Gg CO_2-eq			Nitrous oxide emission / Gg CO_2-eq			Gg CO_2-eq
	Enteric fermentation	Manure management	Total	Manure management	Agricultural soils	Total	TOTAL EMISSION
1990	1,241.92	228.62	**1,470.54**	381.84	2,528.33	**2,910.18**	**4,380.72**
1991	1,138.74	224.57	**1,363.31**	354.98	2,507.64	**2,862.62**	**4,225.93**
1992	904.73	169.82	**1,074.54**	282.53	2,269.23	**2,551.75**	**3,626.30**
1993	881.07	174.68	**1,055.75**	276.21	1,966.50	**2,242.72**	**3,298.47**
1994	796.64	175.38	**972.03**	257.44	1,989.65	**2,247.09**	**3,219.12**
1995	767.22	157.86	**925.08**	241.97	1,895.21	**2,137.18**	**3,054.84**
1996	731.26	155.68	**886.94**	227.56	1,930.88	**2,158.43**	**3,038.12**
1997	727.27	152.86	**880.13**	223.66	2,181.14	**2,404.80**	**3,278.66**
1998	716.89	150.52	**867.41**	217.88	1,925.14	**2,143.02**	**3,005.73**
1999	713.41	166.81	**880.22**	222.78	2,107.08	**2,329.87**	**3,206.66**
2000	701.73	154.90	**856.63**	216.04	2,060.53	**2,276.56**	**3,130.16**
2001	719.27	155.74	**875.01**	218.27	2,231.23	**2,449.50**	**3,321.87**
2002	709.67	158.11	**867.78**	212.82	2,213.25	**2,426.07**	**3,292.23**
2003	742.09	165.69	**907.78**	222.75	2,072.50	**2,295.26**	**3,201.72**
2004	771.66	178.66	**950.32**	227.71	2,268.03	**2,495.74**	**3,445.04**
2005	805.76	155.58	**961.34**	224.02	2,292.53	**2,516.55**	**3,477.70**
2006	820.84	179.87	**1,000.70**	231.79	2,264.89	**2,496.68**	**3,497.55**
2007	791.66	166.44	**958.09**	222.14	2,259.40	**2,481.54**	**3,438.87**
2008	820.08	159.47	**979.56**	209.79	2,239.18	**2,448.97**	**3,427.95**
2009	815.24	172.36	**987.60**	212.23	2,117.21	**2,329.44**	**3,316.88**
2010	808.18	167.17	**975.35**	203.53	2,086.20	**2,289.74**	**3,265.09**

Overview of the greenhouse gas emission calculation according to previously stated sources is presented in the following subchapters.

Table 6.1-2: Emission of greenhouse gases from agriculture

Year	Methane emission / Gg CO_2-eq			Nitrous oxide emission / Gg CO_2-eq			Gg CO_2-eq
	Enteric fermentation	Manure management	Total	Manure management	Agricultural soils	Total	TOTAL EMISSION
1990	1,241.92	228.62	**1,470.54**	381.84	2,528.33	**2,910.18**	**4,380.72**
1991	1,138.74	224.57	**1,363.31**	354.98	2,507.64	**2,862.62**	**4,225.93**
1992	904.73	169.82	**1,074.54**	282.53	2,269.23	**2,551.75**	**3,626.30**
1993	881.07	174.68	**1,055.75**	276.21	1,966.50	**2,242.72**	**3,298.47**
1994	796.64	175.38	**972.03**	257.44	1,989.65	**2,247.09**	**3,219.12**
1995	767.22	157.86	**925.08**	241.97	1,895.21	**2,137.18**	**3,054.84**
1996	731.26	155.68	**886.94**	227.56	1,930.88	**2,158.43**	**3,038.12**
1997	727.27	152.86	**880.13**	223.66	2,181.14	**2,404.80**	**3,278.66**
1998	716.89	150.52	**867.41**	217.88	1,925.14	**2,143.02**	**3,005.73**
1999	713.41	166.81	**880.22**	222.78	2,107.08	**2,329.87**	**3,206.66**
2000	701.73	154.90	**856.63**	216.04	2,060.53	**2,276.56**	**3,130.16**
2001	719.27	155.74	**875.01**	218.27	2,231.23	**2,449.50**	**3,321.87**
2002	709.67	158.11	**867.78**	212.82	2,213.25	**2,426.07**	**3,292.23**
2003	742.09	165.69	**907.78**	222.75	2,072.50	**2,295.26**	**3,201.72**
2004	771.66	178.66	**950.32**	227.71	2,268.03	**2,495.74**	**3,445.04**
2005	805.76	155.58	**961.34**	224.02	2,292.53	**2,516.55**	**3,477.70**
2006	820.84	179.87	**1,000.70**	231.79	2,264.89	**2,496.68**	**3,497.55**
2007	791.66	166.44	**958.09**	222.14	2,259.40	**2,481.54**	**3,438.87**
2008	820.08	159.47	**979.56**	209.79	2,239.18	**2,448.97**	**3,427.95**
2009	815.24	172.36	**987.60**	212.23	2,117.21	**2,329.44**	**3,316.88**
2010	808.18	167.17	**975.35**	203.53	2,086.20	**2,289.74**	**3,265.09**

Overview of the greenhouse gas emission calculation according to previously stated sources is presented in the following subchapters.

6.2. CH_4 EMISSIONS FROM ENTERIC FERMENTATION IN DOMESTIC LIVESTOCK (CRF 4.A.)

6.2.1. SOURCE CATEGORY DESCRIPTION

Methane is a direct product of animal metabolism generated during the digestion process. The greatest producers of methane are ruminants (cows, other cattle and sheep). The amount of methane produced and excreted depends on the animal digestive system and the amount and type of the animal feed. Estimates in the inventory include only emissions in farm animals. Buffalo, camels, and lamas do not occur in the Republic of Croatia. Emissions from wild animals and semi domesticated game are not quantified and neither are emissions from humans or pet animals. Dairy cattle is the single major source of emissions representing about 49% of total CH_4 emission from Enteric fermentation in 2010, followed by non dairy cattle representing about 31%. Jointly, cattle are responsible for around 80% of total CH_4 emission from Enteric fermentation. No methodology for calculating CH_4 emission from poultry is available in Revised 1996 IPCC Guidelines.
Figure 6.2-1 shows emission of methane from Enteric fermentation for the period from 1990-2010. The emission trend follows the trend of animal population which significantly decreased during the war period in the early 1990s (up to 1996). The decrease is recorded for each animal category (see Table 6.2.2).

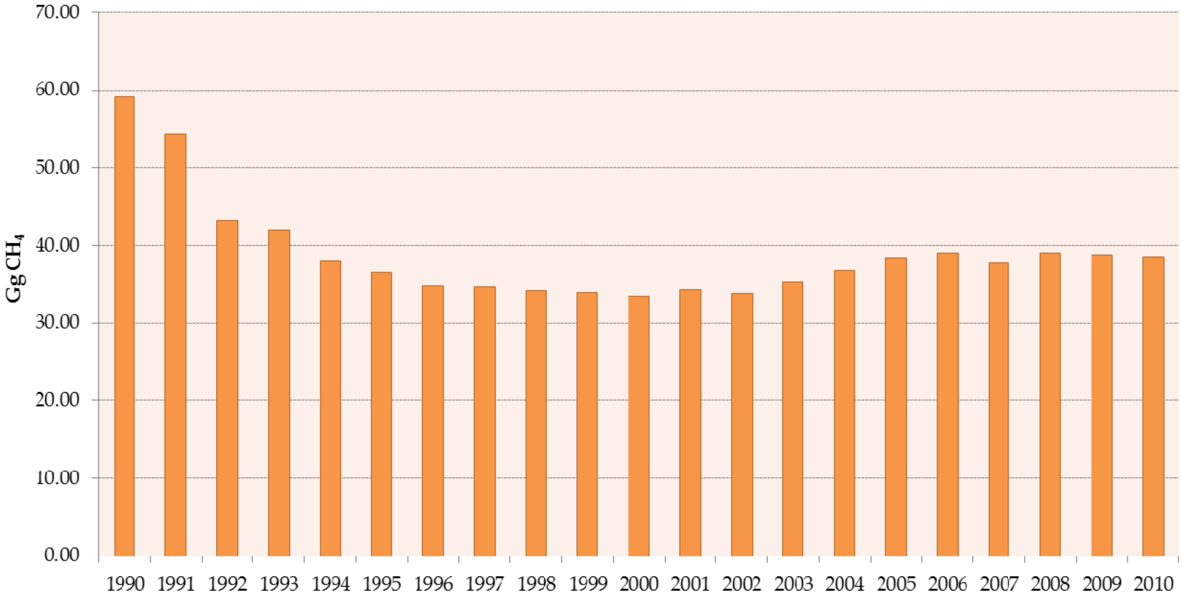

Figure 6.2-1: CH_4 emission from Enteric fermentation

6.2.2. METHODOLOGICAL ISSUES

The IPCC methodology has been used to calculate methane emission from enteric fermentation. For cattle, Tier 2 method was used and for other animals a simplified, Tier 1, method.

The main two sources regarding the animal population are the Central Bureau of Statistics and FAO database. More detailed data on horses and mules/asses was provided by Croatian Horse breeding Centre. See Table 6.2-1 for detailed information.

Table 6.2-1: Sources of activity data regarding animal population

Animal category	CBS	FAO	Croatian Horse breeding Centre	Interpolation
Cattle	1990-2010			
Sheep	1990-2010			
Goats	1990-1991; 1999-2010	1992-1998		
Horses	1990-2004		1995; 1997-2010	1996
Mules/assess	1990-1991	1992-1999	2000-2010	
Swine	1990-2010			
Poultry	1990-2010			

The number of livestock is reported in Table 6.2-2.

Table 6.2-2: Livestock population in the period from 1990 – 2010

Year	*Animal number / 1000 heads*							
	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Mules/asses	Swine	Poultry
1990	460	370	751	172	39	17	1573	17102
1991	422	335	753	133	36	13	1621	16512
1992	369	221	539	114	26	13	1182	13142
1993	333	256	525	105	22	12	1262	12697
1994	328	191	444	108	21	7	1347	12503
1995	308	185	453	107	2	4	1175	12024
1996	283	178	427	105	3	4	1197	10993
1997	279	172	453	100	3	4	1176	10945
1998	270	173	427	84	4	4	1166	9959
1999	268	170	488	78	4	4	1362	10871
2000	262	164	529	79	5	1	1234	11256
2001	254	184	539	93	5	1	1234	11747

2002	247	170	580	97	6	1	1286	11665
2003	252	192	587	86	7	1	1347	11778
2004	226	240	722	126	9	1	1489	11185
2005	235	236	796	134	10	1	1205	10641
2006	233	250	680	103	12	1	1488	10088
2007	225	242	646	92	14	1	1348	10053
2008	213	241	643	84	16	2	1104	10015
2009	212	235	619	76	17	2	1250	10787
2010	182	262	629	75	19	2	1231	9469

The overall livestock population decreased significantly in the war period (1991-1995) compared to 1990. Dairy cattle maintained the decreasing trend over the entire period from 1990-2010. The population of other animal categories fluctuates through the period concerned but the explanation for the latter requires more detailed information which requires additional research. Croatian Horse breeding Centre provided detailed national data for the population numbers of horses (1995; 1997-2010) and mules/asses (2000-2010). CBS data was used for horse and FAOSTAT numbers for mules/assess population were used for the period 1990-1994 and 1990-1999, respectively, due to current unavailability of national data. Since these numbers are not consistent with the new trend, further investigation into this issue is required. Due to the by Croatian Horse breeding Centre gap for the horses in year 1996, interpolation was performed instead of usage of FAOSTAT data to maintain a more correct trend for the entire period 1995-2010.

Cattle classification for Tier 2 is as follows:

- Mature dairy cattle – mature dairy cows
- Mature non dairy cattle – mature females and mature males (other cows, heifers, bullocks, oxen)
- Young cattle - calves

For the calculation of emission factor for dairy cattle, mature non dairy cattle and the young, default factors were used (see Table 6.2-3).

Table 6.2-3: Default data used in emission factor calculation for cattle

Animal	weight (kg)	Cfi	Ca	WG (kg/day)	fat (%)	$C_{pregnancy}$	DE (%)	Ym
mature dairy	550.00	0.335	0.00	0.00	4.00	0.10	60.00	0.060
mature non-dairy	600.00	0.322	0.17	0.00			60.00	0.065
young	230.00	0.322	0.17	0.40			60.00	0.060

Milk yield per cow per day for the period from 1990-2010 is presented in Table 6.2-4.

Table 6.2-4: Milk yield per cow

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Milk yield (kg/day)	5.47	5.03	5.28	5.12	5.03	5.26	5.77	6.12	6.45	6.37

Table 6.2-4: Milk yield per cow, cont.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Milk yield (kg/day)	6.54	7.08	7.44	7.67	7.90	9.08	9.94	10.04	10.34	10.66	11.95

Other parameters are calculated as follows:

- net energy required by the animal for maintenance (NEm) – Equation 4.1
- net energy for animal activity (NEa) – Equation 4.2a
- net energy needed for growth (NEg) – Equation 3 (IPCC Guidelines)
- net energy for lactation (NEl) – Equation 4.5a
- net energy required for pregnancy (NEp) – Equation 4.8
- ratio of net energy available for growth in a diet to digestible energy consumed (NEga/DE) – Equation 4.10
- gross energy (GE) – Equation 4.11

Finally, emission factors for diary and non-dairy cattle are calculated upon the following equation (IPCC Guidelines - equation 14):

Emission factor (kg/yr) = [Intake (MJ/day) x Ym x (365 days/yr)] / 55.65 MJ/kg of methane]

Emission factor for mature non-dairy cattle and young cattle is about 66 kg CH_4/head/yr and 41 kg CH_4/head/yr respectively while the emission factor used for dairy cattle is presented in Figure 6.2-2.

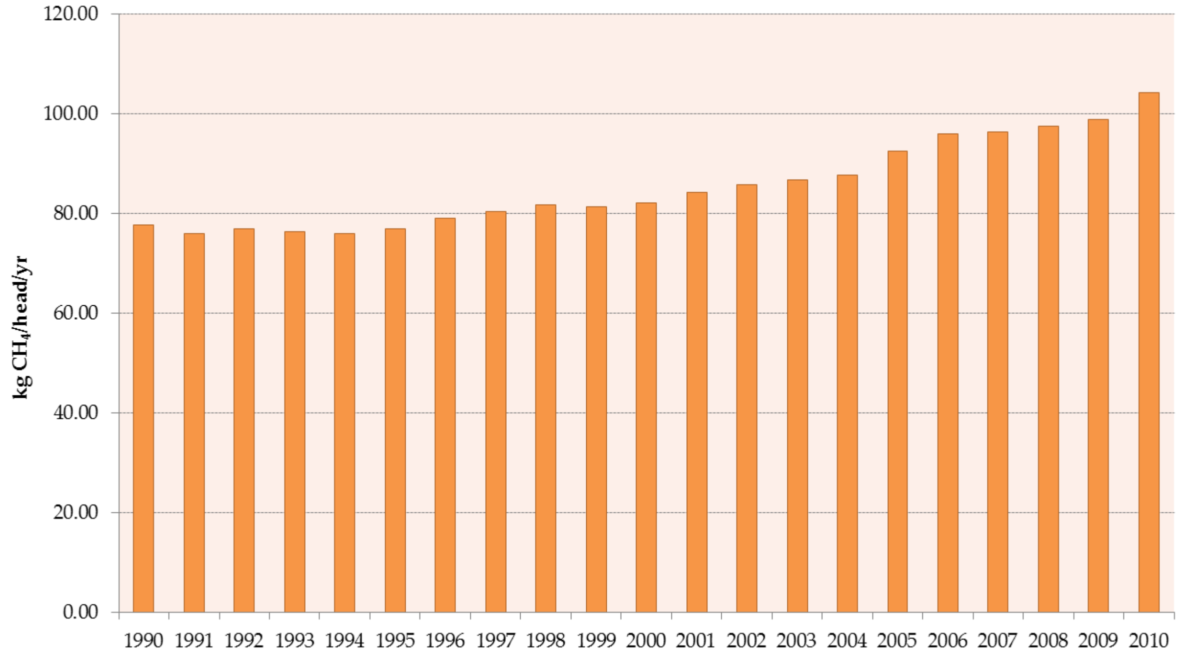

Figure 6.2-2: Enteric fermentation emission factors used for dairy cattle

For other animals (sheep, goats, horses, mules/asses, swine), Tier 1 has been used as well as default EF for developing countries (from 1990-2007) and default EF for developed countries (2008-2010). The only difference is therefore related to sheep and swine since default emission factors for other animal categories are the same for developing and developed countries. Abovementioned is presented in Table 6.2-5.

Table 6.2-5: Default enteric fermentation emission factors for each animal category (except cattle)

Animal Category	EF / kg per head per year	
	1990-2007 (developing countries)	2008-2010 (developed countries)
Sheep	5	8
Goats	5	5
Horses	18	18
Mules/asses	10	10
Swine	1.0	1.5
Poultry	Not estimated	Not estimated

6.2.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Uncertainty estimates are based on expert judgement. Uncertainty of activity data amounts ±10%. Uncertainty of emission factors amounts ±20%.

CH_4 emissions from Enteric Fermentation have been calculated using the same method and data sets for every year in the time series.

6.2.4. SOURCE SPECIFIC RECALCULATIONS

Methane emissions form Enteric fermentation were recalculated for the years 1995-2009 due to:

1.changes of activity data regarding data on sheep population (2009)
2.changes of activity data regarding data on horse population (1995-2009)
3.changes of activity data regarding data on mules/asses population (2000-2009)
4.change of activity date regarding Milk yield per cow (2009)

6.3. MANURE MANAGEMENT – CH_4 EMISSIONS (CRF 4.B.)

6.3.1. SOURCE CATEGORY DESCRIPTION

Management of livestock manure produces both methane (CH_4) and nitrous oxide (N_2O) emissions. Methane is generated under the conditions of anaerobic decomposition of manure. Manure storing methods, in which anaerobic conditions prevail (liquid animal manure in septic pits), are favourable for anaerobic decomposition of organic substance and release of methane. The storing of solid animal manure results in aerobic decomposition and very low production of methane. Methane emission from Manure management for the period from 1990 to 2010 is presented in Figure 6.3-1. The emission trend depends on the animal population trend.

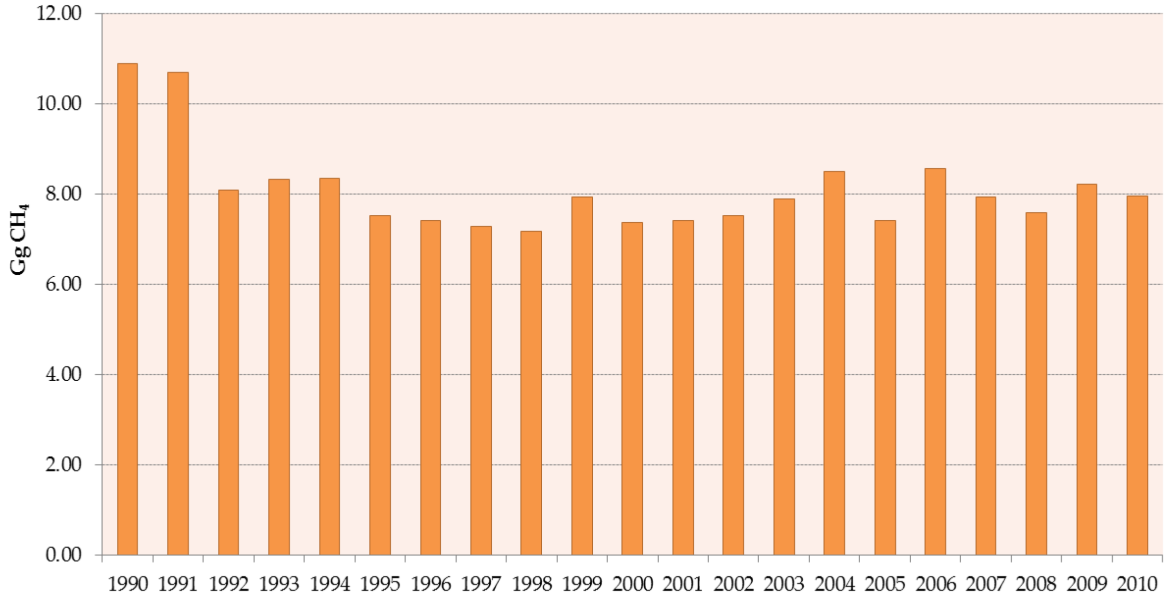

Figure 6.3-1: CH_4 emission from Manure management

6.3.2. METHODOLOGICAL ISSUES

The IPCC methodology (Tier 1) has been used to calculate methane emission from Manure Management. The same activity data as in Enteric fermentation have been used in emission calculation, thus referring to Table 6.2-2. Default emission factors were used for emission calculation according to IPCC Guidelines for National Greenhouse Gas Inventories Reference Manual. They are specified for the animal type, climate region (cool), geographic region and/or the degree of region development. For cattle and swine, emission factors for Eastern Europe have been used. For the period from 1990-2007, these default EFs refer to those of developing countries for sheep, goats, horses, mules/asses and poultry while for the emission calculation for the period 2008-2010 EFs of developed countries have been used. Abovementioned is presented in Table 6.3-1.

Table 6.3-1: Default manure management emission factors for each animal category except cattle

Animal Category	EF / kg per head per year	
	1990-2007 (developing countries)	2008-2010 (developed countries)
Sheep	0.19	0.10
Goats	0.12	0.11
Horses	1.4	1.1
Mules/asses	0.76	0.60
Poultry	0.078	0.012

6.3.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts about 8 percent, based on expert judgements. Uncertainty estimate associated with emission factors amounts 12 percent, according to information provided in the *IPCC Guidelines* (detailed in Annex 5, Tables A5-1, A5-2).

CH_4 emissions from Manure Management have been calculated using the same method and data sets for every year in the time series.

6.3.4. SOURCE SPECIFIC RECALCULATIONS

Methane emissions from Manure management were recalculated for the years 1995-2009 due to:

1. changes of activity data regarding data on sheep population (2009)
2. changes of activity data regarding data on horse population (1995-2009)
3. changes of activity data regarding data on mules/asses population (2000-2009)

6.4. N_2O EMISSIONS FROM MANURE MANAGEMENT (CRF 4.B.)

6.4.1. SOURCE CATEGORY DESCRIPTION

Emissions of nitrous oxide (N_2O) from all animal waste management systems are estimated. A considerable amount of nitrous oxide evolves during storage of animal waste and is attributed to livestock breeding. This includes emissions from anaerobic lagoons, liquid systems, solid storage, dry lot and other systems. Emissions of N_2O from pasture range and paddock are reported under Agricultural soils. Farm animals emit very little nitrous oxide directly and this has not been considered in estimation of GHG emissions. In the Republic of Croatia, manure is not used as fuel.

6.4.2. METHODOLOGICAL ISSUES

The IPCC methodology (Tier 1) has been used. Emission factors are taken from the 1996 IPCC Reference Manual. Nitrous oxide (N_2O) emission is calculated according to the following equations:

$$Nex_{(AWMS)} = \Sigma_{(T)} [N_{(T)} \times Nex_{(T)} \times AMWS_{(T)}]$$

where

$Nex_{(AWMS)}$	stands for	N excretion per Animal Waste Management System
$N_{(T)}$	stands for	number of animals by type
$Nex_{(T)}$	stands for	N excretion of animals by type
$AMWS_{(T)}$	stands for	fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems
T	stands for	type of animal category

$$N_2O_{(AWMS)} = \Sigma [Nex_{(AWMS)} \times EF_3]$$

where

$N_2O_{(AWMS)}$	stands for	N_2O emissions from all Animal Waste Management Systems (kg N/yr)
$Nex_{(AWMS)}$	stands for	N excretion per Animal Waste Management System (kg/yr)
EF_3	stands for	emission factor

Nitrous oxide (N_2O) emissions from Manure management for the period from 1990 to 2010 are presented in Figure 6.4-1. The emission trend depends on the animal population trend.

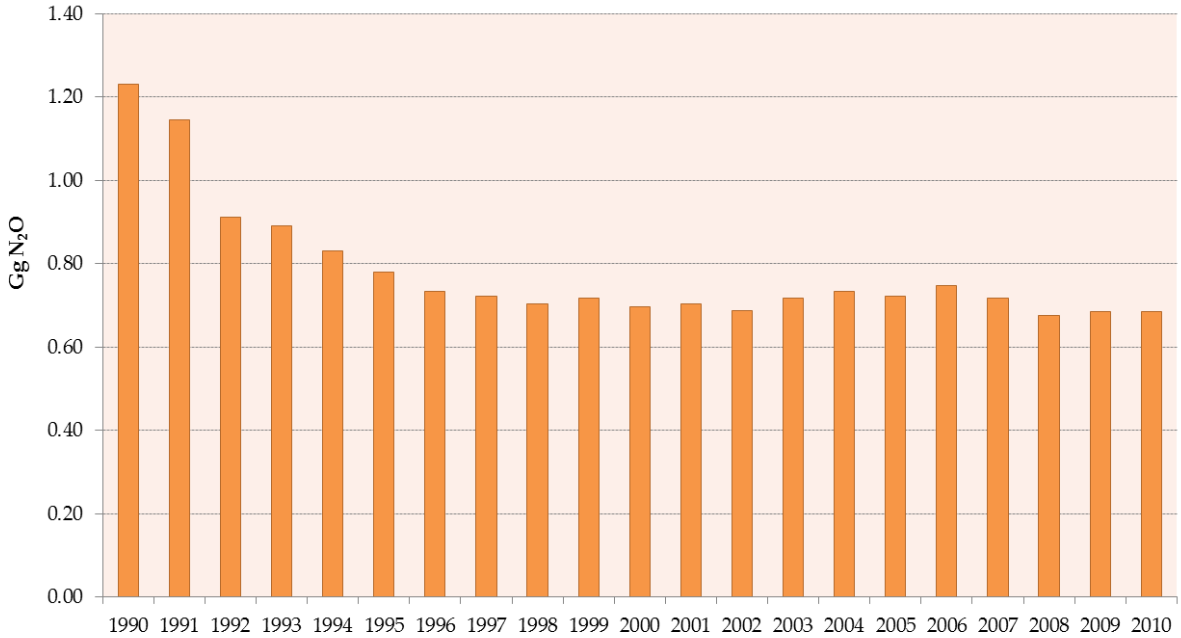

Figure 6.4-1: N_2O Emissions from Manure management

Activity data regarding livestock population are the same as for the calculation of CH_4 emission from Enteric fermentation and Manure management. Nitrogen excretion per each manure management system and emission factors were taken from the 1996 IPCC Reference Manual.

6.4.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 6 percent, based on expert judgements. Uncertainty estimate associated with emission factors amounts 35 percent, according to information provided in the *IPCC Guidelines* (detailed in Annex 5, Tables A5-1, A5-2). N_2O emissions from Manure Management have been calculated using the same method and data sets for every year in the time series.

6.4.4. SOURCE SPECIFIC RECALCULATIONS

Recalculations were performed for the years 1995-2009 due to new and updated data on animal numbers.

6.5. AGRICULTURAL SOILS (CRF 4.D.)

A number of agricultural activities add nitrogen to soils, thereby increasing the amount of nitrogen available for nitrification and denitrification, and ultimately the amount of N_2O emitted.
Three sources of nitrous oxide emissions are distinguished:

- Direct emissions of N_2O from agricultural soils
- Direct soil emissions of N_2O from animal production
- Indirect emissions of N_2O conditioned by agricultural activities

Major part of emission comes directly from agricultural soils by cultivation of soil and crops. The activities stated include the use of synthetic and organic fertilizers, growing of leguminous plants and soybean (nitrogen fixation), nitrogen from agricultural residues and the treatment of histosols. Emissions of nitrous oxide (N_2O) from Agricultural soils for the period from 1990 to 2010 are presented in Figure 6.5-1. Emissions from Agricultural soils decreased after 1990 and during the war due to specific national circumstances and limited agricultural practice at that time. Afterwards, the emission trend is mostly influenced by the changes in the direct soil emissions. In 1997, 2001 and 2002 direct soil emissions increased due to the increase in mineral fertilizer consumption (1997, 2001) and also due to the increase in crop production (2002). In the period from 2004-2008, emission increased in comparison to 2003 due to increases in mineral fertilizer consumption, number of animals and crop production. Emissions for the years 2009 and 2010 follow a declining trend, mostly related to continued economic recession.

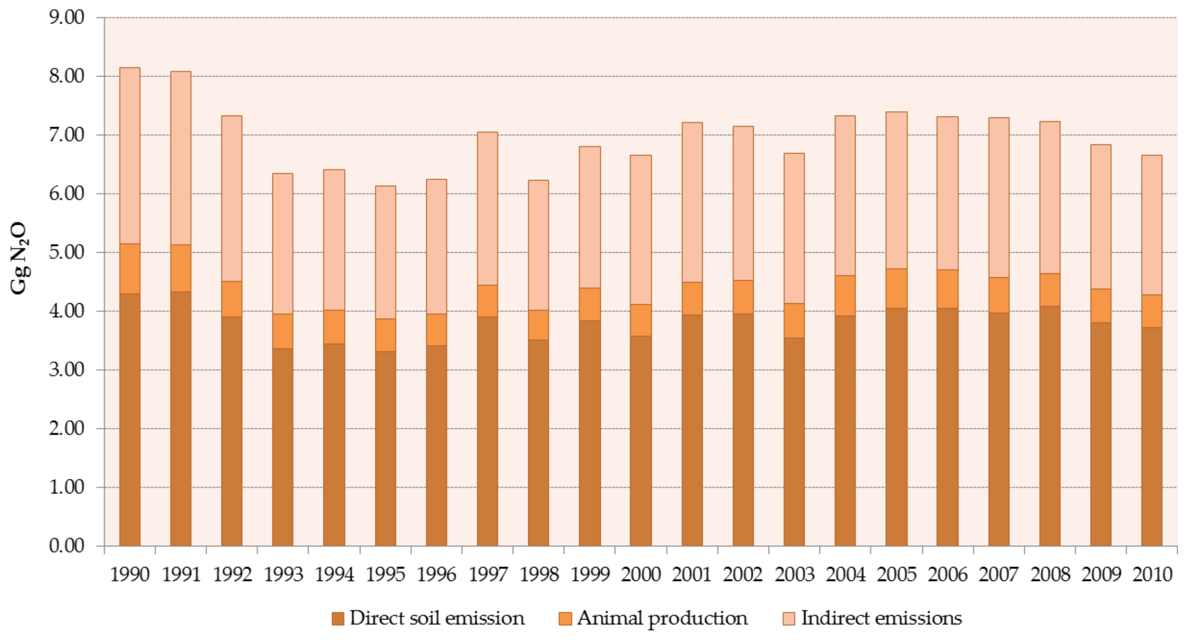

Figure 6.5-1: Total N_2O emissions from Agricultural soils

6.5.1. DIRECT EMISSION FROM AGRICULTURAL SOILS

6.5.1.1. Source category description

Direct N_2O emissions from agricultural soils include total amount of nitrogen applied to soils through cropping practices. These practices include application of synthetic fertilizer, nitrogen from animal waste, production of nitrogen – fixing crops, nitrogen from crop residue mineralization, soil nitrogen mineralization due to cultivation of histosols and nitrogen form sludge applied to soils. Input data required for this part of the calculation are the following:

- annual amount of the synthetic fertilizer applied
- the amount of organic fertilizer applied
- the head of animals by category
- the biomass of leguminous plants and soyabean
- the area of histosols
- annual amount of sludge applied

Direct emission from agricultural soils is calculated by the following equation:

$$N_2O_{\,DIRECT}\,(kg\ N/yr) = (F_{SN} + F_{AW} + F_{CR} + F_{BN} + N_{SEWSLUDGE}) \times EF_1 + (F_{OS}\ x\ EF_2)$$

where

N_2O_{DIRECT}	stands for	direct N_2O emission from agricultural soils (kg N/yr)
F_{SN}	stands for	nitrogen from synthetic fertilizer excluding emissions of NH_3 and NO_x (kg N/yr)
F_{AW}	stands for	nitrogen from animal waste (kg N/yr)
F_{CR}	stands for	nitrogen from crop residues (kg N/yr)
F_{BN}	stands for	nitrogen from N-fixing crops (kg N/yr)
EF_1, EF_2	stands for	emission factors
F_{OS}	stands for	nitrogen from histosols, (kg N/yr)
$N_{SEWSLUDGE}$	stands for	nitrogen from sludge applied to soils, (kg N/yr)

Direct Emissions of N_2O from Agricultural soils for the period from 1990 to 2010 are shown in Figure 6.5-2. Emission trend is also dependent on mineral fertilizer consumption, number of animals and crop production which is already explained in related chapters where activity data trends are provided.

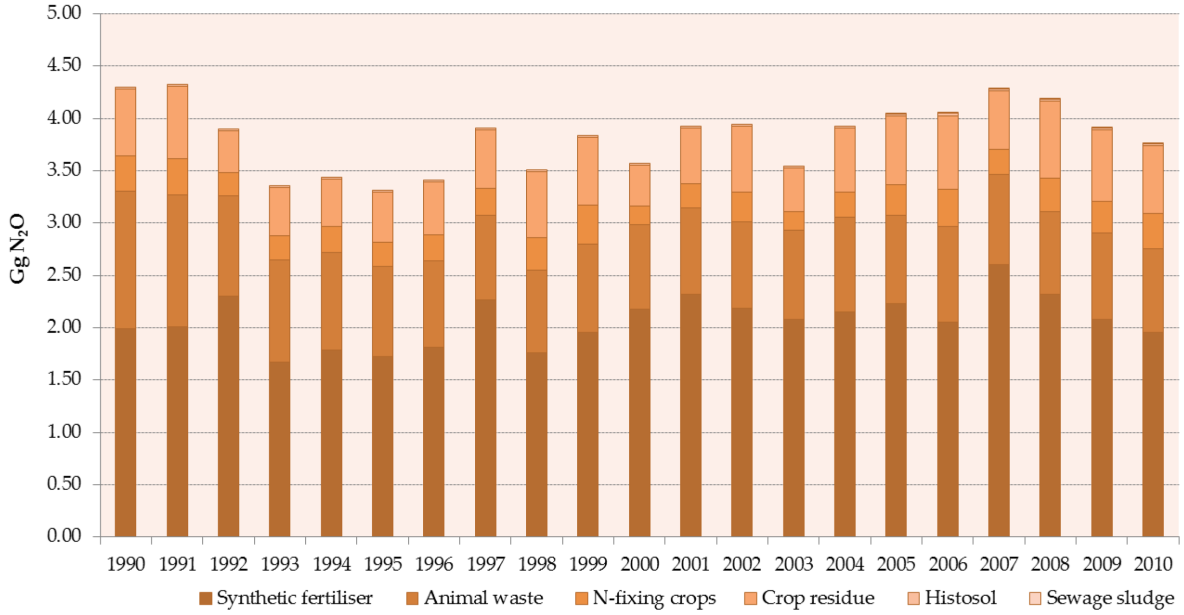

Figure 6.5-2: Direct N_2O emissions from Agricultural soils

6.5.1.2. Methodological issues

In order to calculate emission from Agricultural Soils, the IPCC methodology (Tier 1) has been used. Emission factors were taken from the *Revised 1996 IPCC Reference Manual and IPCC Good Practice Guidance 2000.*

<u>Nitrous oxide from mineral fertilisers</u>

This estimate is based on the amount of N in mineral fertiliser that is annually consumed in the Republic of Croatia. Data on the consumption of mineral fertilisers that are produced and applied in Croatia were obtained from:

- Fertilizer company Petrokemija Kutina, for the period 1992-2010
- Fertilizer company Genera for the period 2006-2010
- Fertilizer company Adriatica Dunav for the year 2010

Data on mineral fertilizers produced and applied in Croatia in 1990 and 1991 have been estimated by extrapolation method using pattern from 1992 to 2006. Data on import of mineral fertilizers were also obtained from Petrokemija, for the period 2000-2010 and Adriatica Dunav, 2010. Data on import before the year 2000 are negligible due to tariffs which were eliminated in 2000. Activity data on amounts of different mineral fertilizer types applied to soils for the entire period from 1990-2010 is presented in Figure 6.5-3 while the nitrogen applied in the same period is shown in Table 6.5-1. Nitrogen dispersed into the atmosphere in the form of NH_3 and NO_x was subtracted from the total estimated quantity of emitted nitrogen N.

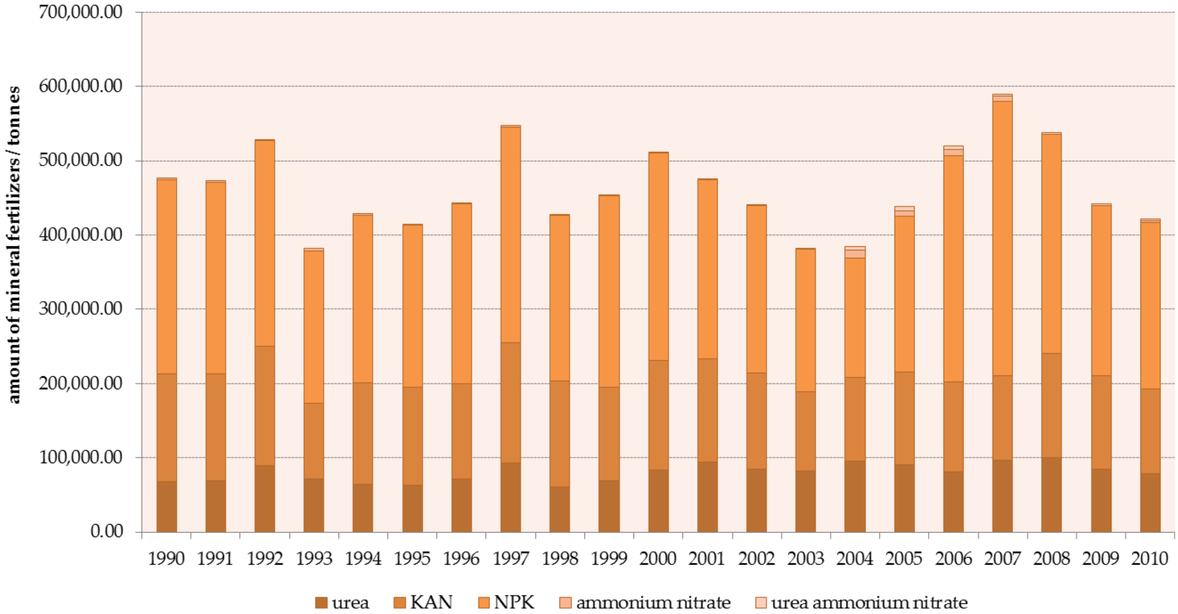

Figure 6.5-3: Mineral fertilizers applied to soil in the period from 1990-2010

Over the years, the consumption of mineral fertilizers fluctuates depending on the prices of the agricultural products. The consumption refers to the amounts produced and sold within the country and imported amounts. Regarding the domestic production for domestic consumption, low consumption in 1993 is recorded due to the war which obstructed the agricultural practice around the country while in 2009 it was caused by the drastic decrease of prices related to agricultural products. Only calcium ammonium nitrate (KAN) stayed at the same level (being the cheapest fertilizer). The consumption trend of this type of mineral fertilizer is decreasing in the period from 1992-2009 although from 2000 onwards is almost stationary. As for urea, its consumption increased from 1998-2008, then decreased in 2009 and 2010. NPK has the highest decreasing trend in the period from 2000-2004 which is a reflection of the economic position of agricultural producers. The consumption of mineral fertilizers peaked in 2007 and was high in 2008 up to the last quarter and was characterized with high prices of agricultural products. The imported amounts were the highest in 2004 because at that time the fertilizer prices decreased in the region while the lowest imported amounts were recorded for 2008.

Table 6.5-1: Nitrogen applied in the period from 1990-2010

Year	Nitrogen applied / tonnes					
	Urea	Calcium ammonium nitrate	NPK	Ammonium nitrate	Urea ammonium nitrate	TOTAL
1990	31,376	39,030	36,286	721	0	107,413
1991	31,957	38,643	37,442	672	0	108,715
1992	41,094	43,521	39,921	282	0	124,818
1993	32,706	27,744	29,856	1,054	0	91,359
1994	29,839	36,708	29,815	549	0	96,911
1995	29,039	35,701	28,396	280	0	93,416
1996	32,894	34,645	30,769	82	0	98,389
1997	42,898	43,609	35,924	921	0	123,352
1998	27,756	38,791	28,359	341	0	95,246
1999	31,669	34,221	39,496	235	0	105,621
2000	38,180	39,922	39,862	42	0	118,005
2001	57,769	37,933	32,341	300	0	128,343
2002	50,656	38,066	31,651	97	0	120,469
2003	42,176	31,017	33,361	5,203	1,863	113,621
2004	45,109	32,070	33,736	5,126	1,647	117,688
2005	41,940	36,265	36,439	4,983	1,683	121,309
2006	37,505	36,121	34,033	2,730	1,390	111,780
2007	44,424	37,701	38,512	3,416	777	124,830
2008	46,659	39,456	34,411	333	590	121,449
2009	39,667	36,486	31,386	19	737	108,295
2010	40,999	34,812	30,614	21	498	106,944

Data on the fraction of synthetic fertilizer nitrogen applied to soils that volatilises as NH_3 and NO_x were obtained from EMEP/EEA Emission Inventory Guidebook (2007) for each fertilizer type (see Table 6.5-2).

Table 6.5-2: Nitrogen fraction emitted as NH_3 and NO_x

Fertilizer type	Fraction of N emitted as NH_3 and NO_x
Urea	0.15
calcium ammonium nitrate (KAN)	0.02
NPK	0.02
Ammonium nitrate	0.02
Urea ammonium nitrate	0.08

The emission of nitrous oxide was then calculated by multiplying the quantity of the remaining N with emission factor 0.0125 kg N_2O-N/kg N (Revised 1996 IPCC Guidelines).

Nitrous oxide from animal manure and liquid/slurry

The estimate is based on the amount of N in solid and liquid manure/slurry which is annually used for crop fertilization. Of the total estimated quantity of emitted nitrogen, the N that is emitted on pasture ($Frac_{GRAZ}$) and N that is dispersed into the atmosphere in the form of NH_3 and NO_x ($Frac_{GASM}$) was subtracted. For $Frac_{GASM}$, default value of 20% was used from Table 4-19 in the IPCC Reference Manual for the entire period. As for the $Frac_{GRAZ}$, the values were calculated as ratios of N excreted during grazing and total N excretion. The latter is as follows:

Year	$Frac_{GRAZ}$
1990	0.242597
1991	0.243235
1992	0.242183
1993	0.237468
1994	0.239793
1995	0.238328
1996	0.241126
1997	0.244305
1998	0.240604
1999	0.246151
2000	0.250735
2001	0.251589
2002	0.260838
2003	0.254671
2004	0.273151
2005	0.283515
2006	0.264639
2007	0.261608
2008	0.261572
2009	0.25744
2010	0.260452

Emission of nitrous oxide was then calculated by multiplying the quantity of the remaining N with emission factor 0.0125 kg N_2O-N/kg N (Revised 1996 IPCC Guidelines).

Nitrous oxide from biological fixation of N

Tier 1b method was used in calculation of nitrous oxide emission due to biological fixation of N. The estimate is based on the amount of N-fixing crops produced in the country as dry biomass. The data on the production were obtained from the Central Bureau of Statistics, FAO database and for certain years by extrapolation (see Table 6.5-3).

Table 6.5-3: Data sources regarding N-fixing crop production

Crop	CBS	FAO	Extrapolation*
Soyabeans	1990-2010		
Beans, dry	1990-2010		
Cow peas, dry	2008-2010	1992-2007	1990-1991
Lentils		1992-2009	1990-1991
Peas, dry	2008-2010	1992-2007	1990-1991
Vetches		1992-2009	1990-1991
Clover	1990-2010		
Alfaalfa	1990-2010		

**Extrapolation was based on data for the period 1992-1995.*

Activity data related to production of N-fixing crops is presented in Table 6.5-4.

Table 6.5-4: Production of N-fixing crops in the period from 1990 – 2010

Year	Production of N-fixing crops / tonnes			
	Soyabeans	Beans, dry	Cow peas, dry	Lentils
1990	55,461	18,437	1,790	219
1991	56,365	21,949	1,521	199
1992	46,129	15,961	895	155
1993	49,456	17,588	1,651	180
1994	44,127	20,596	441	167
1995	34,319	21,844	400	92
1996	35,896	20,221	368	123
1997	39,469	20,527	373	135
1998	77,458	21,003	384	139
1999	115,853	22,291	400	148
2000	65,299	2,657	300	143
2001	91,841	4,421	400	130
2002	129,470	5,163	400	152
2003	82,591	4,967	400	105
2004	97,923	4,459	400	106
2005	119,602	6,041	338	108
2006	174,214	4,058	400	140
2007	90,637	2,503	400	100
2008	107,558	3,263	1,149	41
2009	115,159	2,460	1,468	74
2010	153,580	1,641	1,197	29

Table 6.5-4: Production of N-fixing crops in the period from 1990 – 2010 (cont.)

Year	Production of N-fixing crops / tonnes			
	Peas, dry	Vetches	Clover	Alfaalfa
1990	535	1,888	225,466	252,563
1991	554	2,005	226,546	251,486
1992	812	2,125	129,747	142,613
1993	337	2,160	136,012	137,225
1994	400	2,509	155,087	162,457
1995	853	2,400	143,910	158,557
1996	611	2,207	165,973	188,462
1997	577	2,237	157,559	179,669
1998	746	2,305	158,516	201,778
1999	824	2,400	167,266	223,387
2000	650	2,400	100,179	85,575
2001	739	2,300	115,709	98,305
2002	886	2,690	131,103	107,815
2003	1,335	1,851	51,890	72,056
2004	1,100	1,840	124,813	103,555
2005	893	1,363	125,460	147,272
2006	715	2,400	121,411	162,694
2007	670	2,300	111,675	137,291
2008	870	2,996	176,089	196,244
2009	955	2,000	147,763	174,274
2010	340	1,700	119,968	177,652

By comparing all trends, highest fluctuations can be noticed in regard to dry cow peas, dry peas and soyabeans. Production of dry cow peas and dry peas is obtained from several different sources which resulted in aforementioned fluctuation. Years 2000 and 2003 were very hot and dry which had a negative effect on soyabeans production along with the changes in seed market. Related fluctuations between 2006 and 2007 are caused by changes in harvested area and yield per hectare.

Data on dry matter fraction, residue/crop ratio and N fraction used in emission calculation are as follows.

Table 6.5-5: Dry matter fraction, residue/crop ratio and N fraction for N-fixing crops

Crop	dry matter fraction	residue/crop ratio	N fraction
Soyabeans	0.86	2.10	0.023
Beans, dry	0.895	2.10	0.03
Cow peas, dry	0.85	1.50	0.014
Lentils	0.85	1.00	0.03
Peas, dry	0.87	1.50	0.0142
Vetches	0.85	1.00	0.03
Clover	0.85	0.00	0.03
Alfaalfa	0.85	0.00	0.03

There were four main data sources for the latter:

- Slovenian National Inventory Report (due to similar circumstances)
- Good Practice Guidance 2000
- 1996 IPCC Guidelines – Reference Manual
- Expert judgement

Emission of nitrous oxide was then calculated by multiplying the quantity of the remaining N with emission factor 0.0125 kg N_2O-N/kg N (Revised 1996 IPCC Guidelines).

Emissions of nitrous oxide from crop residue

The estimate is based on a more accurate methodology recommended by the GPG 2000. The basic step in the process is to estimate the amount of crop residue nitrogen that is incorporated in soils for both non-nitrogen-fixing crops and N-fixing crops. In order to do so, a modified approach is used (Tier 1b).

Data on the production of non N-fixing crops were obtained from the Central Bureau of Statistics and/or FAO database (see Table 6.5-6). As for additional uses of crop residues, in Croatia alfalfa and clover are used as fodder. Field burning of crop residues is prohibited by law; therefore fraction of crop residue burnt is set as NO.

Table 6.5-6: Data sources regarding non N-fixing crop production

Crop	CBS	FAO
Wheat	1990-2010	
Maize	1990-2010	
Potatoes	1990-2010	
Sugar beets	1990-2010	
Tobacco	1990-2010	
Sunflowers	1990-2010	
Rape seed	1990-2010	
Tomatoes	1990-2010	
Barley	1990-2010	
Oats	1990-1991; 2000-2010	1992-1999
Cabbages and other brassicas	1990-2010	
Garlic**	1990-2010	
Onions**	1990-2010	
Rye	1990-2010	
Sorghum	1990-1997*	1998-2010
Watermelons	1990-2010	

**CBS stopped obtaining sorghum production data after 1997*

***CBS provides aggregated data for garlic & onions. FAO data was used to calculate yearly ratios of garlic and onions in the total, aggregated number.*

Activity data related to production of non N-fixing crops is presented in Table 6.5-7.

Table 6.5-7: Production of non N-fixing crops in the period from 1990 – 2010

Year	Production of non N-fixing crops / tonnes				
	Wheat	Maize	Potatoes	Sugar beets	Tobacco
1990	1,602,435	1,950,011	610,236	1,205,928	12,394
1991	1,495,625	2,387,533	658,687	1,244,439	10,460
1992	658,019	1,357,663	480,079	525,189	11,651
1993	886,921	1,671,819	507,898	537,196	9,585
1994	750,330	1,686,922	563,285	591,819	8,613
1995	876,507	1,735,854	692,216	690,707	8,548
1996	741,235	1,885,515	666,020	906,246	11,272
1997	833,508	2,183,144	620,032	931,186	11,339
1998	1,020,045	1,982,545	664,753	1,233,322	12,133
1999	558,217	2,135,452	728,646	1,113,969	10,051
2000	865,260	1,190,238	198,243	482,211	9,714
2001	811,674	1,733,003	242,709	964,880	10,502
2002	822,650	1,956,418	266,055	1,183,445	10,905
2003	506,212	1,279,617	164,051	677,569	9,680
2004	801,424	1,931,627	247,057	1,260,444	10,293
2005	601,748	2,206,729	273,409	1,337,750	9,579
2006	804,601	1,934,517	274,529	1,559,737	10,851
2007	812,347	1,424,599	296,302	1,582,606	12,639
2008	858,333	2,504,940	255,554	1,269,536	12,866
2009	936,076	2,182,521	270,251	1,217,041	13,348
2010	681,017	2,067,815	178,611	1,249,151	8,491

Table 6.5-7: Production of non N-fixing crops in the period from 1990 – 2010 (cont.)

Year	Production of non N-fixing crops / tonnes				
	Sunflowers	Rape seed	Tomatoes	Barley	Oats
1990	52,982	33,200	54,742	196,554	62,287
1991	46,430	22,816	48,601	185,695	53,851
1992	40,413	24,183	35,262	106,811	45,262
1993	42,723	28,665	39,771	125,671	41,074
1994	26,474	28,341	46,276	107,810	42,425
1995	37,066	24,472	46,958	103,281	38,237
1996	28,526	11,661	49,019	88,091	39,529
1997	36,138	11,181	48,085	108,496	46,796
1998	62,206	21,967	62,003	143,510	56,110
1999	72,374	32,581	70,816	124,890	56,823
2000	53,956	29,436	26,081	179,652	61,604
2001	42,985	22,456	27,272	192,067	71,632
2002	62,965	25,585	25,988	206,478	74,187
2003	69,253	28,596	22,942	160,203	53,025
2004	68,973	31,392	25,938	237,603	73,462
2005	78,006	41,275	28,930	162,530	49,470
2006	81,614	19,996	29,027	215,262	66,630
2007	54,303	39,330	48,040	225,265	56,150
2008	119,872	62,942	32,358	279,106	65,328
2009	82,098	80,424	37,419	243,609	62,297
2010	61,789	33,047	33,648	172,359	48,190

Table 6.5-7: Production of non N-fixing crops in the period from 1990 – 2010 (cont.)

Year	Production of non N-fixing crops / tonnes					
	Cabbages and other brassicas	Garlic	Onions	Rye	Sorghum	Watermelons
1990	135,637	11,830	40,309	15,840	2,185	20,938
1991	129,437	10,471	38,488	14,069	1,858	17,941
1992	75,981	6,744	28,717	6,069	633	8,062
1993	88,933	7,345	31,081	6,273	678	8,014
1994	104,178	9,346	40,896	7,146	618	16,045
1995	125,874	9,384	43,010	5,051	559	21,384
1996	131,563	8,967	39,274	5,517	466	26,901
1997	143,549	9,002	43,776	5,009	547	25,450
1998	144,298	10,624	51,662	5,530	540	60,243
1999	160,170	10,277	55,633	6,246	485	53,437
2000	36,887	2,553	14,166	7,236	466	25,802
2001	35,570	3,069	18,000	10,796	571	25,837
2002	40,357	2,908	17,385	9,207	626	28,210
2003	38,814	2,609	15,393	5,967	396	16,988
2004	36,127	2,888	17,523	8,994	527	24,237
2005	53,399	3,741	22,059	4,737	600	28,852
2006	52,851	3,445	20,381	5,487	800	26,549
2007	43,582	5,250	31,097	4,364	1,200	30,193
2008	62,820	5,100	30,601	4,079	760	35,608
2009	77,004	5,105	30,529	2,860	1,130	44,175
2010	45,654	3,659	26,704	2,507	250	23,313

Higher fluctuations in trend have been noticed for sunflower, tomato and rape seed. The latter is primarily caused by changes in harvested area and in some cases changes in yield per hectare.

Tier 1b includes crop specific data on the ratio of aboveground biomass to crop product mass (residue/crop ratio), dry matter fraction and N fraction (see Tables 6.5-5 and 6.5-8). Dry matter fraction needed to be incorporated so that adjustments for moisture contents could be made. Moreover, $Crop_{BF}$ should represent all N-fixing crops not just the seed yield of pulses and soybeans.

Table 6.5-8: Dry matter fraction, residue/crop ratio and N fraction for non N-fixing crops

Crop	dry matter fraction	residue/crop ratio	N fraction
Wheat	0.86	1.30	0.0028
Maize	0.86	1.00	0.0081
Potatoes	0.30	0.40	0.011
Sugar beets	0.25	1.40	0.015
Tobacco	0.89	1.00	0.015
Sunflowers	0.92	1.30	0.015
Rape seed	0.90	1.00	0.015
Tomatoes	0.063	1.00	0.015
Barley	0.86	1.20	0.0043
Oats	0.92	1.30	0.007
Cabbages and other brassicas	0.135	0.10	0.0027
Garlic	0.354	1.00	0.0150
Onions, dry	0.142	1.00	0.0150
Rye	0.900	1.60	0.0048
Sorghum	0.910	1.40	0.0108
Watermelons and melons	0.850	0.40	0.0110

N in crop residues returned to soils (F_{CR}) is calculated according to equation 4.29 from GPG 2000. Furthermore, emission of nitrous oxide was calculated by multiplying the quantity of the remaining N with emission factor 0.0125 kg N_2O-N/kg N (Revised 1996 IPCC Guidelines - no change in the GPG 2000).

Emissions of nitrous oxide due to cultivation of organic soils

Cultivation of soils with high content of organic material causes the release of a long term bounded N. New activity data regarding the area of histosols in the Republic of Croatia have been obtained from the Croatian Environment Agency based on the results of a project performed in cooperation with experts from the Faculty of Agronomy, University of Zagreb. The distribution of histosols was revised based on pedological maps (scale 1:50000) and CORINE land cover database. Total histosol area relating to agricultural land is 1.473,8 ha. Based on expert judgment, this value can be used for each year in the entire period from 1990-2010.

Emission of nitrous oxide, due to cultivation of histosols, was then calculated by multiplying the area of histosols with the emission factor 8 kg N/ha/yr. The emission factor represents an updated default value for mid-latitude organic soils (GPG 2000).

Emissions of nitrous oxide due to application of sewage sludge

Emissions of nitrous oxide from sludge input are included for the first time in this year's submission. Sufficient activity data was provided for the period 2005-2010, while for the period 1990-2004 no data is available. Sewage sludge nitrogen was included and calculated according to direct N_20 emissions from agricultural soils equation 4.20 (GPG 2000).

Table 6.5-10: Amount of sludge and nitrogen percentage applied

Year	Amount of sludge applied (tons dry matter)	Nitrogen percentage (N % in dry matter mass)
2005	3	0.11
2006	6	0.11
2007	7	0.11
2008	16	0.11
2009	24	0.11
2010	30.5	0.11

6.5.1.3. Uncertainties and time-series consistency

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 16 percent, based on expert judgements. Uncertainty estimate associated with emission factors amounts 47 percent, according to information provided in the *IPCC Guidelines* (detailed in Annex 5, Tables A5-1, A5-2). Direct N_2O emissions from agricultural soils have been calculated using the same method and data sets for every year in the time series.

6.5.1.4. Source specific recalculations

Recalculations are summarized in Table 6.5-10.

Direct soil emissions

During the 5th Centralized review 2011 ERT noted that, for the 2002-2009 period, FAO data on the N-synthetic fertilizers amount used are higher than the data Croatia used to calculate the N_2O emissions from synthetic fertilizers category. For this year's submission, more detailed country-specific activity data were collected and recalculations of N_2O emissions from mineral fertilisers were made for the period 2006-2009.

Recalculations of N_2O emission from animal manure were made due to changes in animal number. New and updated data were obtained for sheep (CBS, 2009), horses (Croatian Livestock Centre, 1995, 1997-2009; interpolation, 1996) and mules/asses (Croatian Livestock Centre, 2000-2009).

In addition, a mistake was made in the last year's submission regarding *animal waste kg N/year* value in the CRF tables for the period 1990-1993, which however did not affect emission calculation for the period in question. This issue was corrected in this year's submission.

As for the N_2O emissions originating from biological fixation of nitrogen and crop residue, during the 5th Centralized review 2011 ERT found that Croatia did not include the following crops in the estimates of emissions: cabbages, garlic, onions, rye, sorghum and watermelons. In the response, Croatia decided to provide revised estimates of N_2O estimates for Crop residue category for the 1990-2009 period based on the available FAOSTAT data. For this submission, recalculation was performed for the entire period 1990-2009 due to new and updated activity data for cabbage and other brassicas, rye, garlic, onions, watermelons (CBS, 1990-2009), sorghum (CBS, 1990-1997; FAOSTAT, 1998-2009), lentils (FAOSTAT, 1998-2000; 2002-2005), vetches (FAOSTAT, 1996-1998; 2002-2005; 2008) and cow peas,dry (FAOSTAT, 1996-1998; 2000; 2005).

Table 6.5-10: Summary of recalculations of direct N2O emissions from agricultural soils

Recalculations of N_2O emissions from	Due to	For the year/period
Mineral fertilizers	New and updated activity data	2006-2009
Animal manure	change in animal number (sheep)	2009
	change in animal number (horses)	1995-2009
	change in animal number (mules/asses)	2000-2009
Biological fixation Crop residue	new and updated activity data (cabbages and other brassicas)	1990-2009
	new and updated activity data (garlic)	1990-2009
	new and updated activity data (onions)	1990-2009
	new and updated activity data (rye)	1990-2009
	new and updated activity data (sorghum)	1990-2009
	new and updated activity data (watermelons)	1990-2009
	new and updated activity data (lentils)	1998-2000; 2002-2005
	new and updated activity data (vetches)	1996-1998; 2002-2005; 2008
	new and updated activity data (cow peas,dry)	1996-1998; 2000; 2005
Sewage sludge	new activity data	2005-2009

6.5.2. DIRECT N_2O EMISSION FROM PASTURE, RANGE AND PADDOCK MANURE (CRF 4.D.2.)

6.5.2.1. Methodological issues

Estimates of N_2O emissions from animals were based on animal waste deposited directly on soils by animals on pasture, range and paddock. N_2O emissions from animals can be calculated as follows:

$$N_2O_{ANIMALS} = N_2O_{(AWMS)} = \Sigma_{(T)} [N_{(T)} \times Nex_{(T)} \times AWMS_{(T)} \times EF_{3(AWMS)}]$$

where

$N_2O_{animals}$	stands for	N_2O emissions from animal production (kg N/yr)
$N_2O_{(AWMS)}$	stands for	N_2O emissions from Animal Waste Management Systems (kg N/yr)
$N_{(T)}$	stands for	number of animals of type T
$Nex_{(T)}$	stands for	N excretion of animals of type T (kg N/animal/yr)
$AWMS_{(T)}$	stands for	fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems for animals of type T
$EF_{3(AWMS)}$	stands for	emission factor

The same emission factor (0.02 kg N_2O-N/kg of emitted N), recommended by the Revised 1996 IPCC Guidelines, was used for all grazing animals regardless of their species and climatic conditions. Direct N_2O emissions from Pasture, range and paddock manure for the period from 1990 to 2010 are shown in the Figure 6.5-4. The emission trend follows the animal population trend.

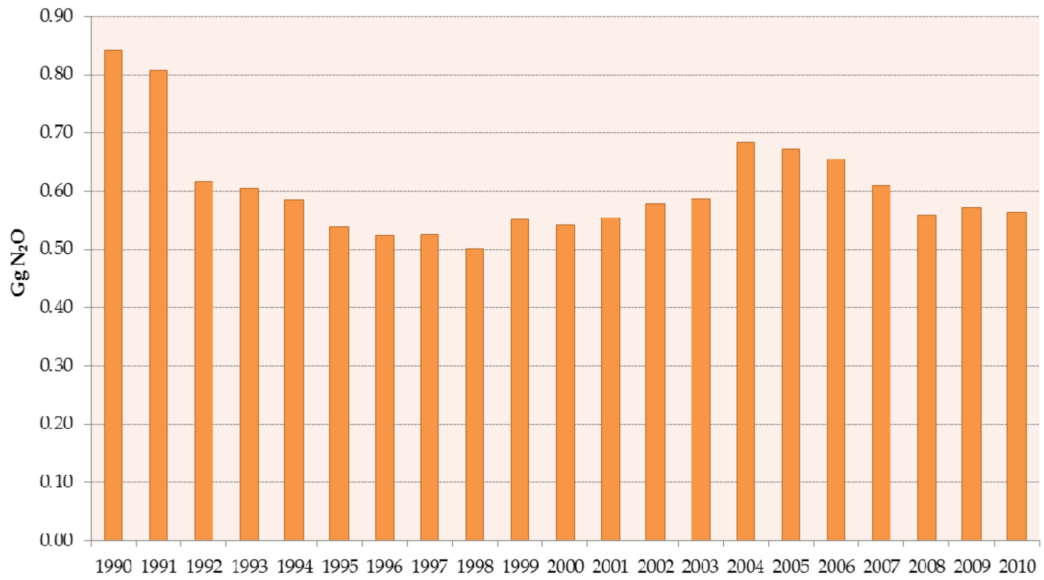

Figure 6.5-4: Direct N_2O emissions from animal production Uncertainties and time-series consistency

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 8.5 percent, based on expert judgements. Uncertainty estimate associated with emission factors amounts 37 percent, according to information provided in the *IPCC Guidelines* (detailed in Annex 5, Tables A5-1, A5-2). Direct N_2O emissions from Pasture, Range and Paddock Manure have been calculated using the same method and data sets for every year in the time series.

6.5.2.2. Source specific recalculations

Due to changes in animal number (sheep 2009, mules/asses 2000-2009, horses 1995-2009) recalculation was performed.

6.5.3. INDIRECT N_2O EMISSIONS FROM NITROGEN USED IN AGRICULTURE

6.5.3.1. Source category description

Calculations of indirect N_2O emission from nitrogen used in agriculture are based on two pathways. These are: volatilization and subsequent atmospheric deposition of NH_3 and NO_x (originating from the application of fertilizers and animal manure) and leaching and runoff of the nitrogen that is applied to or deposited on soils. These two indirect emission pathways are treated separately, although activity data used are identical. The indirect emission of N_2O from the agriculture is calculated using the following equation:

$$N_2O_{\ INDIRECT} = N_2O_{(G)} + N_2O_{(L)}$$

where

$N_2O_{indirect}$	stands for	indirect N_2O emissions (kg N/yr)
$N_2O_{(g)}$	stands for	N_2O emissions due to atmospheric deposition of NH_3 and NO_x (kg N/yr)
$N_2O_{(L)}$	stands for	N_2O emissions due to nitrogen leaching an runoff (kg N/yr)

Emissions of N_2O produced from the discharge of human sewage N into rivers are reported under the sector waste.

Indirect emission of N_2O from agriculture sector for the period from 1990 to 2010 is shown in Figure 6.5-5. The emission trend is influenced by the mineral fertilizer consumption and animal population altogether.

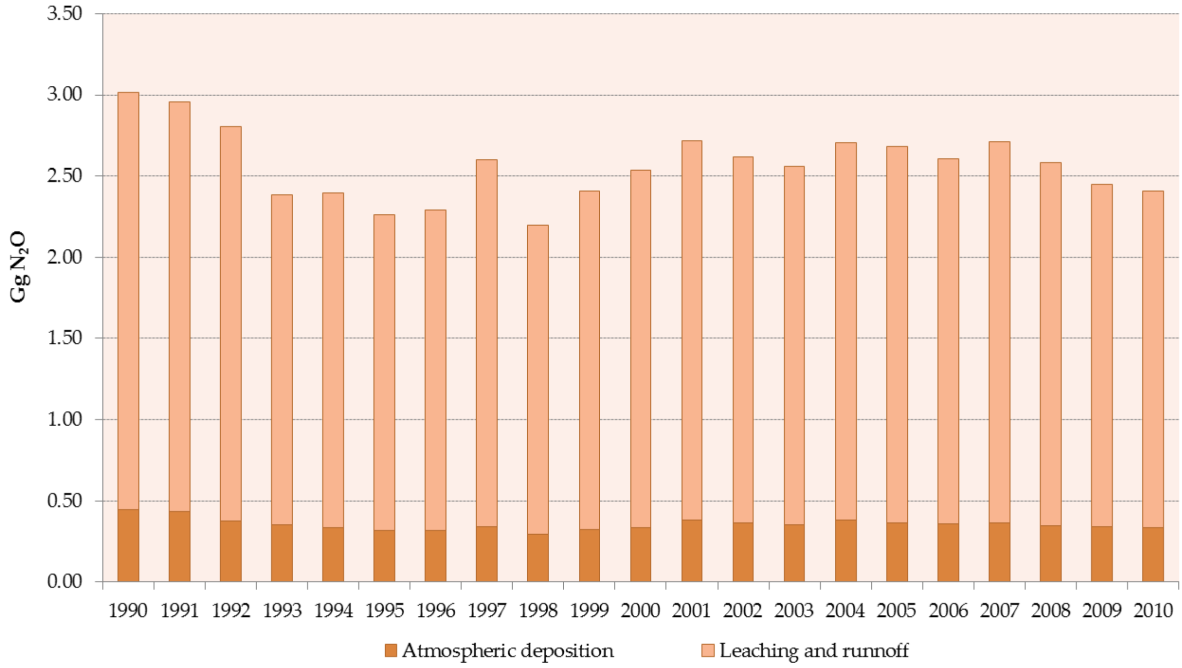

Figure 6.5-5: Indirect N_2O emissions from Agriculture

6.5.3.2. Methodological issues

Nitrous oxide arising due to volatilization of ammonia (NH_3) and nitrogen oxides (NO_x)

While fertilizing agricultural soils with nitrogen fertilizers, some N volatilises in form of ammonia (NH_3) and nitrogen oxides (NO_x). This nitrogen is deposited by precipitation and particulate matter on agricultural soil, in forests and waters and thus indirectly contributes to emissions of N_2O. Emissions are attributed to the place of origin of ammonia and NO_x, not to the place where N is re-deposited, causing N_2O emissions.

<u>*Emissions from mineral fertilizers*</u>

Indirect emissions of nitrous oxide from mineral fertilizers depend to a large extent on the fraction of N that volatilises during fertilization. The amount of volatilised N depends very strongly on the type of fertilizer as well as on weather conditions and the manner of application. Detailed data on fraction of synthetic fertilizer nitrogen applied to soils that volatilises as NH_3 and NO_x were obtained from Croatian documents reporting to the LRTAP Convention for each fertilizer type (see Table 3.5-1). For calculation of indirect emissions of nitrous oxide, the emission factor 0.01 kg N_2O-N/kg NH_3 and NO_x-N has been used (Revised 1996 IPCC Guidelines).

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. Generic IPCC emission factor (20%, Revised 1996 IPCC Guidelines) of the excreted N is 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 0.01 kg N_2O-N/kg NH_3-N and NO_x-N (Revised 1996 IPCC Guidelines).

Nitrous oxide from leaching and runoff of nitrogen compounds into surface waters, groundwater and watercourses

Surface runoff and leaching of N into groundwater, surface waters, and watercourses due to mineral fertilisers

It has been considered that 30% of N from mineral fertilizers is lost through surface runoff and leaching into the groundwater and watercourses. For calculation of emissions of nitrous oxide, it has been considered that, for every kg of leached/run-off nitrogen, 0.025 kg of N_2O-N is emitted (Revised 1996 IPCC Guidelines).

Nitrogen leaching and runoff into groundwater, surface waters, and watercourses due to animal manure

It has been considered that, for every kg of N excreted by farm animals, 0.3 kg of N is lost through surface runoff to watercourses and groundwater (Revised 1996 IPCC Guidelines). For calculation of emissions of nitrous oxide, the same emission factors have been considered, as in the case of nitrogen leaching/runoff due to mineral fertilizer (0.025 kg N_2O-N/kg of leached/run-off N).

6.5.3.3. Uncertainty and time-series consistency

The uncertainty of the calculation is conditioned by the use of emission factors recommended by the methodology and the input data unreliability. According to the bibliography, uncertainty of the recommended emission factors is high.
Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 40 percent, based on expert judgements. Uncertainty estimate associated with emission factors amounts 200 percent, according to information provided in the *IPCC Guidelines* (detailed in Annex 5, Tables A5-1, A5-2). Indirect N_2O emissions have been calculated using the same method and data sets for every year in the time series.

6.5.3.4. Source specific recalculations

Since direct N_2O emissions from mineral fertilizers and animal manure application were recalculated due to change in animal number and mineral fertilizer activity data, recalculations of indirect N_2O emissions from nitrogen used in agriculture were also necessary for the same reason and for the same period and years. The latter refers to indirect N_2O emissions arising from volatilization of ammonia (NH_3) and nitrogen oxides (NO_x) due to application of mineral fertilizers and indirect N_2O emissions from leaching and runoff of nitrogen compounds into surface waters, groundwater and watercourses (due to mineral fertilisers). For further explanations, see Chapter 6.5.1.4.

6.6.SOURCE SPECIFIC QA/QC AND VERIFICATION

During the preparation of inventory submission, activity data regarding animal population and crop production for the entire time series were checked and revised if found necessary. The emission calculation was performed by one person and afterwards independently checked by another person. Therefore, activities related to quality control were focused on completeness and consistency of emission estimates and also on the proper use of notation keys in the CRF tables. After a final draft of this chapter was prepared, an audit was carried out to check selected activities from Tier 1 General inventory level QC procedures which revealed that most of the activities were correctly carried out, during inventory preparation, despite the fact that formal QC procedures were not prepared.

Regarding Tier 2 activities, emission factors and activity data were checked for key source categories.

In Agriculture, six source categories represent key source category (excluding LULUCF):

- CH_4 Emissions from Enteric Fermentation in Domestic Livestock
- CH_4 Emissions from Manure Management
- N_2O Emissions from Manure Management
- Direct N_2O Emissions from Agricultural Soils
- N_2O Emissions from Pasture, Range and Paddock Manure
- Indirect N_2O Emissions from Nitrogen Used in Agriculture

Table 6.6-1: Key categories in agriculture sector based on the level and trend assessment in 2010[12]

IPCC Source Categories	Direct GHG	Criteria for Identification			
		Level		Trend	
		excl. LULUCF	incl. LULUCF	excl. LULUCF	incl. LULUCF
AGRICULTURE SECTOR					
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	L1e	L1i	T1e, T2e	T1i, T2i
N_2O Emissions from Manure Management	N_2O	L1e	L1i	T1e, T2e	T1i, T2i
Direct N_2O Emissions from Agricultural Soils	N_2O	L1e, L2e	L1i, L2i		T1i, T2i
N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	L1e			
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	L1e, L2e	L1i, L2i	T1e, T2e	T1i, T2i

L1e - Level excluding LULUCF Tier1 L2e - Level excluding LULUCF Tier 2
L1i - Level including LULUCF Tier1 L2i - Level including LULUCF Tier 2
T1e - Trend excluding LULUCF Tier1 T2e - Trend excluding LULUCF Tier2
T1i - Trend including LULUCF Tier1 T2i - Trend including LULUCF Tier2

[12] Data on key categories are taken from Annex 1 Key Categories.

6.7. SOURCE SPECIFIC PLANNED IMPROVEMENT

At this point, several areas for improvements have been recognized and accordingly short and mid-term goals have been set.

Short term goals are as follows:

- Further improvements of activity data (mineral fertilizer, crop production, animal population numbers) and investigation with the purpose of more detailed explanation of the activity data trends
- improvements of uncertainty estimates regarding activity data

Planned improvements which are assumed to be mid-term (or long-term) goals are:

- the development of national emission factors for the calculation of CH_4 emission from enteric fermentation and manure management
- the usage of Tier 2 method for the emission calculation regarding manure management

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7 LAND-USE, LAND USE CHANGE AND FORESTRY (CRF sector 5)

7.1 OVERVIEW OF SECTOR

According to the methodology prescribed by the IPCC Good Practice Guidance for LULUCF (GPG 2003), the land use categories relevant for the greenhouse gas (GHG) reporting are:

- Forest land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other land

For this year submission, Croatia reports on each land use category for the first time. In accordance with the IPCC GPG, emissions and removals are reported in subcategory land remaining in the same category and land converted to another land use category. All land use changes are traced down and reported for a transition period of 20 years after which they are reported in the respective categories. Also in accordance with the IPCC GPG, emissions/removals in the categories Wetlands remaining Wetlands, Settlement remaining Settlement and Other land remaining Other land are not estimated. The completeness of the estimated emissions/removals is presented in Table 7.1-1.

Table 7.1-1: Reported LULUCF categories - status of emission estimates

LAND USE CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O
A. Forest land	x	x	x
1.Forest land remaining forest land	x	x	x
2.Land converted to Forest Land	x	NO	NO
B. Cropland	x	NO	x
1.Cropland remaining Cropland	x	NO	NO
2.Land converted to Cropland	x	NO	x
C. Grassland	x	NO	NO
1.Grassland remaining Grassland	NO	NO	NO
2.Land converted to Grassland	x	NO	NO
D. Wetlands	x	NO	NO
1.Wetlands remaining Wetlands	NE	NO	NO
2.Land converted to Wetlands	x	NO	NO
E. Settlements	x	NO	NO

1.Settlements remaining Settlements	NE	NO	NO
2.Land converted to Settlements	x	NO	NO
F. Other land	x	NO	NO
1.Other land remaining Other land	NE	NO	NO
2.Land converted to Other land	NO	NO	NO

7.1.1EMISSION TRENDS

The emissions and removals of each land use category are presented in Table 7.1-2 and Figure 7.1-1.

Table 7.1-2: Net Emissions/removals of greenhouse gases from LULUCF sector [Gg CO_2]

Year	5 Total	**A** Total Forestland	**B** Total Cropland	**C** Total Grassland	**D** Total Wetlands[1]	**E** Total Settlements[1]	**F** Total other land[1]
1990	-6.626	-7.275	189	-162	42	580	0
1991	-6.498	-7.133	176	-139	43	556	0
1992	-6.481	-7.045	166	-137	45	489	0
1993	-6.504	-7.087	177	-161	48	519	0
1994	-6.519	-7.114	179	-164	51	529	0
1995	-6.520	-7.042	190	-189	53	467	0
1996	-6.129	-6.644	184	-205	56	480	0
1997	-6.326	-6.842	190	-210	59	477	0
1998	-6.495	-7.015	207	-229	61	480	0
1999	-6.675	-7.182	197	-240	64	485	0
2000	-6.806	-7.381	251	-240	67	497	0
2001	-6.925	-7.554	286	-286	56	573	0
2002	-7.065	-7.698	264	-274	53	589	0
2003	-7.232	-7.870	252	-273	50	609	0
2004	-7.410	-8.113	263	-291	47	683	0
2005	-7.534	-8.229	247	-280	44	684	0
2006	-7.649	-8.324	232	-286	41	688	0
2007	-7.967	-8.586	159	-282	38	703	0
2008	-8.122	-8.757	127	-284	35	756	0
2009	-7.687	-8.330	115	-280	32	769	0
2010	-8.178	-8.889	151	-258	29	788	0

[1] *Only land use conversions are reported*

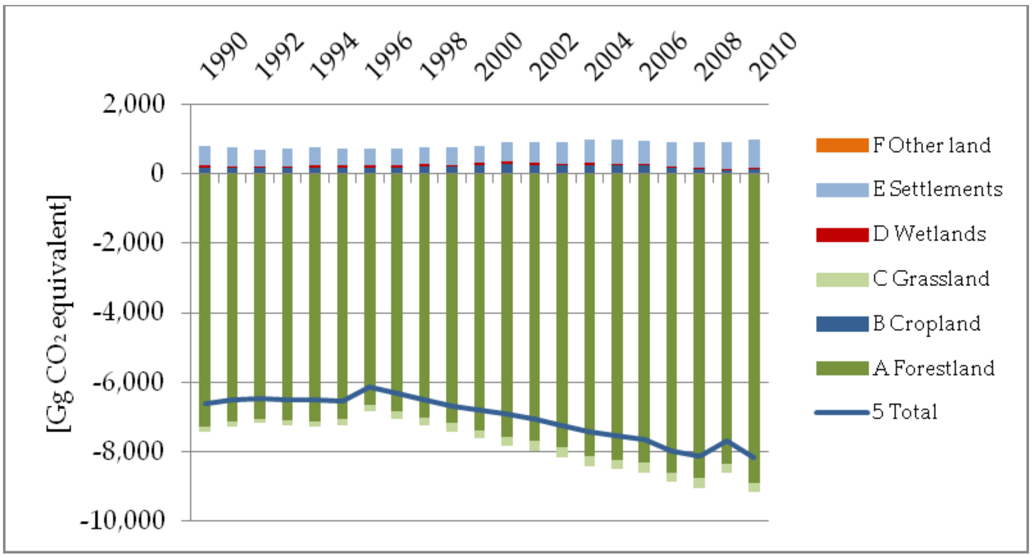
As it can be concluded from the above reported figures and Figure 7.1-2, the LULUCF sector in Croatia presents a sink of greenhouse gases. Two of the land use categories, *Forest land* and *Grassland,* are categories with CO_2 removals, while every other category represents an emission source. After the Homeland War period in Croatia (1991-1996), and reestablishment of the forest management in areas affected by the War, increase of the CO_2 removals from year to year can be observed. The exception of the trend happened in 2009 with lower value as in the year before. Removals for 2010 follow the removal trend in period 1996-2008. In 2008 a decrease in increment was reported for one of the forests districts for the first time. This happened as a result of the constant change in the forest area in that district. Since the problem with the area was not resolved until the conclusion of this report, and happened in one more district in 2010, the approach of the calculation of carbon gains due to the increment in these cases was changed. Instead of correction applied in previous reports, in this report, values of increment were added to the fellings and calculated as carbon losses in case of these two forests districts. In 2009 a significantly lower increment (new activity data) was reported in two forest districts causing the lower removal than in the year before.

Compared to the first year of reporting, the CO_2 removal has increased by about 23% in 2010. The main reason is an increase in biomass carbon stock in forest land due to the increment increase and the fact that fellings do not change significantly from year to year representing about 50% of the increment.

Compared to 1990, an increase of emissions in the settlement category can be observed in 2010. At the same time a decrease of the emissions in cropland and wetland categories was observed.

The share of the LULUCF removals in 1990 makes -17,8% of the total Croatian GHG emissions, while in 2010 the share is -29%.

Figure7.1-1. Emission/removal trend for LULUCF



7.1.2 METHODOLOGY

Data on the total area of forest for the separate years, as well as the relative share of the coniferous and deciduous and the forests out of yield were obtained from the *Croatian Forest Ltd.* company which is pursuant to the *Forest Act* (OG 140/05, 82/06, 129/08, 80/10, 124/10) obliged to manage all the forests in Croatia.

Information on areas of the wetlands, grassland and settlements for the single years (1980, 1990, 2000 and 2006) were obtained from the Corine Land Cover database.

Information on areas of the cropland were extracted from the national Statistical Yearbooks and from the Corine Land Cover database. For the purpose of this report the Croatian Bureau of Statistics (CBS) data from the time series 1960-2000 were used. A deviation in the CBS data series 1992-1997 was adjusted with linear interpolation. Changes in the CBS data collection approach and significant data deviation in the period after 2000 were corrected using the data from the CLC database.

By expert judgment certain land use changes were considered not to occur in Croatia:

- wetlands, settlements or other land converted to cropland or grassland
- cropland or settlements converted to wetlands
- wetlands converted to settlements

The area of other land is reported in accordance with the IPCC GPG. It was interpreted as the difference of the area of all other categories and the whole area of Croatia. Within the reporting period, a decrease in area of other land was observed with simultaneous increase of the forest area. Based on the analysis of land use changes in each land category and available information from *Croatian Forest Ltd.*, it was concluded that the increase of the forest land was coming from grassland and the other land category.

All the information were merged and based on annual land use changes, a matrix for LUC transition period over 20 years was developed (Table 7.1-4).
The remaining area was then calculated as the difference between the total area of a land use category and the land use changes to each category. Detailed descriptions of the methodology of area information are given in corresponding chapters of the report. The table 7.1-3 presents land use data and land use changes in the reporting period.

Table 7.1-3 Land use and LUC for Croatia for the years 1990-2010

area in kha	1990	2010	2010-1990
5. A Forest land - Total	2.055	2.318	263
5 A 1. Forest land remaining forest land	2.025	2.049	24
5A1a Forest land remaining forest land -coniferous	191	182	-8
5A1b Forest land remaining forest land -deciduous	1.578	1.492	-86
5A1c Forest land remaining forest land -out of yield	256	374	118

5 A2. LUC in Forest land	30	269	239
A2.1a Annual cropland in forest land	0	0	0
5A2.1b Perennial cropland in forest land	0	0	0
5A2.2 Grassland in forest land	28	18	-10
5A2.3 Wetlands in forest land	0	0	0
5A2.4 Settlement in forest land	0	0	0
5A2.5 Other land in forest land	2	251	249
5.B Cropland - Total	1.624	1.548	-75
Cropland annual	1.479	1.413	-66
Cropland perennial	145	135	-9
5B1. Cropland remaining cropland	1.616	1.536	-80
5B1a annual cropland remaining annual cropland	1.472	1.401	-71
5B1b perennial cropland remaining perennial cropland	143	134	-9
5B1c LUC perennial cropland in annual cropland	0	0	0
5B1d LUC annual cropland in perennial cropland	1	0	-1
5B2 LUC in cropland	7	12	5
5B2.1a Forest land in annual cropland	0	0	0
5B2.1b Forest land in perennial cropland	0	0	0
5B2.2a Grassland in annual cropland	7	12	5
5B2.2b Grassland in perennial cropland	1	1	0
5B2.3a Wetlands in annual cropland	0	0	0
5B2.3b Wetlands in perennial cropland	0	0	0
5B2.4a Settlements in annual cropland	0	0	0
5B2.4b Settlements in perennial cropland	0	0	0
5B2.5a Other land in annual cropland	0	0	0
5B2.5b Other land in perennial cropland	0	0	0
5. C Grassland	1.211	1.219	9
5C1. Grassland remaining grassland	1.178	1.165	-13
5C2. LUC in grassland	33	55	22
5C2.1 Forest land in grassland	0	0	0
5C2.2a Annual cropland in grassland	30	51	20
5C2.2b Perennial cropland in grassland	3	4	1
5C2.3 wetlands in grassland	0	0	0
5C2.4 Settlements in grassland	0	0	0
5C2.5 Other land in grassland	0	0	0
5. D Wetlands	72	74	2
5D1. Wetlands remaining wetlands	70	72	2
5D2. LUC in wetlands	2	2	0
5D2.1 Forest land in wetlands	0	0	0

5D2.2a Annual cropland in wetlands	2	2	0
5D2.2b Perennial cropland in wetlands	0	0	0
5D2.3 Grassland in wetlands	0	0	0
5D2.4 Settlements in wetlands	0	0	0
5D2.5 Other land in wetlands	0	0	0
5. E Settlements	220	259	39
5E1. Settlements remaining Settlements	196	220	24
5E2. LUC in Settlements	24	39	14
5E2.1 Forest land in Settlements	14	8	-6
5E2.2a Annual cropland in Settlements	6	14	7
5E2.2b Perennial cropland in Settlements	1	2	1
5E2.3 grassland in Settlements	4	15	12
5E2.4 wetlands in Settlements	0	0	0
5E2.5 Other land in Settlements	0	0	0
5. F Other land	478	240	-238
5F1. Other land remaining other land	478	240	-238
5F2. LUC in Other land	0	0	0
5F2.1 Forest land in Other land	0	0	0
5F2.2a Annual cropland in Other land	0	0	0
5F2.2b Perennial cropland in Other land	0	0	0
5F2.3 grassland in Other land	0	0	0
5F2.3 wetlands in Other land	0	0	0
5F2.5 Settlements in other land	0	0	0
Total area Croatia	5.659	5.659	

Table 7.1.-4 Land use change matrix (1990-2010)

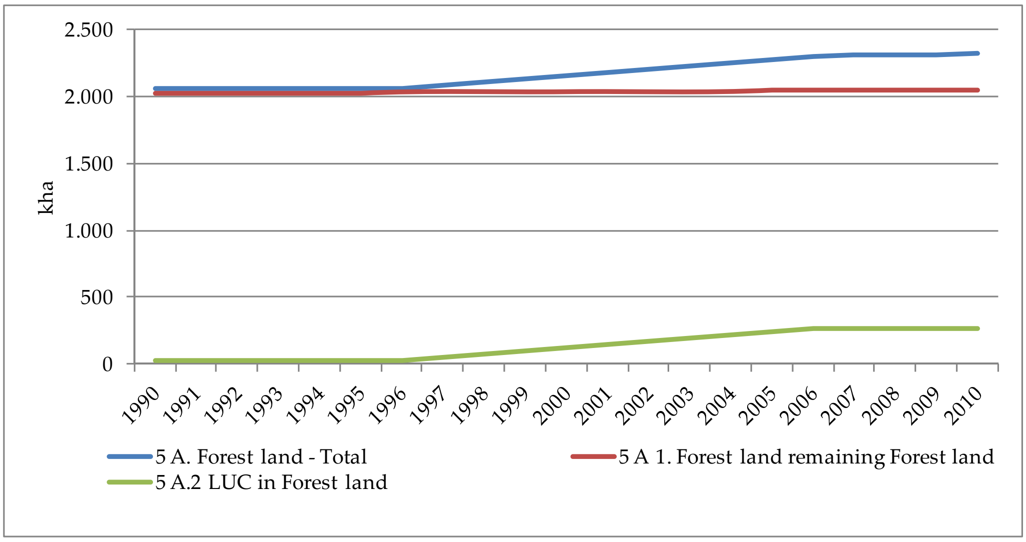
kha	FL	CL	GL	WL	SL	OL	Total 2010
FL	2.049	NO	18	NO	NO	251	**2.318**
CL	NO	1.536	12	NO	NO	NO	**1.548**
GL	NO	55	1.165	NO	NO	NO	**1.220**
WL	NO	2	NO	72	NO	NO	**74**
SL	8	16	15	NO	220	NO	**259**
OL	NO	NO	NO	NO	NO	240	**240**
Total 1990	**2.055**	**1.624**	**1.210**	**72**	**220**	**478**	**5.659**
Net change	263	-76	10	2	39	-238	

7.2FOREST LAND

7.2.1DESCRIPTION

Under this land category, CO_2 emissions/removals from soil and living biomass[13] from the *Forest land remaining forest land* and from *Land converted to forest land* have been reported. For C stock changes in dead organic matter and in soil of *Forest land remaining forest land* the IPCC GPG tier 1 approach is used which assumes no C stock changes in these pools. Non-CO_2 emissions due to wildfires are also reported but only for the *Forest land remaining forest land* because, currently, the area burnt cannot be differentiated between the *Forest land remaining forest land* and *Land converted to forest land* (Table 7.2-2). Figure 7.2-1 represents the trend of forest area and LUC area to forest land in conversion period of 20 years.

*Figure 7.2.-1: Trend of forest land and LUC to forest land in conversion period of 20 years (1990-2010) in kha**



*the forests out of yield are also included in the figures of the total forest land area

CO_2 removals from *Forest land remaining forest land* in 2010 are -8,759 Gg CO_2 and from *Land converted to forest land* -130 Gg CO_2-eq. Therefore, the share of removals from land conversion in total Forest land removals is only about 1.5%. Annual emissions/removals from other land use categories converted to forest land are presented in Table 7.2-1.

Table 7.2-1: Emissions/removals of CO_2 in Forest land remaining Forest land and Land converted to Forest (Gg CO_2)

[13] Below ground biomass is combined with the above ground and thus the notation key IE is used for below ground biomass.

Year	5 A Forest land - Total	5 A 1. Forest land remaining Forest land	5 A 2. Land converted to Forest land	5 A 2.1 Cropland converted to Forest land	5 A 2.2 Grassland converted to Forest land	5 A 2.3 Wetland converted to Forest land	5 A 2.4 Settlement converted to Forest land	5 A 2.5 Other land converted to Forest land
1990	-7.275	-7.059	-216	NO	-216	NO	NO	NE
1991	-7.133	-6.913	-220	NO	-220	NO	NO	NE
1992	-7.045	-6.836	-209	NO	-209	NO	NO	NE
1993	-7.087	-6.878	-209	NO	-209	NO	NO	NE
1994	-7.114	-6.908	-206	NO	-206	NO	NO	NE
1995	-7.042	-6.826	-216	NO	-216	NO	NO	NE
1996	-6644	-6425	-219	NO	-219	NO	NO	NE
1997	-6.842	-6.631	-211	NO	-211	NO	NO	NE
1998	-7.015	-6.803	-212	NO	-212	NO	NO	NE
1999	-7.181	-6.974	-207	NO	-207	NO	NO	NE
2000	-7.381	-7.172	-208	NO	-208	NO	NO	NE
2001	-7.554	-7.348	-206	NO	-206	NO	NO	NE
2002	-7.698	-7.506	-191	NO	-191	NO	NO	NE
2003	-7.870	-7.683	-187	NO	-187	NO	NO	NE
2004	-8.114	-7.926	-188	NO	-188	NO	NO	NE
2005	-8.230	-8.053	-177	NO	-177	NO	NO	NE
2006	-8.324	-8.154	-171	NO	-171	NO	NO	NE
2007	-8.586	-8.423	-163	NO	-163	NO	NO	NE
2008	-8.757	-8.602	-155	NO	-155	NO	NO	NE
2009	-8.330	-8.184	-146	NO	-146	NO	NO	NE
2010	-8.889	-8.759	-130	NO	-130	NO	NO	NE

Table 7.2.-2 CO_2 emissions from wildfires

Year	Area burnt (ha)	CO_2 emission CO_2 equivalent (Gg)	CH_4 emission CO_2 equivalent (Gg)	N_2O emission CO_2 equivalent (Gg)
1990	4.234	128,34	12,50	2,86
1991	4.234	128,34	12,50	2,86
1992	964	29,22	2,85	0,65
1993	8.196	248,45	24,20	5,53
1994	3.723	112,86	10,99	2,51
1995	633	19,19	1,87	0,43

Year	Area burnt (ha)	CO_2 emission CO_2 equivalent (Gg)	CH_4 emission CO_2 equivalent (Gg)	N_2O emission CO_2 equivalent (Gg)
1996	2.550	77,30	7,53	1,72
1997	4.026	122,03	11,88	2,72
1998	7.551	228,91	22,29	5,10
1999	472	14,31	1,39	0,32
2000	17.174	520,62	50,70	11,60
2001	3.514	106,52	10,37	2,37
2002	1.769	53,63	5,22	1,19
2003	8.271	250,73	24,42	5,58
2004	355	10,76	1,05	0,24
2005	381	11,55	1,13	0,26
2006	507	15,37	1,50	0,34
2007	1.698	51,47	5,01	1,15
2008	1.299	39,38	3,84	0,88
2009	646	19,58	1,91	0,44
2010	446	13,52	1,32	0,30

7.2.2INFORMATION ON THE APPROACHES USED TO PRESENT THE DATA ON THE AREAS AND THE DATABASE FOR LAND USE, USED FOR THE INVENTORY

For the purposes of this reporting, data obtained by the *Croatian Forest Ltd* were used for presenting the forest land areas.

The *Forest Act* (OG 140/05, 82/06, 129/08, 80/10, 124/10) regulates the activities in forestry sector in Croatia. The forest management plans determine conditions for harmonious usage of forests and forest land and procedures in that area, necessary scope regarding the cultivation and forest protection, possible utilization degree and conditions for wildlife management. The forest management plans are as follows:

- Forest Management Area Plan for the Republic of Croatia (FMAP)
- Forest Management Plan for management units
- Programmes for management of management units on karst
- Programmes for management of private forests
- Programmes for forest renewal and protection in specially endangered area
- Programmes for management of forest with special purpose
- Annual forest management plans
- Annual operative plans

All forest management plans, their renewal and revision are under supervision of the Ministry of Agriculture.

The FMAP, among the other, appoints activities which will be performed in the forests for the next 10 years but also, to some extent, describes the former management (management in the previous 10-year period) and the status of forests at the beginning of the new 10-year period. So far, three FMAPs have been prepared:

- FMAP encompassing the period from 1986-1995 (FMAP 1986-1995)
- FMAP encompassing the period from 1996-2005 (FMAP 1996-2005)
- FMAP encompassing the period from 2006-2015 (FMAP 2006-2015)

Summarized, the total forest land in Croatia constitutes of one forest management area which is established in order to ensure the unique and sustainable management of the forest land. Therefore, according to the national criteria, both forest land with and without tree cover is sustainably managed regardless of their ownership, purpose, forest stand etc.

Based on the forest management type, according to the *Regulation on Forest Management* (OG 111/06, 141/08), forest stands are managed either as even-aged or uneven-aged. Even-aged forest stands make regular forests which cover about 83% of forest land with tree cover (excluding maquis, scrub, garigue and shrub). Uneven-aged forests make about 17 % of forest land with tree cover (excluding maquis, scrub, garigue and shrub).

State forests are managed either by "Croatian Forests Ltd." or by other legal bodies. As regarding the private forests, the Forest Advisory Service (FAS) was established in 2006 (began working in 2007). Its function was to assist private owners in management and improvement of private forests' condition. This service was merged with the *Croatian Forests Ltd* in 2010.

The forest management system is organized in a way that complete Croatian territory is divided into 16 forest districts (organizational and territorial units). This division was established in 1996.
Districts consist of forest units, currently of 170 units altogether. The single forest unit is the basic organizational unit for performing all expert and technical activities in the forest management. Forest management in each forest unit is based on the forest management plan for individual management unit approved by the Ministry of Agriculture. It should be emphasized that the management system of *Croatian Forests* has the international FSC certification (Forest Stewardship Council A.C.) proving that state forests are managed sustainably.

<u>Forest land</u>

The *Forest Act* regulates the growing, protection, usage and management of forest land as a natural resource aimed to maintain biodiversity and ensure management based on principles of economic sustainability, social responsibility and ecological acceptability. It prohibits the renewal of forests by clear cutting, thus natural rejuvenation is the principal method for renewal of all natural forests.

The following figures are based on data for 2006 provided in the Forest Management Area Plan for the period 2006-2015 (FMAP 2006-2015).

Based on the forest stands, forest land with tree cover is divided as follows:

- high forests
- plantations
- forest cultures
- coppice
- maquia
- scrub
- garigue
- shrub

Their share in the forest land with tree cover is shown in Figure 7.2-2.

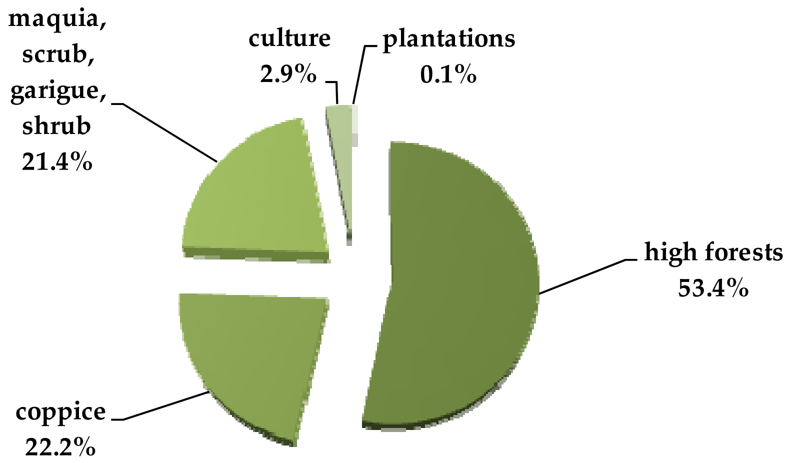


Figure 7.2-2: The share of each forest stand in forest land with tree cover, year 2006

Based on the ownership, there are two types of forests in Croatia:

a) State forests owned by the state and managed by

- the public enterprise "Hrvatske šume d.o.o." (*Croatian Forests Ltd.*)
- legal bodies owned by the state (e.g. national parks, Faculty of Forestry, Ministry of Defence, "Croatian Waters" etc.)

b) Private forests

State forests make about 78% of total forest area, while the remaining 22% are privately owned.

The area of forests is determined based on all available cadastral maps in various scales. However, while preparing the FMAP 2006-2015, it was noticed that cadastral data on forest area did not match real conditions – private forests were larger than those presented in the cadastre. Since private forests are highly fragmented and scattered over the entire Croatian territory, most precise determination of their area and their spatial position was accomplished by applying the remote sensing methods for the forest area extraction and field work to determine forests' condition. The forest area was extracted in three ways: 1. by using the ortophoto (scale 1:5,000), 2. by using the satellite images (scale 1: 1,000,000), 3. by using the CORINE data.

The current FMAP 2006-2015 determines total growing stock of about 398 mil. m^3 in 2006 by calculation based on the following measured data:

- diameters at breast height and
- height of living trees above the taxation level (10 cm in breast height diameter)

The growing stock is not measured for maquia, scrub, garigue and shrub (and also for the first age class of even-aged forests) and this is why carbon stock changes in these forests are not taken into consideration in the report. It should be noted that there is no wood harvest in maquia, scrub, garigue and shrub. So, in line with IPCC GPG approaches is assumed that there is no human-induced C stock change.

Diameters at breast height are measured at sample plots taken from the total sub-compartment area:

- At least 2% in even-aged stands of the second age class regarding the high forests in area that is subject of FMAP, forests with limited management, coppices, protection forests and private forests
- At least 5% in even-aged stands of high forests (age classes above the second age class) in area that is subject of FMAP and in uneven-aged forests

When preparing the FMAPs, the increment is estimated based on the local tables of increment percentage which are made by using the bore-spill method (Article 23, *Regulation on Forest Management*). The increment cores are taken at breast height (1.30 m) with Pressler's borer. ,

Representation of the Forest land in this report is based on the definitions provided in the following chapter (Chapter 7.2.3.). The related data have been obtained from the FMAPs. They are divided in two levels[14]:

- First level – ownership (state – Croatian Forests, state – other legal bodies, private forests)
- Second level – forest type (broadleaved and coniferous forests)

However, it should be emphasized that the *Forest land remaining forest land* and *Land converted to forest land* are through the entire period divided in three types of the ownership but the data are not available for each ownership in each year.

[14] For KP reporting, the division was more spatially explicit for 2008 and 2009 and based on forest districts for state forests managed by "Croatian Forests".

Therefore, the applied approach for representation of the forest land areas is a mixture of Approach 1 and 2 (GPG 2003) because the information/data on land use changes are not highly detailed and spatially explicit for the entire territory.

7.2.3 LAND-USE DEFINITIONS AND CLASSIFICATION SYSTEMS USED AND THEIR CORRESPONDENCE TO THE LULUCF CATEGORIES

Definitions applied within this inventory regarding the Forest land are consistent with the GPG 2003 and also with the KP reporting requirements in order for both UNFCCC and KP reporting frame to be completely harmonized, transparent and comparable. The *Land converted to forest land* is represented in KP reporting within the Article 3.3 activities (Afforestation). All definitions applied for KP are the same as applied for the UNFCCC reporting (see KP Chapters 11.1.1. *Definition of forest and any other criteria* and 5.1.3. *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 Forest land is composed of the *Forest land remaining forest land* and *Land converted to forest land.* The *Forest land remaining forest land* is forest land with tree cover (national frame) but with forest defined as the land spanning more than 0.1 hectares with trees higher than 2 meters and canopy cover more than 10 percent, or trees able to reach these thresholds *in situ* (KP definition). Based on this definition, the forest stands that fall within these thresholds are high forests, plantations, cultures, coppice, maquia and scrub. **However, since a complete dataset required for emission/removal calculation is not available for maquia and scrub, the estimation of carbon stock change for the related forest stands is not performed. It should be noted that there is no wood harvest in maquia, scrub, garigue and shrub.** So, in line with IPCC GPG approaches is assumed that there is no human-induced C stock change. Thus, these areas are excluded from the estimates of C stock changes.
Therefore, the *Forest land remaining forest land* is forest land covered with high forests, plantations, cultures and coppice.

According to the *Regulation on Forest Management* (OG 111/06, 141/08), total forest land in Croatia is divided in two main categories with several subcategories. The latter is as follows:

I. Forest land with tree cover

II. Land under forest management (forest land without tree cover)

- Productive forest land without tree cover (e.g. clearings, grasslands)
- Non-productive forest land without tree cover (e.g. fire lanes, landings)
- Barren wooded land (e.g. forest roads wider than 3 meters, quarries)

Therefore, based on the aforementioned, within the national frames, there exists land without tree cover in Croatia under forest management plans, which represents grassland according to the IPCC definition. The latter indicates for example that afforestation does not necessarily mean land conversion for Croatia in the administrative national frame. According to the IPCC GPG definitions of land use categories, land under the forest management plans on which afforestation is performed in Croatia, falls under the Grassland category. Therefore, this afforestation land (though always "forest land" in the Croatian administrative understanding) represents a LUC land from grassland to forest land according to IPCC GPG and is reported as such. The Croatian reporting of lands and LUCs strictly follows the IPCC GPG definitions. To present land under the forest management (without tree cover) previously it was used Other land category. In this report, this has been changed and this land was reported under the Cropland category.

7.2.4METHODOLOGICAL ISSUES

7.2.4.1 Forest land remaining forest land (5.A.1)

A)Changes in the carbon stock in the living biomass

The dataset required for presenting the biomass carbon stock change encompasses the entire period from 1990-2010 and the main data source is the Forest Management Area Plans (FMAPs). Data are divided based on the ownership and forest type upon which the related emission/removal calculation was performed using primarily Tier 1. The calculation refers only to living biomass. For the C stock changes of the other pools (dead wood, litter, soil) are reported according to IPCC GPG tier 1, no C stock change is assumed. Shortly, the calculation can be presented as follows:

$$\Delta C_{FFLB} = (\Delta CFFG_{CFj} - \Delta CFFL_{CFj}) + (\Delta CFFG_{Other\,j} - \Delta CFFL_{Other\,j}) + (\Delta CFFG_{Private\,j} - \Delta CFFL_{Private\,j})$$

Where:

ΔC_{FFLB} = annual change in carbon stocks in living biomass (includes above and below ground biomass) in the *Forest land remaining forest land*, Cyr^{-1}

$\Delta CFFG_{CFj}$, $\Delta CFFG_{Other\,j}$, $\Delta CFFG_{Private\,j}$ = annual increase in carbon stocks due to biomass growth, in state forests managed by "Croatian Forests" (CF), other state forests (Other) and private forests (Private), by forest types (j=1,2), Cyr^{-1}

$\Delta CFFL_{CFj}$, $\Delta CFFL_{Other\,j}$, $\Delta CFFL_{Private\,j}$ = annual decrease in carbon stocks due to biomass loss, in state forests managed by "Croatian Forests" (CF), other state forests (Other) and private forests (Private), by forest types (j=1,2), Cyr^{-1}

Where j = 1 - broadlevaed
2 - coniferous

The activity data for CO_2 emission/removal calculation includes data on forest area, increment and fellings. However, for state forests managed by other legal bodies and for private forests, data are not at the same level of detail and quality as for the state forests managed by "Croatian Forests". Methodological issues are explained in detail below.

Forest area

Data on forest area are in line with the relevant definitions and therefore exclude afforested area. Figure 7.2-3 shows forest area by ownership for the period 1990-2010.

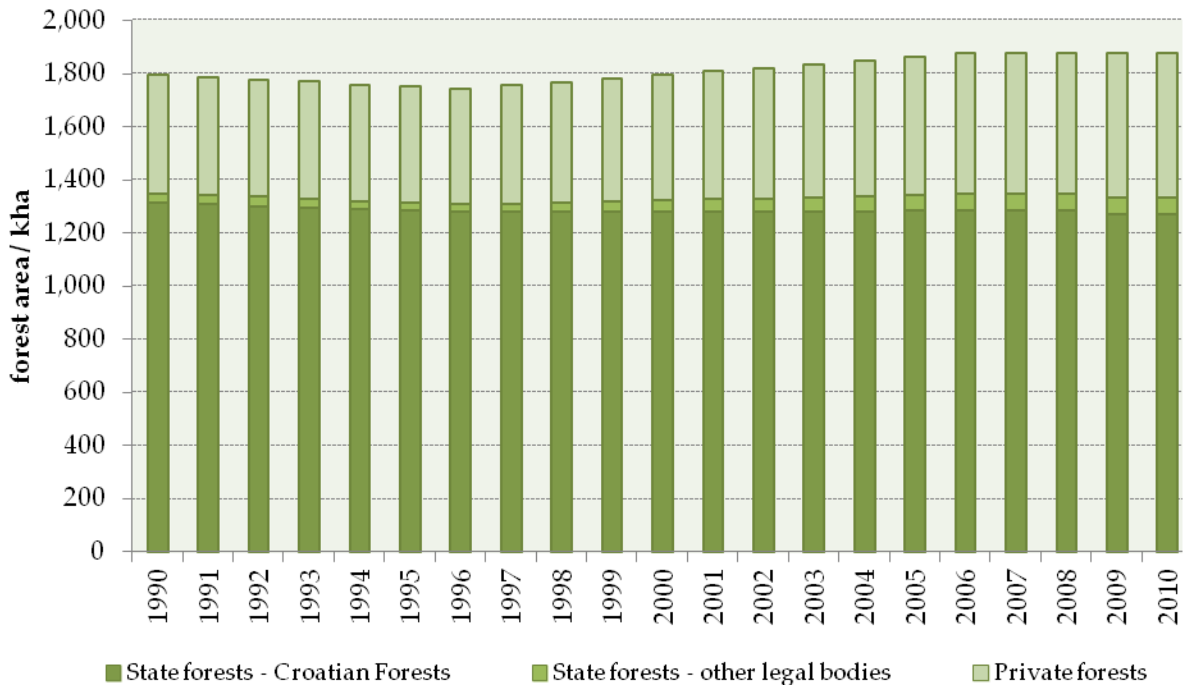


Figure 7.2-3: Forest area by ownership

Increment

The methodological approach, as regarding the annual increment[15], differs between the state forests managed by "Croatian Forests" and other ownerships (other state and private forests) since the data are not at the same level of detail and quality.

The increment in the state forests managed by "Croatian Forests" is calculated based on the difference in growing stock in two points in time and annual fellings. Both growing stock and fellings are divided as broadleaved and coniferous.

[15] Generally speaking, the volume is measured, calculated and presented as the volume of heavy wood (includes branches thicker than 7 cm) for all trees above taxation level which is 10 cm in diameter at breast height (130 cm).

The increment in the state forests managed by other legal bodies was directly taken from the FMAP 2006-2015 while, for the years in between, interpolation was applied. As regarding 1990, considering the fact that more reliable data for this type of ownership are not available, it was assumed that the increment in 1990 was the same as the one in 1996. For the period after 2006 (2007-2010), the increment was determined based on the FMAP data according to which the percentage of growing stock increment in other state forests was 2.4% of the total increment determent (growing stock is available). As regarding the broadleaved/coniferous distribution, the most accurate data is known for 2006 and the related ratio was assumed the same for the entire period concerned from 1990-2010.
The increment in private forests is also based on the FMAP 2006-2015 data and the same approach as for other state forests was applied. The difference is that, for the period after 2006 (2007-2010), the increment was determined based on the FMAP data according to which the percentage of growing stock increment in private forests was 2.7% of the total increment determent. As regarding the broadleaved/coniferous distribution, the most accurate data are also known for 2006 and the related ratio was assumed the same for the entire period concerned from 1990-2010.

The lower increment occured in the War period when the forest management practices were not in their usual frames which indicates the importance of the forest management. Afterwards, the increment increased in all forests regardless of the ownership along with the forestry revitalization in Croatia. Finally, annual increase in carbon stocks due to biomass increment was therefore calculated using Tier 2 with more accurate input data for state forests managed by "Croatian Forests" and related equation 3.2.5 from GPG 2003.

Input data on fellings refer to gross volume felled (overbark), excluding volume cut in deforestation. The fellings are further disaggregated as broadleaved and coniferous in all state and private forests. The volume already includes fuel wood and the volume cut after natural disturbances.

Due to the War conditions, fellings significantly decreased in the period from 1991-1995. Afterwards, the sector began to revitalize and fellings started to increase. In 2010, fellings made about 50% of the increment.
The carbon loss due to fellings is calculated using Tier 2 and **equation 3.2.7 from GPG 2003**.

Since fellings already include the volume cut after natural disturbances, carbon losses due to natural disturbances are allocated within the carbon losses due to fellings. Therefore, notation key IE was used in the CRF tables.

Default data used in the CO2 emission/removal calculation are presented in Table 7.2-3.

Table 7.2-3: Default data used in the CO2 emission/removal calculation

	tonnes d.m.m^{-3}	dimensionless	dimensionless	dimensionless	(tonnes d.m)$^{-1}$
	D	BEF1	R	BEF2	CF
Broadleaved	0.588	1.2	0.24	1.4	0.5
Coniferous	0.4	1.15	0.23	1.3	

The detailed overview of the approach is shown below:

$$\Delta C_{FFLB} = \Delta CFFG_{CFj} - \Delta CFFL_{CFj}$$

$$\Delta CFFG_{CF} = \Sigma_j ((V_{t2CFj} - V_{t1CFj}) + H_{t1CFj}) \times Dj \times BEF1j \times (1+Rj) \times CF$$

Where:

$\Delta CFFG_{CFj}$ = annual increase in carbon stocks due to biomass growth, in state forests managed by *Croatian Forests Ltd.*, by forest types (j=1,2), Cyr^{-1}

$\Delta CFFL_{CFj}$ = annual decrease in carbon stocks due to biomass loss, in state forests managed by *Croatian Forests Ltd*, by forest types (j=1,2), Cyr^{-1}

V_{t2CFj} = mercantable growing stock in states forests managed by "*Croatian Forests Ltd*.at time t_2, by forest types (j=1,2), m^3

H_{t1CFj} = gross volume felled in state forests managed by *Croatian Forests Ltd*. at time t_1 (all losses), by forest types (j=1,2), m^3

D_j = basic wood density, by forest types (j=1,2), tonnes d.m.m^{-3}

$BEF1_j$ = biomass expansion factor for conversion of annual net increment (including bark) to above ground tree biomass increment, by forest types (j=1,2), dimensionless

R_j = Root-to-shoot ratio appropriate to increments, by forest types (j=1,2), dimensionless

CF = carbon fraction of dry matter, (tonnes d.m)$^{-1}$

$$\Delta CFFL_{CF} = L_{fellings} + L_{fuelwood} + L_{other\ losses}$$

$\mathbf{L_{fellings}}$	=	$\mathbf{\Sigma_j H_{t1CFj} \times D_j \times BEF2_j \times CF}$
H_{t1CFj}	=	gross volume felled in state forests managed by *Croatian Forests Ltd*. at time t_1, by forest types (j=1,2), m^3
$BEF2_j$	=	biomass expansion factor for conversion of merchantable volume to above ground tree biomass increment, by forest types (j=1,2), dimensionless
$L_{fuelwood}$	=	fuelwood gathering assumed as negligible
$L_{other\ losses}$	=	no other losses, already included in volume felled

Non-CO_2 greenhouse gas emissions

The controlled burning of managed forest is not carried out in Croatia. The emissions of CO_2 are reported in the sector *Forest land remaining Forest land*. Estimates of non-CO_2 greenhouse gas emissions (CH_4, CO, N_2O and NO_x) released in wildfires were estimated according to Tier 1, equation 3.2.20, IPCC GPG 2003:

$$L_{fire}\ (tGHG) = A \times B \times C \times D \times 10^{-6}$$

Where:

A = area burnt (ha)
B = mass of available fuel (kg d.m./ha)
C = combustion efficiency, dimensionless
D = emission factor (g/kg dm)

Activity data related to area burnt were obtained from the *Croatian Forests Ltd*. Since the data for 1990 and 1991 were not available, average area burnt in the period from 1996-2006 (which is one of the 10-year periods encompassed by the FMAPs) was used. The area destroyed by fires ranges between 446 and 17 174 ha. It should be emphasized that the area burnt on the *Forest land remaining forest land* and area burnt on the *Land converted to forest land* cannot be differentiated for now. Therefore, all non-CO_2 emissions of wildfires are reported only under the subcategory *Forest land remaining Forest land.*
According to the references in the IPCC GPG in calculation a mean value of 19.8 t/ha biomass consumption was applied (BxC). The IPCC GPG 2003 emission factors (D) prescribed in table 3.A.1.16 for CO_2 (1531), CH_4 (7.1) and N_2O (0.11) were used.

The amount of CH_4 and N_2O emissions ranged between 0.24 and 50.70 $GgCO_2$ equivalent in the reporting period.

Table 7.2-4 provides information on annual change in carbon stock in living biomass in the *Forest land remaining forest land*. CO_2 removals for the period from 1990-2010 are presented in Figure 7.2-4.

Table 7.2-4: Annual change in carbon stock in living biomass in Forest land remaining Forest land

Year	Gg C		
	Annual increase in carbon stocks	Annual decrease in carbon stocks due to carbon loss	Annual change in carbon stock in living biomass
1990	3.754,794	1.829,517	1.925,277
1991	3.286,075	1.400,832	1.885,243
1992	3.223,661	1.359,277	1.864,383
1993	3.181,418	1.305,554	1.875,864
1994	3.278,154	1.394,220	1.883,934
1995	3.192,367	1.330,661	1.861,706
1996	3.173,531	1.421,296	1.752,235
1997	3.400,850	1.592,425	1.808,425
1998	3.468,749	1.613,303	1.855,446
1999	3.503,963	1.601,895	1.902,068
2000	3.641,865	1.685,798	1.956,067
2001	3.710,173	1.706,065	2.004,108
2002	3.746,498	1.699,361	2.047,137
2003	3.892,525	1.797,030	2.095,495
2004	4.018,923	1.857,319	2.161,605
2005	4.060,209	1.863,914	2.196,295
2006	4.155,063	1.931,373	2.223,690
2007	4.350,323	2.053,124	2.297,198
2008	4.479,028	2.132,963	2.346,065
2009	4.303,773	2.071,714	2.232,059
2010	4.420,432	2.031,739	2.388,693
Average	3.725,827	1.699,018	2.036,719

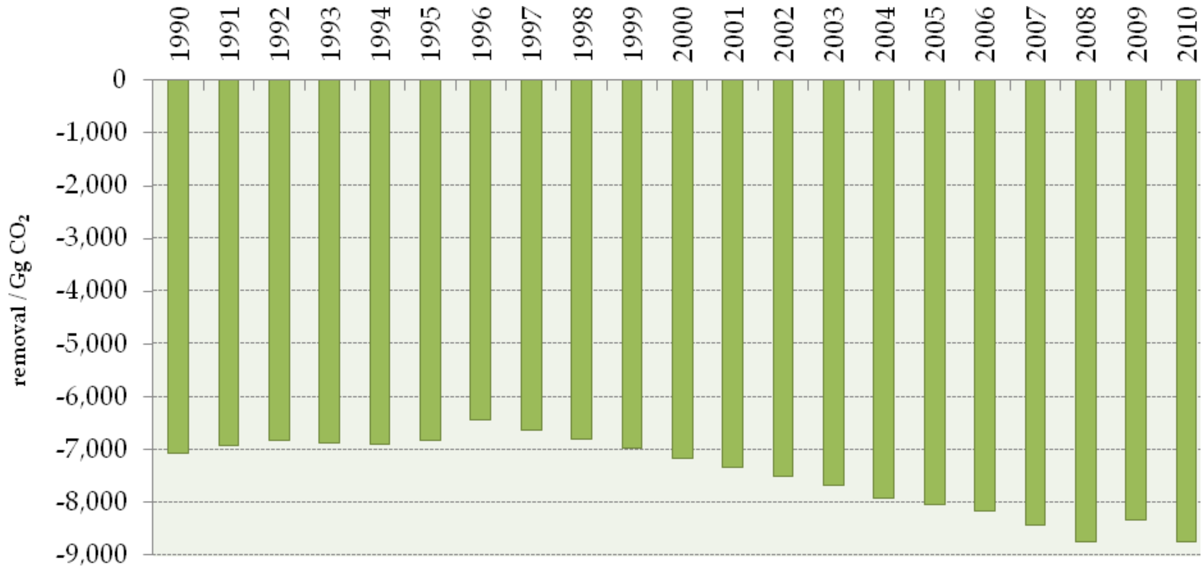


Figure 7.2-3: CO_2 removal in living biomass in FF

During the War period (1991-1995), when the forest management was not in its usual frames, the removal decreased due to primarily lower increment in state forests managed by Croatian Forests. Afterwards, the sector began to revitalize, the increment increased in all forests, regardless of the ownership, resulting in increased CO_2 removals. If 1996 and 2006 are compared, referring to one 10-year period in accordance with the FMAP, the removal increased by about 35%, increment increased by approximately 32% and the fellings about 37%.

B)Changes in the carbon stock in the dead organic matter – dead wood

As regarding the calculation of carbon stock change in this pool, Croatia uses IPCC GPG Tier 1 approach assuming that there are no changes in the dead wood stock in all managed forests.

C)Changes in the carbon stock in the dead organic matter - litter

As regarding the calculation of carbon stock change in this pool, Croatia uses IPCC GPG Tier 1 approach assuming that there are no changes in the litter stock in all managed forests.

D)Soil

There was no change regarding the forest management in the past 20 years. Because of that it is assumed that the average carbon stock in Croatian soils is stable following the approach of the IPCC GPG 2003 Tier 1 methodology.

7.2.5.2 Land Converted to Forest Land (5 A 2)

Emission/removals from land conversion activities have been calculated using the IPCC GPG Tier 2 method for living biomass and soil for the entire period from 1990-2010.

The related definition of *Land Converted to forest land* is provided in Chapter 7.2.3. As stated before, *Land Converted to forest land* refers to *Afforestation* within the KP reporting, but takes the different time frames for both reporting obligations into account (since 1.1.1990 and permanence of AR lands for KP vs. transition period of 20 years for UN-FCCC).

The basic input data for the emission/removal estimates is the area afforested, which refers to the area managed by *Croatian Forests* and private forests. The attained data on annually afforested area are shown in Table 7.2-5. Figure 7.2-5 shows total afforested area in the period 1990-2010. For the period before 1990 (transition period of 20 years), the mean afforestation area 1990-1994 was used. A further share of LUC area to forests results due to area consistency reasons (to cover the full increase in forest area across the time series). By expert judgement it was assumed that this remaining increase in forest area comes from LUC from "other land". For the moment, emissions/removals are only estimated for the LUC area from grassland to forest land, but not for the LUC area from other land to forest land. For the subcategory other land to forest land an assessment is carried out if this land-use change is naturally or human induced, managed or unmanaged land and for the exact year of LUC. Based on the outcome of the survey a decision will be taken whether or not emission/removal estimates of these LUC lands need to be carried out. The assessment will be ready for submission 2013 or 2014, the latest.

Table7.2-5: Land converted to forest land each year

Year	Afforested area (grassland to forests) / ha	LUC area from other land to forests/ha
1990	1.373,99	93,14
1991	695,40	93,14
1992	1.433,50	93,14
1993	1.472,32	93,14
1994	1.983,91	93,14
1995	1.334,84	0,00
1996	814,97	0,00
1997	1.265,55	22.647,77
1998	992,76	23.462,11
1999	1.148,30	23.845,37
2000	715,09	23.716,69
2001	227,30	24.097,82
2002	882,30	24.748,96
2003	969,94	23.916,85
2004	311,23	24.184,16

2005	584,85	24.436,92
2006	443,88	24.512,90
2007	427,48	1.086,55
2008	415,08	5.586,07
2009	516,64	4.244,69
2010	1.617,19	0,00

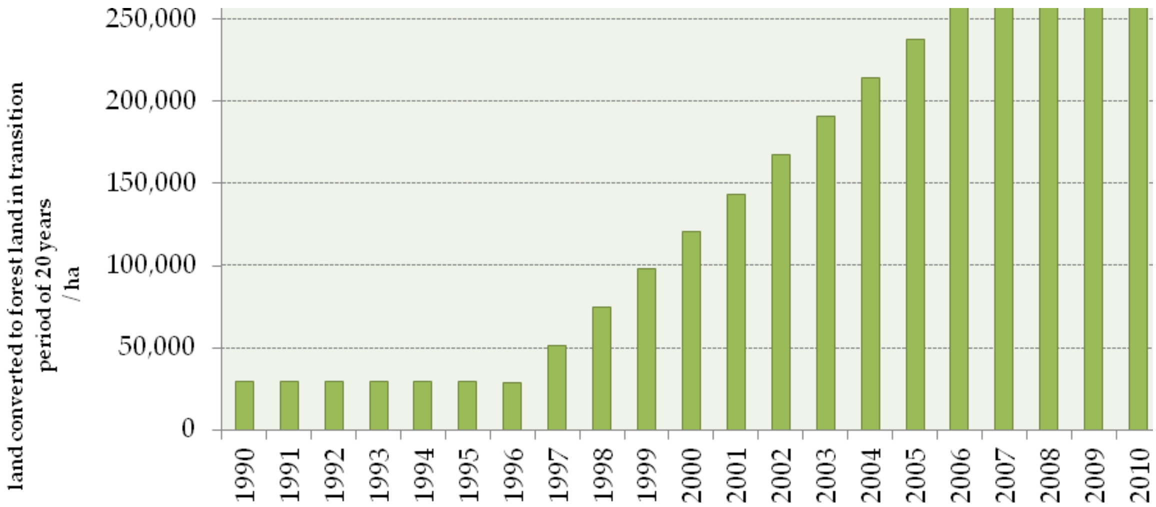


Figure 7.2-5: Land converted to Forest land

The largest part of the forest area in Croatia is managed in a sustainable manner and little is intensively managed. Extensive forest management as such, does not exist in Croatia. According to the forest experts' judgement, the area of land converted to intensively managed forest (in our case plantations) is very small. Since these data were not provided in this form, the calculation was based on the assumption that afforestation resulted in the area of land converted to sustainable managed forest.

As for wildfires, area caught by fire cannot be differentiated between FF and LF area. Nevertheless, all volume burnt is included in the total amount of fellings and thus CO_2 emissions are reported within the *Forest land remaining forest land*. Therefore, CO_2 and non-CO_2 emissions for the *Land converted to forest land* are reported within the subcategory *Forest land remaining forest land* (notation key IE is used in the relevant CRF tables)

A)Biomass

In order to determine the changes in biomass carbon stock in afforested areas in Croatia, the following assumptions and steps were applied:

- During the reporting period, only coniferous species are used for the afforestation
- Average annual increment from the IPCC GPG 2003 was used for the aboveground biomass in natural regeneration. Values for the temperate forest, coniferous species in age class less and equal to 20 years and ≥ 20 years were applied. The applied value is the same for both age classes (3 t dm/ha annually)
- Mean value of the average Root-to-Shoot ratio for coniferous species was used (IPCC GPG 2003, value of 0.46)
- IPCC GPG default value of the Carbon fraction (0.5 tC/ t dm) was used

Based on the above mentioned factors, average biomass growth was calculated to be 2.19 tC/ha annually.

In order to calculate the carbon stock losses as a result of grassland conversion to forestland, the nationally determined value for grassland category of 4.3 tC/ ha annually was used.

A)Soil

The estimates of the soil carbon stock changes at land converted to forest land (afforestation) follow the equation below:

$$\Delta C_{LFMineral} = [(SOC_{ref} - SOC_{Non\ Forest\ Land}) \times A_{Aff}]/T_{Aff}$$

where:

$\Delta C_{LFMineral}$ = annual change in carbon stock in mineral soils for inventory year
SOC_{ref} = reference carbon stock
$SOC_{Non\ Forest\ Land}$ = stable soil organic carbon on previous land use
T_{Aff} = duration of the transition from $SOC_{Non\ Forest\ Land}$ to SOC_{ref} (20 years)
A_{Aff} = total afforested/reforested area after conversion

The mean values of soil carbon stock for the soil depth of 0-20 cm determined through the national scientific soil survey were used in order to present the carbon stock changes in soil (see chapter 7.3.4.1). It should be noted that the forest land soil C stock includes also the C stock of the litter layer (humus layer), the C stock change of the litter layer is therefore reported as IE (covered by the soil C stock changes). Conversion that happens in Croatian case refers to grassland converted to forestland only with the following values:

- Grassland: 108.5 tC/ha
- Forestland: 111.2 tC/ha

Emission factor determined in this case is 0.14 tC/ha annually.

Table 7.2-6 provides information on annual change in carbon stock in living biomass and soil for the *Land converted to forest land*. Since 1991 the conversion from other land use categories to the forest land results in CO_2 removal. The increase of removal follows the increased trend of afforested area.

Table 7.2-6: Annual change in carbon stock in living biomass and soil for Land converted to forest land

Gg C					
Year	Biomass carbon stocks gains	Biomass carbon stocks losses	Biomass net carbon stock change	Net soil carbon stock change	Total
1990	60,92	-5,90	55,02	3,76	58,78
1991	59,40	-2,99	56,41	3,66	60,08
1992	59,49	-6,16	53,33	3,67	57,00
1993	59,67	-6,32	53,34	3,68	57,02
1994	60,96	-8,52	52,44	3,76	56,20
1995	60,84	-5,73	55,10	3,75	58,86
1996	59,54	-3,44	56,10	3,67	59,78
1997	59,28	-5,46	53,82	3,66	57,48
1998	58,41	-4,28	54,13	3,60	57,73
1999	57,89	-4,95	52,94	3,57	56,51
2000	56,42	-3,09	53,33	3,48	56,81
2001	53,88	-1,00	52,88	3,32	56,21
2002	52,77	-3,81	48,96	3,26	52,22
2003	51,86	-4,19	47,67	3,20	50,87
2004	49,50	-1,36	48,15	3,05	51,20
2005	47,75	-2,53	45,21	2,95	48,16
2006	45,68	-1,93	43,75	2,82	46,57
2007	43,57	-1,84	41,73	2,69	44,42
2008	41,43	-1,78	39,65	2,56	42,20
2009	39,51	-2,22	37,29	2,44	39,73
2010	40,04	-6,95	33,10	2,47	35,57

7.2.5UNCERTAINTIES AND TIME-SERIES CONSISTENCY

As regarding the *Forest land remaining forest land*, the uncertainty of activity data for CO_2 emission/removal calculation is estimated at 17% based on the combination of expert judgement and Monte-Carlo method, while in regards to non-CO_2 it is estimated at 40% based only on the expert judgement. Uncertainty of the carbon fraction dry matter is estimated at 2%. Uncertainty of the emission factor for non-CO_2 emission calculation is estimated at 70% (according to GPG 2003).

Based on the expert judgement, as regarding the *Grassland converted to forest land*, the uncertainty of activity data for CO_2 emission/removal calculation is estimated at 50%. Uncertainty of the carbon fraction dry matter is estimated at 2%.

Emissions/removals from the sub-sector *Forest land remaining forest land* and *Land converted to forest land* have been calculated using the same data source for every year in the time series.

Up to now, only Grassland category was included in uncertainty estimates under the land converted to forest land. The model applied in Croatia needs to be upgraded and consultations with various stakeholders have to be held.

7.2.6 SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of inventory submission, all activity data were checked. The emission calculation was performed by one person and afterwards independently checked by another person within the institution that prepared the inventory. Institution that leads the technical work has approval of the Ministry of Environmental and Nature protection for carrying out the GHG calculations. Activities related to quality control were also focused on completeness and consistency of emission estimates and also on the proper use of notation keys in the CRF tables.

As regarding the Forest land (and LULUCF in general), two land subcategories represent key sources as presented in Table 7.2-7.

Table 7.2-7: Key categories regarding the Forest land (and LULUCF) based on the level and trend assessment in 2010

IPCC Categories	Direct GHG	Criteria for Identification			
		Level		Trend	
		excl. LULUCF	incl. LULUCF	excl. LULUCF	incl. LULUCF
FOREST LAND					
Forest land remaining forest land	CO_2		L1i, L2i		T1i, T2i

L1e - Level excluding LULUCF Tier1; L2e - Level excluding LULUCF Tier 2
L1i - Level including LULUCF Tier1; L2i - Level including LULUCF Tier 2
T1e - Trend excluding LULUCF Tier 1; T2e - Trend excluding LULUCF Tier 2
T1i - Trend including LULUCF Tier 1; T2i - Trend including LULUCF Tier 2

7.2.7 SOURCE-SPECIFIC RECALCULATIONS

Recalculations made since the last year of reporting:

- Carbon stock losses that appear due to grassland conversion to Forest land were taken into consideration
- Errors in conversion of units when calculating emissions from biomass burning were corrected; also the whole burnt areas were taken into consideration instead of areas burnt only in state forests
- Removals previously reported as arising from Other land converted to Forestland are now shifted to removals due to conversion from Grassland to Forestland which is the appropriate LUC category according to the IPCC GPG definitions.
- Activity data for LUC areas to forests were re-assessed and LUC lands for consistency reasons with the annual increase in forest lands were estimated and introduced.

Recalculations made after submitting the version 1.1 of the report:

- New activity data on Land converted to forest land (afforested areas) in private forests in the period 1996-2006 are included in this version of the report
- Reduction of area when calculating losses that arises from grassland conversion to forestland were found non justified

7.2.8 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

- Disaggregation of data based on the forest ownership was found as not the most suitable for the purposes of this reporting and needs to be reviewed. Introduction of the data display according to the main species of deciduous and coniferous forests is required
- Investigation on conducted scientific researches regarding the wood densities and use of country specific values for main forests species
- Further stratification (e.g. on species level) in order to improve the overall calculation and to be able to apply more country-specific BEFs
- Increment in maquis and shrub forests needs to be estimated/identified in order to attain the dataset required for emission/removal calculation since this vegetation is also within the Kyoto forest definition
- Improvement of data quality regarding the increment in private forests
- Improvement of data quality regarding the increment in state forests managed by other legal persons
- Improvement of data quality regarding the fellings in state forests managed by other legal persons
- For the subcategory other land to forest land an assessment need to be carried out if this land-use change is naturally or human induced, managed or unmanaged land and for the exact year of LUC. Depending on the outcome estimates for the related emissions/removals will be carried out.

- Attaining required data on forest fires separately for the *Forest land remaining forest land* and *Land converted to forest land* with the purpose of improving the reporting of CO_2 and the non-CO_2 emissions
- Review of the whole LULUCF sector in a part of Uncertainty estimates. Consultations with experts in each land use category need to be conducted

The Croatian National Forest Inventory (CRONFI) is still under consideration among the forestry society and has no official character. In that respect, the Ministry of Agriculture and the Ministry of Environmental and Nature Protection agree that preparation of the annual GHG Inventory in respect of LULUCF sector should be based on the forest management plans. Once CRONFI becomes official, it could be used to fill the gaps in reporting.
By taking into consideration the consistency requirements for this reporting, it should be mentioned that the forest management in Croatia from its beginning relies on the forest management plans while CRONFI was conducted for the first time.

7.3 CROPLAND 5.B

7.3.1 Category Description

In this category emissions/removals from cropland management (Cropland Remaining Cropland and Land Converted to Cropland) were considered.

Cropland area ranged from 1.548 kha to 1.624 kha in the period 1990-2010. Emissions from the change in carbon stock in biomass and soil ranged from 115.38 to 285.97 $GgCO_2$ for the period 1990-2010.

Annual LUCs to Cropland occurs from the Grassland category.

Tables 7.3-1 and 7.3-2 present the land use change and removals/emissions from land use change to cropland in the period 1990-2010.

Table 7.3-1: Activity Data of Cropland from 1990 to 2010 in kha*

Year	5 B Cropland - Total	5B1 Cropland remaining cropland - total	5B1a annual cropland remaining annual cropland	5B1b perennial cropland remaining perennial cropland	5B1c perennial Cropland converted to annual cropland	5B1d annual Cropland converted to perennial Cropland	5B2 Land converted to Cropland	5B2.2a Grassland converted to annual cropland	5B2.2b Grassland converted to perennial cropland
1990	1.623,8	1.616,4	1.472,1	143,1	0,4	0,9	7,3	6,7	0,6
1991	1.607,1	1.600,0	1.457,8	140,9	0,4	0,9	7,1	6,5	0,6

1992	1.604,2	1.597,4	1.457,0	139,1	0,4	0,8	6,8	6,3	0,5
1993	1.601,3	1.594,8	1.456,3	137,3	0,4	0,8	6,5	6,0	0,5
1994	1.598,5	1.592,2	1.455,5	135,5	0,4	0,8	6,3	5,8	0,5
1995	1.595,6	1.589,6	1.454,8	133,7	0,4	0,8	6,0	5,6	0,5
1996	1.592,8	1.587,0	1.454,0	131,9	0,4	0,7	5,7	5,3	0,4
1997	1.589,9	1.584,4	1.453,2	130,0	0,4	0,7	5,5	5,1	0,4
1998	1.587,0	1.581,8	1.452,5	128,2	0,4	0,7	5,2	4,8	0,4
1999	1.590,2	1.585,3	1.455,8	128,4	0,4	0,7	5,0	4,6	0,3
2000	1.591,8	1.587,1	1.466,7	119,4	0,4	0,6	4,7	4,4	0,3
2001	1.587,5	1.582,0	1.463,6	117,5	0,4	0,6	5,5	5,1	0,4
2002	1.583,1	1.576,9	1.458,0	118,0	0,4	0,5	6,2	5,8	0,4
2003	1.578,8	1.571,8	1.453,4	117,6	0,3	0,5	7,0	6,5	0,5
2004	1.574,5	1.566,7	1.446,4	119,5	0,3	0,5	7,8	7,3	0,5
2005	1.570,1	1.561,6	1.441,3	119,5	0,3	0,4	8,5	8,0	0,6
2006	1.565,8	1.556,5	1.432,3	123,5	0,3	0,4	9,3	8,7	0,6
2007	1.561,5	1.551,4	1.418,1	132,7	0,3	0,3	10,1	9,4	0,7
2008	1.557,1	1.546,3	1.407,5	138,2	0,3	0,3	10,8	10,1	0,7
2009	1.552,8	1.541,2	1.399,8	140,8	0,2	0,3	11,6	10,9	0,7
2010	1.548,5	1.536,1	1.401,2	134,4	0,2	0,2	12,4	11,6	0,8

*(LUCs from other categories than Grassland do not occur)

Table 7.3-2: Emissions (+) / removals (-) of CO_2 in cropland from 1990 to 2010 (Gg CO_2 equivalent)

	5 B Total cropland	**5.B.1 Cropland remaining cropland**	**5.B.2 Land converted to cropland**	**5.B.2.1 Forestland converted to cropland**	**5.B.2.2 Grassland converted to cropland**	**5.B.2.3 Wetlands converted to cropland**	**5.B.2.4 Settlements converted to cropland**	**5.B.2.5 Other land converted to cropland**	**N2O in CO2 equiv**
1990	189,49	147,19	42,30	0,00	37,51	NO	NO	NO	4,79
1991	175,67	134,06	41,61	0,00	36,99	NO	NO	NO	4,62
1992	165,92	125,78	40,15	0,00	35,69	NO	NO	NO	4,46
1993	177,13	138,45	38,68	0,00	34,39	NO	NO	NO	4,29
1994	179,44	142,22	37,22	0,00	33,10	NO	NO	NO	4,13
1995	190,42	154,66	35,76	0,00	31,80	NO	NO	NO	3,96
1996	183,53	149,24	34,30	0,00	30,50	NO	NO	NO	3,79
1997	189,62	156,79	32,83	0,00	29,20	NO	NO	NO	3,63
1998	207,49	176,12	31,37	0,00	27,91	NO	NO	NO	3,46
1999	196,55	166,64	29,91	0,00	26,61	NO	NO	NO	3,30

2000	251,21	222,76	28,44	0,00	25,31	NO	NO	NO	3,13
2001	285,97	256,36	29,61	0,00	25,96	NO	NO	NO	3,65
2002	264,45	229,99	34,45	0,00	30,29	NO	NO	NO	4,17
2003	251,80	212,51	39,30	0,00	34,61	NO	NO	NO	4,69
2004	263,43	219,29	44,14	0,00	38,94	NO	NO	NO	5,20
2005	246,55	197,56	48,99	0,00	43,26	NO	NO	NO	5,72
2006	231,64	177,81	53,83	0,00	47,59	NO	NO	NO	6,24
2007	158,61	99,93	58,68	0,00	51,91	NO	NO	NO	6,76
2008	126,87	63,35	63,52	0,00	56,24	NO	NO	NO	7,28
2009	115,38	47,01	68,36	0,00	60,57	NO	NO	NO	7,80
2010	150,93	77,72	73,21	0,00	64,89	NO	NO	NO	8,32

7.3.2 Information on Approaches Used for Representing Land Areas and on Land-Use Databases Used for the Inventory Preparation

To present cropland area in Croatia data from the Croatian Bureau of Statistics (CBS), CLC database (years 1980, 1990, 2000 and 2006) and ARKOD database were reviewed. Significant changes among data obtained from these databases were observed, requiring data adjustments for certain time periods.

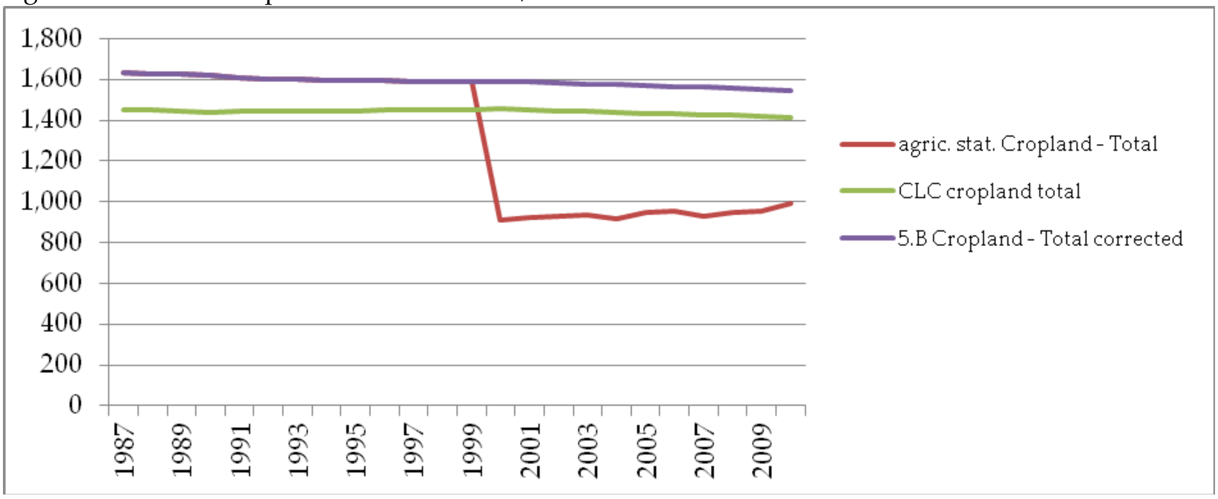
ARKOD presents a national system of identification of land parcels and use of agricultural land in Croatia. It is based on digital ortho-photo maps at a scale of 1:5000, which serve as a basis for interpreting and determining the area of agricultural land farms.
The Ministry of Agriculture and the Paying Agency for Agriculture, Fisheries and Rural Development established this system in 2009 as part of the Croatian alignment with EU requirements. ARKOD makes an integral part of the Integrated Administration and Control System (IACS) by which EU member countries allocate, monitor and control direct EU payments to farmers. Full ARKOD application starts with the Croatian membership to the EU. Since 2011 this system has been used to track the payments of nationally paid subsidies.
At the moment ARKOD is not complete. It contains data for only about 1 million ha of agricultural land in Croatia and needs to be gradually completed. The majority of ARKOD data was taken over from the Farm Register established in Croatia in 2003 for the purpose of granting subsidies to farmers. This Register is based on cadastral data.

Based on the fact that ARKOD contains data (approximately for about 60% of all agricultural land) only on agricultural land under the incentive system, it is not complete and could not be used for the purpose of this report.
For future reporting purposes, this database should be taken into consideration, in particular after the entry of Croatia into the EU when the ARKOD will have to contain information on all farms in Croatia.

For the purpose of this report the CBS data from the time series 1960-2000 were used. The CBS data in the period after 2000 needed to be adjusted due to significant changes in cropland area compared to data from previous periods and data obtained from other data sources. A detailed description of the related changes about CBS data collection and application of new EUROSTAT methodology which caused significant changes in cropland and grassland area in the period after 2000 is presented in Chapter 7.4.2 of this report.
The adjustment was done using the relative trend of the CLC.

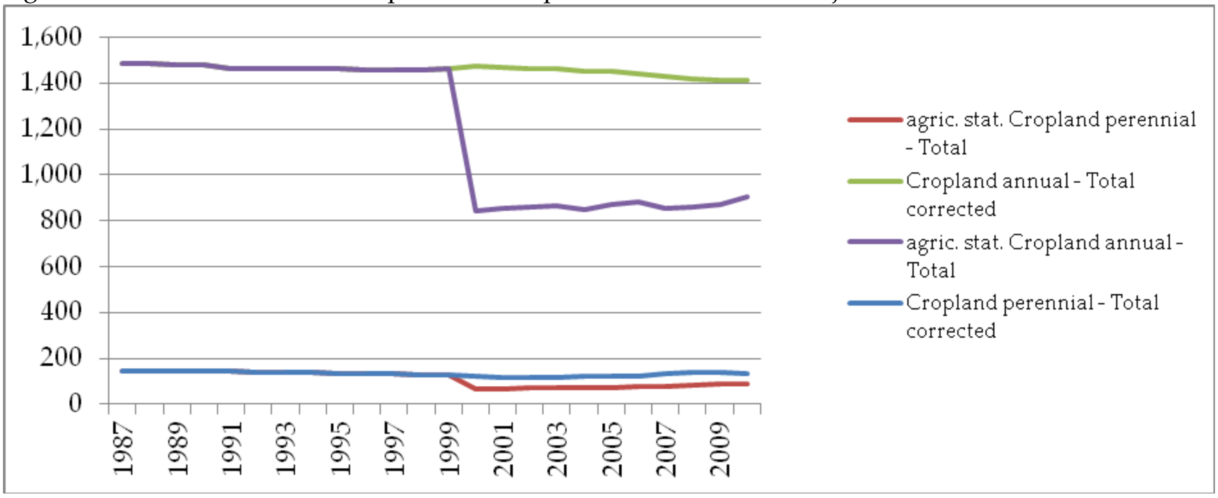
Although the CBS data on cropland area are consistent during the period 1960-2000, a deviation in data series 1992-1997 due to War influences was recorded. In order to adjust this period, linear interpolation of the CBS data from the period 1991-1998 was used.
Changes in the CBS data collection approach and application of new EUROSTAT methodology required data adjustment for the period 2000-2010 (Figure 7.3-1).

Figure 7.3-1: Total Cropland Area Corrected, kha



The share of perennial cropland in the adjusted total cropland area since 2000 has been estimated based on the relative shares of perennial cropland according to CBS data from the 2000ies. For the years before 2000 the CBS data on annual and perennial cropland area were used. The relative shares of perennial and annual cropland are rather consistent across the whole time series (0.1 vs. 0.9).

Figure 7.3-2: Area of annual and perennial cropland in Croatia after adjustement of CBS data, kha



For the comparison in this figure the CLC results are based on linear interpolation between the single CLC assessment years (1980–1990, 1981-1989, 1990-2000 and 2000-2006). For the years after 2006 extrapolation of the CLC trend 2000-2006 was applied.

7.3.3 Land-use Definitions and Classification System Used and Their Correspondence to the LULUCF Categories

Based on the IPCC GPG definition of the cropland category the area under the following classification of the CBS nomenclature was included in this report:

- Arable Land and Gardens
- Nurseries
- Osier Willows
- Orchards
- Olive groves
- Vineyards

After the year 2000 the area under the CBS nomenclature was compared and data were adjusted with the below presented CLC nomenclature:

- Non-irrigated arable land
- Permanently irrigated arable land
- Vineyards
- Fruit trees and berry plantations
- Olive groves
- Annual crops associated with permanent crops (Complex cultivation patterns)

7.3.4Methodological Issues

7.3.4.1Cropland Remaining Cropland (5.B.1)

This section provides information about emissions/removals from soil and biomass in the cropland category and comprises the following:

1.annual remaining annual and perennial remaining perennial cropland
2.annual cropland converted to perennial cropland
3.perennial cropland converted to annual cropland

Although the IPCC GPG does not foresee any method for land use changes within the cropland category, the soil and biomass gains/or losses of annual cropland due to land use changes to/from annual cropland were presented in this report. This country specific approach was applied following the fact that annual cropland has a completely different carbon stock and accumulation rate than perennial cropland and following the examples of some other countries (Austria, Bulgaria, Luxemburg) presenting carbon stock changes in this land use category.

A)Biomass

Since the biomass of annual cropland is harvested on an annual basis, there is no long term carbon storage, thus changes in carbon stocks in biomass are not considered in this estimation under the subcategory "annual cropland remaining annual cropland".
For the subcategory "perennial cropland remaining perennial cropland" the carbon stock changes were estimated using the Tier 1 method. According to this IPCC GPG method the perennial cropland accumulates biomass over the first 30 years, and on an annual basis 3.33% of perennial crops are removed causing the emissions.

- For calculating the carbon stock change of living biomass on perennial cropland remaining perennial cropland, the following IPCC GPG Tier 1 equation was used:

Annual change in biomass = *(area of perennial cropland remaining perennial cropland x carbon accumulation rate) – (area of perennial cropland 30 years[1] ago x 0.033 x biomass carbon stock at harvest)*

[1] *Excluding perennial cropland areas lost due to land use changes*

For the annual carbon accumulation rate in perennial cropland the IPCC GPG default value of 2.1 tC/ha annually was used.

For the aboveground biomass carbon stock at harvest, the IPCC GPG default value of 63 tC/ha annually was used.

- To calculate the annual change in carbon stock of annual cropland living biomass converted to perennial cropland an approach following the IPCC GPG Tier 1 method for LUCs with partly country specific EFs and equation 3.3.8 was applied:

Annual change in carbon stock in biomass = conversion area for a transition period of 20 years x ΔC_{Growth} + *annual area of currently converted land x* $L_{Conversion}$

where:

$L_{Conversion} = C_{After} - C_{Before}$

ΔC_{Growth} = Carbon accumulation rate of perennial cropland = 2.1 t C/ ha annually (IPCC GPG default value)

C_{Before} = biomass carbon stock of annual cropland before conversion is: 5.67 tC/ha annually

C_{After} = carbon stock immediately after conversion = 0 t C/ ha (IPCC GPG default value)

For annual cropland biomass losses in the year of LUC from annual to perennial cropland the county specific average biomass stock in annual cropland was used. The source of information for the annual cropland aboveground biomass was the CBS Statistical Yearbooks with published data for the yield biomass of annual crops (i.e. wheat, maize, oats, rye, triticale etc.) in the period 2000-2010. For all annual crops mentioned in the Statistical Yearbooks, the absolute dry weight had to be determined. Due to the fact that there were no nationally available absolute dry weight factors for this purpose, approaches used by other countries were followed (Austria, Bulgaria), as well as expansion factors from the Austrian Expert Panel for Soil Fertility. The related biomass of strew, leaves or other aboveground plant parts has been determined using the expansion factor from Austria also.

In order to provide an estimate of the belowground biomass the estimated aboveground biomass in annual cropland was multiplied with the root/shoot ratio. Root/shoot ratios of the United States Department of Agriculture were applied for this purpose following examples from other countries. The explanation for the use of this root/shoot ratio was found fitting for Croatia too (all the mentioned countries belong to the temperate region).

For each year from the period 2000-2010 the weighted mean value of the total biomass per ha was calculated on the basis of yields of individual crops and the corresponding areas. From the results thus obtained the average annual carbon stock in annual cropland biomass for Croatia (5.67 tC/ha) was determined.

- To calculate the annual change in carbon stock of perennial cropland living biomass converted to annual cropland an approach following the IPCC GPG Tier 1 method for LUCs with partly country specific EFs and equation 3.3.8 was applied:

Annual change in carbon stock in biomass = Annual area of converted land x ($L_{Conversion} + \Delta C_{Growth}$)

where:

$L_{Conversion} = C_{After} - C_{Before}$

ΔC_{Growth} = annual cropland carbon accumulation rate: **1)** 5.7 tC/ha for annual cropland

C_{Before} = carbon stock of perennial cropland biomass before conversion: 63 tC/ha (IPCC GPG default value) (accounted only for the year of LUC)

C_{After} = carbon stock immediately after conversion is 0 t C/ ha (IPCC GPG default value)

According to the IPCC GPG the gains of the annual cropland biomass during land use changes to annual cropland are accounted only once, in the year of LUC to annual cropland.

The area of Cropland Remaining Cropland in 2010 was 1.536 kha.

B)Soil

For the purpose of this report and presenting the soil carbon stock changes the results of the scientific research program named “Geological Maps of Croatia” were used. The work performed in the period 1997-2003 presents a continuation of former researches in this field in Croatia and has a perennial character.
In that period the whole of Croatian territory was covered by setting samples sites in a grid of 5x5 km. Soil samples were collected at depths of 0 to 20 cm (surface horizon A0-20) in such a way that the whole humus layer was included. By this method 2521 soil samples were taken in different land use categories. Each sample was composed of five sub-samples, thus reducing the probability of random errors which appear mainly as a result of local enrichment/depletion of a certain chemical element. The samples were dried, sieved to the fraction of <0.063 mm, homogenized and analyzed on a set of 41 chemical elements. During the evaluation process of carbon content the contribution of rock fragments to the soil’s total carbon content was not considered.

The performed statistical analysis included all samples with basic statistical parameters about 27 chemical elements. For the construction of geochemical maps scientists used: 5th, 10th, 25 th (lower quartile), 50th (median), 75th (upper quartile), 90th and 98th percentile.
These soil data were analyzed and it was concluded that the median values determined for each land use category need to be taken into calculation, because they are less influenced by outliers.
For the needs of future reports the results of this scientific research need to be compared with the results of other studies on similar issues (see Chapter 7.9).
According to expert judgment there was no change in the relative stock change factors (tillage factor FMG; land use factor FLU, input factor FI) during the past 20 years; these factors are set by default to 1. Thus there was no change in carbon stocks in soils of annual cropland remaining annual cropland and perennial cropland remaining perennial cropland due to management.

- The land use change area from annual cropland converted to perennial cropland in the conversion status of 20 years changed from 0.89 kha to 0.22 kha from 1990 to 2010.

Following the IPCC GPG (Tier 1) approach, the annual change in carbon stock of mineral soils of annual cropland converted to perennial cropland is calculated as follows:

Annual change in carbon stock in soil = conversion area for a transition period of 20 years x ΔSOC

$$\Delta SOC = (SOC_0 - SOC_{0\text{-}T})/20 = 2.72 \text{ tC/ha annually}$$

where:

ΔSOC = annual change in carbon stock soil

SOC_{0-T} = Croatian soil organic carbon stock in the inventory year = 126,3 tC/ha for perennial cropland

SOC_T = Croatian soil organic carbon stock *T* years prior to the inventory = 71,9 tC/ha for annual cropland

T = Assessment period (20 years)

- Emission/removals due to changes of carbon stock in soils of perennial cropland converted to annual cropland were calculated using the same national figures for the soil carbon content in perennial cropland as in annual cropland. The equation used for this purposes is the same as above:

Annual change in carbon stock in soil = conversion area for a transition period of 20 years x ΔSOC

$$\Delta SOC = (SOC_0 - SOC_{0\text{-}T})/20 = -2.72 \text{ tC/ha annually}$$

ORGANIC SOILS

By expert judgment the area of cultivated organic soils is determined to be 1.18 kha (based on data published in Basic pedology Map of Croatia), with emissions of 3.22 GgCO_2 annually.
For estimating CO_2 emissions from organic soils in the Cropland Remaining Cropland category the IPCC GPG 3.3.5 equation was applied:

$$\Delta C_{CC\ Organic} = A x EF$$

Where:

$\Delta C_{CC\ Organic}$= CO2 emissions from cultivated organic soils (tC/year)

A= land area of organic soils (ha)

EF= emission factor for warm temperate climate = 10 t C/ha annually (IPCC GPG default value)

C) Liming

The application of lime to agricultural soils has yet to be estimated in Croatia. At the time of preparing this report no national data about lime application were available.

However, based on the fact that more than 1.5 million ha of the Croatian soils are acid (Designated Soil Map, Bogunović & et al. 1997), it can be assumed that lime application still occurs in Croatia. For this year's report it was not possible to estimate the amounts of lime used in soils, because the application of lime depends on the general economic situation and the situation in the agricultural sector in particular.

Investigation on this issue needs to be conducted in due time until submission 2013 or 2014. See Chapter 7.9

7.3.4.2Land Use Change to Cropland (5.B.2)

7.3.4.2.1 Forest Land Converted to Cropland (5.B.2.1)

There has been no conversion from forestland to cropland in the last decades.

7.3.4.2.2Grassland Converted to Cropland (5.B.2.2)

A) Changes in Carbon Stocks in Biomass

Based on the CLC results, the LUCs to cropland category occur on basis of grassland. The area coming from grassland also had to be divided into LUCs to annual cropland and LUCs to perennial cropland which was done directly on basis of specific CLC subcategories representing annual or perennial cropland or according to the share of these land uses in total cropland (0.9 vs 0.1) for mixed CLC categories which include both, annual and perennial cropland in one CLC category.

Representing a LUC transition period of 20 years, 12 kha of grassland area were converted to cropland in 2010. The changes of carbon stocks during the conversion from one category to another vary from year to year. In 1990 LUC in this category resulted in emissions of 37.51 Gg CO_2 and in 2010 in emissions of 64.89 GgCO_2.

For the calculation of carbon stock in living biomass of grassland national data were used. The source of information for the grassland aboveground biomass was the CBS Statistical Yearbooks with published data for hay yield. Based on data available for the period 2000-2010 the mean value of hay biomass was calculated (2.5 t dm/ha annually). The total biomass was calculated (4.29 tC/ha) by adding the aboveground stubble biomass (1.6 t dm/ha, IPCC GPG default value) and the appropriate IPCC GPG root to shoot ratio (2.8) and converting it to t C.

The approach used to determine the accumulation of carbon stock in the biomass of annual cropland in the first year after the conversion is presented in Chapter 7.3.4.1

To calculate the annual change in carbon stock of grassland living biomass converted to annual and perennial cropland the IPCC GPG Tier 1 equation 3.3.8 was applied, as follows:

Annual change in carbon stock in biomass = annual area of converted land x ($L_{Conversion} + \Delta C_{Growth}$)

where:

$L_{Conversion} = C_{After} - C_{Before}$

ΔC_{Growth} = carbon accumulation rate which amounts to:

1) 5.7 tC/ha for annual cropland

2) 2.1 t C/ ha for perennial cropland = (IPCC GPG default value)

C_{Before} = carbon stock of grassland biomass before conversion = 4.3 tC/ha

C_{After} = carbon stock immediately after conversion = 0 t C/ ha

B)Changes in Carbon Stocks in Soil

For the calculation of the average annual change in carbon stock of mineral soils of grassland converted to cropland, specific data for the country were used and the IPCC GPG Tier 1 equation was applied, as follows:

$\Delta SOC = (SOC_0 – SOC_{0-T})/20$

ΔSOC = annual change in carbon stock soil

SOC_{0-T} =soil organic carbon stock in the inventory year, which amounts to:

1) 71,9 tC/ha for annual cropland

2) 126,3 tC/ha for perennial cropland

SOC_T = soil organic carbon stock *T* years prior to the inventory, which equals 108,48 tC/ha

T = Assessment period (20 years)

The change in carbon stock in soils of grassland converted to annual and perennial cropland was further calculated by multiplying the emission factor by the area of converted territory in a transition period of 20 years. The emission factor for grassland converted to annual cropland was calculated to be -1.82 tC/ha annually, and 0.89 tC/ha annually for the area of grassland converted to perennial cropland.

The net soil carbon stock changes resulted in removals in the range of 1.06 to 2.58 GgCO_2 in case of grassland converted to perennial cropland and in emissions in case of grassland converted to annual cropland in the range of 29.33 to 77.69 GgCO_2 for the period 1990-2010.

7.3.4.2.3 N_2O Emissions in Soils of Land Converted to Cropland

The annual release of N_2O due to the conversion of grassland to cropland was calculated using the IPCC default value (Tier 1) and equations 3.3.14 and 3.3.15:

$N_2O_{net\text{-}min}$ - N = EF_1 x $\Delta C_{LCmineral}$ x 1/(C/N ratio)

where:

EF_1 = the emission factor for calculating emissions of N_2O from N in the soil = 0.0125 kg N_2O-N/kg N (IPCC GPG default value)

$\Delta C_{LCmineral}$ = change in the carbon stock in mineral soils in grassland converted to cropland

C/N = ratio by mass of C to N in the soil organic matter = 15 (IPCC GPG default value).

7.3.5Uncertainty Assessment

The cropland category has been included into the key category analysis for the first time. The analysis using Tier 1 and Tier 2 Level and Trend methods excluded cropland as a key category. The uncertainty of this subcategory has not yet been defined (see chapter 7.3.8).

7.3.6 QA/QC and Verification

The calculation of data for the category 5.B was included in the overall QA/QC system of the Croatian GHG inventory.

7.3.7 Recalculations

This land use category has been examined and interpreted for the first time in the Croatian Inventory. As a consequence there are no recalculations.

7.3.8 Planned Improvements

The uncertainty assessment model applied in Croatia does not include the cropland subcategory in the calculation. This needs to be adjusted. Consultations with various stakeholders have to be held in order to define the uncertainty of this subcategory. See also Chapter 7.9

7.4 GRASSLAND 5.C

7.4.1 Category Description

In this category only emissions/removals from the grassland management (Grassland Remaining Grassland and Land Converted to Grassland) were considered. For the purpose of this report a combination of the IPCC GPG Tier 1 and Tier 2 approach was used to calculate the carbon stock changes.

The grassland area ranged from 1.211 kha to 1.232 kha in the period 1990-2010. Removals from the change in carbon stock in biomass and soil ranges from 136.9 GgCO_2 to 290.6 GgCO_2 in period 1990-2010.

Annual LUCs to grassland occurred from the cropland category (annual and perennial) only.

Some management practices, such as burning of stubble-fields, are forbidden in Croatia.

Dead wood and litter pools do not exist in the grassland category, so they are not subject to this report.

Tables 7.4-1 and 7.4-2 show the land use change and removals/emissions from LUC to grassland in the period from 1990 to 2010.

Table 7.4-1: Activity Data of Grassland in the period 1990-2010 in kha

Year	5.C Grassland Total	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.2.2 annual Cropland land converted to Grassland	5.C.2.2 perennial 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
1990	1.211	1.178	33	NO	33	30	3	NO	NO	NO
1991	1.213	1.178	35	NO	35	32	3	NO	NO	NO
1992	1.215	1.177	37	NO	37	34	3	NO	NO	NO
1993	1.217	1.177	39	NO	39	36	3	NO	NO	NO
1994	1.219	1.177	42	NO	42	39	3	NO	NO	NO
1995	1.221	1.177	44	NO	44	41	3	NO	NO	NO
1996	1.223	1.177	46	NO	46	43	3	NO	NO	NO
1997	1.225	1.177	48	NO	48	45	4	NO	NO	NO
1998	1.227	1.177	50	NO	50	47	4	NO	NO	NO
1999	1.230	1.177	53	NO	53	49	4	NO	NO	NO
2000	1.232	1.177	54	NO	54	50	4	NO	NO	NO
2001	1.230	1.176	54	NO	54	50	4	NO	NO	NO
2002	1.229	1.175	54	NO	54	50	4	NO	NO	NO
2003	1.228	1.173	55	NO	55	51	4	NO	NO	NO
2004	1.227	1.172	54	NO	54	50	4	NO	NO	NO
2005	1.226	1.171	55	NO	55	50	4	NO	NO	NO
2006	1.224	1.170	54	NO	54	50	4	NO	NO	NO
2007	1.223	1.169	54	NO	54	50	4	NO	NO	NO
2008	1.222	1.168	54	NO	54	50	4	NO	NO	NO
2009	1.221	1.166	54	NO	54	50	4	NO	NO	NO
2010	1.219	1.165	55	NO	55	51	4	NO	NO	NO

Table 7.4-2: Emissions (+) / removals (-) of CO_2 in Grassland 1990-2010 (Gg CO_2 equivalent)

Year	5.C Grassland Total	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
1990	-162,1	2,7	-164,8	0,0	-164,8	0,0	0,0	0,0
1991	-138,9	2,7	-141,6	0,0	-141,6	0,0	0,0	0,0
1992	-136,9	2,7	-139,6	0,0	-139,6	0,0	0,0	0,0
1993	-160,9	2,7	-163,5	0,0	-163,5	0,0	0,0	0,0
1994	-164,4	2,7	-167,1	0,0	-167,1	0,0	0,0	0,0
1995	-188,7	2,7	-191,4	0,0	-191,4	0,0	0,0	0,0
1996	-204,9	2,7	-207,6	0,0	-207,6	0,0	0,0	0,0
1997	-209,8	2,7	-212,4	0,0	-212,4	0,0	0,0	0,0
1998	-228,7	2,7	-231,4	0,0	-231,4	0,0	0,0	0,0
1999	-239,7	2,7	-242,4	0,0	-242,4	0,0	0,0	0,0
2000	-240,4	2,7	-243,1	0,0	-243,1	0,0	0,0	0,0
2001	-286,5	2,7	-289,1	0,0	-289,1	0,0	0,0	0,0
2002	-274,3	2,7	-277,0	0,0	-277,0	0,0	0,0	0,0
2003	-272,8	2,7	-275,4	0,0	-275,4	0,0	0,0	0,0
2004	-290,6	2,7	-293,3	0,0	-293,3	0,0	0,0	0,0
2005	-279,7	2,7	-282,4	0,0	-282,4	0,0	0,0	0,0
2006	-286,0	2,7	-288,7	0,0	-288,7	0,0	0,0	0,0
2007	-281,6	2,7	-284,2	0,0	-284,2	0,0	0,0	0,0
2008	-283,7	2,7	-286,4	0,0	-286,4	0,0	0,0	0,0
2009	-279,7	2,7	-282,4	0,0	-282,4	0,0	0,0	0,0
2010	-258,2	2,7	-260,9	0,0	-260,9	0,0	0,0	0,0

7.4.2Information on Approaches Used for Representing Land Areas and on Land-Use Databases Used for the Inventory Preparation

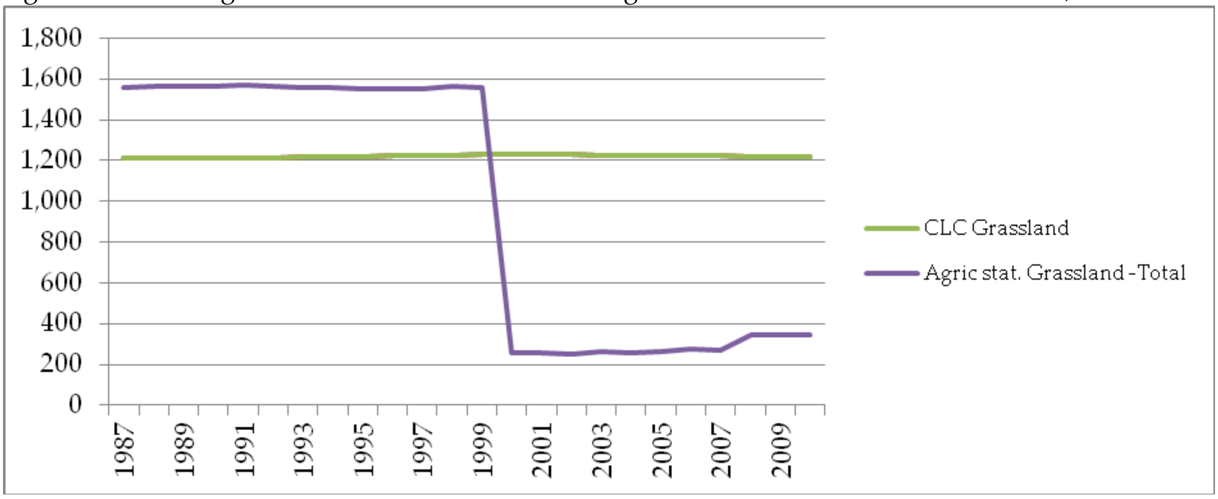
For the presentation of grassland area in Croatia data from the Croatian Bureau of Statistics (CBS) and the CLC databases (years 1980, 1990, 2000 and 2006) were reviewed. Significant changes were observed requiring data adjustments for the whole time series.

The complete examination of CBS data demonstrated its inadequateness related to the total area of Croatia. The adjustment of CBS data with CLC data for the time series since 2000 had the same results, leading to the exceedance of the total area of Croatia. At the same time, self-standing CLC data fitted adequately to the Croatian area and were used in this report for this reason.

Data from the CBS are the result of the Croatian statistical surveys in the field of agriculture.
Before the year 2005 the CBS recorded data for legal entities and parts of legal entities were collected through regular annual reports, while data on private family farms were collected separately using the estimation method by agricultural estimators on the basis of cadastre data. Tradesmen were included in the part of statistics that referred to livestock and poultry slaughtering.
Data gathered on private family farms using this methodology showed significant reduction of the grassland area in Croatia in the period 1992-1995 compared to the previous as well as the following years (i.e. in 1987 the area was 1.56 million ha, while in 1995 it was 1.10 million ha). The main reason for this difference was the Croatian Homeland War, because of which investigation could not be carried out on the whole of Croatian territory. A separate and additional problem was areas contaminated with mines. On this land, forest vegetation was gradually taking over due to the stop of grassland management at these lands.

To analyze the CBS data for the purpose of this report, linear interpolation of trend 1991-1996 of the CBS data were used in order to adjust the data for the years with partial data in the period 1992-1995 (Figure 7.4-1)

Figure 7.4-1: Total grassland area in Croatia according to the CBS data andd CLC database, kha



Since 2005 the CBS has been applying a new methodology in its work. It records data on entities and parts thereof and data on tradesmen jointly through regular annual reports, while data on private family farms are collected separately. Crop production statistics on private family farms using the interview method on a selected sample with the help of interviewers was prepared in 2005 for the first time. All obtained data were expanded and compared to data from previous years (i.e. the data from the 2003 Agricultural Census and available administrative sources such as the Register of Agricultural Holdings of the Ministry of Agriculture etc.). Where necessary, corrections were made based on all available data. Changes in the data collection method caused significant differences in the land areas data of some crops, vineyards and orchards. They mostly related to the reduction of land areas, and were found as caused by the tardiness of the cadastre.

In order to be fully harmonized with the EUROSTAT requirements in this field of statistics, the CBS was invited to revise the crop production data series 2000-2004. The main reason for this was the methodological harmonization of data and methods of data assessment for this period, since EUROSTAT adopted a new data processing methodology in 2000. The recalculation was done based on the Census of Agriculture 2003.
Data for the period 2005-2010 were collected through regular surveys applying the sampling method, and they mostly remained the same.

Applying the interview method on private family farms and the new EUROSTAT methodology in its statistical work after 2000, the CBS was focusing only on categories of utilized agricultural area and utilized arable land. Collecting data in such a way, the CBS included data on intensively and extensively managed areas, and completely omitted records on the traditionally less managed or unmanaged grassland areas in Croatia (i.e. meadows). This explains the difference between the CBS data series for the period 1990-1999 and the period 2000-2010.

In this report CLC data were used to present cropland area in Croatia in the years 1980, 1990, 2000 and 2006. Linear interpolation of the CLC trend between these CLC assessment years was carried out. Extrapolation of the CLC trend 2000-2006 was applied for the years after 2006.

According to the CLC trends, the grassland increased in the period 1990-2000 by 2.1 kha annually, and decreased in the period 2001-2010 by 1.2 kha annually.

7.4.3 Land-Use Definitions and Classification System Used and Their Correspondence to the LULUCF Categories

Based on the IPCC GPG definition of the grassland category the following classes of the CLC database nomenclature are included in this report:

- Pastures
- Land principally occupied by agriculture, with significant areas of natural vegetation
- Natural grasslands
- Moors and heathland
- Sclerophyllous vegetation

7.4.4 Methodological Issues

Emissions arisen as the result of LUC were estimated by applying country specific values for the average annual growth in grassland biomass (4.29 t C/ha annually).

7.4.4.1 Grassland Remaining Grassland (5.C.1)

Since the biomass of grassland is harvested on an annual basis, there is no long-term carbon storage; thus changes in carbon stocks in biomass were not considered in the estimation (IPCC GPG 2003).

The area of grassland remaining grassland in 2010 amounts to 1.165 kha.

According to the IPCC GPG Tier 1 there was no carbon stock change in soil in the category Grassland Remaining Grassland, since - based on expert judgment - there have been no changes in management practices for grassland in the past 20 years.

The area of organic soils in the grassland category in Croatia was estimated to be 0.29 kha (expert judgment based on data published in Basic pedology Map of Croatia).
The emissions from organic soils were calculated using the IPCC GPG default emission factor (Tier 1) for organic grassland soils in warm temperate climates (2.5 t C/ ha annually). The emissions from organic soils were determined in the value of 2.76 GgCO_2 annually for the period 1990-2010.

According to expert judgment liming does not occur in the grassland category.

7.4.4.2 Land use change to Grassland (5.C.2)
7.4.4.2.1 Forest land converted to Grassland (5.C.2.1)

There has not been conversion from the Forestland to Grassland in the last decades.

7.4.4.2.2 Cropland converted to Grassland (5.C.2.2)

C)Changes in carbon stocks in biomass

According to the CLC results it is concluded that the LUCs into Grassland come from the Cropland area. The area coming from this category of land needed to be also divided into annual Cropland and perennial Cropland. This was done directly on basis of specific CLC subcategories representing annual or perennial cropland or according to the share of these land uses in total cropland (0.9 vs 0.1) for mixed CLC categories which include both, annual and perennial cropland in one CLC category.
With respect to the LUC transition period of 20 years, 54.8 kha of Cropland area were converted into Grassland in year 2010. The changes of carbon stocks during the conversion from one category to another vary between years. In year 1990 LUCs in this category resulted in emissions of 7.66 Gg CO_2 and in year 2010 in emissions of 8.22 GgCO_2.

For the calculation of carbon stock in living biomass of Grassland, national data were used. Source of information for the Grassland aboveground biomass were CBS Statistical Yearbooks with the published data for the hay yield. Based on the available data for period 2000-2010 the mean value of the hay biomass was calculated (2.5 t dm/ha annually). The total biomass was calculated (4.29 tC/ha) by adding of the aboveground stubble biomass (1.6 t dm/ha, IPCC GPG value) and using the IPCC GPG root to shoot ratio (2.8) and the conversion factor to t C.

To calculate annual change in carbon stock of the living biomass of Cropland converted to Grassland the IPCC GPG Tier 1 equation 3.3.8 was applied:

Annual change in carbon stock in biomass = *Annual area of converted land* x ($L_{Conversion}$ + ΔC_{Growth})

where:

$L_{Conversion} = C_{After} - C_{Before}$

ΔC_{Growth} = Carbon accumulation rate in Grasslands in Croatia = 4.29 t C/ ha

C_{Before} = Carbon stock of Cropland biomass before conversion is: **1)** 5.7 t C/ ha for annual Cropland and **2)** 63 t C/ha for perennial Cropland (IPCC GPG value)

C_{After} = Carbon stock immediately after conversion = 0 t C/ha (IPCC GPG value)

D)Changes in carbon stocks in soil

For the calculation of average annual change in carbon stock of mineral soils of Cropland converted to Grassland specific data for the country were used and IPCC GPG Tier 1 equation was applied, as follows:

$\Delta SOC = (SOC_0 – SOC_{0-T})/20$

ΔSOC = annual change in carbon stock soil

SOC_0 =soil organic carbon stock in the inventory year, which is: **1)** 71.9 tC/ha for annual Cropland **2)** 126.3 tC/ha for perennial Cropland

SOC_{0-T} = soil organic carbon stock *T* years prior to the inventory, which is 108.48 tC/ha for grassland

The change in carbon stock in soils of annual and perennial Cropland converted to Grassland was further calculated by multiplying the emission factor by the area of the converted territory in transition of 20 years. Soil emission factor for the annual Cropland converted to grassland in Croatia is calculated to be 1.82 tC/ha annually, and 0.89 tC/ha annually for the perennial Cropland converted to grassland.

Net carbon stock change is resulting in removals in range of 201.66 to 341 GgCO_2 in perennial Cropland converted to Grassland and in emissions in case of annual Cropland converted to Grassland in range of 7.33 to 14.66 GgCO_2 in period 1990-2010.

7.4.5 Uncertainty assessment

The Grassland category has been included into the key category analysis for the first time. The analysis using Tier 1 and Tier 2 Level and Trend methods excluded Grassland as a key category. The uncertainty of this subcategory has not yet been defined (see chapter 7.4.8).

7.4.6 QA/QC and Verification

The calculation of the data for category 5.C was included in overall QA/QC system of the Croatian GHG inventory.

7.4.7 Recalculations

This land use category has been examined and interpreted for the first time in the Croatian Inventory. As a consequence, there are no recalculations.

7.4.8 Planned improvements

Uncertainty assessment model applied in Croatia does not include Grassland subcategory into the calculation. This needs to be adjusted. Consultations with various stakeholders have to be held in order to define uncertainty of this subcategory. See also Chapter 7.9

7.5 WETLANDS 5.D

7.5.1 Category Description

In this category only emissions/removals from the sub-categories "Land Converted to Wetland" were considered.

Due to lack of information it was assumed that the carbon stock in biomass, dead organic matter and soil of surface waters was 0.

Peat extraction does not occur in Croatia.

The wetland area ranged from 72,320 kha in 1990 to 74,345 kha in 2010.

The land use change and removals/emissions from the IPCC land use categories to wetland in the period 1990-2010 are presented in Tables 7.5-1 and 7.5-2.

Table 7.5-1: Activity data of wetland in the period 1990-2010 in ha

Year	5 D Total wetland	1. Wetland remaining Wetland	2. Land converted to Wetland	2.1 Forest land converted to Wetland	2.2 Cropland converted to Wetlands	2.3 Grassland converted to Wetlands	2.4 Settlements converted to Wetlands	2.5 Other land converted to Wetlands
1990	72.320	70.057	2.263	NO	2.263	NO	NO	NO
1991	72.509	70.057	2.452	NO	2.452	NO	NO	NO
1992	72.699	70.057	2.642	NO	2.642	NO	NO	NO
1993	72.888	70.057	2.831	NO	2.831	NO	NO	NO
1994	73.077	70.057	3.020	NO	3.020	NO	NO	NO
1995	73.267	70.057	3.210	NO	3.210	NO	NO	NO
1996	73.456	70.057	3.399	NO	3.399	NO	NO	NO
1997	73.645	70.057	3.588	NO	3.588	NO	NO	NO
1998	73.834	70.057	3.777	NO	3.777	NO	NO	NO
1999	74.024	70.057	3.967	NO	3.967	NO	NO	NO
2000	74.213	70.057	4.156	NO	4.156	NO	NO	NO
2001	74.226	70.283	3.943	NO	3.943	NO	NO	NO
2002	74.239	70.510	3.730	NO	3.730	NO	NO	NO
2003	74.253	70.736	3.517	NO	3.517	NO	NO	NO
2004	74.266	70.962	3.303	NO	3.303	NO	NO	NO
2005	74.279	71.189	3.090	NO	3.090	NO	NO	NO
2006	74.292	71.415	2.877	NO	2.877	NO	NO	NO
2007	74.305	71.641	2.664	NO	2.664	NO	NO	NO
2008	74.318	71.867	2.451	NO	2.451	NO	NO	NO
2009	74.332	72.094	2.238	NO	2.238	NO	NO	NO
2010	74.345	72.320	2.025	NO	2.025	NO	NO	NO

Table 7.5-2: Emissions of wetland in the period 1990-2010 in Gg CO_2

Year	5 D Total wetland	1. Wetland remaining Wetland	2. Land converted to Wetland	2.1 Forest land converted to Wetland	2.2 Cropland converted to Wetlands	2.3 Grassland converted to Wetlands	2.4 Settlements converted to Wetlands	2.5 Other land converted to Wetlands
1990	41,55	NE	41,55	0	41,55	0	0	0
1991	42,69	NE	42,69	0	42,69	0	0	0
1992	45,38	NE	45,38	0	45,38	0	0	0
1993	48,06	NE	48,06	0	48,06	0	0	0
1994	50,75	NE	50,75	0	50,75	0	0	0
1995	53,43	NE	53,43	0	53,43	0	0	0
1996	56,11	NE	56,11	0	56,11	0	0	0
1997	58,80	NE	58,80	0	58,80	0	0	0
1998	61,48	NE	61,48	0	61,48	0	0	0
1999	64,17	NE	64,17	0	64,17	0	0	0
2000	66,85	NE	66,85	0	66,85	0	0	0
2001	56,47	NE	56,47	0	56,47	0	0	0
2002	53,44	NE	53,44	0	53,44	0	0	0
2003	50,42	NE	50,42	0	50,42	0	0	0
2004	47,40	NE	47,40	0	47,40	0	0	0
2005	44,38	NE	44,38	0	44,38	0	0	0
2006	41,35	NE	41,35	0	41,35	0	0	0
2007	38,33	NE	38,33	0	38,33	0	0	0
2008	35,31	NE	35,31	0	35,31	0	0	0
2009	32,29	NE	32,29	0	32,29	0	0	0
2010	29,26	NE	29,26	0	29,26	0	0	0

7.5.2 Information on Approaches Used for Representing Land Areas and on Land-Use Databases Used for the Inventory Preparation

In order to present the wetland area in Croatia data presented in the Corine Land Cover databases (years 1980, 1990, 2000 and 2006) and the GIS database on the distribution of habitat types in Croatia were compared. A habitat map was built in a scale of 1:100.000, with a minimum mapping unit of 9 hectares, also containing data on wetlands in Croatia protected under the Ramsar Convention. The primary mapping method was the analysis of Landsat ETM+ satellite images, in combination with other data sources (air photos, literature data) and field work. Habitats throughout the Croatian territory were mapped. No significant differences between the wetland areas according to these databases were found and it was decided that CLC data would be used for the wetlands area presentation.

Linear interpolation of the CLC trend between the CLC assessment years was carried out. For the years after 2006 extrapolation of the CLC trend 2000-2006 was applied.
According to CLC trends the wetland area increased 226 ha per year in the period 1980-1990, 189 ha per year in the period 1991-2000 and 13 ha per year in the period 2001-2010. The LUC from cropland to wetland was divided into annual and perennial cropland according to the share of these land uses in total cropland (0.9 vs 0.1).

An assessment of the land use changes according to CLC suggested that the observed wetland area increase comes only from the cropland area in Croatia.

7.5.3 Land-Use Definitions and Classification System Used and Their Correspondence to the LULUCF Categories

Two levels of the first classes under the CLC nomenclature (Wetlands and Water Bodies) were examined; the below presented classes were included into the wetland area:

- inland marshes
- salt marshes
- salines
- intertidal flats
- water courses
- water bodies
- coastal lagoons

7.5.4 Methodological Issues

7.5.4.1 Land Use Change to Wetland (5.D.2)

Based on analyzed data it was concluded that no conversion occurred from other land use categories to wetland except from cropland.

7.5.4.1.1 Cropland Converted to Wetland (5.D.2.2)

Changes in Carbon stocks in Biomass of Cropland Converted to Wetland

For the calculation of the annual change in carbon stocks of living biomass in cropland converted to wetland the GPG equation 3.5.6 was applied.

The annual change in carbon stocks of living biomass in cropland converted to wetland (t C/a):

$$\Delta C_{LW\ flood} = \sum A_i \times (B_{after} - B_{before})_i$$

A_i = area of land converted annually to flooded land from original land use *i*, ha yr^{-1}

B_{Before} = living biomass in land immediately before conversion to wetland:

1)for annual cropland 5.7 t C /ha a and 2) for perennial cropland 63 t C / ha (IPCC GPG default value)

B_{After}= living biomass in land immediately before conversion to wetland (default = 0 t C/ha a)

Changes in carbon stocks in soil of cropland converted to wetland

$$\Delta C_{LW\ flood} = \sum A_i \times (B_{after} - B_{before})_i /20$$

A_i = area of land converted to flooded land for a transition period of 20 years, ha

B_{Before} = carbon stock in soil immediately before conversion to wetland:

1) for annual cropland 71.9 t C /ha a, and 2) for perennial cropland 126.3 t C / ha a (See Chapter 7.2.1.)

B_{After} = carbon stock in soil immediately after conversion to wetland (default = 0 t C/ha a)

7.5.5 Uncertainty assessment

The Wetland category has been included into the key category analysis for the first time. The analysis using Tier 1 and Tier 2 Level and Trend methods excluded Wetland as the key category. The uncertainty of this subcategory has not yet been defined (see chapter 7.5.8).

7.5.6 QA/QC and Verification

The calculation of the data for category 5.D was included in overall QA/QC system of the Croatian GHG inventory.

7.5.7 Recalculations

This land use category has been examined and interpreted for the first time in the Croatian Inventory. As a consequence, there are no recalculations.

7.5.8 Planned improvements

Uncertainty assessment model applied in Croatia does not include Wetland subcategory into the calculation. This needs to be adjusted. Consultation with various stakeholders have to be held in order to define uncertainty of this subcategory. See also Chapter 7.9

7.6 SETTLEMENTS 5.E

7.6.1 Category Description

In this category only emissions/removals from sub-categories "Land converted to Settlements" were considered.

It was assumed that dead wood and litter do not occur in the settlements area.

The settlements area ranges from 220 002 ha in 1990 to 258 645 ha in 2010. Emissions from the change in the carbon stock in biomass and soil ranges from 467 to 788 Gg CO_2 respectively.

Annual LUCs to Settlements occur from the subcategories Forest Land, Cropland (annual and perennial) and Grassland.

Tables 7.6-1 and 7.6-2 show the land use change and removals/emissions from LUC to Settlements in the period 1990 to 2010.

Table 7.6-1: Activity data of Settlements for 1990-2010 in ha

Year	Total Settlement	5.E.1 Settlement remaining settlement	5.E.2 Land converted to Settlement	5.E.2.1 Forest land converted to Settlement	5.E.2.2 Cropland converted to Settlement	5.E.2.3 Grassland converted to Settlement	5.E.2.4 wetland converted to Settlement	5.E.2.5 Other land converted to Settlement
1990	220.002	195.580	24.422	13.565	7.122	3.735	NO	NO
1991	221.142	196.834	24.307	12.990	7.258	4.060	NO	NO
1992	222.282	198.089	24.193	12.430	7.386	4.376	NO	NO
1993	223.422	198.917	24.505	13.307	7.010	4.188	NO	NO
1994	224.562	200.124	24.437	13.804	6.634	4.000	NO	NO
1995	225.701	201.853	23.849	13.426	6.434	3.989	NO	NO
1996	226.841	203.107	23.734	12.827	6.583	4.325	NO	NO
1997	227.981	204.362	23.619	12.341	6.674	4.604	NO	NO
1998	229.121	205.617	23.505	11.823	6.782	4.900	NO	NO
1999	230.261	206.871	23.390	11.414	6.835	5.141	NO	NO
2000	231.401	208.126	23.276	11.032	6.874	5.369	NO	NO
2001	234.126	209.380	24.745	10.599	7.732	6.415	NO	NO
2002	236.850	210.635	26.215	10.328	8.508	7.379	NO	NO
2003	239.575	211.890	27.685	9.881	9.372	8.432	NO	NO
2004	242.299	213.144	29.155	9.788	10.059	9.307	NO	NO
2005	245.023	214.399	30.625	9.290	10.950	10.385	NO	NO
2006	247.748	215.653	32.094	9.141	11.665	11.288	NO	NO
2007	250.472	216.908	33.564	8.615	12.569	12.381	NO	NO
2008	253.197	218.163	35.034	8.331	13.351	13.351	NO	NO
2009	255.921	219.229	36.692	7.929	14.381	14.381	NO	NO
2010	258.645	220.002	38.644	7.933	15.356	15.356	NO	NO

Table 7.6-2: Emissions of Settlements 1990-2010 in Gg CO_2

Year	Total Settlement	5.E.1 Settlement remaining settlement	5.E.2 Land converted to Settlement	5.E.2.1 Forest land converted to Settlement	5.E.2.2 Cropland converted to Settlement	5.E.2.3 Grassland converted to Settlement	5.E.2.4 wetland converted to Settlement	5.E.2.5 Other land converted to Settlement
1990	580	NE	580	404	103	74	NO	NO
1991	556	NE	556	351	119	86	NO	NO
1992	489	NE	489	277	120	92	NO	NO
1993	519	NE	519	344	95	80	NO	NO
1994	529	NE	529	363	89	77	NO	NO
1995	467	NE	467	294	94	79	NO	NO
1996	480	NE	480	279	110	91	NO	NO
1997	477	NE	477	273	109	95	NO	NO
1998	480	NE	480	267	111	101	NO	NO
1999	485	NE	485	270	110	105	NO	NO
2000	497	NE	497	278	110	109	NO	NO
2001	573	NE	573	277	155	142	NO	NO
2002	589	NE	589	268	162	159	NO	NO
2003	609	NE	609	251	177	180	NO	NO
2004	683	NE	683	309	179	195	NO	NO
2005	684	NE	684	266	200	218	NO	NO
2006	688	NE	688	253	202	233	NO	NO
2007	703	NE	703	224	222	257	NO	NO
2008	756	NE	756	255	228	274	NO	NO
2009	769	NE	769	230	244	294	NO	NO
2010	788	NE	788	223	254	312	NO	NO

7.6.2 Information on Approaches Used for Representing Land Areas and on Land-Use Databases Used for the Inventory Preparation

In order to present the settlements area in Croatia data presented in the Corine Land Cover databases (years 1980, 1990, 2000 and 2006) and the State Geodetic Administration's Register of spatial units were found useful for this report.
Although the Register contains information on state, county, city of Zagreb, town, municipality, settlements, protected areas, cadastral municipality, statistical range etc, it turned out that the data presentation was not in line with the requirements of this report (i.e. build-up areas are not presented in the Register). This is why expert judgment recommended to use data from the CLC databases.

Comparing CLC data under the settlements category with the same data in other countries (Austria and Luxemburg), it was observed that the total CLC settlement area in Croatia represents only 2.9 % of total land while in other countries it is significantly higher. Furthermore, it has been observed that roads and railroads within the Croatian CLC settlements category were represented only with 1.5%. Detailed Austrian and Luxembourgian data report that 45 to 50 % of the settlement area is composed of roads and railroad lines.
It was expert judgment that the difference between Croatian CLC settlements area and Austrian and Luxembourgian area were most likely due to the fact that the roads and railroads area outside of the settlements in Croatia was not covered by the CLC database due to the area resolution of CLC and the insignificant narrow areas represented by these traffic lines in the CLC assessment units. Because of that, Croatian CLC settlements data needed to be adjusted for these uncovered countryside traffic areas. The data adjustment for the years 1980, 1990, 2000 and 2006 was done using the correction factor which is estimated to be:

((1/(1-0.45+0.015))-(0.029 x 0.45 x total area of Croatia)

This correction factor is multiplied with the CLC settlement area to estimate the adjusted settlement area. The term **1/(1-0.45+0.015))** expands the settlement area for traffic lines (45 % of the settlement area are assumed to be traffic lines, of which only 1.5 % are covered by the CLC results and need to be added to avoid an overestimate). In a next step of this correction factor estimate **-(0.029 x 0.45 x total area of Croatia)** those 45% area share of traffic lines that fall within the detected CLC settlement areas (2.9 % of total area of Croatia) but which are also assessed as other settlement categories than traffic lines due to the area dominance of other categories (e.g. urban fabric) have to be subtracted to avoid traffic area double accounting.
After that linear interpolation of the CLC trend between the assessment years was carried out. For the years after 2006 extrapolation of the CLC trend 2000-2006 was applied.

Based on the CLC data on LUC areas and the information from Croatian Forests Ltd. on defoprestation areas it was concluded that LUCs in settlements come from the Forest Land, Grassland and Cropland category. According to the CLC 1990-2000 and CLC 2000-2006 half of the settlements area increaseon basis of agricultural land comes from cropland and half from grassland subcategories. The area coming from cropland was divided

into annual cropland and perennial cropland according to the share of these land uses in total cropland (0.9 vs 0.1).
The annual increase in the settlements area coming from forest land was recorded based on the data delivered by the Croatian Forests Ltd..

For the years before 1990 the mean LUC areas of the years 1990-1994 were used as LUCs into settlements.

7.6.3 Land-Use Definitions and Classification System Used and Their Correspondence to the LULUCF Categories

Based on the LULUCF definition of the settlement category the following classes of the CLC database nomenclature were included in this report:

- continuous and discontinuous urban fabric area
- industrial or commercial units
- road and rail networks and associated land
- port areas
- airports
- mineral extraction sites
- dump sites
- construction sites
- green urban areas
- sport and leisure facilities

7.6.4Methodological Issues

7.6.4.1Land Use Change to Settlements (5.E.2)

A)Biomass

For the calculation of the annual change in carbon stocks of living biomass of the IPCC land use categories converted to settlements the IPCC Tier 2 approach was used. The approach follows exactly the method in the other LUC categories. Country specific biomass data for grassland and annual plants of cropland were used. Based on expert judgment the biomass carbon stocks of annual plants in unsealed areas of settlements was estimated to be the same as the grassland biomass (4.29 t C/ha), corrected as per the relative share of the unsealed areas of settlements in Croatia. According to the CLC database the average share of unsealed areas in the settlements category was 4.5%. Carbon stocks of sealed areas were set to be zero.
The biomass carbon stock growth rates of perennial plants at unsealed settlement areas were not yet estimated due to missing data.

The average annual carbon stock in annual plants of cropland before the LUC was determined to be 5.7 t C/ha. The GPG default value of 63 t C/ha for perennial cropland was used to calculate the biomass carbon stock change in perennial cropland converted to settlements.
For the calculation of the annual change in carbon stocks of living biomass of forest land converted to settlements, specific harvest data for these deforestation areas delivered by the Croatian Forests Ltd were used.

B)Soil

The approach follows exactly the method in the other LUC categories. The calculation of emissions from soil carbon stock changes due to land use changes from other subcategories refer to a soil depth of 0-25 cm. Research on carbon stock in Croatian soils was done so that the skeleton and whole humus layers were included into the soil analysis. The calculation of the emissions from soils as a result of the conversion of other subcategories to settlements was made using national data for carbon stocks in the soils of the land use categories involved in the LUCs (forest land, annual and perennial cropland, grassland, settlement). The soil carbon stocks in unsealed areas of settlements were assessed by this soil survey to be on average 85.5 t C/ha, corrected as per the relative share of the unsealed areas of settlements in Croatia. By expert judgment the median value of the carbon stock was used, because it is less influenced by outliers (see Chapter 7.2.3.1). The used soil C stocks of the previous land uses are the same as represented in the other LUC chapters.

According to GPG the carbon stock change calculation in the litter pool was to be done including the whole humus layer. Consequently, in case of Croatia the carbon stock change in litter is included in the soil C stock change results because the soil C stock of forest land used for the estimates includes also the C stock of the litter layer.

7.6.4.1.1 Forest Land Converted to Settlements (5.E.2.1)

The area in conversion status from forest land to settlements for the time period of 20 years ranged from 9,290 kha to 13,565 kha.

Changes in Carbon Stocks in Biomass of Forest Land Converted to Settlements

Annual net emission rates due to loss of forest biomass and increase of biomass in the settlements area ranged from 26 to 136 GgCO_2 in the period 1990-2010.

Changes in Carbon Stocks in Soil and Dead Wood of Forest Land Converted to Settlements

The calculation of the emissions from soils as a result of the conversion of forest land to settlements was made by using national data for carbon stocks in soils in forest land (111.19 t C/ha) and carbon stocks in soils of settlements (85.53 t C/ha for the unsealed settlement area or 3.8 t C/ha for the total settlement area).

Annual net emission rates due to carbon stock changes in soil ranged from 156 to 272 GgCO_2 in the years 1990 to 2010.

The average annual carbon stock change in dead wood in forest land deforested in Croatia is included in the stemwood loss of deforestation areas and therefore included in the biomass results.

7.6.4.1.2 Cropland Converted to Settlements (5.E.2.2)

The area in conversion status from cropland to settlements for the time period of 20 years ranged from 6,634 kha to 15,356 kha in the years 1990-2010.

Changes in Carbon Stocks in Biomass of Cropland Converted to Settlements

Annual net emission rates due to loss of cropland biomass and increase of biomass in settlements area ranged from 23 to 0 GgCO_2 in annual cropland and 29 to 0 GgCO_2 in perennial cropland converted to settlements in the years 1990-2010.

Changes in Carbon Stocks in Soil of Cropland Converted to Settlements

The calculation of the emissions from soils as a result of the conversion of cropland to settlements was made by using national data for carbon stocks in soils in annual cropland (71.91 t C/ha) and perennial cropland (126.33 t C/ha), as well as carbon stocks in soils of settlements (85.53 t C/ha for the unsealed settlement area or 3.8 t C/ha for the total settlement area).

Annual net emission rates due to carbon stock changes in soil ranged from 72 to 173 GgCO_2 in annual cropland and 14 to 35 Gg CO_2 in perennial cropland converted to settlements in the years 1990-2010.

7.6.4.1.3 Grassland Converted to Settlements (5.E.2.3)

The area in conversion status from grassland to settlements for the time period of 20 years ranged from 3,735 kha to 15,356 kha.

Changes in Carbon Stocks in Biomass of Grassland Converted to Settlements

Annual net emission rates due to loss of grassland biomass and increase of biomass in settlements area ranged from 19 to 0 GgCO_2 during the period 1990-2010.

Changes in Carbon Stocks in Soil of Grassland Converted to Settlements

The calculation of emissions from soils as a result of conversion of grassland to settlements was made by using national data for carbon stocks in soils in grassland (108.49 t C/ha) and carbon stocks in soils of settlements (85.53 t C/ha for the unsealed settlement area or 3.8 t C/ha for the total settlement area).

Annual net emission rates due to carbon stock changes in soil ranged from 72 to 295 $GgCO_2$ in the years 1990-2010.

7.6.5 Uncertainty assessment

The Settlements category, has been included into the key category analysis (as completely examined) for the first time. Uncertainty of the activity data for CO2 emissions/removals from the category land converted to settlements was estimated to be 40%. Emission factor uncertainty was estimated to be 2%. The analysis using Tier 1 Level and Trend methods found total settlements as the key category. The uncertainty of this subcategory has to be reviewed and upgraded in a way that corresponds to the complete analysis of this land use category (see chapter 7.6.8).

7.6.6 QA/QC and Verification

The calculation of the data for category 5.E was included in overall QA/QC system of the Croatian GHG inventory.

7.6.7 Recalculations

This land use category as complete has been examined and interpreted for the first time in the Croatian Inventory. As a consequence, there are no recalculations.

7.6.8 Planned improvements

Uncertainty assessment model applied in Croatia does not include whole Settlements subcategory into the calculation. This needs to be adjusted. Consultations with various stakeholders have to be held in order to define uncertainty of this subcategory. See also Chapter 7.9

7.7 OTHER LAND 5.F

In this category only the total area of land was considered. There was no conversion from other land use categories to other land.

7.7.1Category Description

Table 7.7-1: Activity Data for Other Land, kha

Year	5 E Total Other land	5.E.1 Other land remaining other land	5.E.2 Land converted to Other land	5.E.2.1 Forest and converted to Other land	5.E.2.2 Cropland converted to Other land	5.E.2.3 Cropland converted to Other land	5.E.2.4 wetland converted to Other land	5.E.2.5 Settlement converted to Other land
1990	478	478	NO	NO	NO	NO	NO	NO
1991	491	491	NO	NO	NO	NO	NO	NO
1992	489	489	NO	NO	NO	NO	NO	NO
1993	488	488	NO	NO	NO	NO	NO	NO
1994	486	486	NO	NO	NO	NO	NO	NO
1995	485	485	NO	NO	NO	NO	NO	NO
1996	484	484	NO	NO	NO	NO	NO	NO
1997	459	459	NO	NO	NO	NO	NO	NO
1998	434	434	NO	NO	NO	NO	NO	NO
1999	402	402	NO	NO	NO	NO	NO	NO
2000	373	373	NO	NO	NO	NO	NO	NO
2001	352	352	NO	NO	NO	NO	NO	NO
2002	330	330	NO	NO	NO	NO	NO	NO
2003	308	308	NO	NO	NO	NO	NO	NO
2004	287	287	NO	NO	NO	NO	NO	NO
2005	265	265	NO	NO	NO	NO	NO	NO
2006	243	243	NO	NO	NO	NO	NO	NO
2007	245	245	NO	NO	NO	NO	NO	NO
2008	242	242	NO	NO	NO	NO	NO	NO
2009	240	240	NO	NO	NO	NO	NO	NO
2010	242	242	NO	NO	NO	NO	NO	NO

7.7.2Information on Approaches Used for Representing Land Areas and on Land-Use Databases Used for the Inventory Preparation

In order to present the category of other land area in Croatia data presented in CLC the database (years 1980, 1990, 2000 and 2006) were examined.

According to the definition of CLC classes, the following areas were included into this land use category:

- Beaches, dunes, sands

- Bare rocks
- Sparsely vegetated areas
- Burnt areas

According to CLC the total other land category ranged between 79 and 71 kha in the period 1990-2010, which does not match the available area of the total area of Croatia. The difference between the CLC other land area and available area under the total area ranged between 168 and 413 kha in the reporting period.
This is why the total area of other land is reported according to the IPCC GPG 2003 as the difference between the area of all land use categories except other land and the total area of Croatia, which ranges between 240.11 and 491.19 kha.
Table 7.7-1 presents calculated other-land areas. As can be seen, there are annual decreases of the area of other land. These areas are assumed to change completely to Forest land due to the unfavourable conditions of other land for other land uses.

The other land category has been included into the key category analysis for the first time. The analysis using Tier 1 and Tier 2 Level and Trend methods excluded other land as a key category. The uncertainty of this subcategory has not been defined.

The calculation of data for category 5.F was included in the overall QA/QC system of the Croatian GHG inventory.

This land use category has been examined and interpreted for the first time in the Croatian Inventory. As a consequence, there are no recalculations.

The uncertainty assessment model applied in Croatia does not include the other land category into the calculation. This needs to be adjusted. Consultations with various stakeholders have to be held in order to define the uncertainty of this subcategory (see also Chapter 7.9).

7.8 QA/QC VERIFICATION

The input data, estimates and results were checked as follows.

1) Bottom-up check

1.1. Input data

- Check for the plausibility of the activity data and their trend
- Check for plausibility of the emission factors as well as the related input data and their trends

- Check of input data for completeness

1.2. Estimations

- Check of the correctness of all equations in the estimate files
- Check of the correctness of all interim results
- Check of the plausibility of the results and their trends
- Check of the correctness of all data and results transfer

2) Top-down check

During the preparation of inventory, experts from all relevant fields were included. All input data were checked by the experts. The definitions, factors and methods applied in the report were agreed with the experts in relevant fields, ensuring in that way consistency and completeness of input data. The final calculated data were sent to the experts for their approval. The used activity data and emission factors were also compared with the data from other data sources (e.g. from literature, results in NIRs of other comparable regions, IPCC default values).

7.9 CATEGORY SPECIFIC PLANNED IMPROVEMENTS

By taking into consideration the relevance of the removals from the LULUCF sector in the implementation of UNFCCC and the Kyoto Protocol commitments, the following actions (Table 7.9-1) are found worth of examining in order to improve the Croatian future reporting:

Table 7.9-1 – Planned improvements for LULUCF sector

GHG source & sink category	Planned improvements
	Introduction of the data disaggregation according to the main species of deciduous and coniferous forests
	Investigation on conducted scientific researches regarding wood densities and use of country specific values for main forests species
	Further stratification (e.g. on species level) in order to improve the overall calculation and to be able to apply more country-specific BEFs
	Increment in maquis and shrub forests needs to be estimated/identified in order to attain the dataset required for emission/removal calculation since this vegetation is also within the Kyoto forest definition
	Improvement of data quality regarding the increment in private

5 A	forests
	Improvement of data quality regarding the increment in state forests managed by other legal persons
	Improvement of data quality regarding the fellings in state forests managed by other legal persons
	Attaining required data on forest fires separately for the *Forest land remaining forest land* and *Land converted to forest land* with the purpose of improving the reporting of CO_2 and the non-CO_2 emissions
	Investigation on land use changes from Other land category to forest land
	Improvement in data collection regarding volume harvested on deforested areas is needed
5 B	Data on liming application need to be collected. One of the possibilities is through involvement of at least one office of the Public Agricultural Extension services and field monitoring;
	Organic soils area was determined based on expert judgement; At least a further investigation of scientific researches on the subject needs to be conducted to improve the estimates
5 C	Organic soils area was determined based on the expert judgement; At least a further investigation of scientific researches on the subject needs to be conducted to improve the estimates
5 E	Settlement area is corrected by the expert judgement. Investigation on the issue needs to be conducted Carbon stock in perennial biomass in unsealed settlement area needs to be estimated. A possible source of information is a study conducted by the City of Zagreb
5A – 5F	Review of the whole LULUCF sector in Uncertainty estimates. Consultations with experts in each land use category need to be conducted
	Comparison of used country-specific soil carbon content data with the data derived from similar Croatian scientific investigations needs to be conducted (i.e. data presented in the Basic Geological Map of the Republic of Croatia)

8.WASTE (CRF sector 6)

8.1. OVERVIEW OF SECTOR

Waste management activities, such as disposal and treatment of municipal solid waste and wastewaters handling as well as waste incineration, can produce emissions of greenhouse gases (GHGs) including methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O).

CH_4 emissions as a result of disposal and treatment of municipal solid waste, CH_4 emissions from treatment of industrial wastewater and disposal of domestic and commercial wastewater in septic tanks, indirect N_2O emissions from human sewage and CO_2 emissions resulting from incineration of waste (without energy recovery) are included in emissions estimates in this sector.

The methodology used to estimate emissions from waste management activities requires country-specific knowledge on waste generation, composition and management practice. The fact that waste management activities in Croatia are not organized and implemented completely results in the lack and inconsistency of data. Therefore, effort was done in order to evaluate and compile data coming from different sources and adjust them to recommended Intergovernmental Panel on Climate Change (IPCC) methodology which is used for GHGs emissions estimation.

Implementation and establishment of the integral waste management system in Croatia are ensured by applying and fulfilling the objectives defined by the Waste Act[16], Strategy[17] and Plan[18]. Management of the different types of waste is arranged by the Strategy and Plan, which are harmonised by objectives of the hierarchical concept of waste management. Three phases of the hierarchical concept, avoiding/reduction - reuse/recovery - disposal, are ordered according to importance. Avoiding and reducing of waste generation has the highest priority and results in reduction of quantity and adversity of produced waste which enters into the next phase. Reuse/recovery of produced waste has the purpose to use material and energy potentials of waste, in the framework of technical, ecological and economic possibilities. Disposal of remaining inert waste at the managed controlled landfills has the lowest rank in the waste management hierarchy. According to the Plan, waste management system in Croatia will be organized as integral unit of all subjects at the national, regional and local level by predicted establishment of regional and counties' waste management centres.

Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official Gazette No. 1/07) prescribes obligation and procedure for emissions monitoring, which comprise estimation and/or reporting of all anthropogenic emissions and removals. According to requirement, sources of abovementioned greenhouse gases should report required activity data for more accurate emissions estimation. Whereas, some

[16] Waste Act (OG 178/04, 111/06, 60/08, 87/09)

[17] Waste Management Strategy of the Republic of Croatia (OG 130/05)

[18] Waste Management Plan of the Republic of Croatia for 2007 - 2015 (OG 85/07, 126/10, 31/11)

of data (e.g. sludge) are not available in sufficient form. Submitted data show that aerobic processes are used for sludge treatment, which mean that no methane emission.

The total annual emissions of GHGs, expressed in Gg CO_2-eq, from waste management in the period 1990-2010 are presented in the Figure 8.1-1.

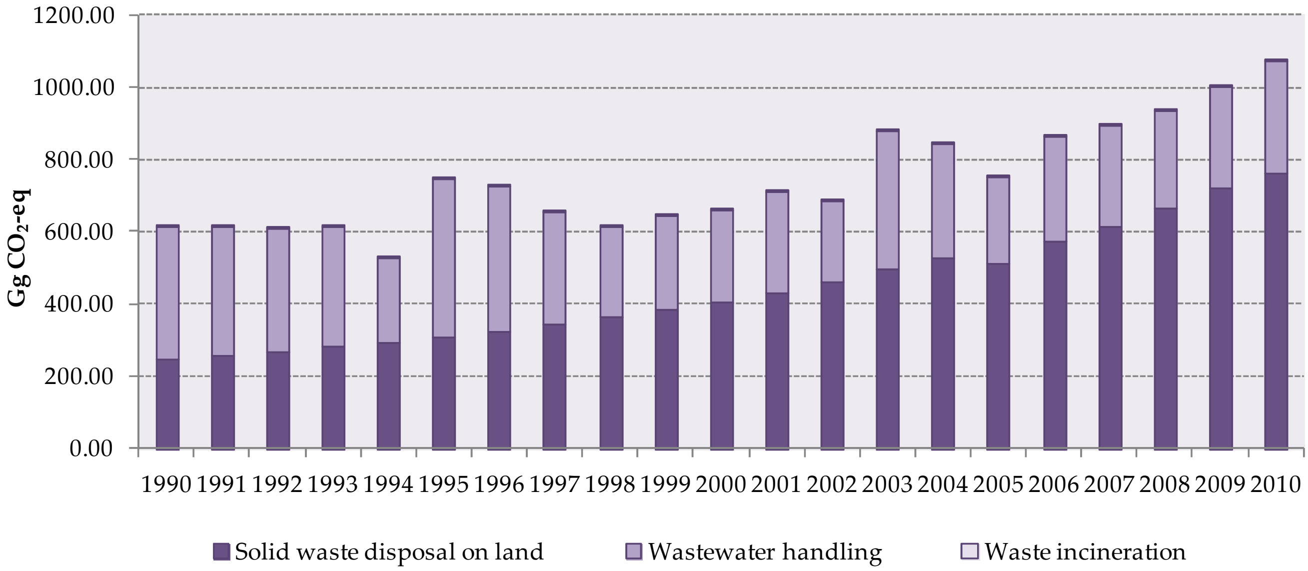


Figure 8.1-1: Emissions of GHGs from Waste (1990-2010)

In Waste sector, two source categories represent key source category regardless of LULUCF (detailed in Table 8.1-1):

Table 8.1-1: Key categories in Waste sector based on the level and trend assessment in 2010[19]

IPCC Source Categories	Direct GHG	Criteria for Identification			
		Level		Trend	
		excl. LULUCF	incl. LULUCF	excl. LULUCF	incl. LULUCF
WASTE					
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	L1e,L2e	L1i,L2i	T1e,T2e	T1i,T2i
CH_4 Emissions from Waste Water Handling	CH_4	L1e,L2e	L1i		

L1e - Level excluding LULUCF Tier1
L1i - Level including LULUCF Tier1
T1e - Trend excluding LULUCF Tier 1
T1i - Trend including LULUCF Tier 1
L2e - Level excluding LULUCF Tier 2
L2i - Level including LULUCF Tier 2
T2e - Trend excluding LULUCF Tier 2
T2i - Trend including LULUCF Tier 2

[19] Data on key categories are taken from Annex 1 Key categories (Tier 1 and Tier 2)

8.2. SOLID WASTE DISPOSAL ON LAND (CRF 6.A.)

8.2.1. SOURCE CATEGORY DESCRIPTION

Landfill gas consists of approximately 50 percent CO_2 and 50 percent CH_4 by volume. Anaerobic decomposition of organic matter in Solid Waste Disposal Sites (SWDSs) results in the release of CH_4 to the atmosphere. The composition of waste is one of the main factors influencing the amount and the extent of CH_4 production within SWDSs. Temperature, moisture content and pH are important physical factors influencing fermentation of degradable organic substances and gas production.

8.2.2. METHODOLOGICAL ISSUES

A method used to calculate CH_4 emissions according to *Revised 1996 IPCC Guidelines* is First Order Decay (FOD) method. The quantity of CH_4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste. DOC was estimated by using country-specific data on waste composition and quantities based on compiled data from Potočnik, V. (2000), *Report: The basis for methane emissions estimation in Croatia 1990-1998, B. Data on Municipal Solid Waste in Croatia 1990-1998*.

Country-specific composition of waste is presented in the Table 8.2-1.

Table 8.2-1: Country-specific composition of waste

Waste stream	Percent in the MSW	Percent DOC
Paper and textiles	21 - 22	40
Garden and park waste	18 - 19	17
Food waste	23 - 24	15
Wood and straw waste	3	30

The country-specific fraction of DOC in municipal solid waste (MSW), according to data from Table 8.2-1, was estimated to be 0.17 in the period 1990-2004 and 0.16 in the period 2005-2010. The decomposition of DOC does not occur completely and some of the potentially degradable materials always remain in the site over a long period of time. According to *Good Practice Guidance* approximately 50-60 percent of total DOC actually degrades[20] and converts to landfill gas. A mean value, i.e. 55 percent, was taken into account for the purpose of CH_4 emissions estimation from SWDSs.

[20] The *Revised 1996 IPCC Guidelines* provide a default value of 77 percent for DOC that is converted to landfill gas, but this value, according to review of recent literature, is too high.

The methodology provides a classification of SWDSs into "managed" and "unmanaged" sites through knowledge of site activities carried out. Unmanaged sites are further divided as deep ($\geq$5m depth) or shallow (<5m depth). The classification is used to apply a methane correction factor (MCF) to account for the methane generation potential of the site.

Quality and composition of disposed MSW and the main characteristic of SWDSs in Croatia have been evaluated for the entire time series.

Historical data for the total amount of generated waste and disposed MSW for the period 1955-1990 have been estimated based on national rate for waste generation and fraction of MSW disposed at different types of SWDSs. Data have been assessed for the following years: 1955 (0.34 kg/capita/day), 1960 (0.39 kg/capita/day), 1970 (0.46 kg/capita/day), 1980 (0.55 kg/capita/day). Interpolation method has been used to obtain insufficient data.

Total annual MSW disposed to SWDSs for the period 1990-1998 has been evaluated from available relevant data compiled into Report; Fundurulja, D., Mužinić, M. (2000) *Estimation of the Quantities of Municipal Solid Waste in the Republic of Croatia in the period 1990 – 1998 and 1998 – 2010*, Zagreb. Data for the quantity of disposed MSW in 1999 were evaluated by interpolation method. Data for the quantity of disposed MSW in 2000 were obtained from *Report of Environment Condition*, Ministry of Environmental and Nature Protection. Data for the quantity of disposed MSW in 2005 were obtained from *Waste Management Plan in the Republic of Croatia (2007-2015*). Taking into account the pattern over 2000 and 2005 (total quantity of disposed MSW), quantity of MSW disposed to different types of SWDSs and the main characteristic of SWDSs for the period 2001 to 2004 were assessed by interpolation method. Data for the quantity of disposed MSW in the period 2006-2010 were obtained from *Cadastre of Waste - Municipal Solid Waste,* as a part of Environmental Pollution Register/Waste[21].

Information on CH_4 that is recovered and burned in a flare or energy recovery device in the period 2005-2010 has been estimated by official document provided by ZGOS Ltd. and Environmental Pollution Register (ROO) provided by Croatian Environment Agency (2.48 Gg CH_4 has been recovered in 2005, 1.61 Gg CH_4 in 2006, 1.99 Gg CH_4 in 2007, 2.19 Gg CH_4 in 2008, 2.15 Gg CH_4 in 2009 and 2.47 Gg CH_4 in 2010).

The most of managed SWDSs are not covered with aerated material and because of that default value for oxidation factor (OX), which equals zero, has been used.

The total annual MSW disposed to different types of SWDSs in the period 1990-2010 and related MCF are reported in the Table 8.2-2.

[21] Environmental Pollution Register (ROO) is group of data on sources, type, quantities, methods and places of pollutants and waste exhaust, transfer and disposal into environment (Croatian Environment Agency, www.azo.hr)

Table 8.2-2: Total annual MSW disposed to SWDSs and related MCF (1990-2010)

Year	Managed SWDS (Gg)	Unmanaged SWDS (≥5m) (Gg)	Unmanaged SWDS (<5m) (Gg)	MCF (fraction)
1990	18	277	295	0.606
1991	19	280	300	0.606
1992	20	284	309	0.605
1993	22	297	324	0.606
1994	26	322	329	0.613
1995	31	364	342	0.623
1996	35	392	361	0.625
1997	40	433	375	0.632
1998	45	470	398	0.636
1999*	54	538	383	0.654
2000	60	618	260	0.702
2001*	131	627	250	0.727
2002*	202	635	240	0.748
2003*	273	644	230	0.767
2004*	344	652	220	0.784
2005	415	661	210	0.799
2006	528	720	200	0.818
2007	660	760	190	0.835
2008	825	763	143	0.862
2009	1031	553	107	0.897
2010	1289	214	80	0.882

* data on the annual MSW disposed to different types of SWDSs were obtained by interpolation method

Although increasing of municipal solid waste amounts as a result of the growth in the living standard, this rise has slightly declined due to effects of measures undertaken to avoid/reduce and recycle waste. Priority is given according avoiding and reducing waste generation and reducing its hazardous properties. If waste generation can neither be avoided nor reduced, waste must be re-used-recycled and/or recovered; reasonably unusable waste must be permanently deposited in an environmentally friendly way. These objectives, defined by Strategy and Plan, include the assumed time-lags with respect to relevant EU legislation[22]. CH_4 that is recovered and burned in a flare or energy recovery device in the period 2005-2010 have been included in emission estimation and subtracted from generated CH_4.

The resulting annual emissions of CH_4 from land disposal of MSW in the period 1990-2010 are presented in the Figure 8.2-1.

[22] Council Directive 1999/31/EC

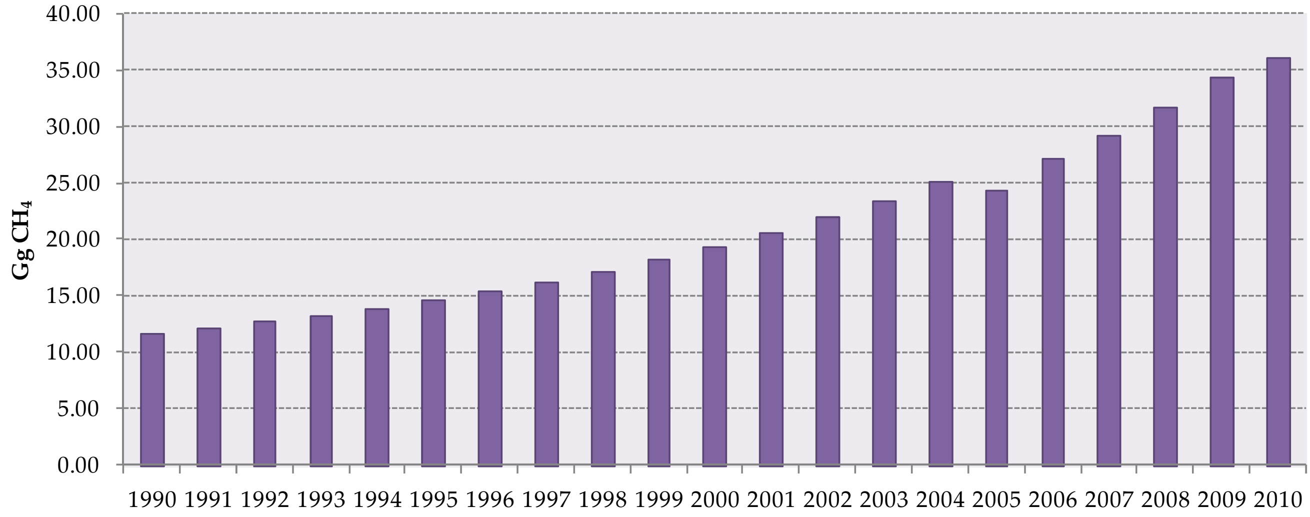


Figure 8.2-1: Emissions of CH_4 from Solid Waste Disposal on Land (1990-2010)

8.2.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainties contained in CH_4 emissions estimates are related primarily to assessment of historical data for quantity of MSW disposed to different types of SWDSs and the main characteristic of SWDSs as well as the usage of default IPCC methane generation rate constant (k=0.05).

In addition, SWDSs in Croatia are classified into several categories, according to applied waste management activities, legality, volume (capacity and quantity of disposed MSW) as well as status. "Official" SWDSs do not necessarily fall under managed SWDSs category as defined by IPCC (site management activities carried out in "Official" SWDSs in some cases do not meet requirements to be characterized as managed). "Unofficial" SWDSs can be described as locations where all sorts of waste are dumped uncontrollably without any site management activities carried out. In order to adjust country-specific to IPCC SWDSs classification it was proposed that "Unofficial" SWDSs fall under unmanaged shallow and deep IPCC categories, whereas "Official" SWDSs fall under all three IPCC categories depending on management activities and dimensions of waste disposal sites. It is obvious that this distribution represents additional uncertainty in the estimation of country-specific MCF.

Another uncertainty is related to estimation of degradable organic carbon (DOC) in MSW. There were several sorting of waste in Croatia, and in consequence of that these results were compared and adjust to relevant data in similar countries.

Activity data and emission factor uncertainty was calculated in detail using Monte-Carlo analysis. Uncertainty estimate associated with activity data amounts 50 percent, based on expert judgements. Uncertainty estimate

associated with emission factor amounts 50 percent, according to the provided uncertainty assessment in *Good Practice Guidance* (detailed in Annex 5, Tables A5-1, A5-2).
Emissions from Solid waste Disposal on Land have been calculated using the same method for every year in the time series. Different source of information were used for data sets.

8.2.4. SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

After preparation of final draft of this chapter an audit was carried out to check selected activities from Tier 1 General inventory level QC procedures and Tier 2 source-specific QC procedures. Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories. Solid waste disposal on land represent key source category in Waste sector. CH_4 emissions from solid waste disposal on land were estimated using Tier 2 method which is a *good practice.* The uncertainty of activity data is very high due to high discrepancy between various data sources. Basic country-specific activity data for CH_4 emission calculation were compared with data set from similar countries. Results of this comparison showed that there is no significant difference between these two sets of data.

8.2.5. SOURCE SPECIFIC RECALCULATIONS

In this report, new data on total annual MSW disposed to SDWSs for 2009 was provided. Thereupon, CH_4 emissions and related MCF have been recalculated for 2009.

8.2.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

8.2.6.1. Activity data improvement

The base for systematic gathering and saving activity data was created by establishment of the Cadastre of Waste. This presents part of new software - Environmental Pollution Register, ROO. Environmental Pollution Register/Waste contains data on produced, collected and processed waste against different types of waste. Data on municipal, non-hazardous and hazardous waste are collected by State Administration Offices in counties and City of Zagreb Office. Data collected at the counties' level are integrated at the Croatian Environment Agency. Consequently, more accurate data for CH_4 emission calculations should be available. Although, data for the quantity of generated and disposed MSW in the period 2006-2010, which were obtained by ROO, are not complete fully, because a lot of SWDSs is not supplied with required equipment.

For the purposes of improvement activity data gathering from solid waste disposal activities it is necessary to improve quality of existing data:

- equipping the major landfills with automatic weigh-bridges in order to accurately estimate the quantities of delivered MSW;
- providing methodology to determine country-specific MSW composition;
- periodic analysis of waste composition at major landfills according to provided methodology;
- modification of Environmental Pollution Register, ROO Reporting Forms regarding to MSW with additional information on waste quantities and composition.

8.2.6.2.Emission factor and methodology improvement

For the purposes of emission inventory improvement it is necessary to adjust country-specific to IPCC SWDSs classification, in order to accurately estimate the MCF. Due to lack of adequate information, interpolation/extrapolation method has been applied for estimation of waste and landfills characteristics over a long period of time. It is necessary to improve the quality of existing data and to reconstruct historical data. It is also necessary to apply a unique methodology to determinate waste quantity and composition.

8.3. WASTEWATER HANDLING (CRF 6.B.)

8.3.1. SOURCE CATEGORY DESCRIPTION

Aerobic biological process is used mostly in wastewater treatment. Disposal of domestic and commercial wastewater, particularly in rural areas where systems such as septic tanks are used, are partly anaerobic without flaring, which results with CH_4 emissions. Anaerobic process is applied in some industrial wastewater treatment. Data for 4 industries with the largest potential for wastewater methane emissions (Manufacture of food products and beverages, Manufacture of textiles, Manufacture of pulp, paper and paper products and Manufacture of chemicals and chemical products) were considered.

CH_4 emissions from treatment of industrial, domestic and commercial wastewater and indirect N_2O emissions from human sewage are included in emission estimates for the period 1990-2010.

Data on sludge treatment are not available in sufficient form. Submitted data show that aerobic processes are used for sludge treatment, which mean that no methane emission.

8.3.2. METHODOLOGICAL ISSUES

8.3.2.1. Domestic and commercial wastewater

Methane emissions from domestic and commercial wastewater (disposal particularly in rural areas where systems such as septic tanks are used) have been calculated using the methodology proposed by *Revised 1996 IPCC Guidelines,* by multiplying the total domestic organic wastewater in kg BOD/yr and emission factor which was obtained using default value for maximum methane producing capacity (0.25 kg CH_4/kg BOD).

Data for population with individual system of drainage and data for calculation of degradable organic component in kg BOD/1000 person/yr have been obtained by state company Croatian Water (Hrvatske vode) for 1990, 1995, 2000 and for the period 2003-2010. Insufficient data have been assessed by interpolation method. Data for CH_4 emission calculation for the period 1990-2010 are presented in the Table 8.3.1.
There are no available data on sludge in required form.

Table 8.3-1: Data for CH_4 emission calculation from Domestic and Commercial Wastewater (1990-2010)

Year	DOC (kg BOD/1000persons/yr)	Population*
1990	21,899.86	2,866,000
1991	21,899.55	2,842,800
1992	21,899.58	2,819,600
1993	21,899.60	2,796,400
1994	21,899.63	2,773,200

Table 8.3-1: Data for CH_4 emission calculation from Domestic and Commercial Wastewater (1990-2010), cont.

Year	DOC (kg BOD/1000persons/yr)	Population*
1995	21,900.00	2,750,000
1996	21,900.00	2,732,000
1997	21,900.00	2,714,000
1998	21,900.00	2,696,000
1999	21,900.00	2,678,000
2000	21,900.00	2,660,000
2001	21,899.65	2,630,333
2002	21,899.70	2,601,666
2003	21,900.16	2,574,000
2004	21,900.00	2,560,000
2005	21,900.01	2,541,460
2006	21,900.17	2,525,460
2007	21,899.89	2,514,488
2008	21,900.13	2,478,889
2009	21,900.13	2,459,300
2010	21,983.27	2,450,000

* data for population with individual system of drainage

The resulting annual emissions of CH_4 from Domestic and Commercial Wastewater in the period 1990-2010 are presented in the Figure 8.3-1.

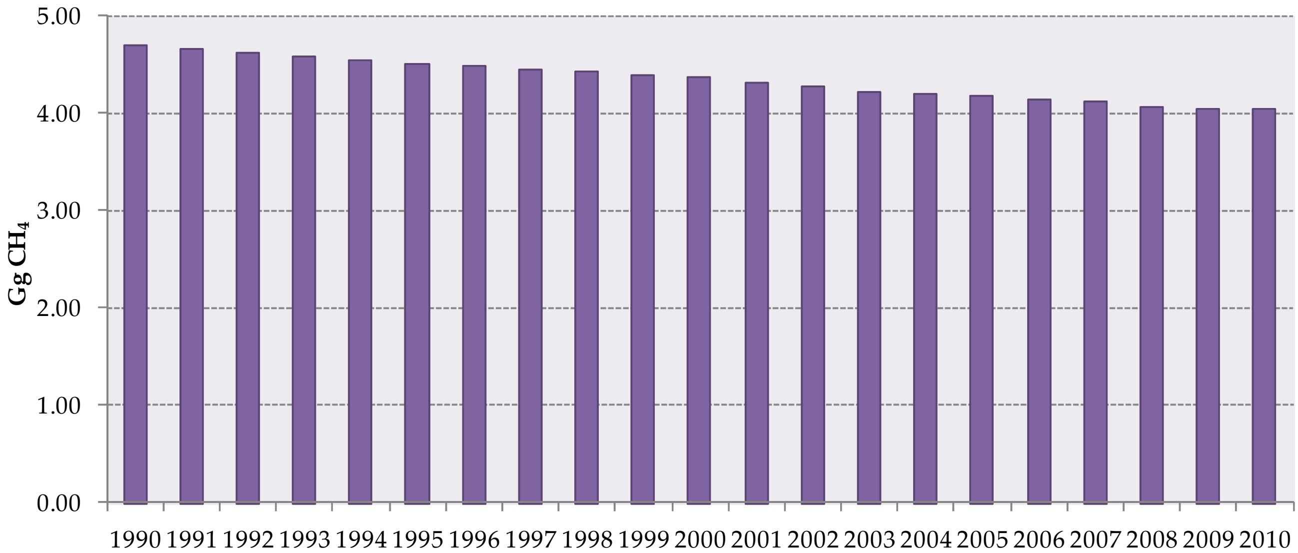


Figure 8.3-1: Emissions of CH_4 from Domestic and Commercial Wastewater (1990-2010)

8.3.2.2. Industrial wastewater

Methane emissions from industrial wastewater have been calculated using the methodology proposed by *Revised 1996 IPCC Guidelines,* by multiplying the total industrial output with degradable organic component (kg COD/m^3 wastewater), wastewater produced (m^3/tonnes of product) and fraction of DOC removed as sludge. This value represents total organic wastewater from industrial source (kg COD/yr). Default values for fraction of wastewater treated, methane conversion factor (MCF), maximum methane producing capacity (kg CH_4/kg COD) and EF (which equals 0.001425 kg CH_4/kg COD) have been used for methane emissions calculation.

Data for 4 industries with the largest potential for wastewater methane emissions (Manufacture of food products and beverages, Manufacture of textiles, Manufacture of pulp, paper and paper products and Manufacture of chemicals and chemical products) were taken from Statistical Yearbooks. Data for 1997 are insufficient and assessed by interpolation. Data for the period 1990-1993 are available in different (aggregated) form. These data also assessed by extrapolation to enable usage of same methodology during the time series. The other parameters required for the calculation were taken from the IPCC good practice guidance. Expert judgement has been used for assessment of MCF (comparison with the other countries were performed).
There are no available data on sludge in required form.

Data for CH_4 emission calculation for the period 1990-2010 are presented in the Table 8.3.2.

Table 8.3-2: Data for CH_4 emission calculation from Industrial Wastewater (1990-2010)

Year	Total industrial output (000 m^3)				Total organic wastewater (Gg COD/yr)
	Manufacture of food products and beverages	Manufacture of textiles	Manufacture of pulp, paper and paper products	Manufacture of chemicals and chemical prod.	
1990	7,237	1,502	3,208	2,875	6,010.94
1991	7,128	1,393	3,079	2,883	5,800.55
1992	7,018	1,284	2,951	2,891	5,590.15
1993	6,909	1,175	2,822	2,899	5,379.76
1994	5,911	1,213	679	2,115	2,030.79
1995	6,157	1,234	5,224	1,806	8,616.35
1996	5,274	967	3,817	6,896	7,482.78
1997	6,471	738	2,309	2,930	4,538.19
1998	9,348	25	1,130	1,571	2,643.92
1999	9,759	350	1,065	2,371	2,790.01
2000	4,914	393	1,169	2,189	2,560.97
2001	4,715	316	1,808	1,577	3,343.29
2002	5,630	44	132	3,619	1,334.26
2003	5,037	41	3,695	4,936	6,750.44
2004	4,767	151	2,213	3,519	4,302.35
2005	6,440	83	681	1,864	1,846.63
2006	5,045	40	1,692	3,375	3,516.73
2007	4,941	46	1,646	1,624	3,091.11

Table 8.3-2: Data for CH_4 emission calculation from Industrial Wastewater (1990-2010), cont.

Year	Total industrial output (000 m^3)				Total organic wastewater (Gg COD/yr)
	Manufacture of food products and beverages	Manufacture of textiles	Manufacture of pulp, paper and paper products	Manufacture of chemicals and chemical prod.	
2008	2,570	63	1,574	1,007	2,693.10
2009	2,553	70	1,766	1,332	3,038.22
2010	3,086	52	2,508	1,437	4,176.96

The resulting annual emissions of CH_4 from Industrial Wastewater in the period 1990-2010 are presented in the Figure 8.3-2.

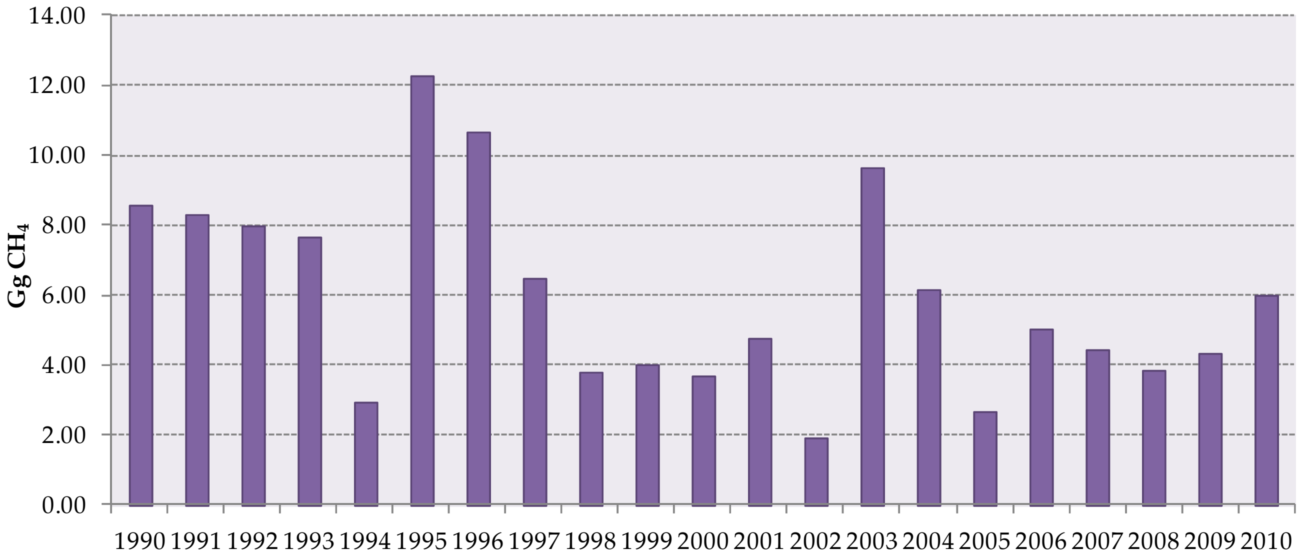


Figure 8.3-2: Emissions of CH_4 from Industrial Wastewater (1990-2010)

8.3.2.3. Human sewage

Indirect nitrous oxide (N_2O) emissions from human sewage have been calculated using the methodology proposed by *Revised 1996 IPCC Guidelines*, by multiplying annual per capita protein intake, fraction of nitrogen in protein, number of people in country and default emission factor which equals 0.01 kg N_2O-N/kg sewage N produced. The population estimate of the Republic of Croatia for the period 1990-2010 were taken from Statistical Yearbook. Croatian data on the annual per capita Protein intake value (PIV), for the period 1992-2007, were obtained by the FAOSTAT Statistical Database. Extrapolation method has been used for calculation of insufficient data. Taking into account the PIV trend, the pattern over three years from 1992 to 1994 has been used for calculation of data in 1990 and 1991. Data on 2006 and 2007 have been used as the pattern for calculation of insufficient data for the period 2008 -2010. Data for N_2O emission calculation from Human Sewage for the period 1990-2010 are presented in the Table 8.3.3.

Table 8.3-3: Data for N_2O emission calculation from Human Sewage (1990-2010)

Year	Protein intake (kg/person/yr)	Population
1990	24.23	4,778,000
1991	23.96	4,513,000
1992	22.48	4,470,000
1993	21.46	4,641,000
1994	21.94	4,649,000
1995	23.54	4,669,000
1996	23.18	4,494,000
1997	22.89	4,572,000
1998	22.70	4,501,000
1999	24.05	4,554,000
2000	24.09	4,426,000
2001	25.81	4,440,000
2002	27.41	4,440,000
2003	27.56	4,440,000
2004	27.48	4,439,000
2005	27.70	4,442,000
2006	29.02	4,440,000
2007	29.24	4,436,000
2008	29.45	4,434,000
2009	29.67	4,429,000
2010	29.89	4,418,000

The resulting annual emissions of N_2O from Human Sewage in the period 1990-2010 are presented in the Figure 8.3-3.

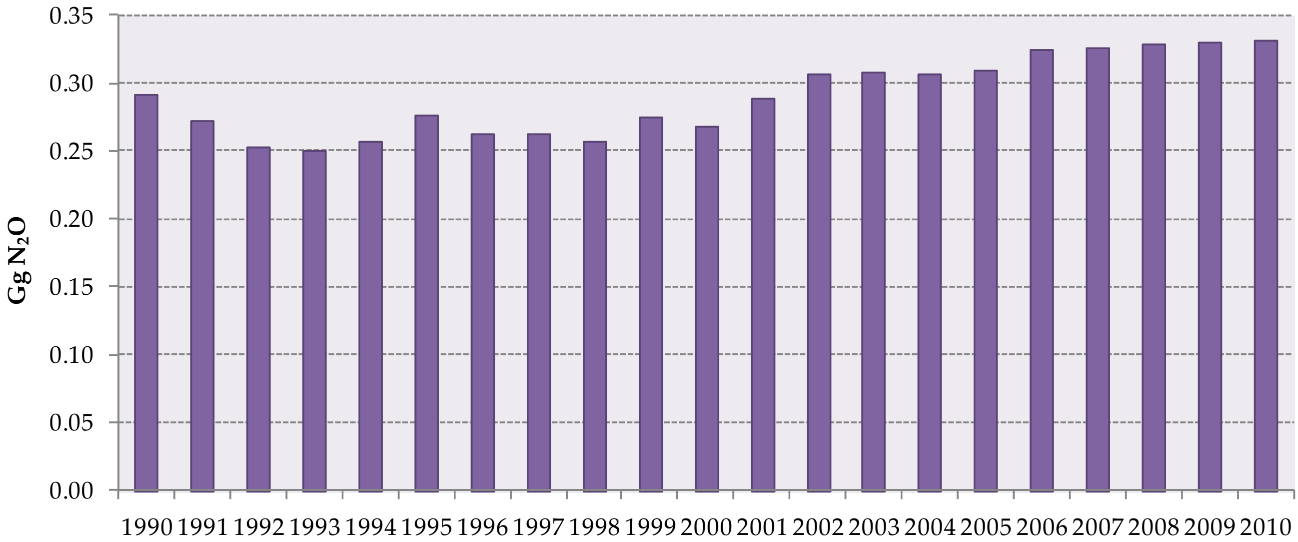


Figure 8.3-3: Emissions of N_2O from Human Sewage (1990-2010)

8.3.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainties contained in CH_4 emissions estimates are related primarily to applied default emission factor and assessed values for degradable organic component. Data have been assessed based on information from different sources and consequently have high uncertainty. Also, insufficient data have been assessed by interpolation, which represents additional uncertainty in the estimations.
The uncertainties contained in N_2O emissions estimates are related primarily to applied default emission factor and extrapolated values for protein intake.

Activity data and emission factor uncertainty for CH_4 emission from Industrial Wastewater and Domestic and Commercial Wastewater was calculated in detail using Monte-Carlo analysis.
Uncertainty estimate associated with activity data for CH_4 and N_2O emission calculation amounts 50 percent, based on expert judgements. Uncertainty estimate associated with CH_4 and N_2O emission factor amounts 30 percent, accordingly to provided uncertainty assessment in *Good Practice Guidance* (detailed in Annex 5, Tables A5-1, A5-2).

Emissions from Industrial Wastewater, Domestic and Commercial Wastewater and Human Sewage have been calculated using the same method for every year in the time series. Different source of information were used for data sets.

8.3.4. SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

After preparation of final draft of this chapter an audit was carried out to check selected activities from Tier 1 General inventory level QC procedures and Tier 2 source-specific QC procedures. Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories. Wastewater handling represent key source category (Trend assessment) in Waste sector. CH_4 emissions from wastewater handling estimated using Tier 1 method. The uncertainty is very high due to assessment of insufficient data and applied default emission factors. Investigation will be performed with a view to collect more accurate data.

8.3.5. SOURCE SPECIFIC RECALCULATIONS

There are no source-specific recalculations in this report.

8.3.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Improvements in the sub-sector Disposal of Domestic and Commercial Wastewater are related primarily to establishment of effectively *Water Information System* with base for systematic gathering and saving data needed for monitoring and planning of development of all wastewater handling systems.

In order to improve completeness of inventory, sufficient data for sludge treatment should be collected during survey of all relevant institutions and companies owing for gathering of data on sludge.

8.4. WASTE INCINERATION (CRF 6.C.)

8.4.1. SOURCE CATEGORY DESCRIPTION

Incineration of waste produces emissions of CO_2, CH_4 and N_2O. According to *Revised 1996 IPCC Guidelines* only CO_2 emissions resulting from incineration of carbon in waste of fossil origin (e.g. plastics, textiles, rubber, liquid solvents and waste oil) without energy recovery, should be included in emissions estimates from Waste sector. Emissions from incineration with energy recovery should be reported in the Energy sector.

CO_2 emissions from incineration of clinical waste are included in emission estimates for the period 1990-2010. CO_2 emissions from incineration of hazardous waste have not been estimated for entire period because data for categorisation of waste types is lacking. An incinerator of hazardous waste was functioning in Croatia between 1998 and 2002. By means of more detailed collected data in the framework of Environmental Pollution Register (ROO), data for CO_2 emission calculation from incineration of hazardous waste and plastics are used for the period 2007-2010.

8.4.2. METHODOLOGICAL ISSUES

CO_2 emissions from incineration of waste have been calculated using the methodology proposed by *Revised 1996 IPCC Guidelines*, by multiplying the total incinerated waste with default values for fraction of carbon content, fraction of fossil carbon and burn out efficiency of combustion.

Data for quantity of incinerated hospital waste for the period 2004-2010 were obtained by Croatian Environment Agency. Data are accepted from Environmental Pollution Register (ROO) Reporting Forms. Insufficient data for the period 1990-2003 have been assessed using population data as reference. Data on incineration of hazardous waste and plastics for the period 2007-2010 have been provided by Croatian Environment Agency that collects data from emission point sources in the Environmental Pollution Register (ROO). Insufficient data for 2009 have been assessed according to data for 2008.
Data for CO_2 emission calculation for the period 1990-2010 are presented in the Table 8.3.4.

Table 8.3-4: Incinerated waste (1990-2010)

Year	Incinerated waste (tonnes)
1990	51.70
1991	48.83
1992	48.37
1993	50.22
1994	50.31
1995	50.52
1996	48.63
1997	49.47

Table 8.3-4: Incinerated waste (1990-2009), cont.

Year	Incinerated waste (tonnes)
1998	48.71
1999	49.28
2000	47.41
2001	48.01
2002	48.08
2003	48.07
2004	49.20
2005	40.23
2006	48.05
2007	54.75
2008	238.50
2009	91.05
2010	87.00

Quantities of incinerated waste without energy recovery were not increased significantly in 2007, but CO_2 emission increased. The reason is accessibility of more detailed data on types of incinerated waste. CO_2 emissions from incineration of hazardous waste for the period 1990-2006 have not been estimated because data for categorisation of waste types is lacking.

Quantities of incinerated waste without energy recovery were increased significantly in 2008. The latter is due to large quantity of hospital waste which was incinerated without energy recovery in 2008. In the previous period, as well as in 2009 and 2010, hospital waste was incinerated with energy recovery.

The resulting annual emissions of CO_2 from Waste Incineration in the period 1990-2010 are presented in the Figure 8.3-4.

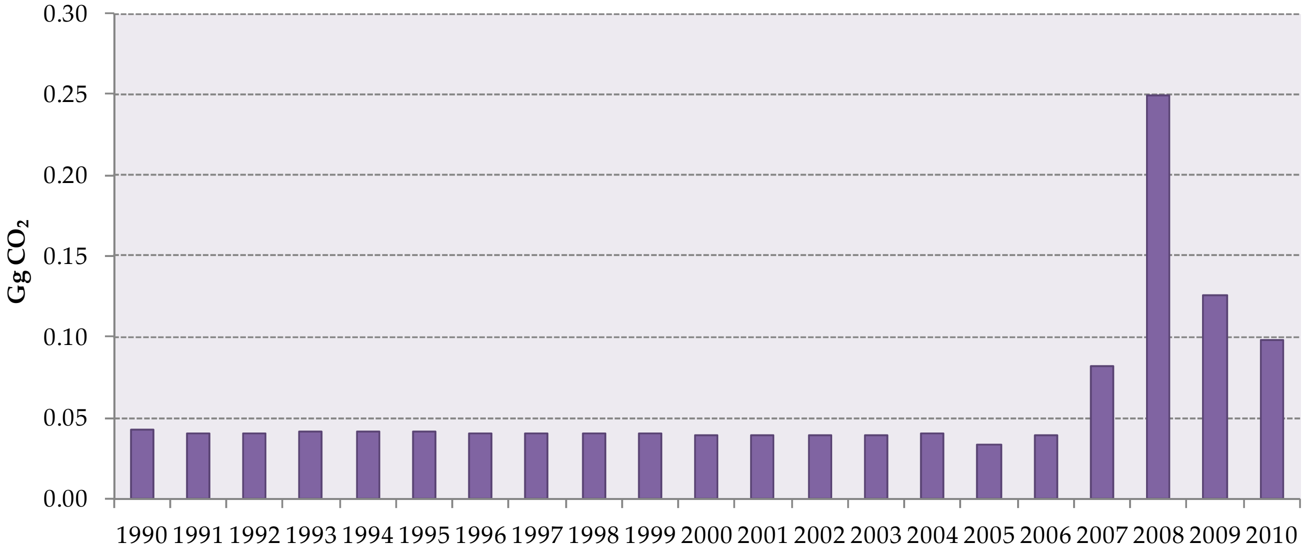


Figure 8.3-4: Emissions of CO_2 from Waste Incineration (1990-2010)

8.4.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainties contained in CO_2 emissions estimates from incineration of waste are related primarily to assessed activity data and applied default emission factor.

Uncertainty estimate associated with activity data amounts 50 percent, based on expert judgements. Uncertainty estimate associated with emission factor amounts 30 percent, according to the provided uncertainty assessment in *Good Practice Guidance* (detailed in Annex 5, Tables A5-1, A5-2).

8.4.4. SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation keys in the CRF tables according to QA/QC plan.

After preparation of final draft of this chapter an audit was carried out to check selected activities from Tier 1 General inventory level QC procedures. Since this source category is not a key source, QA/QC plan does not prescribes source specific quality control procedures.

8.4.5. SOURCE SPECIFIC RECALCULATIONS

There are no source-specific recalculations in this report.

8.4.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Improvements in the sub-sector Waste Incineration are related primarily to aggregation of accurate data for CO_2 emission calculations from incineration of different types of waste.

8.5. EMISSION OVERVIEW

Emissions of GHGs from Waste in the period 1990-2010 are presented in Table 8.5-1.

Table 8.5-1: Emissions from Waste (1990-2010)

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Waste	Percentage in Total Country Emission
Solid Waste Disposal on Land	1990	CH_4	11.55	21	242.62	39.67	0.77
	1991		12.09		253.95	41.64	1.03
	1992		12.63		265.23	43.61	1.15
	1993		13.20		277.15	45.27	1.20
	1994		13.82		290.13	55.15	1.31
	1995		14.54		305.26	41.05	1.33
	1996		15.32		321.80	44.62	1.36
	1997		16.20		340.30	52.25	1.36
	1998		17.13		359.75	58.83	1.43
	1999		18.18		381.84	59.37	1.45
	2000		19.24		404.11	61.64	1.55
	2001		20.47		429.83	60.54	1.58
	2002		21.85		458.90	67.14	1.62
	2003		23.39		491.15	55.98	1.64
	2004		25.07		526.39	62.77	1.76
	2005		24.25		509.26	68.07	1.68
	2006		27.14		569.94	66.06	1.85
	2007		29.14		611.87	68.57	1.89
	2008		31.61		663.71	71.23	2.14
	2009		34.25		719.28	72.10	2.48
	2010		36.08		757.78	70.78	2.65
Domestic and Commercial Wastewater	1990	CH_4	4.71	21	98.85	16.16	0.31
	1991		4.67		98.05	16.08	0.40
	1992		4.63		97.25	15.99	0.42
	1993		4.59		96.45	15.75	0.42
	1994		4.55		95.65	18.18	0.43
	1995		4.52		94.85	12.75	0.41
	1996		4.49		94.23	13.07	0.40
	1997		4.46		93.61	14.37	0.38
	1998		4.43		92.99	15.21	0.37
	1999		4.40		92.37	14.36	0.35
	2000		4.37		91.75	13.99	0.35
	2001		4.32		90.73	12.78	0.33
	2002		4.27		89.74	13.13	0.32
	2003		4.23		88.78	10.12	0.30
	2004		4.20		88.30	10.53	0.29
	2005		4.17		87.66	11.72	0.29
	2006		4.15		87.11	10.10	0.28
	2007		4.13		86.73	9.72	0.27
	2008		4.07		85.50	9.18	0.28
	2009		4.04		84.83	8.50	0.29
	2010		4.04		84.83	7.92	0.30

Table 8.5-1: Emissions from Waste (1990-2010), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Waste	Percentage in Total Country Emission
Industrial Wastewater	1990	CH_4	8.57	21	179.88	29.41	0.57
	1991		8.27		173.58	28.46	0.70
	1992		7.97		167.29	27.51	0.72
	1993		7.67		160.99	26.29	0.70
	1994		2.89		60.77	11.55	0.27
	1995		12.28		257.84	34.67	1.12
	1996		10.66		223.92	31.05	0.95
	1997		6.47		135.81	20.85	0.54
	1998		3.77		79.12	12.94	0.32
	1999		3.98		83.49	12.98	0.32
	2000		3.65		76.64	11.69	0.29
	2001		4.76		100.05	14.09	0.37
	2002		1.90		39.93	5.84	0.14
	2003		9.62		202.01	23.02	0.68
	2004		6.13		128.75	15.35	0.43
	2005		2.63		55.26	7.39	0.18
	2006		5.01		105.24	12.20	0.34
	2007		4.40		92.50	10.37	0.29
	2008		3.84		80.59	8.65	0.26
	2009		4.33		90.92	9.11	0.31
	2010		5.95		125.00	11.67	0.44
Human Sewage	1990	N_2O	0.29	310	90.24	14.75	0.29
	1991		0.27		84.27	13.82	0.34
	1992		0.25		78.34	12.88	0.34
	1993		0.25		77.64	12.68	0.34
	1994		0.26		79.49	15.11	0.36
	1995		0.28		85.67	11.52	0.37
	1996		0.26		81.19	11.26	0.34
	1997		0.26		81.55	12.52	0.33
	1998		0.26		79.65	13.02	0.32
	1999		0.28		85.38	13.28	0.32
	2000		0.27		83.10	12.68	0.32
	2001		0.29		89.30	12.58	0.33
	2002		0.31		94.86	13.88	0.34
	2003		0.31		95.37	10.87	0.32
	2004		0.31		95.09	11.34	0.32
	2005		0.31		95.92	12.82	0.32
	2006		0.32		100.42	11.64	0.33
	2007		0.33		101.09	11.33	0.31
	2008		0.33		101.79	10.92	0.33
	2009		0.33		102.43	10.27	0.35
	2010		0.33		102.93	9.61	0.36

Table 8.5-1: Emissions from Waste (1990-2009), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Waste	Percentage in Total Country Emission
Waste Incineration	1990	CO_2	0.043	1	0.043	0.007	0.0001
	1991		0.041		0.041	0.007	0.0002
	1992		0.040		0.040	0.007	0.0002
	1993		0.042		0.042	0.007	0.0002
	1994		0.042		0.042	0.008	0.0002
	1995		0.042		0.042	0.006	0.0002
	1996		0.041		0.041	0.006	0.0002
	1997		0.041		0.041	0.006	0.0002
	1998		0.041		0.041	0.007	0.0002
	1999		0.041		0.041	0.006	0.0002
	2000		0.040		0.040	0.006	0.0002
	2001		0.040		0.040	0.006	0.0001
	2002		0.040		0.040	0.006	0.0001
	2003		0.040		0.040	0.005	0.0001
	2004		0.041		0.041	0.005	0.0001
	2005		0.034		0.034	0.004	0.0001
	2006		0.040		0.040	0.005	0.0001
	2007		0.083		0.083	0.009	0.0003
	2008		0.250		0.250	0.027	0.0008
	2009		0.127		0.127	0.013	0.0004
	2010		0.099		0.099	0.009	0.0003

[1] Time horizon chosen for GWP values is 100 years

8.6. REFERENCES

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9 OTHER (CRF sector 7)

At present, no greenhouse gas emissions are calculated for Croatia which cannot be allocated to one of the existing source categories.

10 RECALCULATIONS AND IMPROVEMENTS

The key differences between the previous and latest submission of CRF tables for the time series 1990-2008 are outlined in this chapter. Detailed description and explanations for recalculations are shown in recalculation sections in the sector chapters (Chapters 3 to 8).

10.1EXPLANATIONS AND JUSTIFICATIONS FOR RECALCULATIONS, INCLUDING IN RESPONSE TO THE REVIEW PROCESS

The recalculations are performed in accordance with:
1) Decisions of sectoral experts
2) Suggestions of expert review team (suggestions reported in“ DRAFT Report of the individual review of the greenhouse gas inventory of Croatia submitted in 2010”)

Recalculations are performed in the following sectors:

- Energy
  - Public Electricity and Heat Production
  - Road transport
  - Agriculture/Forestry/Fisheries
  - CO_2 emission from Natural gas scrubbing
- Industrial Processes
  - Lime Production, Limestone and Dolomite Use, Soda Ash Production and Use, Consumption of Halocarbons and SF_6
- Solvent and Other Product Use
- Agriculture
- CH_4 emissions from Enteric fermentation in domestic livestock, CH_4 and N_2O emissions from Manure management, N_2O emissions from Agricultural soils
- LULUCF
  - Emissions/removals from Forest land remaining forest land and Land converted to settlements
- Waste
  - Solid Waste Disposal on Land

In this section, the summary of the recalculations performed and justification is given using the following categories of distinction:

- Changes or refinements in methods (Chapter 10.1.1.)
- Correction of errors (Chapter 10.1.2.)

10.1.1 CHANGES OR REFINEMENTS IN METHODS

The following methodological changes were made for the calculation of greenhouse gases according to:

- Changes in available data;
- Consistency with good practice guidance;
- New methods.

10.1.1.1 Changes in available data

__Energy sector__

CO_2 emission from Natural gas scrubbing (1.B.2.b.ii)

Recalculations were made for the period 1990-2009 because new official and verified data were obtained from CPS Molve.

__Industrial processes__

Mineral products (2.A.); Lime Production (2.A.2)

New data collected from sugar manufacturers have been included in calculations. Consequently, recalculations of emissions from this sub-sector have been performed for the entire calculation period.

Mineral products (2.A.); Limestone and Dolomite Use (2.A.3)

In this sub-sector, emission recalculations were made for the entire period by adding new data collected from manufacturers.

Mineral products (2.A.); Soda Ash Production and Use (2.A.4.)

Recalculations were made for the period 1997-1999 and 2001-2009 because new data collected from manufacturers have been added.

Consumption of Halocarbons and SF_6 (2.F.); Refrigeration and Air Conditioning Equipment (2.F.1.)

New data have been compiled by the Ministry of Environmental and Nature Protection. Accordingly, potential emissions from Refrigeration and Air Conditioning Equipment for the period 1995-2009 have been recalculated.

Solvent and Other Product Use

Solvent and Other Product Use (3.A.B.C.D.)

Activity data for NMVOC emission calculation for the whole period 1990-2009 has been updated according to the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2010* Submission to the Convention on Long-range Transboundary Air Pollution'. Therefore, CO_2 emissions have been recalculated for the period 1990-2009 in this report.

Agriculture

CH_4 Emissions from Enteric Fermentation in Domestic Livestock (4.A.)

Methane emissions form Enteric fermentation were recalculated for the period 1990-1993, for 1999, 2006 and 2008 due to changes of activity data regarding animal population

For certain animal categories, new and updated data on animal population have been obtained as follows:

- Non-dairy cattle – 1990-1993
- Goats – 1999
- Horses – 2006

Detailed data on the population of goats (1992, 1994-1998) and mules/asses (1992-1994) have been included in the CRF database within the animal population cell but the latter did not influence emissions because correct/more detailed values were used in the calculation and correct emission values were reported in the CRF. Thus, only the correction of activity data was performed.

Manure management (4.B.)

Methane emissions from Manure management were recalculated for the period 1990-1993, for 1999, 2006 and 2008 due to changes of activity data regarding animal population in the period from 1990-1993, for 1999 and 2006. Also, more detailed activity data regarding animal population of goats (1992, 1994-1998) and mules/asses (1992-1994) were available.

Recalculations for N_2O emission were performed for the period from 1990-1993, for 1999, 2006 due to new and updated data on animal number 2006 (presented and explained in regards to enteric fermentation).

Agricultural soils (4.D.)

Direct emission from Agricultural soils

Recalculations of N_2O emission from animal manure[23] were made due to changes in animal number (new and updated data were obtained) regarding cattle (1990-1993), goats (1999) and horses (2006). More detailed activity data regarding goats (1992, 1994-1998) and mules/asses (1992-1994) have also been used for emission recalculation.

As for the N_2O emissions originating from biological fixation of nitrogen and crop residue, recalculation was performed for the period from 2000 - 2008 because new and updated activity data was available regarding dry beans (CBS, period 2000 - 2008) and lentils (FAOSTAT, 2008).

Due to new activity data regarding histosol area in Croatia, recalculations of N_2O emissions from histosols were performed for the entire period from 1990-2008.

Direct N_2O emission from pasture, range and paddock manure

Recalculation of N_2O emissions from pasture, range and paddock manure was performed due to changes in animal number (goats 1992, 1994-1999; mules/asses 1992-1994, horses 2006).

Indirect N_2O emissions from nitrogen used in agriculture

Since direct N_2O emissions from animal manure application were recalculated due to change in animal number, recalculations of indirect N_2O emissions from nitrogen used in agriculture were also necessary for the same reason and for the same years.

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[23] During the 2010 review of the Croatian greenhouse gas inventory, ERT identified that the total amount of nitrogen (N) excreted from animal waste management systems (AWMS), after discounting the N volatilized ($Frac_{GASM}$ = 0.2), did not match the value reported for nitrogen from animal manures applied to the soil. The reason for this was the use of equation from the Revised 1996 IPCC Guidelines instead of the equation from the IPCC Good Practice Guidance. There was also an error in $Frac_{GRAZ}$ which was used and reported as a constant value of 0.24 instead of the actual value for every year.
Therefore, N_2O emissions from animal manure and liquid/slurry_have been recalculated for the entire period 1990-2008, using the equation 4.23 from the IPCC Good Practice Guidance instead of the one provided in the 1996 IPCC Reference Manual. $Frac_{GRAZ}$ constant value of 0.24 has also been replaced with correct, calculated value for the entire period 1990-2008. These recalculations were also reported and submitted in Croatia's response to the ERT in September 2010. Revised estimations were included within the 16th October resubmission of the CRF tables.

LULUCF

Since Addendum to NIR 2010, certain recalculations were performed in regards to *Forest land remaining forest land* based on more detailed data attained which enabled further division (e.g. state forests are divided to state forests managed by Croatian Forests and state forests managed by other legal bodies) and thus further disaggregation of the emission/removal calculation. New data were attained specifically for other state and private forests directly from the FMAP 2006-2015. These new data are considered more reliable; therefore, presenting a calculation improvement.

Waste

Solid Waste Disposal on Land (6.A.)

New data on total annual MSW disposed to SDWSs for 2009 was provided. Thereupon, CH_4 emissions and related MCF have been recalculated for 2009.

10.1.1.2Consistency with good practice guidance

Energy

Public Electricity and Heat Production (1.A.1.a.)

Some inconsistencies in data occurred because two different approaches were used for emission calculation (bottom up for large point sources and top down for the rest of the sector). Recalculations are carried out to reconcile these two approaches for emission calculation. Fuel consumption from CHP and TPP plants (tier 2) were compared to same subsector in national energy balance. The differences which occurred were added to consumption of PHP plants. In such way total consumption of this sector is equal to total consumption in national energy balance. This approach assures that neither double-counting nor omissions occur. Recalculation was performed for the whole period of time (1993-2009).part of emissions of CO_2 from natural gas which used as fuel in ammonia production was relocated from Industrial processes sector (Ammonia Production – 2.B.1) into Energy sector (Manufacturing Industries and Construction, Other, Petrochemical Production – 1.A.2.f) as ERT recommended. In Manufacturing Industries and Construction sector, the new category is added (Petrochemical Production). Recalculation is carried out adding fuel consumption in Petrochemical Production. Recalculation was performed for the whole period (from 1990 to 2009).

10.1.1.3New methods

Energy

Road transport CRF (1.A.3.b)

Emission of this sector have been recalculated for the sequence 1990-2009. The reason of recalculation is the usage of new version of COPERT 4 for calculating the pollutant emissions from the road traffic, COPERT 4 ver9.0. Using the new version is the recommendations of the European Commission because they bring improvement in traffic emissions calculation, and eliminate existing bugs in the software package. As a result of introduction of newer version, there was a minor changes in CO2 emissions due to updated emission factors, bugs fixed (corrected CH4, N2O emissions calculation), increase in fuel consumption due to usage of air conditioning system that are now installed in almost 95% of all new passenger cars, the NO2/NOx ratios have been completed for some vehicle technologies for which no values were available in the older COPERT 4 versions, the default O:C, H:C ratios for biodiesel have changed to 0.11 and 1.94, respectively, assuming a typical biodiesel ester molecule containing 18 C atoms, 2 O atoms, and one double bond.

Agriculture

CH_4 Emissions from Enteric Fermentation in Domestic Livestock (4.A.)

The recalculation refers only to 2008 for animal categories sheep and swine due to change in the methodology – EFs for developed countries are used instead of EFs for developing ones.
The ERT considers that animals in Croatia are similar to those in other European countries with regard to weight and feed and that Croatia should use emission factors for developed countries not for developing ones (the only difference between EFs for developed and developing countries refers to sheep and swine). Since Croatia used EFs for developing countries for each animal category, the ERT considered the latter as an underestimation of CH_4 emission from enteric fermentation and thus initiated and prepared adjustments in accordance with the guidance for adjustments under Article 5, paragraph 2 of the Kyoto Protocol (decision 20/CMP.1). Also, in accordance with the guidelines for review under Article 8 of the Kyoto Protocol (decision 22/CMP.1), the ERT officially notified Croatia of the calculated adjustments. The ERT concluded that the most appropriate methodology for the adjustment in accordance with the technical guidance for adjustments, as set out in the annex to decision 20/CMP.1, would be the use of IPCC default values for developed countries (table 4-3) from the Revised 1996 IPCC Guidelines to estimate CH_4 emissions for sheep and swine. For other animals (goats, horses, mules and asses) the IPCC default EFs for developing countries are the same as for developed countries and therefore the emissions are not underestimated. Adjusted emissions have been calculated using AD (animal population data) as provided in the Croatian 2010 annual submission.

CH_4 Emissions from Manure management (4.B.)

The recalculation refers only to 2008 for animal categories sheep, goats, horses, mules/asses and poultry due to change in the methodology – EFs for developed countries are used instead of EFs for developing ones.

Since Croatia used EFs for developing countries for each animal category, the ERT considered the latter as an underestimation of CH_4 emission from manure management and thus also initiated and prepared adjustments in accordance with the guidance for adjustments under Article 5, paragraph 2 of the Kyoto Protocol (decision 20/CMP.1). Furthermore, in accordance with the guidelines for review under Article 8 of the Kyoto Protocol (decision 22/CMP.1), the ERT officially notified Croatia of the calculated adjustments. The ERT concluded that the most appropriate methodology for the adjustment in accordance with the technical guidance for adjustments, as set out in the annex to decision 20/CMP.1, would be the use of IPCC default values for developed countries (table 4-5) from the Revised 1996 IPCC Guidelines to estimate CH_4 emissions for sheep, goats, horses, mules/asses and poultry. Adjusted emissions have been calculated using AD (animal population data) as provided in the Croatian 2010 annual submission.

LULUCF

Due to change in the methodology in regards to land subcategory *Land converted to settlements* related recalculations were performed for the entire period from 1990-2009. Previously, equation 3.2.5. was used instead of 3.2.7.

10.1.2 CORRECTION OF ERRORS

This chapter presents corrected errors noticed after the resubmission. Necessary recalculations were mostly due to typing errors. The latter are explained only in this report.

Energy

Agriculture/Forestry/Fisheries (1.A.4.c)

In 2008. wrong Net calorific value is used for emission calculacion. In this submission error is corrected.

Consumption of Halocarbons and SF_6 (2.F.); Refrigeration and Air Conditioning Equipment (2.F.1.)

A mistake was detected in the calculation of potential emissions of gas HFC-125 for the year 2004 and gas HFC-143a for 1998. These mistakes were corrected for this report.

Consumption of Halocarbons and SF_6 (2.F.); Other Consumption of HFCs, PFCs and SF_6 (2.F.2. Foam Blowing, 2.F.3. Fire Extinguishers, 2.F.4. Aerosols/Metered Dose Inhalers, 2.F.8. Electrical Equipment)

A mistake in data input made in the previous report regarding potential emissions of HFC-227a from Fire Extinguishers for 2007 and 2008 was corrected.

A mistake was noticed in calculation of actual emissions of SF_6 for 2008 and was corrected in this report.

Agriculture

CH_4 Emissions from Manure management (4.B.)

Within the CRF table 4.B(a) submitted in October 2010 (CRF v3.1), a mistake was noticed in regard to implied emission factors for horses, mules/asses and poultry for the period from 1990-2008. The mistake refers to 1000 times lower IEF than the normal one which resulted in 1000 times lower CH_4 emission from manure management of these animal categories. The mistake was generated by using Gg instead of tonnes. Aforementioned was corrected.

In the previous submission, regarding dairy cattle and its nitrogen excretion in solid storage and dry lot, mistakenly 9,972,018.70 kg N for 2008 was reported while the correct value was and is still now 10,120,854.80 kg N. The latter is corrected but it did not influence the reported N_2O emission (correct emission value was reported); thus, emission recalculation was not required.

A mistake regarding allocation of mature dairy cattle is also corrected in the CRF and now the sum of allocation values amounts 100%.

Agricultural soils (4.D.)

Direct emission from Agricultural soils

Recalculations of N_2O emissions from mineral fertilisers were made due to a mistake noticed regarding the fraction of N emitted as NH_3 and NO_x. - for urea ammonium nitrate a fraction of 0.02 was used instead of 0.08. Recalculation was performed for all years in which the mentioned fertilizer was applied; thus referring to the period from 2003 – 2008. In years prior to this period, this type of fertilizer was not used.

Indirect N_2O emissions from nitrogen used in agriculture

Since direct N_2O emissions from mineral fertilizers were recalculated due to correction of N-fraction emitted as NH_3 or NO_x, recalculations of indirect N_2O emissions from nitrogen used in agriculture were also necessary for the same reason and for the same period. The latter refers to indirect N_2O emissions arising from volatilization of ammonia (NH_3) and nitrogen oxides (NO_x) due to application of mineral fertilizers and indirect N_2O emissions from leaching and runoff of nitrogen compounds into surface waters, groundwater and watercourses (due to mineral fertilisers).

10.2 THE IMPLICATION OF THE RECALCULATIONS ON THE LEVEL AND TREND, INCLUDING TIME SERIES CONSISTENCY

This section outlines the implications over time for the emission levels as well as the implications for emission trends, including time-series consistency.

Table 10.2-1 shows the differences between the last submission (NIR 2011) and current submission (NIR 2012), on the level of the different greenhouse gases.

Table 10.2-1: Differences between NIR 2011 and NIR 2012, for 1990-2009 due to recalculations

Source		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 (Tg) Incl. LULUCF	NIR 2011	16.2	10.3	9.7	10.1	9.4	10.1	11.1	11.9	12.6	13.3
	NIR 2012	16.3	10.5	9.8	10.5	9.6	10.2	11.2	12.2	12.9	13.4
	Difference %	***1.2***	***1.5***	***0.7***	***3.1***	***2.0***	***0.8***	***1.6***	***2.1***	***2.5***	***1.3***
CO_2 (Tg) Excl. LULUCF	NIR 2011	23.1	17.2	16.5	17.0	16.3	17.0	17.5	18.6	19.4	20.3
	NIR 2012	23.1	17.1	16.5	17.0	16.3	17.0	17.6	18.7	19.5	20.4
	Difference %	***0.0***	***-0.1***	***0.1***	***0.1***	***0.0***	***0.3***	***0.5***	***0.5***	***0.1***	***0.4***
CH_4 (CO_2-eq Gg)	NIR 2011	3461	3205	2893	3009	2704	2876	2833	2819	2607	2619
	NIR 2012	3483	3218	2902	3021	2719	2888	2845	2831	2620	2631
	Difference %	***0.6***	***0.4***	***0.3***	***0.4***	***0.6***	***0.4***	***0.4***	***0.4***	***0.5***	***0.5***
N_2O (CO_2-eq Gg)	NIR 2011	3943	3759	3652	3117	3180	3058	3033	3321	2884	3175
	NIR 2012	3946	3762	3654	3125	3190	3054	3053	3345	2883	3217
	Difference %	***0.1***	***0.1***	***0.1***	***0.3***	***0.3***	***-0.1***	***0.6***	***0.7***	***-0.1***	***1.3***
HFCs (CO_2-eq Gg)	NIR 2011	0.0	NO	NO	NO	NO	49.2	68.1	90.9	118.2	142.6
	NIR 2012	NO	NO	NO	NO	NO	49.4	68.3	90.9	118.2	142.6
	Difference %	NO	NO	NO	NO	NO	***0.4***	***0.3***	***0.0***	***0.0***	***0.0***
PFCs (CO_2-eq Gg)	NIR 2011	936.6	642.4	NO	NO	NO	NO	NO	NO	NO	NO
	NIR 2012	936.6	642.4	NO	NO	NO	NO	NO	NO	NO	NO
	Difference %	***0.0***	***0.0***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***
SF_6 (CO_2-eq Gg)	NIR 2011	11.0	10.8	10.9	11.0	11.2	11.7	12.1	12.0	12.6	12.6
	NIR 2012	11.0	10.8	10.9	11.0	11.2	11.7	12.1	12.0	12.6	12.6
	Difference %	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***
Total (Tg CO_2-eq) Incl. LULUCF	NIR 2011	24.5	17.9	16.2	16.3	15.3	16.1	17.0	18.2	18.2	19.2
	NIR 2012	25.9	19.3	16.6	18.8	16.5	16.4	17.9	19.6	20.6	19.6
	Difference %	***5.6***	***7.4***	***2.1***	***15.7***	***8.0***	***1.6***	***5.3***	***7.6***	***13.1***	***1.9***
Total (Tg CO_2-eq) Excl.LULUCF	NIR 2011	31.4	24.8	23.1	23.1	22.2	23.0	23.5	24.9	25.1	26.2
	NIR 2012	31.5	24.8	23.1	23.2	22.2	23.0	23.6	25.0	25.1	26.4
	Difference %	***0.1***	***0.0***	***0.1***	***0.2***	***0.1***	***0.3***	***0.5***	***0.5***	***0.1***	***0.5***

Table 10.2-1: Differences between NIR 2011 and NIR 2012 for 1990-2009 due to recalculations, cont.

Source		2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2 (Tg) Incl. LULUCF	NIR 2011	12.7	13.5	14.3	15.6	15.0	15.3	15.3	16.3	15.0
	NIR 2012	13.4	13.8	14.7	16.1	15.4	15.6	15.7	16.7	15.3
	Difference %	***5.5***	***2.5***	***2.4***	***3.1***	***2.4***	***1.9***	***2.5***	***2.0***	***2.3***
CO_2 (Tg) Excl. LULUCF	NIR 2011	19.9	20.9	21.9	23.4	23.0	23.4	23.5	24.8	23.6
	NIR 2012	19.9	20.9	21.9	23.4	23.0	23.3	23.6	24.9	23.7
	Difference %	***0.1***	***0.1***	***0.2***	***0.0***	***0.2***	***-0.1***	***0.3***	***0.1***	***0.1***
CH_4 (CO_2-eq Gg)	NIR 2011	2679	2851	2863	3128	3156	3070	3360	3479	3446
	NIR 2012	2691	2865	2884	3149	3163	3075	3380	3496	3447
	Difference %	***0.5***	***0.5***	***0.7***	***0.7***	***0.2***	***0.2***	***0.6***	***0.5***	***0.0***
N_2O (CO_2-eq Gg)	NIR 2011	3238	3339	3263	3107	3482	3487	3417	3475	3453
	NIR 2012	3285	3338	3263	3107	3483	3485	3418	3635	3505
	Difference %	***1.4***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***4.6***	***1.5***
HFCs (CO_2-eq Gg)	NIR 2011	170.7	193.5	225.1	263.0	300.0	333.6	364.9	405.0	423.4
	NIR 2012	170.7	193.4	225.1	263.0	300.1	333.4	365.0	405.1	423.2
	Difference %	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***-0.1***	***0.0***	***0.0***	***-0.1***
PFCs (CO_2-eq Gg)	NIR 2011	NO	NO	NO	NO	NO	NO	NO	NO	NO
	NIR 2012	NO	NO	NO	NO	NO	NA.NO	NA.NO	NA.NO	NA.NO
	Difference %	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***
SF_6 (CO_2-eq Gg)	NIR 2011	12.2	12.3	12.6	12.9	13.2	13.7	13.6	13.7	13.7
	NIR 2012	12.2	12.3	12.6	12.9	13.2	13.7	13.6	13.7	13.7
	Difference %	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***
Total (Tg CO_2-eq) Incl. LULUCF	NIR 2011	18.8	19.9	20.7	22.1	22.0	22.2	22.4	23.7	22.3
	NIR 2012	24.2	21.2	21.5	24.9	22.4	22.6	23.0	24.7	23.1
	Difference %	***28.8***	***6.6***	***4.1***	***12.5***	***2.1***	***1.8***	***2.4***	***4.1***	***3.4***
Total (Tg CO_2-eq) Excl.LULUCF	NIR 2011	26.0	27.3	28.3	29.9	29.9	30.3	30.7	32.2	31.0
	NIR 2012	26.1	27.3	28.3	29.9	30.0	30.2	30.7	32.4	31.0
	Difference %	***0.3***	***0.1***	***0.3***	***0.0***	***0.2***	***-0.1***	***0.3***	***0.6***	***0.3***

Table 10.2-1: Differences between NIR 2011 and NIR 2012 for 1990-2009 due to recalculations, cont.

Source		2009
CO_2 (Tg) Incl. LULUCF	NIR 2011	13.0
	NIR 2012	14.0
	Difference %	***7.0***
CO_2 (Tg) Excl. LULUCF	NIR 2011	21.8
	NIR 2012	21.9
	Difference %	***0.6***
CH_4 (CO_2-eq Gg)	NIR 2011	3463
	NIR 2012	3464
	Difference %	***0.0***
N_2O (CO_2-eq Gg)	NIR 2011	3206
	NIR 2012	3257
	Difference %	***1.6***
HFCs (CO_2-eq Gg)	NIR 2011	428.7
	NIR 2012	428.7
	Difference %	***0.0***
PFCs (CO_2-eq Gg)	NIR 2011	0.2
	NIR 2012	0.2
	Difference %	***NO***
SF_6 (CO_2-eq Gg)	NIR 2011	14.1
	NIR 2012	14.1
	Difference %	***0.0***
Total (Tg CO_2-eq) Incl. LULUCF	NIR 2011	20.2
	NIR 2012	21.3
	Difference %	***5.7***
Total (Tg CO_2-eq) Excl.LULUCF	NIR 2011	28.9
	NIR 2012	29.1
	Difference %	***0.7***

The change in the 1990-2009 trend for the greenhouse gas emissions compared to the previous submission is presented in Table 10.2-2. It can be concluded that the trend in the total national emissions decreased by 5.7 percent including LULUCF and 0.7 percent excluding LULUCF comparing NIR 2011 and NIR 2012. The largest absolute changes in emission trends are recorded for CO_2, N_2O and total CO_2-eq, described in Table 10.2-2.

Table 10.2-2: Differences between NIR 2011 and NIR 2012 for the emission trends 1990-2009

Gas	Trend (absolute)		
CO_2-eq (Gg)	NIR 2011	NIR 2012	*Difference*
CO_2 emissions including net CO_2 from LULUCF	-863.98	-673.00	*-190.98*
CO_2 emissions excluding net CO_2 from LULUCF	417.86	476.61	*-58.75*
CH_4	-100.51	-102.48	*1.97*
N_2O	-525.54	-527.85	*2.31*
HFCs	364.88	0.00	*364.88*
PFCs	0.00	0.00	*0.00*
SF6	0.00	2.68	*-2.68*
Total (including LULUCF)	**-2059.05**	-2881.85	*822.80*
Total (excluding LULUCF)	**-777.20**	-722.64	*-54.55*

Table 10.2-2: Differences between NIR 2011 and NIR 2012 for the emission trends 1990-2009, cont.

Gas	Trend (percent)		
CO_2-eq (Gg)	NIR 2011	NIR 2012	*Difference*
CO_2 emissions including net CO_2 from LULUCF	-19.27	-21.91	*2.64*
CO_2 emissions excluding net CO_2 from LULUCF	-5.78	-8.29	*2.51*
CH_4	0.05	3.05	*-3.00*
N_2O	-18.68	-15.13	*-3.55*
HFCs	100.00	100.00	*0.00*
PFCs	-99.98	-100.00	*0.02*
SF_6	28.82	28.82	*0.00*
Total (including LULUCF)	**-17.76**	-21.50	*3.74*
Total (excluding LULUCF)	**-8.19**	-9.13	*0.94*

10.3 PLANNED IMPROVEMENTS TO THE INVENTORY

The framework for development of Croatian greenhouse gas emissions inventory was established during preparation of the First National Communication to the UNFCCC in 2001. The framework was built upon experiences and lessons learned from the previously established scheme for national reporting and international data exchange through the EEA/ETC-ACC system and reporting under Convention on Long-range Transboundary Air Pollution (CLRTAP). Since then Croatia has submitted National Inventory Reports in 2003 for the period 1995-2001, in 2004 for the period 1990-2002, in 2005 for the period 1990-2003, in 2006 for the period 1990-2004, in 2007 for the period 1990-2005, in 2008 for the period 1990-2006, in 2008 Resubmission of Croatia's 2008 Inventory Submission, in 2009 for the period 1990-2007, in 2010 for the period 1990-2008, in 2011 for the period 1990-2009 and this latest submission in April 2012.

Generally, Croatia has developed a sound and well-documented greenhouse gas inventory system but it still requires continuous improvements in almost all key elements related to compilation and submission of the inventory. In order to fulfil these requirements Croatia has taken strategic approach and as a result a draft of National GHG Inventory Improvement Strategy has been prepared[24]. The purpose of this strategic document is to recognize strengths and weaknesses of the existing national GHG inventory system and to determine a realistic short- and long- term objectives in order to establish cost-effective GHG inventory preparation system that will enable timely, accurate, transparent and consistent international reporting, taking into account national circumstances, resources and available information.

There are several priority tasks for improvements of the inventory system which are outlined in the strategy:

- Regulation on the Greenhouse Gas Emissions Monitoring in the Republic of Croatia (Official Gazette No. 1/2007), which came into force in January 2007, should improve existing system of greenhouse gas emission monitoring and reporting in accordance with the requirements of the Kyoto protocol and relevant legislation of the EU (Decision 280/2004/EC) and defines institutional responsibilities and mandates for national inventory compilation;
- authorization of appropriate national institution to be in charge of approving the inventory;
- establish national reference centre for air and climate change;
- ensuring sustainable inventory preparation process including establishment of QA/QC system;
- carrying out awareness-raising campaign targeting policy-makers and other stakeholders on importance and benefits of sustainable inventory process;
- improving collection of activity data, emission factors and overall emission calculation for key sources, based on long-term inventory preparation program;
- increasing the financial, technical and human resources for inventory preparation, based on long-term inventory program.

[24] National GHG Inventory Improvement Strategy was prepared under UNDP/GEF regional project Capacity Building for Improving the Quality of GHG Inventories (Europe and CIS Region).

Sector specific goals are outlined below:

ENERGY

Fuel combustion

For the purpose of GHG inventory improvement, missing data should be collected and quality of existing data, emission factors and methods should be improved. Implementation of well-documented country specific emission factors and appropriate detailed methods are recommended. Short-term and long-term goals for GHG inventory improvement are:

Short-term goals (< 1 years)

Usage of more source-specific QA/QC procedures will improve the quality of GHG inventory in Energy sector.

Long-term goals (> 1 years)

The project on national level (Development of software for web based energy data collection), which will contribute to data collection improvement, is in progress.

The changes from Tier 1 to Tier 2/3 estimation methodologies for Energy key sources, as much as possible, are recommended. The priority should be the key sources with high uncertainties of emission estimation. But, significant constrains are availability of activity data, especially for the beginning years of concerned period. Consequently, implementation of more detailed methodology approach (Tier 2/3) for key sources, for entire period, will be very difficult.

In addition, the extensive use of plant-specific data which will be collected in the Register of Environmental Pollution is highly recommended ("bottom up" approach).

Fugitive emission

For estimation of fugitive emissions from oil and natural gas operations, a source-specific evaluations approach (Tier 3) is recommended. However, additional technical and financial resources are necessary for implementation the Tier 3 approach. As a first step in order to implementation source-specific evaluations approach the workshop for determining fugitive emission from oil and natural gas system was held. The aim of the workshop was to identify the data needed to improve estimate of fugitive emission.

INDUSTRIAL PROCESSES AND SOLVENT AND OTHER PRODUCT USE

Short-term goals (< 1 years)

Uncertainty of emission estimation is caused by implementation of default IPCC emission factors. Consequently, wider use of well documented country-specific (technology-specific and plant-specific) emission factors is an important short-term goal. There are gaps in the time series of some productions, provided by statistical institutions. Filling these gaps by using direct surveys and comparison with time series of other related data is recommended.

Usage of more source-specific QA/QC procedures will improve the quality of GHG inventory in Industrial processess sector.

For the purpose of accurate halocarbons and SF_6 actual emissions calculation, data on annual stocks in operating system as well as data on decommissioning and disposal need to be additionally investigated. Data on consumed gasses, which are used for potential emission calculation, also need to be additionally investigated. The workshop with the aim to improve data collection and accordingly include all sources of SF_6 emissions in invertory preparation was held. MENP is involved in some projects associated with consumption of HFCs and it could be expected that some project will be directed to the SF_6 consumption. Therefore, it is expected that information on consumption of HFCs, PFCs and SF_6 will be available at the rather detailed level in the future period.

Long-term goals (> 1 years)

It is considered wider use of source-specific verification procedures, through systematic cross-checking of plant-specific information with production statistics, and also the use other sources of information, such as CEE and the national energy balance.

Investigation of conversion factor C/NMVOC, using for calculation of CO_2 emission in Solvent and Other Product Use, need to be performed with purpose of accurate CO_2 emission calculation.

AGRICULTURE

The availability of activity data is still a major problem in certain key source categories within this sector. Planned improvement is the usage of Tier 2 method for calculation of emissions from the manure management subsector.

LAND-USE CHANGE AND FORESTRY

The availability of detailed activity data is still a major problem within this sector and application of higher Tier methodologies will be possible in the future after detailed research and adjustments of methods for data collection have been performed. Development of land use database needed for greenhouse gas inventories with aim to collect more quality data and to use complete land inventories represents an important task.

WASTE

Short-term goals (< 1 years)

Croatia plans to improve its waste statistics and to carry out sector-specific studies related to Solid Waste Disposal in order to improve usage of the Tier 2 method.

For the purposes of emission inventory improvement it is necessary to adjust country-specific to IPCC SWDSs classification, in order to accurately estimate the MCF.

Also, it is necessary to apply a unique methodology to determine waste quantity and composition. For the purposes of improvement activity data gathering from solid waste disposal activities it is necessary to improve quality of existing data:

- equipping the major landfills with automatic weigh-bridges in order to accurately estimate the quantities of delivered MSW;
- providing methodology to determine country-specific MSW composition;
- periodic analysis of waste composition at major landfills according to provided methodology;
- modification of Environmental Pollution Register, ROO Reporting Forms regarding to MSW with additional information on waste quantities and composition.

Long-term goals (> 1 years)

New waste statistics and sector-specific studies should be used to reconstruct historical activity data in applying the Tier 2 method for key source Solid Waste Disposal on Land.

Improvements in the sub-sector Wastewater Handling are related primarily to establishment of effectively *Water Information System* with base for systematic gathering and saving data needed for monitoring and planning of development of all wastewater handling systems.

Improvements in the sub-sector Waste Incineration are related primarily to aggregation of accurate data for CO_2 emission calculations from incineration of hazardous and clinical waste.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

11.1GENERAL INFORMATION

Upon the establishment of the National system in 2007 required under the Decision 19/CMP.1, the Ministry of Environmental and Nature Protection undertakes different activities in order to streamline and strengthen flow of data and information relevant for accounting of LULUCF activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol. This includes development of *Action plan for implementation of Article 3, paragraphs 3 and 4 of the Kyoto Protocol,* use of the EU short-term technical assistance and involvement on regular bases of all relevant stakeholders in this subject.

This year's submission follows the previously agreed procedure between the Ministry of Agriculture and the Ministry of Environmental and Nature Protection that preparation of the annual GHG Inventory, in respect of LULUCF sector, should be based on forest management plans. The results of conducted national forest inventory (CRONFI) still have no official status and consequently cannot be used for purposes of this reporting.

The UNFCCC and the KP reporting are harmonized as presented in Table 11.1-1; thus, the same data division was used in emission/removal calculation. Therefore, all stated for the UNFCCC is valid also for the KP (definitions, methodology, etc.). The issue of other land converted to forest land still deserves an examination as it represents AR-lands according to the KP and related definitions. For that reason emissions/removals were not yet estimated.

Table 11.1-1: The relationship between KP activities and reported UNFCCC land categories

UNFCCC			KP	
Land use category	**Subcategories**		**Article**	**Activities**
Forest Land	*Land converted to Forest land*	*Grassland converted to Forest land* *Other land converted to Forest land*	3.3	Afforestation
Settlements	*Land converted to Settlements*	*Forest land converted to Settlements*		Deforestation

11.1.1DEFINITION OF FOREST AND ANY OTHER CRITERIA

Definition of forest:

Forest is a land spanning more than 0.1 hectares with trees higher than 2 meters and canopy cover more than 10 percent, or trees able to reach these thresholds *in situ* (Table 11.1-2).

Table 11.1-2: Thresholds in defining forest

Parameter	Range	Selected value
Minimum land area	0.05 - 1 ha	0.1 ha
Minimum crown cover	10 - 30 %	10 %
Minimum tree height	2- 5 m	2 m

Based on the selected values for KP reporting, forest includes the following forest stands: high forests, plantations, forest cultures, coppice, maquia and scrub. **However, it is important to emphasize** that the entire dataset required for emission/removal calculation is not completely available for maquia and scrub because some parameters (e.g. growing stock) are not measured within the national system. Thus, for now, estimates for these forest types are excluded and estimates for forests are carried out for the following types (see also subchapters 7.2-3 and 7.2.2.1.):

- high forests
- forest cultures
- plantations
- coppice

Based on the *Forest Act*, forests represent also forest nurseries and seed orchards that are an integral part of the forest; forest infrastructure; fire breaks and other less open areas within forests; forests in protected areas under a special regulation; forests of special ecological, scientific, historical or cultural interest; windshields and buffer zones in area larger than 10 acres and a width greater than 20 m.

A separate group of forest trees in the area up to 10 acres, forest nurseries and seed orchards, which are not part of the forest, windbreaks and buffer zones - protective tree belt area of less than 10 acres and a width of less than 20 m, tree rows and parks in urban areas do not present forest.

11.1.2ELECTED ACTIVITIES UNDER ARTICLE 3, PARAGRAPH 4, OF THE KYOTO PROTOCOL

Croatia has chosen to elect Forest Management (FM) as an activity under Article 3.4 for inclusion in the accounting for the first commitment period in accordance with Paragraph 6 of the Annex to Decision 16/CMP.1. Credits from Forest Management are capped in the first commitment period. Following the Decision 22/CP.9, the cap is equal to 0.265 Mt C (0.972 Mt CO_2) per year, or to 1.325 Mt C (4.858 Mt CO_2) for the whole commitment period. For 2010, the cap presents about 11% of the estimated removal resulted from Forest Management.

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 time consistency is achieved because the data were collected for the entire period from 1990–2010 based on definitions presented further in this subchapter.
Applied definitions are as follows:

Afforestation/Reforestation

Afforestation in national circumstances is the activity within the biological forest renewal and it refers to afforestation of non-forest land and establishing plantations of fast growing species. Biological forest renewal is part of the FMAPs and thus afforestation is clearly human induced. Reforestation, as defined by Kyoto, does not exist in Croatia due to strict legal provisions. See explanation given under *Forest Management*.

Deforestation

According to the Croatian *Forest Act* (OG 140/05, 82/06, 129/08, 80/10, 124/10), deforestation is clear cutting of forest for land use change to other culture and it is performed in accordance with the spatial planning documents. Therefore, for an activity to be referred as deforestation, certain forest area must be excluded from the national forest management area which is strictly regulated by the Act (Articles 35 and 51). Based on the latter, land use changes from forest to other land use categories are allowed in very limited circumstances (e.g. for important infrastructure projects etc.). The national definition is in line with the KP definition.

Forest Management

Based on the Croatian Forest Act (OG 140/05, 82/06, 129/08, 80/10, 124/10), national definition of forest management is in accordance with the Kyoto definition of FM. According to national criteria, forest land with and without tree cover constitutes one forest management area which is sustainably managed based on the FMAPs regardless of the ownership, purpose, forest stand etc. (see Chapter 7.2.2.1. for detail explanation). Therefore, the area under Forest Management according to the KP is not identical to forest management area in the national frame since KP refers only to one part of the forest land (the one with tree cover) which is in line with the Kyoto definition of forest (Table 11.1-2). Therefore, the Croatian area reported under forest management for the KP reporting refers to the area of high forests, cultures, plantations and coppice, excluding at this moment estimates of the C stock changes of maquia and scrub due to unavailability of complete dataset. The latter is illustrated in Figure 11.1-1.

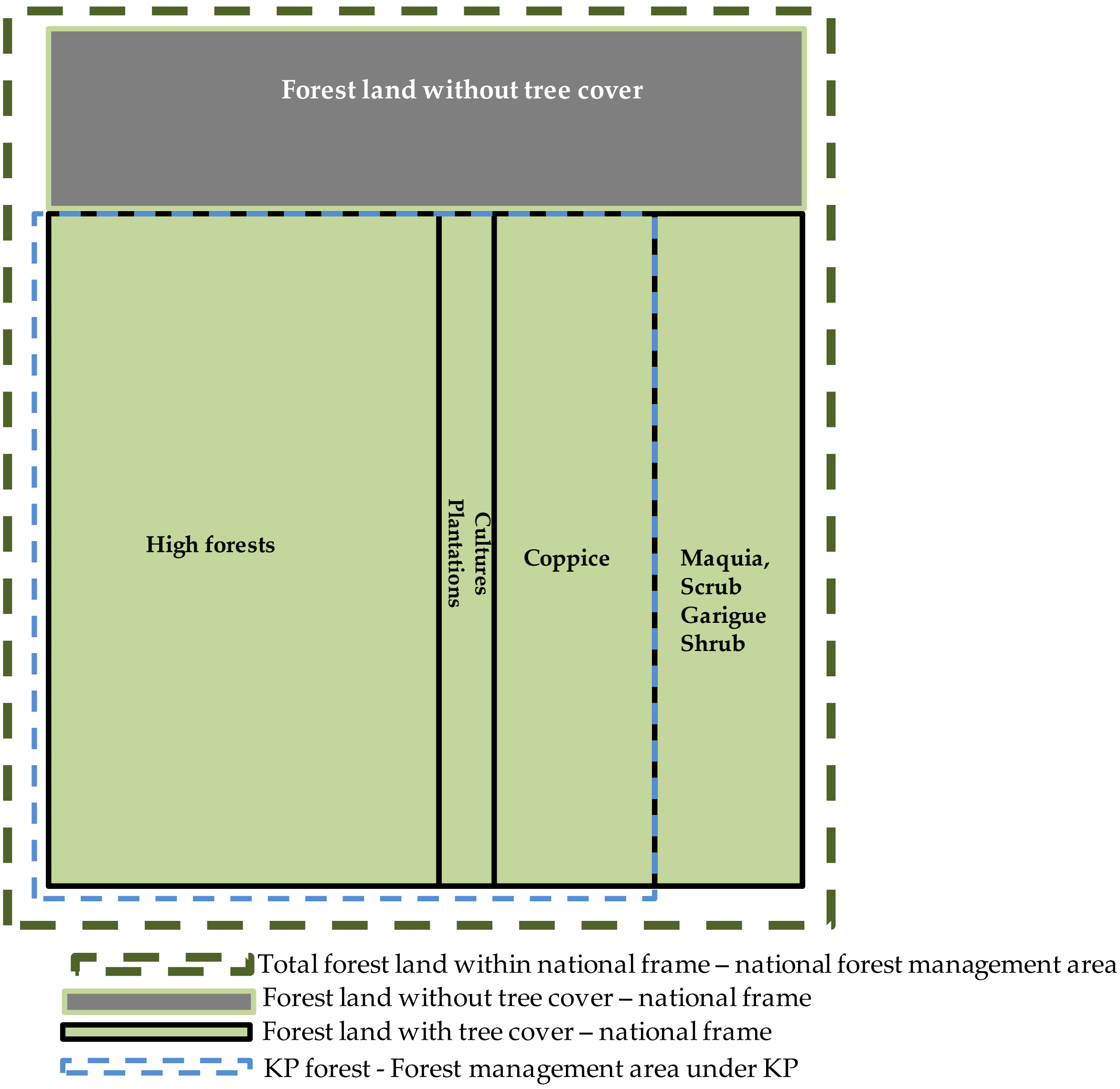

Figure 11.1-1: Forest management area under KP and within the national frame

11.1.4 DESCRIPTION OF PRECEDENCE CONDITIONS AND/OR HIERARCHY AMONG ARTICLE 3.4 ACTIVITIES, AND HOW THEY HAVE BEEN CONSISTENTLY APPLIED IN DETERMINING HOW LAND WAS CLASSIFIED

As Croatia has elected only the *forest management* under Article 3.4 activities, there is no need to develop a hierarchy between *forest management* and other Article 3.4 activities.

11.2 LAND-RELATED INFORMATION

11.2.1 SPATIAL ASSESSMENT UNIT USED FOR DETERMINING THE AREA OF THE UNITS OF LAND UNDER ARTICLE 3.3

The spatial assessment unit to determine the area of units of land under Article 3.3 is 0.1 ha, which is the same as the minimum area of forest.

11.2.2 METHODOLOGY USED TO DEVELOP THE LAND TRANSITION MATRIX

Activity matrices are presented for 2010, 2009 and 2008 (Tables 11.2-1, 11.2-2, 11.2-3).
Corrections have been made in comparison to matrix presented in previous reports. The main reason is the fact that for this year submission Croatia managed to develop matrix, which corresponds to the total area of Croatia. The matrix was developed by adding and subtracting the conversion areas to and from land use category areas using the data from different databases available in Croatia (i.e. Croatian Forests Ltd.,Croatian Bureau of Statistics, Corine Land Cover). Detailed information on approaches used to define the land use change area of each IPCC Land use category are given in parts 7.2-7.7 of the report.

Annual figures for the forest land area, and consequently for *afforestation/reforestation* areas were derived from the *Croatian Forests Ltd* official database. Based on the *Forest Act* and *Forest Ordinance* (OG 111/06, OG 141/08) afforestation works have to be prescribed by the *Forest Management Plan for management units (*FMAP*).* *Deforestation* data were derived also from the *Croatian Forest* database. According to the *Forest Act* deforestation is strictly regulated and allowed in very limited circumstances.
The data for the total forest area for the single years as well as the relative share of coniferous and deciduous and forests out of yield were derived from *Croatian Forests Ltd*, and are based on Forest management plans. The forest management system is organized in a way that complete Croatian territory is divided into 16 forest districts (organizational and territorial units). This division was established in 1996. Districts consist of forest units, currently of 170 units altogether. The single forest unit is the basic organizational unit for performing all expert and technical activities in the forest management (see Chapter 7.2.2).
Within the reporting period, an increase of forest area was noticed. Based on the FMAPs total area of forest land in Croatia is known. Also, based on the strict national legislation, forestland converted to settlements category is well known. Also, the grassland area converted to forestland is well known due to the fact that afforesttation in Croatia has been done strictly on land under the forest management plans (without tree cover) which belongs to the grassland category according to the IPCC GPG. At the same time, categories that were facing with area decrease during the reporting period were grassland and other land categories.
Since the conversion of grassland to forestland is known, and a remaining grassland area decrease to account for the total observed forest land increase was not available, it was concluded that increase of forest area can be only due to conversion of other land to forest land. This only can be happened as a result of poor forest management in areas of some forest districts during the War period in Croatia. Since the War is a human

induced activity, a more thorough investigation on these LUC lands from other land to forests needs to be conducted in Croatia before they are estimated and accounted as AR lands.

Table 11.2-1: Land transition matrix for year 2010, kha

		Article 3.3 activities		Article 3.4 activities				Other	TOTAL 2010
		A/R	D	FM	CM	GM	RV		
Article 3.3 activities	A/R	18,01	0.00						18,01
	D		7,93						7,93
Article 3.4 activities	FM		0,45	1.875,07					1.875,52
	CM	NA	NA		NA	NA	NA		NA
	GM	NA	NA		NA	NA	NA		NA
	RV	NA			NA	NA	NA		NA
Other		1,62	0.00	1.875,07	0.00	0.00	0.00	3.756,32	3.757,94
TOTAL (end of 2010)		19,63	8,38	1.875,07	0.00	0.00	0.00	3.756,32	5.659,40

Table 11.2-2: Land transition matrix for year 2009, kha

		Article 3.3 activities		Article 3.4 activities				Other	TOTAL 2009
		A/R	D	FM	CM	GM	RV		
Article 3.3 activities	A/R	17,49	0.00						17.49
	D		7,64						7,64
Article 3.4 activities	FM		0,29	1.874,86					1.875,15
	CM	NA	NA		NA	NA	NA		NA
	GM	NA	NA		NA	NA	NA		NA
	RV	NA			NA	NA	NA		NA
Other		0,52	0.00	0.00	0.00	0.00	0.00	3.758,60	3.759.12
TOTAL (end of 2009)		18,01	7,93	1.874,86	0.00	0.00	0.00	3.758,60	5.659,40

Table 11.2-3: Land transition matrix for year 2008, kha

		Article 3.3 activities		Article 3.4 activities				Other	TOTAL 2008
		A/R	D	FM	CM	GM	RV		
Article 3.3 activities	A/R	17,08	0.00						17,08
	D		7,23						7,23
Article 3.4 activities	FM		0,41	1.874,13					1.874,54
	CM	NA	NA		NA	NA	NA		NA
	GM	NA	NA		NA	NA	NA		NA
	RV	NA			NA	NA	NA		NA
Other		0,41	0.00	0.00	0.00	0.00	0.00	3.760,13	3.760,54
TOTAL (end of 2008)		17,49	7,64	1.874,13	0.00	0.00	0.00	3.760,13	5.659,40

11.2.3 MAPS AND/OR DATABASE TO IDENTIFY THE GEOGRAPHICAL LOCATIONS, AND THE SYSTEM OF IDENTIFICATION CODES FOR THE GEOGRAPHICAL LOCATIONS

Geographical units used for reporting are basically related to the ownership (state and private forests). The annex to FMAP 2006-2015 is composed of certain thematic maps, map on the forest ownership being one of them. The map is prepared by connecting digital spatial data with HS-Fond database, scale 1:100,000. Therefore, the ownership is spatially located (See Chapter 7.2.2). Also, according to the Forests Act, the Overview map of forest areas by main forest species in scale of 1:300 000 makes integral part of the *Forest Management Area Plan for the Republic of Croatia*.

11.3 ACTIVITY-SPECIFIC INFORMATION

Data used in the calculations are attained from FMAPs. The data were divided based on the ownership (state - Croatian Forests, state - other legal bodies, private) and forest type (broadleaved, conifers) (Table 11.3-1). Within the KP database, state forests managed by "Croatian Forests" are presented as the *State forests (CF)*, state forests managed by other legal bodies as the *State forests (Other)* and private forests as the *Private forests*. This disaggregation of data was used for presenting the carbon stock in living biomass. Data on carbon stocks in soil are presented in aggregated way without division by type of ownership.

Table 11.3-1: Activity data division for 2008, 2009 and 2010

	Level 1 - Ownership	*Sublevel I*	Level 2 – Forest type
CROATIA	State forests – Croatian Forests	*FD Vinkovci*	broadleaved
			coniferous
		FD Osijek	broadleaved
			coniferous
		FD Našice	broadleaved
			coniferous
		FD Požega	broadleaved
			coniferous
		FD Bjelovar	broadleaved
			coniferous
		FD Koprivnica	broadleaved
			coniferous
		FD Zagreb	broadleaved
			coniferous
		FD Sisak	broadleaved
			coniferous
		FD Karlovac	broadleaved
			coniferous
		FD Ogulin	broadleaved
			coniferous
		FD Delnice	broadleaved
			coniferous
		FD Buzet	broadleaved
			coniferous
		FD Senj	broadleaved
			coniferous
		FD Gospić	broadleaved
			coniferous
		FD Split	broadleaved
			coniferous
		FD Nova Gradiška	broadleaved
			coniferous
	State Forests – Other legal bodies	*State Forests – Other legal bodies*	broadleaved
			coniferous
	Private forests	*Private forests*	broadleaved
			coniferous

11.3.1METHODS FOR CARBON STOCK CHANGE AND GHG EMISSION AND REMOVAL ESTIMATES

11.3.1.1Description of the methodologies and the underlying assumptions used

1)ARD activities

Emissions and removals from ARD activities have been calculated using Tier 1 method for biomass gains and Tier 2 method for biomass losses and for soil and litter (GPG 2003) and Level 1 and Level 2 activity data disaggregation. However, related activity data regarding other state forests are not available and consequently removals from these forests are not accounted. The spatially more explicit calculation at the sublevel I also could not be performed for some ownerships since all required data were not available at this point. The activity data obtained refer to living biomass and soil as follows:

- For afforestation – afforested area
- For deforestation – deforested area and related volume felled

As regarding the afforestation, all units of land were not harvested since the beginning of the commitment period and related emission/removals have been reported.

B)Biomass

To determine the changes in biomass carbon stock in afforested areas in Croatia, following assumptions and steps were applied:

- During the reporting period, only coniferous species were used for the afforestation
- Average annual increment from the IPCC GPG 2003 was used for the aboveground biomass in natural regeneration. Values for the temperate forest, coniferous species in age class less and equal to 20 years and ≥ 20years were applied. The applied value is the same for both age classes (3 t dm/ha annually)
- Mean value of the average Root to Shoot ratio for coniferous species was used (IPCC GPG 2003, value of 0.46)
- IPCC GPG default value of the Carbon fraction (0.5 tC/ t dm) was used

Based on the above mentioned factors, average biomass growth was calculated to be 2.19 tC/ha annually. This constant value was used for all afforested areas of the first age class and multiplied by the total AR area of the first age class. The estimates for the second age class (AR areas that have been changed into second age class since 1990) were calculated by multiplying the average biomass stock of the second age class by the area of the second age class.

In order to calculate the biomass carbon stock losses as a result of grassland conversion to the forestland, the nationally determined value for grassland category of 4.3 tC/ ha annually was used.

As regarding D areas, the losses in living tree biomass per ha in the year of D are calculated using also IPCC GPG 2003 values as follows:

- Harvested stemwood volumes at the D areas according to the information by Croatian Forests Ltd.
- Wood densities (0.588 t dm/m^3 for deciduous and 0.400 t dm/m^3 for coniferous according to IPCC GPG)
- Carbon content of dry matter (0.5 tC/t dm according to IPCC GPG)
- Biomass expansion factor (1.40 for deciduous and 1.30 for coniferous according to IPCC GPG)

As regarding the biomass growth of deforested area, the county specific value of 0.19 tC/ha annually for settlements was used following the fact that deforestation in Croatia occurs only due to conversion to the settlement. Description of the underlying methods and assumptions can be found in related part of the report (Chapter 7.6.4.1).

C)Dead wood

Dead wood occurs only in forest lands. Therefore, this pool would represent a sink at AR lands if estimated or data were available. For D lands, the data of extracted stem volume at these lands according to Croatian Forests Ltd. also account for dead wood. Therefore, the emissions from the dead wood pool at the D lands are included in the emissions from the biomass pool in the D lands and IE is reported for the dead wood pool.

D)Litter

It should be noted that the used soil C stocks of forest land according to the national scientific investigation also include the C stock of the litter (humus layer). Therefore, the changes of the C stocks of the litter layer at ARD lands are included in the C stock changes of the soil pool and IE is reported for the litter pool.

E)Soil

The estimates of the soil carbon stock changes at ARD areas follow the equation below:

$$\Delta C_{LFMineral} = [(SOC_{ref} - SOC_{before\ ARD}) \times A_{ARD}] / T_{ARD}$$

where:

$\Delta C_{LFMineral}$ = annual change in carbon stock in mineral soils for inventory year

SOC_{ref} = reference carbon stock

$SOC_{before\ ARD}$ = stable soil organic carbon on previous land use

T_{ARD} = duration of the transition from $SOC_{before\ ARD}$ to SOC_{ref} (20 years)

A_{ARD} = total AR or D area after conversion still in SOC transition of 20 years

The values of soil carbon stock determined through national scientific investigation were used in order to estimated the carbon stock changes in soil. Conversion that happens in the Croatian case refers to grassland converted to forestland only with following soil C stocks:

- Grassland: 108.5 tC/ha
- Forestland: 111.2 tC/ha

Soil emission factor determined in this case is 0.14 tC/ha annually.

For determination of soil carbon stock changes in deforested areas the used values of soil carbon stocks are presented below, and emission factor was calculated to be -5.37 tC/ha annually.

- Settlements: 3.8 tC/ha
- Forestland: 111.2 tC/ha

Detailed description of the methodologies and the underlying assumptions used are presented in Chapter 7.2.4. *Methodological issues* and Chapter 7.6.4.1.1 *Forest Land Converted to Settlements.*

2) FM activities

Emissions and removals from FM were calculated based on the GPG 2003 and related equations were used covering estimates for the biomass carbon pool.
The entire calculation and description of the methodological approach are presented in Chapter 7.2.4.
The estimates under forest management for the KP reporting refers to high forests, cultures, plantations and coppice. At this moment estimates of the C stock changes of maquia and scrub are not carried out due to the unavailability of a complete dataset. However, it should be noted that there is no biomass harvest in maquia and scrub lands. Therefore, for these lands in accordance with the IPCC GPG no human induced C stock change is assumed.

CO_2 removal in 2008, 2009 and 2010, divided by ownership, are presented in Table 11.3-2. Regarding the state and private forests, the removal increased due to increased increment.

Table11.3-2: CO_2 removal in state and private forests in 2008, 2009 and 2010

Year	CO_2 removal / Gg CO_2			
	State forests (CF)	State forests (Other)	Private forests	TOTAL
2008	-4.482,18	- 687,41	- 3.432,65	**- 8.602,24**
2009	-3.986,10	- 721,00	- 3.477,12	**- 8.184,22**
2010	-4.633,32	- 638,91	- 3.486,31	**- 8.758,54**

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Omitting GHG emissions/removals

Table 5(KP-I)A.1.2 Article 3.3 activities: Afforestation and Reforestation. Units of land harvested since the beginning of the commitment period

Since fellings are not performed on afforested area due to the young age of the forests and the Croatian way of forest management, Croatia uses the notation key NO.

Table 5(KP-I)A.2.1 Article 3.3 activities: Deforestation. Units of land otherwise subject to elected activities under Article 3.4 (information item)

Only forest management has been elected under Article 3.4. As Deforestation is a permanent loss of forest cover, any unit of land that has been deforested under Article 3.3 cannot also be subject to the forest management under Article 3.4.

Table 5(KP-II)1. Direct N_2O emissions from N fertilization

N fertilization of forests is not performed in Croatia, so emissions are reported as not occurring.

Table 5(KP-II)2. N_2O emissions from drainage of soils

Drainage of soils does not occur in Croatia.

Table 5(KP-II)3. N_2O emissions from disturbance associated with land use conversion to cropland.

Deforestation to Cropland is not occurring in Croatia, as total deforested area was transition into settlements.

Table 5(KP-II)4. Carbon emissions from lime application

No lime is applied to forests, so emissions are reported as not occurring.

Controlled biomass burning

Controlled biomass burning does not occur in Croatia. All fires can be addressed as wildfires.

Wildfire

Currently, there are no data available presenting wildfires on AR and FM area separately. Therefore, all emissions of wildfires are reported under FM and IE is reported in the corresponding ARD tables.

Omitting carbon pools

Croatia estimated the aboveground and belowground biomass, dead wood, litter and soil for Article 3.3 and the aboveground and belowground biomass for 3.4 activities. As for other carbon pools, based on the forest management practices and the legal framework within which the latter is performed, it is concluded that these pools do not represent emission sources. The background information in this regard is as follows:

ARD activities

As for afforestation areas and the dead wood carbon pool, it is considered that conversion of Grassland to Forestland cannot generate carbon stock changes in terms of losses of dead wood, especially in the long-term. Generally, afforestation is performed on the land under forest management that is without tree cover. Based on the IPCC GPG land use category definitions, this type of land falls under the Grassland category. Since there is no dead wood stock in Grassland area, conversion of this type of land to the Forest land contributes to an increase in the dead wood pool and is not a source of emissions.

As regarding the deforestation and reporting of carbon stock changes in dead wood, it is included in the figures of extracted stemwood and therefore included in the C stock losses of the biomass pool.

Based on the applied methodology during the scientific research on soil carbon stock in land use categories in Croatia (see Chapter 7.3.4.1), soil carbon stock measurement was performed including the litter pool. Therefore, the litter carbon stock changes at ARD lands are included in the reported soil C stock changes.

FM activities

a) Dead wood

According to FRA 2005, carbon stock in this pool for forest land has increased in Croatia from 1990-2005:

FRA 2005	1990	2000	2005
dead wood / Mt C	20.8	26	27

The latter clearly indicates that this pool is not an emission source.

Data on wood removal from FRA reports (for 1990 FRA 2005 and for 2000 and 2005 FRA 2010) were compared to NIR data on fellings. The comparison indicated that not all wood was removed from the forest and that certain percentage (about 10-15%) was left in the forest; thus contributing to a C input in other carbon pools. Reporting on wood removals under the FRA fits adequately to the wood removals practices conducted in Croatia that is performed in a way that harvest residues and wood less than 7 cm in diameter are left in the forest. Within the KP Forest management reporting, total gross fellings (i.e. including branches and bark) are reported. Considering the latter, there are no underestimations in regard to dead wood.

Furthermore, there is a steady increase in the standing stocks in Croatia while the forest management methods remain the same. Under such circumstances and due to the fact that mortality is correlated with stand density also an increase in dead wood stocks as indicated by the FRA results is very likely.
Also, it should be mentioned that the forest management practice is governed by the strict legal framework which prohibits for example cutting the branches or their parts (unless it is provided by the forest management plans), collecting and removing leaf litter, moss etc. (*Forest Act*, Article 32, OG 140/05, 82/06, 129/08, 80/10, 124/10).
So, from all this facts we assume that the dead wood pool in the Croatian forests represents a C sink.

b) litter

Following the legal framework mentioned above that prohibits the removal of peat, litter and humus from the forest and herein reported data that clearly indicate increase of biomass stock and increment and harvest, it can be concluded that a decrease in the carbon stocks of the litter pool is unlikely. In addition to this, based on the Forest act, exceptionally and under strict conditions, the usage of humus can be allowed but only if it is in accordance with the forest management plans and special legal regulations. By taking the latter into account and evidence for a rise in the C input into litter/soil due to the increase in biomass standing stock and in harvest causing an increase in the input of harvest residues, it can be concluded that the litter pool of the Croatian forests is not an emission source.

c) soil

Within the reporting period, there was no change in the forest management. Based on this fact and explanations provided under *the dead wood* and *litter* pools, it can be concluded that also the soil carbon stock under forest management is not a source of emissions because the increase in biomass stock and harvest is correlated with a higher litter input to the soil and consequently with an increase of carbon stock in litter and soil.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Croatia has not factored out removals from elevated carbon dioxide concentrations, indirect nitrogen deposition or the dynamic effects of age structure resulting from activities prior to 1 January 1990, considering also that GPG gives no methods for factoring out. For the first commitment period, the effect of indirect and natural removals will be considered through the cap under Article 3.4 credits from the *Forest management*. For Croatia the cap is 0.265 Mt C per year.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

Recalculation made after submitting version 1.1 of the report:

- New activity data on afforested areas in private forests within the period 1996-2006 are included in this version of the report
- Reduction of area when calculating losses that arises from grassland conversion to forestland were found unjustified
- Data on deforestation for 2010 were corrected. Incorrect input data were put into the Excel sheet.
- New activity data on deforested areas in private forests for 2006 are included in calculation

11.3.1.5 Uncertainty estimates

The LULUCF sector calculation has many input parameters that lead to uncertainty, in respect to accuracy and precision. If data are not available from the field, or national data bases, an expert may provide estimations or use default values. The *good practice* (as defined in GPG) requires that inventories should be accurate in the sense that they are neither over- nor underestimated as far as can be judged, and uncertainties are reduced as far as practicable.

Based on the improvements explained in Chapter *Methodological issues* (regarding the Forest land), it could be concluded that uncertainty of the estimates has decreased.

Some of the assumptions and parameters, implemented for calculation, certainly lead to bias of final results. In Table 11.3-3 given below is a list of elements which should be improved in future works, by additional research, on field measurement and data collection.

Table 11.3-3: Uncertainty elements for state forests

Uncertainty elements	Bias
The biomass of maquis, scrubs and first age class (trees bellow 10 cm in diameter) are not included in the calculation of gains and losses, but they belong to KP definition of forests	+
BEF1 and BEF2 factors should be adjusted according to a better representation of national situation	+

+ means that element, if corrected, will create higher carbon sink

In total, if all the above mentioned pluses and minuses are summing up, the judgment is that carbon sink is more underestimated than overestimated.

Since the same methodology was applied for both the UNFCCC and the KP reporting frame, the uncertainty estimates rely on the same assumptions and judgements already presented in subchapters 11.2.5. and 11.3.5.A specific uncertainty estimates for the KP reporting needs to be conducted until 2014.

11.3.1.6 Information on other methodological issues

No information on other methodological issues.

11.3.1.7 The year of the onset of an activity, if after 2008

For 2008-2010, Croatia reports afforestation, deforestation and forest management activities.

11.4 ARTICLE 3.3

In the period 1990-2010, afforestation activities resulted in net removals while deforestation presented a net source. The data are presented in Table 11.4-1.

Table 11.4-1: Emissions/removals of Article 3.3 activities [Gg CO_2]

	Article 3.3 - Total	**AR** Biomass (Aboveground + belowground)	**AR** Dead wood	**AR** Litter	**AR** Soil	**D** Biomass (Aboveground + belowground)	**D** Dead wood	**D** Litter	**D** Soil
2008	98,55	-134,19	NO	IE	-8,68	91,01	IE	IE	150,42
2009	84,73	-136,74	NO	IE	-8,94	74,31	IE	IE	156,10
2010	81,40	-132,40	NO	IE	-9,06	66,70	IE	IE	156,16

In each year, mentioned activities altogether resulted in emissions.

11.4.1 INFORMATION DEMONSTRATING THAT ACTIVITIES UNDER ARTICLE 3.3 BEGAN ON OR AFTER 1 JANUARY 1990 AND BEFORE 31 DECEMBER 2012 AND ARE DIRECTLY HUMAN-INDUCED

All data regarding the Article 3.3 activities were attained from HS database related to FMAPs. As mentioned previously, there are three main FMAPs. The first FMAP in this sense is the FMAP encompassing the period from 1986-1995 thus including 1990.

As stated earlier, *afforestation in national circumstances is the activity within the biological forest renewal and it refers to afforestation of non-forest land and establishing plantations of fast growing species*. This activity mentioned is laid down in forest management plans with a clear indication of the time when it is carried out; thus is human induced and not a result of natural succession.
Deforestation requires land use change and relies on a strict legal frame. It is mainly performed due to large infrastructure projects.
Therefore, all activities reported under Article 3.3 (afforestation and deforestation) began on or after 1 January 1990 and are human induced.

11.4.2 INFORMATION ON HOW HARVESTING OR FOREST DISTURBANCE THAT IS FOLLOWED BY THE RE-ESTABLISHMENT OF FOREST IS DISTINGUISHED FROM DEFORESTATION

The main criteria for distinguishing the harvesting or forest disturbance followed by the re-establishment of forest from deforestation is whether or not the land use has changed, which is strictly regulated by the legal framework. More detailed information is provided below.

While comparing and interpreting definitions within the IPCC framework and within the national legislation, it was concluded that deforestation in national circumstances referred to clear cutting intended for land use change of forest land in accordance with the spatial planning documents. However, this activity is forbidden except in very specific cases which are regulated by the *Forest Act*, Article 35 and 51 (OG 140/05, 82/06, 129/08, 80/10, 124/10). Since all forest land in Croatia can be considered managed, if a certain forest land area is permanently removed from the forest management area (in specific circumstances, e.g. for road construction), then this event should be reported as deforestation.

The re-establishment of forest on harvested areas or areas affected by forest disturbance is also regulated by the *Forest Act* (Article 10 and 28) and the *Regulation on Forest Management* (OG 111/06, 141/08).
The FMAPs make a clear distinction between areas that are deforested and areas that are cleared for forest management purposes, all consistent with the provisions of the Forest Act. By that, both activities can be easily distinguished.

11.4.3 INFORMATION ON THE SIZE AND GEOGRAPHICAL LOCATION OF FOREST AREAS THAT HAVE LOST FOREST COVER BUT WHICH HAVE NOT YET BEEN CLASSIFIED AS DEFORESTED

Generally, forest cover can be lost through harvesting or forest disturbance which represent a temporary loss. Permanent loss of forest cover includes land use change. Therefore, there are no forest areas that have permanently lost forest cover but which have not yet been classified as deforested.

11.5 ARTICLE 3.4

11.5.1 INFORMATION DEMONSTRATING THAT ACTIVITIES UNDER ARTICLE 3.4 HAVE OCCURRED SINCE 1 JANUARY 1990 AND ARE HUMAN-INDUCED

Croatia has a very long tradition in the forest management. As stated before, all data have been obtained from FMAPs, the first covering the period from 1986-1995 (thus including 1990). Since forest management area under the KP is all managed based on the FMAPs, if human induced is assumed equivalent with the managed, then it is demonstrated that the forest management as an activity under Article 3.4 of the KP is human induced. Croatia has stock and harvest data in an annual resolution. Therefore, an easy assessment of the year of activity is possible.

11.5.2 INFORMATION RELATED TO THE CROPLAND MANAGEMENT, GRAZING LAND MANAGEMENT AND REVEGETATION, IF ELECTED, FOR THE BASE YEAR

Croatia has not elected these activities for the first commitment period.

11.5.3 INFORMATION RELATED TO THE FOREST MANAGEMENT

As stated before, all forest management area within the national frame is managed based on the FMAP and is even wider than the forest management area under the KP because it includes, for example, afforested area and also "forest land" (in Croatian sense) that is covered with vegetation which does not reach the selected thresholds for the KP definition of forest (all land under FMAPs, see Figure 5.1-1).

Forest management resulted in net removals in 2008, 2009 and 2010. Carbon stock changes in living biomass resulted in removals presented in Table 11.5-1.

Table 11.5-1: Emissions/removals of Article 3.4 activity

Activity	Emissions/removals / Gg CO_2		
	2008	2009	2010
Forest Management	**- 8.602,24**	**- 8.184,22**	**- 8.758,54**

11.6 OTHER INFORMATION

There is no 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 only key category, also reported in CRF table NIR.3, is the elected activity under Article 3.4 – Forest Management.

11.7 INFORMATION RELATED TO ARTICLE 6

Croatia is not participating in any project under Article 6.

12. INFORMATION ON ACCOUNTING OF KYOTO UNITS

Information on accounting of Kyoto units is presented in Table 12.1-1.

Table 12.1-1: Information on accounting of Kyoto units

Annual Submission Item	HR report
15/CMP.1 annex I.E paragraph 11: Standard electronic format (SEF)	The Standard Electronic Format report for 2011 has been submitted to the UNFCCC Secretariat electronically and the contents of the report can also be found in annex 6 of this document.
15/CMP.1 annex I.E paragraph 12: List of discrepant transactions	No discrepant transactions occurred in 2011.
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	No CDM notifications occurred in 2011.
15/CMP.1 annex I.E paragraph 15: List of non-replacements	No non-replacements occurred in 2011.
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2011.
15/CMP.1 annex I.E paragraph 17 Actions and changes to address discrepancies	No actions were taken or changes made to address discrepancies for the period under review.
15/CMP.1 annex I.E Publicly accessible information	The public website of Croatian National registry can be found at http://www.azo.hr/ghgregistry. The web site and the CR user interface is bilingual: Croatian and English. CR user interface will be publicaly available through the Internet after 1.1.2013. when the registry became operational. Croatian National registry is in reconciliation mode only until 1.1.2013. when Croatia is obliged to join to the Emission Trading Scheme (ETS) because of accession to European Union. In 2011 Croatian did not make any transactions and did not have any units on accounts (including AAUs) because of not solved pending issues. For more details please check documents: **FCCC/KP/CMP/2010/2 "Appeal by Croatia against a final decision of the enforcement branch of the Compliance Committee".** http://unfccc.int/resource/docs/2010/cmp6/eng/02.pdf **CC-2009-1-11/Croatia/EB** http://unfccc.int/files/kyoto_protocol/compliance/questions_of_implementation/application/pdf/cc-2009-1-11_croatia_eb_decision_on_r_&_a_of_plan.pdf

Annual Submission Item	HR report
	CC-2009-1-12/Croatia/EB http://unfccc.int/files/kyoto_protocol/compliance/enforcement_branch/application/pdf/cc-2009-1-12_croatia_eb_revised_plan.pdf **CC-2009-1-13/Croatia/EB** http://unfccc.int/files/kyoto_protocol/compliance/questions_of_implementation/application/pdf/cc-2009-1-13_croatia_eb_confirmation_of_cad_update.pdf **CC-2009-1-14/Croatia/EB** http://unfccc.int/files/kyoto_protocol/compliance/questions_of_implementation/application/pdf/cc-2009-1-14_croatia_eb_decision_on_reinstatement.pdf All required public information pursuant to paragraph 44 to 48 of the annex to decision 13/CMP.1. will be publicly available after joining HR to the EU ETS which will take place on 1.1.2013. According to the previous ERT recommendations Croatia made changes of publicly availabe information. Please check below list: • updates related to publicly accessible user interface through the Internet according to the paragraph 44 of the annex to decision 13/CMP.1 • updates related to information about accounts according to the paragraph 45 of the annex to decision 13/CMP.1 • updates related to information about Article 6 project information according to the paragraph 46 of the annex to decision 13/CMP.1 • updates related to information about unit holdings and transactions according to the paragraph 47 of the annex to decision 13/CMP.1 • updates related to information about list of legal entities authorized by the Party to hold units according to the paragraph 48 of the annex to decision 13/CMP.1
15/CMP.1 annex I.E paragraph 18 CPR Calculation	Total emissions without LULUCF = 28,597,025.08 t CO_2eq CPR = 5 x 28,597,025.08 t CO_2eq = 142,985,125.42 t CO_2eq

13. INFORMATION ON CHANGES IN NATIONAL SYSTEM

National system was changed compared to the description given in last inventory submission in May 2010 in part related to legal arrangements where new Air Protection Act was enacted in November 2011. Air Protection Act in part related to greenhouse gas monitoring is further strengthening obligation for activity data collection by sectoral competent authorities, including penalties for non-compliance and establishment of Committee for cross-sectoral coordination for national system. These two elements were previously identified as system's shortcomings and it is believed that activity data flow and verification will be more streamlined and less time-consuming.

Currently, Ministry of Environmental and Nature Protection is in the process of revision of the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia in order to align with: requirements of Decision 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementation the Kyoto Protocol, Decision 2005/166/EC laying down the rules implementing Decision 280/2004/EC and with proposal for a regulation on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change. It is expected that new regulation will be enacted in the first half of 2012.

14. INFORMATION ON CHANGES IN NATIONAL REGISTRY

Information on changes in National Registry is presented in Table 14.1-1.

Table 14.1-1: Information on changes in National Registry

Annual Submission Item	HR report
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No change in the name or contact information of the registry administrator occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(b) Change of cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database or the capacity of national registry	No change to the database or to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change of conformance to technical standards	No change in the registry's conformance to technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change of discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change of security	No change of security measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(g) Change of list of publicly available information	No change to the list of publicaly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry Internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change of data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change of test results	No change of test results occurred during the reporting period.

Annual Submission Item	HR report
The previous Annual Review recommendations	1.FCCC/ARR/2010/HRV 147. The ERT recommends that once the assigned amount is established, the CPR be calculated fully in accordance with paragraphs 6 and 8 of the annex to decision 11/CMP.1. Based on the most recently reviewed GHG inventory (31,233.29 Gg CO2 eq.), which includes the calculated adjustments to the emissions in 2008,the ERT calculates the CPR to be 156,166.446 t CO2 eq. **HRV_SIAR_Part2_Assessment_Report v1.0. ref Nr P2.4.1.4** Please check **CC-2009-1-13/Croatia/EB (12 January 2012)** http://unfccc.int/files/kyoto_protocol/compliance/questions_of_implementation/application/pdf/cc-2009-1-13_croatia_eb_confirmation_of_cad_update.pdf AAU = 148.778.503 tCO_2eq CPR =133.900.653 tCO_2eq 2.FCCC/ARR/2010/HRV 145 b. The ERT reiterates the recommendation of the SIAR assessor who recommends that Croatia make publicly available the information required under paragraphs 45–48 of the annex to decision 13/CMP.1, and report, in its next annual submission, any changes to that public information. Public information are updated with all availabe information referred to in paragraph 45-48 of annex to decision 13/CMP.1. and reports. Please check www.azo.hr/ghgregistry 3.The SIAR assessor recommends that Croatia make the required information publicly available once the pending issue on calculation of the assigned amount of Croatia, ref. document FCCC/KP/CMP/2010/2, 19 February 2010, has been resolved, and at the latest when the national registry has transferred or acquired Kyoto Protocol units. **HRV_SIAR_Part2_Assessment_Report v1.0. ref Nr P2.4.2.1** Public information are updated with assigned amount of Croatia. In 2012 Croatia did not make any transaction. The issuance of AAU was made in February 2012 Please check www.azo.hr/ghgregistry

15. INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3.14.

Parties included in Annex I are required to provide information relating to how it is striving under Article 3.14 to implement its commitments mentioned in Article 3.1. This section should provide an overview of its commitments under Article 3, paragraph 1, and how these are to be implemented to minimize adverse social, environmental and economic impacts on developing countries.

In its Fifth National Communication Croatia has elaborated on policy and measures for mitigation of climate change in order to fulfill its commitments under Article 3, paragraph 1.

The underlying policy elements are:

- Croatia has become a candidate country for the EU membership in 2004, accession negotiations are near the end, which means that Croatia has harmonized its legislation with the EU acquis communautaire, including the one referred to mitigation of climate change. Accession to the EU is expected by 2012.
- Regarding the development, Croatia had, within the last years prior to economical and financial crisis, high GDP growth rate, at the level of 3.8-5.5% (from 2001-2007). On such bases, with a purpose to come closer to the EU average, regarding that GDP is at this moment less than 50% of the EU average, Croatia was planning its development until 2020 with GDP growth rate of 5% per year. In line with such goal and assumption, the Energy Development Strategy of the Republic of Croatia (OG 130/2009) has been prepared, defining the goals and suggesting measures until 2020, with a view to 2030. The Strategy provides a framework for development without pretension to strictly define fuel structure and penetration of certain types of technology, except for renewable energy sources and energy efficiency.
- Climate change mitigation measures are determined by the Air Quality Protection and Improvement Plan of the Republic of Croatia for the period 2008-2011. Majority of measures has a long-term character and their implementation and effect will be clearly seen within the period after 2011.

Air Quality Protection and Improvement Plan determine 33 basic measures that are in a phase of implementation, while some of them in a phase of preparation, as it follows:

- Promoting the application of renewable energy sources in electricity generation
- Promoting the application of cogeneration (simultaneous generation of thermal and electrical energy)
- Reduction in fossil fuel consumption through utilization of biodegradable municipal wastes in district heating plants or landfill biogas
- Reduction in fossil fuel consumption through the use of biodegradable municipal wastes in cement industry
- Loan programme for the preparation of renewable energy sources projects in Croatia through the Croatian Bank for Reconstruction and Development
- Promoting the use of renewable energy sources and energy efficiency through the Environmental Protection and Energy Efficiency Fund
- Promoting energy efficiency through implementation of the project "Removal of Barriers to Energy Efficiency in Croatia"

- HEP ESCO energy efficiency programme
- Measures of energy efficiency upgrading in building sector
- Energy efficiency labelling of household appliances
- Setting up a framework for the establishment of ecological design requirements
- Raising attractiveness of rail transport
- Introduction of biofuel
- Promoting the use of low CO2 vehicles
- Promoting the use of gas in vehicles
- N_2O emission reduction measure in nitric acid production
- Burning or thermal utilization of methane captured at landfills
- Action plan for the sector of agriculture from the aspect of adaptation to climate change and reduction of greenhouse gas emissions
- Decision on taking advantage of Article 3.4 of the Kyoto Protocol
- Establishment of the system of trading in CO2 emission allowances
- Increasing CO_2 charge
- Reporting under the UNFCCC and the Kyoto Protocol
- Capacity building program for implementation of the UN Framework Convention on Climate Change and the Kyoto Protocol
- Active participation in international negotiations about the commitment period after 2012 («Post-Kyoto»)
- Preparation of plans, programmes and studies for efficient implementation and creation of the climate change policy
- Establishment of a research and development programme focusing on climate change issues
- National energy programmes
- Public education and information programme
- Support to programmes and projects of the technology and know-how transfer
- Establishment of infrastructure for application of flexible mechanisms under the Kyoto Protocol
- Implementation of JI projects in Croatia
- Facilitating investments in CDM and JI project activities in other countries
- Inclusion of Croatia into the European emission trading scheme

Beside these measures, ten more measures are in preparation or adoption phase. The most important is that the Croatian legislation is harmonized with the EU acquis communautaire and it performs the same climate change policy as other EU member states do. Strong stimulation of measures began with the establishment of the Environmental Protection and Energy Efficiency Fund in 2003. Long-term the most important measures were defined by new energy strategy from 2009, which determines 20% of renewable energy sources in gross final energy consumption in 2020 and stimulates energy efficiency in accordance with the relevant EU directives.

ANNEX 1

KEY CATEGORIES

A1.1. DESCRIPTION OF METHODOLOGY USED FOR INDENTIFYING KEY CATEGORIES

Key categories according to the IPCC Good Practice Guidance (IPCC, 2000) are those found in the accumulative 95% (Tier 1) or 90% (Tier 2) of the total annual emissions in the last reported year or belonging to the total trend, when ranked from contributing the largest to smallest share in annual total and in the trend. As originally designed it applied only to source categories. In addition, *Good Practice Guidance for Land Use, Land-Use Change and Forestry* expands the original approach to enable the identification of key categories that are either sources or sinks, which provides on how to indentify key categories for the LULUCF. Therefore, the key category analysis was determined using both approaches:

- excluding LULUCF
- including LULUCF

Following the *Good Practice Guidelines*, Croatia undertook a key category analysis using Tier 1 and Tier 2 Level and Trend methods.

The IPCC and *Good Practice Guidance for Land Use, Land-Use Change and Forestry* also recommended which sources should be checked for their key category status, Table A1.1-1. Additionally, other sources of direct greenhouse gas emissions not listed in above mentioned guidance were added to the list, e.g. CO_2 Emissions from Natural Gas Scrubbing, CO_2 Emissions from Solvent and Other Product Use.

Level assessment

Level assessment involves an identification of categories as a key by calculating the proportion of emissions and removals in each category to the total emissions and removals. The calculated values of proportion are added from the category that accounts for the largest proportion, until the sum reaches 95% for Tier 1, 90% for Tier 2. Tier 1 level assessment uses emissions and removals from each category directly and Tier 2 level assessment analyzes the emissions and removals of each category, multiplied by the uncertainty (which is calculated in uncertainty analysis chapter) of each category.

Trend Assessment

The purpose of the trend assessment is to identify categories that may not be large enough to be identified by the level assessment, but whose trend is significantly different from the trend of the overall inventory and should therefor recive particular attention.

The difference between the rate of change in emissions and removals in a category and the rate of change in total emissions and removals is calculated. The trend assessment is calculated by multiplying this value by the ratio of contribution of the relevant category to total emissions and removals. The calculated results, regarded as trend assessment values, are added from the category of which the proportion to the total of trend assessment values is the largest, until the total reaches 95% for Tier 1, 90% for Tier 2. At this point, these categories are defined as the key categories. Tier 2 trend assessment is calculated multiplying the tier 1 trend assessment with uncertainty of each category (Table A5.2-1, Table A5.2-2).

Table A1.1-1: Categories Assessed in Key Category Analysis

Source Categories Assessed in Key Source Category Analysis	Direct GHG	Special Considerations
ENERGY SECTOR		
CO_2 Emissions from Stationary Combustion - Coal	CO_2	
CO_2 Emissions from Stationary Combustion - Oil	CO_2	
CO_2 Emissions from Stationary Combustion - Gas	CO_2	
Non-CO_2 Emissions from Stationary Combustion	CH_4	
Non-CO_2 Emissions from Stationary Combustion	N_2O	
Mobile Combustion - Road Vehicles	CO_2	
Mobile Combustion - Road Vehicles	CH_4	
Mobile Combustion - Road Vehicles	N_2O	
Mobile Combustion: Water-borne Navigation	CO_2	
Mobile Combustion: Water-borne Navigation	CH_4	
Mobile Combustion: Water-borne Navigation	N_2O	
Mobile Combustion: Aircraft	CO_2	
Mobile Combustion: Aircraft	CH_4	
Mobile Combustion: Aircraft	N_2O	
Combustion - Agriculture/Forestry/Fishing	CO_2	
Combustion - Agriculture/Forestry/Fishing	CH_4	
Combustion - Agriculture/Forestry/Fishing	N_2O	
Fugitive Emissions from Coal Mining and Handling	CH_4	
Fugitive Emissions from Oil and Gas Operations	CH_4	
CO_2 Emissions from Natural Gas Scrubbing	CO_2	IPCC doesn't offer methodology for estimating emission of CO_2 scrubbed from natural gas and subsequently emitted into atmosphere. Natural gas produced in Croatian gas fields has a large amount of CO_2, more than 15 percent. The maximum volume content of CO_2 in commercial natural gas is 3 percent and gas must be cleaned before coming to pipeline and transport to users. Because of that, the Scrubbing Units exist at largest Croatian gas field. The CO_2, scrubbed from natural gas, is emitted into atmosphere. The emission is estimated by material balance method.
INDUSTRIAL SECTOR		
CO_2 Emissions from Cement Production	CO_2	
CO_2 Emissions from Lime Production	CO_2	
CO_2 Emissions from Iron and Steel Production	CO_2	
N_2O Emissions from Nitric Acid Production	N_2O	
N_2O Emissions from Adipic Acid Production	N_2O	
PFC Emissions from Aluminium production	PFC	
CO_2 Emissions from Ammonia Production	CO_2	
CO_2 Emissions from Ferroalloys Production	CO_2	
CO_2 Emissions from Aluminium production	CO_2	
Sulfur hexaflouride (SF_6) from Magnesium Production	SF_6	
SF_6 Emissions from Electical Equipment	SF_6	
SF_6 Emissions from Other Sources of SF_6	SF_6	
SF_6 Emissions from Production of SF_6	SF_6	
PFC, HFC, SF_6 Emissions from Semiconductor manufacturing		
Emissions from Substitutes for Ozone Depleting Substances (ODS Substitutes)		
HFC-23 Emissions from HCFC-22 Manufacture	HFC-23	
HFC Emissions from Consumption of HFCs, PFCs and SF_6	HFC	
SOLVENT AND OTHER PRODUCT USE	CO_2	
AGRICULTURE SECTOR		
CH_4 Emissions from Enteric Fermentation in Domestic	CH_4	
CH_4 Emissions from Manure Management	CH_4	

N_2O Emissions from Manure Management	N_2O	
CH_4 and N_2O Emissions from Savanna Burning		
CH_4 and N_2O Emissions from Agricultural Residue Burning		
Direct N_2O Emissions from Agricultural Soils	N_2O	

Table A1.1-1: Categories Assessed in Key Category Analysis (cont.)

N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	
CH_4 Emissions from Rice Cultivation	CH_4	
LULUCF		
Forest land remaining forest land	CO_2	
Forest land remaining forest land	CH_4	
Forest land remaining forest land	N_2O	
Total Cropland	CO_2	
Total grassland	CO_2	
Total wetlands	CO_2	
Total settlements	CO_2	
Total Otherland	CO_2	
Land converted to Forest land	CO_2	
Land converted to Settlements	CO_2	
WASTE SECTOR		
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	
Emissions from Waste Water Handling	CH_4	
Emissions from Waste Water Handling	N_2O	
Emissions from Waste Incineration	CO_2	
Emissions from Waste Incineration	N_2O	

The reference to the summary overview for Key Categories 2010 in CRF tables is the Excel file HRV-2011-2010-v1.1, Table 7.

The level of disaggregation is in accordance with the suggested source categories split of the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* and additionally, with the LULUCF category following the *Good Practice Guidance for Land Use, Land-Use Change and Forestry*.

This year Approach 2 has been done for the first time in defining and calculating key categories.
Using the aggregate emission factors for each sector, the differences between various types of coal and especially liquid fuel are not included, nor are the differences in the technology and the contribution of equipment for emission reduction. Therefore, the uncertainties associated with emission estimates of these gases are greater than estimates of CO_2 emissions from the fossil fuel combustion.
Uncertainty of N_2O emission is estimated to factor 2 (the emission could be twice larger or smaller than the estimated one).
Because of the high uncertainties (200%) for categories Fuel Combustion - Stationary Sources (N_20) and Mobile Combustion - Road Vehicles (N_20), they were calculated as key categories.

(Table A1.2-7: Level Assessment - Tier 2 (Excluding LULUCF)-1990) ,(Table A1.2-9: Key categories analysis – Trend Assessment - Tier 2 (Excluding LULUCF)-2010), (Table A1.2-11: Key categories analysis – Level Assessment - Tier 2 (Excluding LULUCF)-2010), (Table A1.2-8: Key categories analysis – Level Assessment - Tier 2 (Including LULUCF)-1990) and (Table A1.2-12: Key categories analysis – Trend Assessment - Tier 2 (Including LULUCF)-2010).

A1.2. TABLES 7.A1-7.A3 OF THE IPCC GOOD PRACTICE GUIDANCE

Table A1.2-1: Key categories analysis – Level Assessment - Tier 1(Excluding LULUCF)-1990

Tier 1 Analysis - Level Assessment – Excluding LULUCF				
IPCC Source Categories	Direct GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Level Assessment	Cumulative Total (%)
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	0.270	27%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	0.142	41%
Mobile Combustion - Road Vehicles	CO2	3559.716	0.113	53%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.088	61%
Direct N2O Emissions from Agricultural Soils	N2O	1333.134	0.042	66%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.039	70%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	0.038	73%
CO2 Emissions from Cement Production	CO2	1085.790	0.035	77%
PFC Emissions from Aluminium production	PFC	936.564	0.030	80%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	0.030	83%
Combustion - Agriculture/Forestry/Fishing	CO2	839.189	0.027	85%
Nitric Acid Production	N2O	803.886	0.026	88%
CO2 Emissions from Ammonia Production	CO2	466.009	0.015	89%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	0.013	91%
N2O Emissions from Manure Management	N2O	381.844	0.012	92%
Emissions from Waste Water Handling	CH4	278.732	0.009	93%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	0.008	94%
Solid Waste Disposal Sites	CH4	242.623	0.008	94%
CH4 Emissions from Manure Management	CH4	228.623	0.007	95%
Fuel Combustion - Stationary Sources	CH4	168.641	0.005	96%
Mobile Combustion: Domestic Aviation	CO2	154.724	0.005	96%
CO2 Emissions from Lime Production	CO2	153.440	0.005	97%
Mobile Combustion: Railways	CO2	138.142	0.004	97%
Mobile Combustion: Water-borne Navigation	CO2	132.980	0.004	98%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.004	98%
Aluminium Production	CO2	111.372	0.004	98%
Emissions from Waste Water Handling	N2O	90.235	0.003	99%
Total Solvent and Other Product Use	CO2	82.417	0.003	99%
Fuel Combustion - Stationary Sources	N2O	62.365	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.491	0.002	99%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.002	99%
Mobile Combustion - Road Vehicles	N2O	40.247	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	0.001	100%
Mobile Combustion - Road Vehicles	CH4	34.117	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	0.001	100%

CO2 Emissions from Iron and Steel Production	CO2	21.447	0.001	100%
Production of Chemicals	CH4	15.798	0.001	100%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.954	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
TOTAL		**31,448.699**		

Table A1.2-2: Key categories analysis – Level Assessment - Tier 1(Including LULUCF)-1990

Tier 1 Analysis - Level Assessment – Including LULUCF				
IPCC Source Categories	Direct GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Level Assessment	Cumulative Total (%)
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	0.215	22%
Forest land remaining forest land	CO2	7059.300	0.179	39%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	0.113	51%
Mobile Combustion - Road Vehicles	CO2	3559.716	0.090	60%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.070	67%
Direct N2O Emissions from Agricultural Soils	N2O	1333.134	0.034	70%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.031	73%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	0.030	76%
CO2 Emissions from Cement Production	CO2	1085.790	0.028	79%
PFC Emissions from Aluminium production	PFC	936.564	0.024	81%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	0.024	84%
Combustion - Agriculture/Forestry/Fishing	CO2	839.189	0.021	86%
Nitric Acid Production	N2O	803.886	0.020	88%
Total settlements	CO2	580.666	0.015	89%
CO2 Emissions from Ammonia Production	CO2	466.009	0.012	91%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	0.011	92%
N2O Emissions from Manure Management	N2O	381.844	0.010	93%
Emissions from Waste Water Handling	CH4	278.732	0.007	93%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	0.007	94%
Solid Waste Disposal Sites	CH4	242.623	0.006	95%
CH4 Emissions from Manure Management	CH4	228.623	0.006	95%
Total Cropland	CO2	189.487	0.005	96%
Fuel Combustion - Stationary Sources	CH4	168.641	0.004	96%
Mobile Combustion: Domestic Aviation	CO2	154.724	0.004	96%
CO2 Emissions from Lime Production	CO2	153.440	0.004	97%
Mobile Combustion: Railways	CO2	138.142	0.003	97%
Land converted to Settlements	CO2	137.000	0.003	98%
Mobile Combustion: Water-borne Navigation	CO2	132.980	0.003	98%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.003	98%
Aluminium Production	CO2	111.372	0.003	99%
Emissions from Waste Water Handling	N2O	90.235	0.002	99%
Total Solvent and Other Product Use	CO2	82.417	0.002	99%
Fuel Combustion - Stationary Sources	N2O	62.365	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.491	0.001	99%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.001	99%
Total wetlands	CO2	41.554	0.001	99%
Mobile Combustion - Road Vehicles	N2O	40.247	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	0.001	100%
Mobile Combustion - Road Vehicles	CH4	34.117	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	0.001	100%
Production of Other Chemicals	CH4	15.798	0.000	100%
Forest land remaining forest land	CH4	12.499	0.000	100%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.954	0.000	100%
Total grassland	CO2	9.500	0.000	100%
Forest land remaining forest land	N2O	2.858	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.000	100%
Land converted to Forest land	CO2	0.227	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.000	100%

Emissions from Waste Incineration	CO2	0.043	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.000	100%
Total Otherland	CO2	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
TOTAL		**39,481.790**		

Table A1.2-3: Key categories analysis – Level Assessment - Tier 1(Excluding LULUCF)-2010

Tier 1 Analysis - Level Assessment – Excluding LULUCF					
IPCC Source Categories	Direct GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Current Year (2010) Estimate (Gg eq-CO_2)	Level Assessment	Cumulative Total (%)
Mobile Combustion - Road Vehicles	CO2	3559.716481	5673.398126	0.198385238	20%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539387	5375.516537	0.187969027	39%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.043518	3891.112143	0.136062936	52%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447145	2696.202773	0.094279798	62%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.179639	1526.2651	0.05336986	67%
CO2 Emissions from Cement Production	CO2	1085.789849	1198.26	0.041900302	71%
Direct N2O Emissions from Agricultural Soils	N2O	1333.134496	1165.251293	0.040746066	75%
Nitric Acid Production	N2O	803.885862	815.3	0.028509102	78%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.91959	808.1777737	0.028260054	81%
Solid Waste Disposal Sites	CH4	242.6230166	757.7820382	0.026497835	84%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.0662738	746.1158482	0.026089896	86%
Combustion - Agriculture/Forestry/Fishing	CO2	839.1893711	715.3307369	0.025013414	89%
CO2 Emissions from Ammonia Production	CO2	466.0087331	501.3281562	0.017530253	90%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	487.261397	0.017038372	92%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.95424235	480.07112	0.016786945	94%
Emissions from Waste Water Handling	CH4	278.7322216	209.8233974	0.007337025	95%
N2O Emissions from Manure Management	N2O	381.8439137	203.531586	0.007117015	95%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.1304071	174.8372658	0.006113643	96%
CH4 Emissions from Manure Management	CH4	228.623136	167.1725107	0.005845625	96%
CO2 Emissions from Lime Production	CO2	153.4398697	151.5300882	0.005298647	97%
Total Solvent and Other Product Use	CO2	82.41669965	119.6457318	0.004183727	97%
Mobile Combustion: Water-borne Navigation	CO2	132.9799557	115.1415657	0.004026227	98%
Fuel Combustion - Stationary Sources	CH4	168.6405735	104.2430964	0.003645133	98%
Emissions from Waste Water Handling	N2O	90.23517838	102.9266762	0.003599101	99%
Mobile Combustion: Railways	CO2	138.1421391	89.25497361	0.003121034	99%
Mobile Combustion: Domestic Aviation	CO2	154.7238583	81.10413105	0.002836019	99%
Mobile Combustion - Road Vehicles	N2O	40.24668859	60.36169213	0.002110705	99%
Fuel Combustion - Stationary Sources	N2O	62.36534997	46.0037484	0.001608642	100%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.4905	36.75847112	0.001285356	100%
Total Solvent and Other Product Use	N2O	34.72	31.06665	0.001086327	100%
CO2 Emissions from Iron and Steel Production	CO2	21.44681309	27.27	0.000953567	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.73996	19.9453	0.00069744	100%
Mobile Combustion - Road Vehicles	CH4	34.11705025	14.20344183	0.000496661	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.03845243	1.737453528	6.07546E-05	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.29868284	1.078726635	3.77205E-05	100%
Production of Chemicals	CH4	15.7980942	0.840042	2.93743E-05	100%
Mobile Combustion: Aircraft	N2O	1.355213564	0.710906251	2.48587E-05	100%
Mobile Combustion: Railways	N2O	0.391653938	0.60374856	2.11117E-05	100%
Mobile Combustion: Water-borne Navigation	N2O	0.336673206	0.291403968	1.01897E-05	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190057455	0.16450224	5.75225E-06	100%
Mobile Combustion: Railways	CH4	0.213595515	0.15337161	5.36304E-06	100%
Emissions from Waste Incineration	CO2	0.043223273	0.09899945	3.46178E-06	100%
Mobile Combustion: Aircraft	CH4	0.022951197	0.012039541	4.20994E-07	100%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0	0	100%
Aluminium Production	CO2	111.372	0	0	100%
Other non-specified NEU	CO2	0	0	0	100%
Fugitive Emissions from Coal Mining and Handling	CH4	48.75698205	0	0	100%
PFC Emissions from Aluminium production	PFC	936.564272	0	0	100%
TOTAL		**31,448.699**	**28,597.8845**		

Table A1.2-4: Key categories analysis – Level Assessment - Tier 1 (Including LULUCF)-2010

Tier 1 Analysis - Level Assessment – Including LULUCF				
IPCC Source Categories	Direct GHG	Last Year (2010) Estimate (Gg eq-CO2)	Level Assessment	Cumulative Total (%)
Forest land remaining forest land	CO2	8758.500	0.228	23%
Mobile Combustion - Road Vehicles	CO2	5673.398	0.148	38%
CO2 Emissions from Stationary Combustion - Gas	CO2	5375.517	0.140	52%
CO2 Emissions from Stationary Combustion - Oil	CO2	3891.112	0.101	62%
CO2 Emissions from Stationary Combustion - Coal	CO2	2696.203	0.070	69%
Fugitive Emissions from Oil and Gas Operations	CH4	1526.265	0.040	73%
CO2 Emissions from Cement Production	CO2	1198.260	0.031	76%
Direct N2O Emissions from Agricultural Soils	N2O	1165.251	0.030	79%
Nitric Acid Production	N2O	815.300	0.021	81%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	808.178	0.021	83%
Total settlements	CO2	788.522	0.021	85%
Solid Waste Disposal Sites	CH4	757.782	0.020	87%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	746.116	0.019	89%
Combustion - Agriculture/Forestry/Fishing	CO2	715.331	0.019	91%
CO2 Emissions from Ammonia Production	CO2	501.328	0.013	92%
CO2 Emissions from Natural Gas Scrubbing*	CO2	487.261	0.013	93%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	480.071	0.013	95%
Emissions from Waste Water Handling	CH4	209.823	0.005	95%
N2O Emissions from Manure Management	N2O	203.532	0.005	96%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	174.837	0.005	96%
CH4 Emissions from Manure Management	CH4	167.173	0.004	97%
CO2 Emissions from Lime Production	CO2	151.530	0.004	97%
Total Cropland	CO2	150.930	0.004	98%
Total Solvent and Other Product Use	CO2	119.646	0.003	98%
Mobile Combustion: Water-borne Navigation	CO2	115.142	0.003	98%
Fuel Combustion - Stationary Sources	CH4	104.243	0.003	98%
Emissions from Waste Water Handling	N2O	102.927	0.003	99%
Mobile Combustion: Railways	CO2	89.255	0.002	99%
Mobile Combustion: Domestic Aviation	CO2	81.104	0.002	99%
Land converted to Settlements	CO2	67.000	0.002	99%
Mobile Combustion - Road Vehicles	N2O	60.362	0.002	99%
Fuel Combustion - Stationary Sources	N2O	46.004	0.001	100%
CO2 Emissions from Limestone and Dolomite Use	CO2	36.758	0.001	100%
Total Solvent and Other Product Use	N2O	31.067	0.001	100%
Total wetlands	CO2	29.263	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	27.270	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	19.945	0.001	100%
Mobile Combustion - Road Vehicles	CH4	14.203	0.000	100%
Total grassland	CO2	4.039	0.000	100%
Land converted to Forest land	CO2	3.719	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	1.737	0.000	100%
Forest land remaining forest land	CH4	1.317	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.079	0.000	100%
Production of Other Chemicals	CH4	0.840	0.000	100%
Mobile Combustion: Aircraft	N2O	0.711	0.000	100%
Mobile Combustion: Railways	N2O	0.604	0.000	100%
Forest land remaining forest land	N2O	0.301	0.000	100%

Mobile Combustion: Water-borne Navigation	N2O	0.291	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.165	0.000	100%
Mobile Combustion: Railways	CH4	0.153	0.000	100%
Emissions from Waste Incineration	CO2	0.099	0.000	100%
Mobile Combustion: Aircraft	CH4	0.012	0.000	100%
CO2 Emissions from Ferroalloys Production	CO2	0.000	0.000	100%
Aluminium Production	CO2	0.000	0.000	100%
Total Otherland	CO2	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
Fugitive Emissions from Coal Mining and Handling	CH4	0.000	0.000	100%
PFC Emissions from Aluminium production	PFC	0.000	0.000	100%
TOTAL		**38,401.476**		

Table A1.2-5: Key categories analysis – Trend Assessment - Tier 1 (Excluding LULUCF)-2010

Tier 1 Analysis - Trend Assessment – Excluding LULUCF							
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2010) Estimate (Gg eq-CO_2)	Trend Assess	% Contrib. on to trend	Cumulative Total of Column F
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	3891.112	0.147	0.322	32%
Mobile Combustion - Road Vehicles	CO2	3559.716	5673.398	0.094	0.204	53%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	5375.517	0.051	0.111	64%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.033	0.071	71%
Solid Waste Disposal Sites	CH4	242.623	757.782	0.021	0.045	75%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.954	480.071	0.018	0.039	79%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	1526.265	0.017	0.036	83%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.920	808.178	0.012	0.027	86%
CO2 Emissions from Cement Production	CO2	1085.790	1198.260	0.008	0.018	87%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	2696.203	0.006	0.014	89%
N2O Emissions from Manure Management	N2O	381.844	203.532	0.006	0.012	90%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	487.261	0.004	0.009	91%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.000	0.004	0.009	92%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.066	746.116	0.004	0.009	93%
Aluminium Production	CO2	111.372	0.000	0.004	0.008	94%
Nitric Acid Production	N2O	803.886	815.300	0.003	0.007	94%
CO2 Emissions from Ammonia Production	CO2	466.009	501.328	0.003	0.007	95%
N2O Emissions from Pasture, Range and Paddock	N2O	261.130	174.837	0.002	0.005	95%
Mobile Combustion: Domestic Aviation	CO2	154.724	81.104	0.002	0.005	96%
Fuel Combustion - Stationary Sources	CH4	168.641	104.243	0.002	0.004	96%
Combustion - Agriculture/Forestry/Fishing	CO2	839.189	715.331	0.002	0.004	97%
Total Solvent and Other Product Use	CO2	82.417	119.646	0.002	0.004	98%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.000	0.002	0.004	98%
Emissions from Waste Water Handling	CH4	278.732	209.823	0.002	0.004	98%
CH4 Emissions from Manure Management	CH4	228.623	167.173	0.002	0.003	99%
Mobile Combustion: Railways	CO2	138.142	89.255	0.001	0.003	99%
Mobile Combustion - Road Vehicles	N2O	40.247	60.362	0.001	0.002	99%
Emissions from Waste Water Handling	N2O	90.235	102.927	0.001	0.002	99%
Mobile Combustion - Road Vehicles	CH4	34.117	14.203	0.001	0.001	99%
Production of Chemicals	CH4	15.798	0.840	0.001	0.001	100%
CO2 Emissions from Lime Production	CO2	153.440	151.530	0.000	0.001	100%
Fuel Combustion - Stationary Sources	N2O	62.365	46.004	0.000	0.001	100%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.491	36.758	0.000	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	27.270	0.000	0.001	100%
Mobile Combustion: Water-borne Navigation	CO2	132.980	115.142	0.000	0.000	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	19.945	0.000	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.711	0.000	0.000	100%
Total Solvent and Other Product Use	N2O	34.720	31.067	0.000	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.604	0.000	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	1.737	0.000	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	1.079	0.000	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.099	0.000	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.153	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.291	0.000	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.012	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.165	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	0.000	0.000	100%
TOTAL		**31,448.699**	**28,597.885**			

Table A1.2-6: Key categories analysis – Trend Assessment - Tier 1 (Including LULUCF)-2010

Tier 1 Analysis - Trend Assessment – Including LULUCF						
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2010) Estimate (Gg eq-CO_2)	Trend Assess	% Contrib. on to trend	Cumulative Total of Column F
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.0435	3891.1121	0.1171	0.3076	31%
Mobile Combustion - Road Vehicles	CO2	3559.7165	5673.3981	0.0592	0.1555	46%
Forest land remaining forest land	CO2	7059.3000	8758.5000	0.0507	0.1331	60%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.5394	5375.5165	0.0278	0.0731	67%
PFC Emissions from Aluminium production	PFC	936.5643	0.0000	0.0244	0.0641	73%
Solid Waste Disposal Sites	CH4	242.6230	757.7820	0.0140	0.0367	77%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.9542	480.0711	0.0126	0.0330	80%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.9196	808.1778	0.0107	0.0281	83%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.1796	1526.2651	0.0096	0.0252	86%
Total settlements	CO2	580.6662	788.5224	0.0060	0.0157	87%
N2O Emissions from Manure Management	N2O	381.8439	203.5316	0.0045	0.0118	88%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.0663	746.1158	0.0043	0.0114	90%
CO2 Emissions from Cement Production	CO2	1085.7898	1198.2600	0.0038	0.0100	91%
Direct N2O Emissions from Agricultural Soils	N2O	1333.1345	1165.2513	0.0035	0.0092	91%
CO2 Emissions from Ferroalloys Production	CO2	118.8360	0.0000	0.0031	0.0081	92%
Aluminium Production	CO2	111.3720	0.0000	0.0029	0.0076	93%
Combustion - Agriculture/Forestry/Fishing	CO2	839.1894	715.3307	0.0027	0.0071	94%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.9490	487.2614	0.0022	0.0058	94%
N2O Emissions from Pasture, Range and Paddock	N2O	261.1304	174.8373	0.0021	0.0056	95%
Mobile Combustion: Domestic Aviation	CO2	154.7239	81.1041	0.0019	0.0049	95%
Land converted to Settlements	CO2	137.0000	67.0000	0.0018	0.0047	96%
Emissions from Waste Water Handling	CH4	278.7322	209.8234	0.0016	0.0043	96%
Fuel Combustion - Stationary Sources	CH4	168.6406	104.2431	0.0016	0.0042	97%
CH4 Emissions from Manure Management	CH4	228.6231	167.1725	0.0015	0.0039	97%
CO2 Emissions from Ammonia Production	CO2	466.0087	501.3282	0.0013	0.0034	97%
Fugitive Emissions from Coal Mining and Handling	CH4	48.7570	0.0000	0.0013	0.0033	98%
Mobile Combustion: Railways	CO2	138.1421	89.2550	0.0012	0.0032	98%
Total Solvent and Other Product Use	CO2	82.4167	119.6457	0.0011	0.0028	98%
Nitric Acid Production	N2O	803.8859	815.3000	0.0009	0.0023	99%
Total Cropland	CO2	189.4875	150.9300	0.0009	0.0023	99%
Mobile Combustion - Road Vehicles	N2O	40.2467	60.3617	0.0006	0.0015	99%
Mobile Combustion - Road Vehicles	CH4	34.1171	14.2034	0.0005	0.0013	99%
Emissions from Waste Water Handling	N2O	90.2352	102.9267	0.0004	0.0011	99%
Fuel Combustion - Stationary Sources	N2O	62.3653	46.0037	0.0004	0.0010	99%
Production of Other Chemicals	CH4	15.7981	0.8400	0.0004	0.0010	99%
Mobile Combustion: Water-borne Navigation	CO2	132.9800	115.1416	0.0004	0.0010	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.4905	36.7585	0.0004	0.0009	100%
Total wetlands	CO2	41.5544	29.2634	0.0003	0.0008	100%
Forest land remaining forest land	CH4	12.4985	1.3167	0.0003	0.0008	100%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.4471	2696.2028	0.0002	0.0006	100%
CO2 Emissions from Iron and Steel Production	CO2	21.4468	27.2700	0.0002	0.0005	100%
Total grassland	CO2	9.4998	4.0390	0.0001	0.0004	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.7400	19.9453	0.0001	0.0004	100%
Land converted to Forest land	CO2	0.2267	3.7189	0.0001	0.0002	100%
Total Solvent and Other Product Use	N2O	34.7200	31.0667	0.0001	0.0002	100%
Forest land remaining forest land	N2O	2.8585	0.3011	0.0001	0.0002	100%
CO2 Emissions from Lime Production	CO2	153.4399	151.5301	0.0001	0.0002	100%

Mobile Combustion: Aircraft	N2O	1.3552	0.7109	0.0000	0.0000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.0385	1.7375	0.0000	0.0000	100%
Mobile Combustion: Railways	N2O	0.3917	0.6037	0.0000	0.0000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.2987	1.0787	0.0000	0.0000	100%
Emissions from Waste Incineration	CO2	0.0432	0.0990	0.0000	0.0000	100%
Mobile Combustion: Railways	CH4	0.2136	0.1534	0.0000	0.0000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.3367	0.2914	0.0000	0.0000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.1901	0.1645	0.0000	0.0000	100%
Mobile Combustion: Aircraft	CH4	0.0230	0.0120	0.0000	0.0000	100%
Total Otherland	CO2	0.0000	0.0000	0.0000	0.0000	100%
Other non-specified NEU	CO2	0.0000	0.0000	0.0000	0.0000	100%
TOTAL		**39,481.790**	**38,401.476**			

Table A1.2-7: Key categories analysis – Level Assessment - Tier 2 (Excluding LULUCF)-1990

Tier 2 Analysis - Level Assessment – Excluding LULUCF				
IPCC Source Categories	**Direct GHG**	**Base Year (1990) Estimate (Gg eq-CO_2)**	**Level Assessment Tier 2**	**Cumulative Total (%)**
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	0.435	43%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	0.167	60%
Direct N2O Emissions from Agricultural Soils	N2O	1333.134	0.084	69%
PFC Emissions from Aluminium production	PFC	936.564	0.030	72%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	0.030	75%
Nitric Acid Production	N2O	803.886	0.029	77%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.023	80%
Emissions from Waste Water Handling	CH4	278.732	0.021	82%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	0.016	83%
N2O Emissions from Manure Management	N2O	381.844	0.016	85%
Solid Waste Disposal Sites	CH4	242.623	0.015	87%
Fuel Combustion - Stationary Sources	N2O	62.365	0.015	88%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.015	90%
Mobile Combustion - Road Vehicles	CO2	3559.716	0.013	91%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.013	92%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	0.011	93%
Fuel Combustion - Stationary Sources	CH4	168.641	0.010	94%
Mobile Combustion - Road Vehicles	N2O	40.247	0.010	95%
Total Solvent and Other Product Use	CO2	82.417	0.006	96%
CO2 Emissions from Cement Production	CO2	1085.790	0.005	96%
CH4 Emissions from Manure Management	CH4	228.623	0.005	97%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.004	97%
Aluminium Production	CO2	111.372	0.004	98%
Emissions from Waste Water Handling	N2O	90.235	0.003	98%
CO2 Emissions from Ammonia Production	CO2	466.009	0.003	98%
Combustion - Agriculture/Forestry/Fishing	CO2	839.189	0.003	99%
Total Solvent and Other Product Use	N2O	34.720	0.003	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.491	0.002	99%
Mobile Combustion - Road Vehicles	CH4	34.117	0.002	99%
Mobile Combustion: Railways	CO2	138.142	0.001	99%
Mobile Combustion: Water-borne Navigation	CO2	132.980	0.001	99%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	0.001	100%
Mobile Combustion: Domestic Aviation	CO2	154.724	0.001	100%
CO2 Emissions from Lime Production	CO2	153.440	0.001	100%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.954	0.001	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	0.000	100%
Production of Chemicals	CH4	15.798	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.000	100%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
TOTAL		**31,448.699**		

Table A1.2-8: Key categories analysis – Level Assessment - Tier 2 (Including LULUCF)-1990

Tier 2 Analysis - Level Assessment – Including LULUCF				
IPCC Source Categories	Direct GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Level Assessment Tier 2	Cumulative Total (%)
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	0.369	37%
Forest land remaining forest land	CO2	7059.300	0.145	51%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	0.141	66%
Direct N2O Emissions from Agricultural Soils	N2O	1333.134	0.071	73%
PFC Emissions from Aluminium production	PFC	936.564	0.026	75%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	0.025	78%
Nitric Acid Production	N2O	803.886	0.025	80%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.019	82%
Emissions from Waste Water Handling	CH4	278.732	0.018	84%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	0.014	85%
N2O Emissions from Manure Management	N2O	381.844	0.013	87%
Solid Waste Disposal Sites	CH4	242.623	0.013	88%
Fuel Combustion - Stationary Sources	N2O	62.365	0.013	89%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.012	90%
Mobile Combustion - Road Vehicles	CO2	3559.716	0.011	92%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.011	93%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	0.009	94%
Fuel Combustion - Stationary Sources	CH4	168.641	0.009	94%
Mobile Combustion - Road Vehicles	N2O	40.247	0.008	95%
Land converted to Settlements	CO2	137.000	0.006	96%
Total Solvent and Other Product Use	CO2	82.417	0.005	96%
CO2 Emissions from Cement Production	CO2	1085.790	0.005	97%
CH4 Emissions from Manure Management	CH4	228.623	0.004	97%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.004	98%
Aluminium Production	CO2	111.372	0.003	98%
Emissions from Waste Water Handling	N2O	90.235	0.003	98%
CO2 Emissions from Ammonia Production	CO2	466.009	0.003	98%
Combustion - Agriculture/Forestry/Fishing	CO2	839.189	0.003	99%
Total Solvent and Other Product Use	N2O	34.720	0.003	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.491	0.002	99%
Mobile Combustion - Road Vehicles	CH4	34.117	0.001	99%
Mobile Combustion: Railways	CO2	138.142	0.001	99%
Mobile Combustion: Water-borne Navigation	CO2	132.980	0.001	99%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	0.001	100%
Forest land remaining forest land	CH4	12.499	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	0.001	100%
Mobile Combustion: Domestic Aviation	CO2	154.724	0.001	100%
CO2 Emissions from Lime Production	CO2	153.440	0.001	100%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.954	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	0.000	100%
Production of Other Chemicals	CH4	15.798	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.000	100%
Forest land remaining forest land	N2O	2.858	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	0.000	100%
Land converted to Forest land	CO2	0.227	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.000	100%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
TOTAL		**38,660.582**		

Table A1.2-9: Key categories analysis – Level Assessment - Tier 2 (Excluding LULUCF)-2010

Tier 2 Analysis - Level Assessment – Excluding LULUCF				
IPCC Source Categories	**Direct GHG**	Last Year (2010) Estimate (Gg eq-CO_2	**Level Assessment Tier 2**	**Cumulative Total (%)**
Fugitive Emissions from Oil and Gas Operations	CH4	1526.265	0.525	52%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	746.116	0.137	66%
Direct N2O Emissions from Agricultural Soils	N2O	1165.251	0.067	73%
Solid Waste Disposal Sites	CH4	757.782	0.055	78%
Nitric Acid Production	N2O	815.300	0.028	81%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	480.071	0.021	83%
Mobile Combustion - Road Vehicles	CO2	5673.398	0.018	85%
CO2 Emissions from Stationary Combustion - Gas	CO2	5375.517	0.017	87%
Mobile Combustion - Road Vehicles	N2O	60.362	0.014	88%
Emissions from Waste Water Handling	CH4	209.823	0.014	89%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	808.178	0.013	91%
CO2 Emissions from Stationary Combustion - Oil	CO2	3891.112	0.012	92%
Fuel Combustion - Stationary Sources	N2O	46.004	0.011	93%
N2O Emissions from Manure Management	N2O	203.532	0.008	94%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	174.837	0.007	95%
Total Solvent and Other Product Use	CO2	119.646	0.007	95%
CO2 Emissions from Stationary Combustion - Coal	CO2	2696.203	0.007	96%
Fuel Combustion - Stationary Sources	CH4	104.243	0.006	97%
CO2 Emissions from Natural Gas Scrubbing*	CO2	487.261	0.006	97%
CO2 Emissions from Cement Production	CO2	1198.260	0.006	98%
Emissions from Waste Water Handling	N2O	102.927	0.004	98%
CO2 Emissions from Ammonia Production	CO2	501.328	0.003	98%
CH4 Emissions from Manure Management	CH4	167.173	0.003	99%
Combustion - Agriculture/Forestry/Fishing	CO2	715.331	0.003	99%
Total Solvent and Other Product Use	N2O	31.067	0.003	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	36.758	0.001	99%
CO2 Emissions from Iron and Steel Production	CO2	27.270	0.001	100%
Mobile Combustion: Water-borne Navigation	CO2	115.142	0.001	100%
Mobile Combustion: Railways	CO2	89.255	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	19.945	0.001	100%
Mobile Combustion - Road Vehicles	CH4	14.203	0.001	100%
CO2 Emissions from Lime Production	CO2	151.530	0.001	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	1.737	0.000	100%
Mobile Combustion: Domestic Aviation	CO2	81.104	0.000	100%
Mobile Combustion: Aircraft	N2O	0.711	0.000	100%
Mobile Combustion: Railways	N2O	0.604	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.291	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.079	0.000	100%
Production of Chemicals	CH4	0.840	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.165	0.000	100%
Mobile Combustion: Railways	CH4	0.153	0.000	100%
Emissions from Waste Incineration	CO2	0.099	0.000	100%
Mobile Combustion: Aircraft	CH4	0.012	0.000	100%
CO2 Emissions from Ferroalloys Production	CO2	0.000	0.000	100%
Aluminium Production	CO2	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
Fugitive Emissions from Coal Mining and Handling	CH4	0.000	0.000	100%
PFC Emissions from Aluminium production	PFC	0.000	0.000	100%
TOTAL		**28,597.885**		

Table A1.2-10: Key categories analysis – Level Assessment - Tier 2 (Including LULUCF)-2010

Tier 2 Analysis - Level Assessment – Including LULUCF				
IPCC Source Categories	Direct GHG	Last Year (2010) Estimate (Gg eq-CO_2	Level Assessment Tier 2	Cumulative Total (%)
Fugitive Emissions from Oil and Gas Operations	CH4	1526.265	0.448	45%
Forest land remaining forest land	CO2	8758.500	0.143	59%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	746.116	0.117	71%
Direct N2O Emissions from Agricultural Soils	N2O	1165.251	0.057	77%
Solid Waste Disposal Sites	CH4	757.782	0.047	81%
Nitric Acid Production	N2O	815.300	0.024	84%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	480.071	0.018	85%
Mobile Combustion - Road Vehicles	CO2	5673.398	0.015	87%
CO2 Emissions from Stationary Combustion - Gas	CO2	5375.517	0.014	88%
Mobile Combustion - Road Vehicles	N2O	60.362	0.012	89%
Emissions from Waste Water Handling	CH4	209.823	0.012	91%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	808.178	0.011	92%
CO2 Emissions from Stationary Combustion - Oil	CO2	3891.112	0.011	93%
Fuel Combustion - Stationary Sources	N2O	46.004	0.009	94%
N2O Emissions from Manure Management	N2O	203.532	0.007	94%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	174.837	0.006	95%
Total Solvent and Other Product Use	CO2	119.646	0.006	96%
CO2 Emissions from Stationary Combustion - Coal	CO2	2696.203	0.006	96%
Fuel Combustion - Stationary Sources	CH4	104.243	0.005	97%
CO2 Emissions from Natural Gas Scrubbing*	CO2	487.261	0.005	97%
CO2 Emissions from Cement Production	CO2	1198.260	0.005	98%
Emissions from Waste Water Handling	N2O	102.927	0.003	98%
CO2 Emissions from Ammonia Production	CO2	501.328	0.003	98%
CH4 Emissions from Manure Management	CH4	167.173	0.003	99%
Land converted to Settlements	CO2	67.000	0.003	99%
Combustion - Agriculture/Forestry/Fishing	CO2	715.331	0.002	99%
Total Solvent and Other Product Use	N2O	31.067	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	36.758	0.001	99%
CO2 Emissions from Iron and Steel Production	CO2	27.270	0.001	100%
Mobile Combustion: Water-borne Navigation	CO2	115.142	0.001	100%
Mobile Combustion: Railways	CO2	89.255	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	19.945	0.001	100%
Mobile Combustion - Road Vehicles	CH4	14.203	0.001	100%
CO2 Emissions from Lime Production	CO2	151.530	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	1.737	0.000	100%
Mobile Combustion: Domestic Aviation	CO2	81.104	0.000	100%
Land converted to Forest land	CO2	3.719	0.000	100%
Mobile Combustion: Aircraft	N2O	0.711	0.000	100%
Mobile Combustion: Railways	N2O	0.604	0.000	100%
Forest land remaining forest land	CH4	1.317	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.291	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.079	0.000	100%
Production of Other Chemicals	CH4	0.840	0.000	100%
Forest land remaining forest land	N2O	0.301	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.165	0.000	100%
Mobile Combustion: Railways	CH4	0.153	0.000	100%
Emissions from Waste Incineration	CO2	0.099	0.000	100%
Mobile Combustion: Aircraft	CH4	0.012	0.000	100%
CO2 Emissions from Ferroalloys Production	CO2	0.000	0.000	100%
Aluminium Production	CO2	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
Fugitive Emissions from Coal Mining and Handling	CH4	0.000	0.000	100%
PFC Emissions from Aluminium production	PFC	0.000	0.000	100%
TOTAL		**37,428.721**		

Table A1.2-11: Key categories analysis – Trend Assessment - Tier 2 (Excluding LULUCF)-2010

Tier 2 Analysis - Trend Assessment – Excluding LULUCF						
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2010) Estimate (Gg eq-CO_2)	Trend Assess Tier 2	% Contrib. on to trend	Cumulative Total of Column F
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	1526.265	5.007	0.437	44%
Solid Waste Disposal Sites	CH4	242.623	757.782	1.300	0.113	55%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.890	0.078	63%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.954	480.071	0.696	0.061	69%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.066	746.116	0.636	0.055	74%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.000	0.426	0.037	78%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	3891.112	0.412	0.036	82%
Mobile Combustion - Road Vehicles	CO2	3559.716	5673.398	0.252	0.022	84%
N2O Emissions from Manure Management	N2O	381.844	203.532	0.198	0.017	86%
Mobile Combustion - Road Vehicles	N2O	40.247	60.362	0.183	0.016	87%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.920	808.178	0.172	0.015	89%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	5375.517	0.137	0.012	90%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.000	0.128	0.011	91%
Aluminium Production	CO2	111.372	0.000	0.117	0.010	92%
Nitric Acid Production	N2O	803.886	815.300	0.098	0.009	93%
Emissions from Waste Water Handling	CH4	278.732	209.823	0.096	0.008	94%
Fuel Combustion - Stationary Sources	CH4	168.641	104.243	0.095	0.008	95%
Total Solvent and Other Product Use	CO2	82.417	119.646	0.092	0.008	95%
Direct N2O Emissions from Agricultural Soils	N2O	1333.134	1165.251	0.090	0.008	96%
N2O Emissions from Pasture, Range and Paddock	N2O	261.130	174.837	0.089	0.008	97%
Fuel Combustion - Stationary Sources	N2O	62.365	46.004	0.082	0.007	98%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	487.261	0.044	0.004	98%
CO2 Emissions from Cement Production	CO2	1085.790	1198.260	0.033	0.003	98%
CH4 Emissions from Manure Management	CH4	228.623	167.173	0.026	0.002	99%
Mobile Combustion - Road Vehicles	CH4	34.117	14.203	0.026	0.002	99%
Emissions from Waste Water Handling	N2O	90.235	102.927	0.025	0.002	99%
CO2 Emissions from Ammonia Production	CO2	466.009	501.328	0.017	0.002	99%
Production of Chemicals	CH4	15.798	0.840	0.016	0.001	99%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	2696.203	0.014	0.001	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.491	36.758	0.012	0.001	100%
Mobile Combustion: Railways	CO2	138.142	89.255	0.010	0.001	100%
Mobile Combustion: Domestic Aviation	CO2	154.724	81.104	0.009	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	27.270	0.009	0.001	100%
Combustion - Agriculture/Forestry/Fishing	CO2	839.189	715.331	0.006	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	19.945	0.004	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.711	0.004	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.604	0.002	0.000	100%
Mobile Combustion: Water-borne Navigation	CO2	132.980	115.142	0.002	0.000	100%
CO2 Emissions from Lime Production	CO2	153.440	151.530	0.001	0.000	100%
Total Solvent and Other Product Use	N2O	34.720	31.067	0.001	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	1.737	0.001	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	1.079	0.000	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.099	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.291	0.000	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.153	0.000	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.012	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.165	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	0.000	0.000	100%
TOTAL		**31,448.699**	**28,597.885**			

Table A1.2-12: Key categories analysis – Trend Assessment - Tier 2 (Including LULUCF)-2010

Tier 2 Analysis - Trend Assessment – Including LULUCF						
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2010) Estimate (Gg eq-CO_2)	Trend Assess Tier 2	% Contrib. on to trend	Cumulative Total of Column F
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	1526.265	2.875	0.327	33%
Solid Waste Disposal Sites	CH4	242.623	757.782	0.879	0.100	43%
Forest land remaining forest land	CO2	7059.300	8758.500	0.847	0.096	52%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.066	746.116	0.696	0.079	60%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.663	0.075	68%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.954	480.071	0.484	0.055	73%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	3891.112	0.327	0.037	77%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.000	0.317	0.036	81%
Direct N2O Emissions from Agricultural Soils	N2O	1333.134	1165.251	0.176	0.020	83%
N2O Emissions from Manure Management	N2O	381.844	203.532	0.161	0.018	84%
Mobile Combustion - Road Vehicles	CO2	3559.716	5673.398	0.160	0.018	86%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.920	808.178	0.149	0.017	88%
Mobile Combustion - Road Vehicles	N2O	40.247	60.362	0.114	0.013	89%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.000	0.096	0.011	90%
Emissions from Waste Water Handling	CH4	278.732	209.823	0.094	0.011	91%
Aluminium Production	CO2	111.372	0.000	0.087	0.010	92%
Fuel Combustion - Stationary Sources	CH4	168.641	104.243	0.080	0.009	93%
Fuel Combustion - Stationary Sources	N2O	62.365	46.004	0.078	0.009	94%
N2O Emissions from Pasture, Range and Paddock	N2O	261.130	174.837	0.078	0.009	95%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	5375.517	0.075	0.009	96%
Land converted to Settlements	CO2	137.000	67.000	0.071	0.008	97%
Total Solvent and Other Product Use	CO2	82.417	119.646	0.057	0.006	97%
Nitric Acid Production	N2O	803.886	815.300	0.027	0.003	98%
CH4 Emissions from Manure Management	CH4	228.623	167.173	0.025	0.003	98%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	487.261	0.023	0.003	98%
Mobile Combustion - Road Vehicles	CH4	34.117	14.203	0.020	0.002	98%
Forest land remaining forest land	CH4	12.499	1.317	0.017	0.002	99%
CO2 Emissions from Cement Production	CO2	1085.790	1198.260	0.016	0.002	99%
Emissions from Waste Water Handling	N2O	90.235	102.927	0.013	0.001	99%
Production of Other Chemicals	CH4	15.798	0.840	0.012	0.001	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.491	36.758	0.011	0.001	99%
Mobile Combustion: Railways	CO2	138.142	89.255	0.009	0.001	99%
Combustion - Agriculture/Forestry/Fishing	CO2	839.189	715.331	0.008	0.001	99%
Mobile Combustion: Domestic Aviation	CO2	154.724	81.104	0.008	0.001	100%
CO2 Emissions from Ammonia Production	CO2	466.009	501.328	0.008	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	27.270	0.005	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	31.067	0.005	0.001	100%
Land converted to Forest land	CO2	0.227	3.719	0.005	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	19.945	0.004	0.000	100%
Forest land remaining forest land	N2O	2.858	0.301	0.004	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.711	0.003	0.000	100%
Mobile Combustion: Water-borne Navigation	CO2	132.980	115.142	0.003	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	1.737	0.001	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.604	0.001	0.000	100%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	2696.203	0.000	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	1.079	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.291	0.000	0.000	100%
CO2 Emissions from Lime Production	CO2	153.440	151.530	0.000	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.099	0.000	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.153	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.165	0.000	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.012	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	0.000	0.000	100%
TOTAL		**38,660.582**	**37,428.721**			

Table A1.2-13: Key categories for Croatia – summary (Excluding LULUCF)-1990

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	Direct GHG	Key Source Category Flag	Criteria for Identification
ENERGY SECTOR			
CO_2 Emissions from Stationary Combustion: Coal	CO_2	Yes	L1
CO_2 Emissions from Stationary Combustion: Oil	CO_2	Yes	L1, L2
CO_2 Emissions from Stationary Combustion: Gas	CO_2	Yes	L1 ,L2
Non-CO_2 Emissions from Stationary Combustion	CH_4	No	
Non-CO_2 Emissions from Stationary Combustion	N_2O	Yes	L2
Mobile Combustion: Road Vehicles	CO_2	Yes	L1
Mobile Combustion: Railways	CO_2	No	
Mobile Combustion: Domestic Aviation	CO_2	No	
Mobile Combustion: National Navigation	CO_2	No	
Combustion: Agriculture/Forestry/Fishing	CO_2	Yes	L1
Mobile Combustion: Road Vehicles	CH_4	No	
Mobile Combustion: Railways	CH_4	No	
Mobile Combustion: Domestic Aviation	CH_4	No	
Mobile Combustion: National Navigation	CH_4	No	
Combustion: Agriculture/Forestry/Fishing	CH_4	No	
Mobile Combustion: Road Vehicles	N_2O	No	
Mobile Combustion: Railways	N_2O	No	
Mobile Combustion: Domestic Aviation	N_2O	No	
Mobile Combustion: National Navigation	N_2O	No	
Combustion: Agriculture/Forestry/Fishing	N_2O	No	
Fugitive Emissions from Coal Mining and Handling	CH_4	Yes	L2
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L1, L2
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	L1
INDUSTRIAL SECTOR			
CO_2 Emissions from Cement Production	CO_2	Yes	L1
CO_2 Emissions from Lime Production	CO_2	No	
CO_2 Emissions from Limestone and Dolomite Use	CO_2	No	
CO_2 Emissions from Soda Ash Production and Use	CO_2	No	
CO_2 Emissions from Ammonia Production	CO_2	Yes	L1
CO_2 Emissions from Iron and Steel Production	CO_2	No	
CO_2 Emissions from Ferroalloys Production	CO_2	No	
CO_2 Emissions from Aluminium Production	CO_2	No	
CH_4 Emissions from Production of Other Chemicals	CH_4	No	
N_2O Emissions from Nitric Acid Production	N_2O	Yes	L1 ,L2
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	No	
PFC Emissions from Aluminium production	PFC	Yes	L1, L2
CO_2 Emissions from Other non-specified NEU	CO_2	No	
SOLVENT AND OTHER PRODUCT USE			
CO_2 Emissions from solvent and other product use	CO_2	No	
N_2O Emissions from solvent and other product use	N_2O	No	
AGRICULTURE SECTOR			
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L1,L2
CH_4 Emissions from Manure Management	CH_4	Yes	L1
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	L1, L2
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L1, L2

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	Direct GHG	Key Source Category Flag	Criteria for Identification
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	L1
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L1, L2
CH_4 and N_2O Emissions from Agricultural Residue Burning	N_2O	No	
WASTE SECTOR			
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	L1, L2
CH_4 Emissions from Waste Water Handling	CH_4	Yes	L1 ,L2
N_2O Emissions from Human Sewage	N_2O	No	

L1 - Level excluding LULUCF Tier1
L2 - Level excluding LULUCF Tier2

Table A1.2-14: Key categories for Croatia – summary (Excluding LULUCF)-2010

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	Direct GHG	Key Source Category Flag	Criteria for Identification
ENERGY SECTOR			
CO_2 Emissions from Stationary Combustion: Coal	CO_2	Yes	L1,T1
CO_2 Emissions from Stationary Combustion: Oil	CO_2	Yes	L1,T1,T2
CO_2 Emissions from Stationary Combustion: Gas	CO_2	Yes	L1,T1,L2,T2
Non-CO_2 Emissions from Stationary Combustion	CH_4	No	
Non-CO_2 Emissions from Stationary Combustion	N_2O	No	
Mobile Combustion: Road Vehicles	CO_2	Yes	L1,T1,L2,T2
Mobile Combustion: Railways	CO_2	No	
Mobile Combustion: Domestic Aviation	CO_2	Yes	
Mobile Combustion: National Navigation	CO_2	No	
Combustion: Agriculture/Forestry/Fishing	CO_2	Yes	L1
Mobile Combustion: Road Vehicles	CH_4	No	
Mobile Combustion: Railways	CH_4	No	
Mobile Combustion: Domestic Aviation	CH_4	No	
Mobile Combustion: National Navigation	CH_4	No	
Combustion: Agriculture/Forestry/Fishing	CH_4	No	
Mobile Combustion: Road Vehicles	N_2O	Yes	T2
Mobile Combustion: Railways	N_2O	No	
Mobile Combustion: Domestic Aviation	N_2O	No	
Mobile Combustion: National Navigation	N_2O	No	
Combustion: Agriculture/Forestry/Fishing	N_2O	No	
Fugitive Emissions from Coal Mining and Handling	CH_4	Yes	T2
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L1,T1,L2,T2
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	L1,T1
INDUSTRIAL SECTOR			
CO_2 Emissions from Cement Production	CO_2	Yes	L1,T1
CO_2 Emissions from Lime Production	CO_2	No	
CO_2 Emissions from Limestone and Dolomite Use	CO_2	No	
CO_2 Emissions from Soda Ash Production and Use	CO_2	No	
CO_2 Emissions from Ammonia Production	CO_2	Yes	L1,T1
CO_2 Emissions from Iron and Steel Production	CO_2	No	
CO_2 Emissions from Ferroalloys Production	CO_2	Yes	T1
CO_2 Emissions from Aluminium Production	CO_2	Yes	T1
CH_4 Emissions from Production of Other Chemicals	CH_4	No	
N_2O Emissions from Nitric Acid Production	N_2O	Yes	L1,T1,L2
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	Yes	L1,T1,L2,T2
PFC Emissions from Aluminium production	PFC	Yes	T1,T2
CO_2 Emissions from Other non-specified NEU	CO_2	No	
SOLVENT AND OTHER PRODUCT USE			
CO_2 Emissions from solvent and other product use	CO_2	No	
N_2O Emissions from solvent and other product use	N_2O	No	
AGRICULTURE SECTOR			
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L1,T1,T2
CH_4 Emissions from Manure Management	CH_4	No	
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	L1,T1,T2
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L1,L2

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	Direct GHG	Key Source Category Flag	Criteria for Identification
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	L1,T1
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L1,T1,L2,T2
CH_4 and N_2O Emissions from Agricultural Residue Burning	N_2O	No	
WASTE SECTOR			
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	L1,T1,L2,T2
CH_4 Emissions from Waste Water Handling	CH_4	Yes	L1,L2
N_2O Emissions from Human Sewage	N_2O	No	

L1 - Level excluding LULUCF Tier1 T1 - Trend excluding LULUCF Tier1
L2 - Level excluding LULUCF Tier2 T2 - Trend excluding LULUCF Tier2

Table A1.2-15: Key categories for Croatia – summary (Including LULUCF)-1990

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	Direct GHG	Key Source Category Flag	Criteria for Identification
ENERGY SECTOR			
CO_2 Emissions from Stationary Combustion - Coal	CO_2	Yes	L1
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	L1,L2
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	L1,L2
Non-CO_2 Emissions from Stationary Combustion	CH_4	No	
Non-CO_2 Emissions from Stationary Combustion	N_2O	Yes	L2
Mobile Combustion – Road Vehicles	CO_2	Yes	L1
Mobile Combustion - Railways	CO_2	No	
Mobile Combustion - Domestic Aviation	CO_2	No	
Mobile Combustion - National Navigation	CO_2	No	
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	Yes	L1
Mobile Combustion – Road Vehicles	CH_4	No	
Mobile Combustion - Railways	CH_4	No	
Mobile Combustion - Domestic Aviation	CH_4	No	
Mobile Combustion - National Navigation	CH_4	No	
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	No	
Mobile Combustion – Road Vehicles	N_2O	No	
Mobile Combustion - Railways	N_2O	No	
Mobile Combustion - Domestic Aviation	N_2O	No	
Mobile Combustion - National Navigation	N_2O	No	
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	No	
Fugitive Emissions from Coal Mining and Handling	CH_4	Yes	L2
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L1,L2
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	L1
INDUSTRIAL SECTOR		No	
CO_2 Emissions from Cement Production	CO_2	Yes	L1
CO_2 Emissions from Lime Production	CO_2	No	
CO_2 Emissions from Limestone and Dolomite Use	CO_2	No	
CO_2 Emissions from Soda Ash Production and Use	CO_2	No	
CO_2 Emissions from Ammonia Production	CO_2	Yes	L1
CO_2 Emissions from Iron and Steel Production	CO_2	No	
CO_2 Emissions from Ferroalloys Production	CO_2	No	
CO_2 Emissions from Aluminium Production	CO_2	No	
CH_4 Emissions from Production of Other Chemicals	CH_4	No	
N_2O Emissions from Nitric Acid Production	N_2O	Yes	L1,L2
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	No	
PFC Emissions from Aluminium production	PFC	Yes	L1,L2
CO_2 Emissions from Other non-specified NEU	CO_2	No	
SOLVENT AND OTHER PRODUCT USE			
CO_2 Emissions from solvent and other product use	CO_2	No	
N_2O Emissions from solvent and other product use	N_2O	No	
AGRICULTURE SECTOR			
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L1,L2
CH_4 Emissions from Manure Management	CH_4	No	
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	L1,L2
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L1,L2
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	L1

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	Direct GHG	Key Source Category Flag	Criteria for Identification
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L1,L2
CH_4 and N_2O Emissions from Agricultural Residue Burning	N_2O	No	
LULUCF			
CO_2 Emissions from Forest land remaining forest land	CO_2	Yes	L1,L2
CH_4 Emissions from Forest land remaining forest land	CH_4	No	
N_2O Emissions from Forest land remaining forest land	N_2O	No	
Land converted to Forest land	CO_2	No	
Land converted to Settlements	CO_2	No	
Total Cropland	CO_2	No	
Total grassland	CO_2	No	
Total wetlands	CO_2	No	
Total settlements	CO_2	Yes	L1
Total Otherland	CO_2	No	
WASTE SECTOR			
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	L1,L2
CH_4 Emissions from Waste Water Handling	CH_4	Yes	L1,L2
N_2O Emissions from Human Sewage	N_2O	No	

L1 - Level including LULUCF Tier1
L2 - Level including LULUCF Tier2

Table A1.2-16: Key categories for Croatia – summary (Including LULUCF)-2010

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	Direct GHG	Key Source Category Flag	Criteria for Identification
ENERGY SECTOR			
CO_2 Emissions from Stationary Combustion - Coal	CO_2	Yes	L1
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	L1,T1,T2
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	L1,L2,T1
Non-CO_2 Emissions from Stationary Combustion	CH_4	No	
Non-CO_2 Emissions from Stationary Combustion	N_2O	No	
Mobile Combustion – Road Vehicles	CO_2	Yes	L1,L2,T1,T2
Mobile Combustion - Railways	CO_2	No	
Mobile Combustion - Domestic Aviation	CO_2	Yes	T1
Mobile Combustion - National Navigation	CO_2	No	
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	Yes	L1,T1
Mobile Combustion – Road Vehicles	CH_4	No	
Mobile Combustion - Railways	CH_4	No	
Mobile Combustion - Domestic Aviation	CH_4	No	
Mobile Combustion - National Navigation	CH_4	No	
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	Yes	
Mobile Combustion – Road Vehicles	N_2O	Yes	L2,T2
Mobile Combustion - Railways	N_2O	No	
Mobile Combustion - Domestic Aviation	N_2O	No	
Mobile Combustion - National Navigation	N_2O	No	
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	No	
Fugitive Emissions from Coal Mining and Handling	CH_4	Yes	T2
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L1,L2,T1,T2
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	L1,T1
INDUSTRIAL SECTOR		No	
CO_2 Emissions from Cement Production	CO_2	Yes	L1,T1
CO_2 Emissions from Lime Production	CO_2	No	
CO_2 Emissions from Limestone and Dolomite Use	CO_2	No	
CO_2 Emissions from Soda Ash Production and Use	CO_2	No	
CO_2 Emissions from Ammonia Production	CO_2	Yes	L1
CO_2 Emissions from Iron and Steel Production	CO_2	No	
CO_2 Emissions from Ferroalloys Production	CO_2	Yes	T1,T2
CO_2 Emissions from Aluminium Production	CO_2	Yes	T1
CH_4 Emissions from Production of Other Chemicals	CH_4	No	
N_2O Emissions from Nitric Acid Production	N_2O	Yes	L1,L2
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	Yes	L1,L2,T1,T2
PFC Emissions from Aluminium production	PFC	Yes	T1,T2
CO_2 Emissions from Other non-specified NEU	CO_2	No	
SOLVENT AND OTHER PRODUCT USE			
CO_2 Emissions from solvent and other product use	CO_2	No	
N_2O Emissions from solvent and other product use	N_2O	No	
AGRICULTURE SECTOR			
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L1,T1,T2
CH_4 Emissions from Manure Management	CH_4	No	
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	T1,T2
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L1,L2,T1,T2

Tier 1 and Tier 2 Analysis – Source Analysis Summary (Croatian Inventory)			
IPCC Source Categories	**Direct GHG**	**Key Source Category Flag**	**Criteria for Identification**
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	T1
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L1,L2,T1,T2
CH_4 and N_2O Emissions from Agricultural Residue Burning	N_2O	No	
LULUCF			
CO_2 Emissions from Forest land remaining forest land	CO_2	Yes	L1,L2,T1,T2
CH_4 Emissions from Forest land remaining forest land	CH_4	No	
N_2O Emissions from Forest land remaining forest land	N_2O	No	
Land converted to Forest land	CO_2	No	
Land converted to Settlements	CO_2	No	
Total Cropland	CO_2	No	
Total grassland	CO_2	No	
Total wetlands	CO_2	No	
Total settlements	CO_2	Yes	L1,T1
Total Otherland	CO_2	No	
WASTE SECTOR			
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	L1,L2,T1,T2
CH_4 Emissions from Waste Water Handling	CH_4	Yes	L1
N_2O Emissions from Human Sewage	N_2O	No	

L1 - Level including LULUCF Tier1 T1 - Trend including LULUCF Tier1
L2 - Level including LULUCF Tier2 T2 - Trend including LULUCF Tier2

Table A1.2-17: Changes in Key categories for Croatia based on the Level and Trend of Emissions

Tier 1 Analysis – Source Analysis Summary (Croatian Inventory)					
IPCC Source Categories	Direct GHG	Criteria for Identification			
		Level		Trend	
		2009	2010	2009	2010
ENERGY SECTOR					
CO_2 Emissions from Stationary Combustion: Coal	CO_2	Yes	Yes	Yes	Yes**
CO_2 Emissions from Stationary Combustion: Oil	CO_2	Yes	Yes	Yes	Yes
CO_2 Emissions from Stationary Combustion: Gas	CO_2	Yes	Yes	Yes	Yes
Mobile Combustion: Road Vehicles	CO_2	Yes	Yes	Yes	Yes
Mobile Combustion: Agriculture/Forestry/Fishing	CO_2	Yes	Yes	Yes*	Yes*
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	Yes	Yes	Yes
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	Yes	Yes	Yes
INDUSTRIAL SECTOR					
CO_2 Emissions from Cement Production	CO_2	Yes	Yes	Yes	Yes
CO_2 Emissions from Lime Production	CO_2	No	No	No	No
CO_2 Emissions from Ammonia Production	CO_2	Yes	Yes	No	Yes**
N_2O Emissions from Nitric Acid Production	N_2O	Yes	Yes	Yes	Yes**
CO_2 Emissions from Ferroalloys Production	CO_2	No	No	Yes	Yes
CO_2 Emissions from Aluminium Production	CO_2	No	No	Yes	Yes
HFC Emissions from Consumption of HFCs	HFC	Yes	Yes	Yes	Yes
PFC Emissions from Aluminium production	PFC	No	No	Yes	Yes
SOLVENT AND OTHER PRODUCT USE					
CO_2 Emissions from solvent and other product use	CO_2	No	No	No	No
AGRICULTURE SECTOR					
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	Yes	Yes	Yes
CH_4 Emissions from Manure Management	CH_4	No	No	No	No
N_2O Emissions from Manure Management	N_2O	Yes	Yes**	Yes	Yes
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Yes	Yes*	Yes*
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	Yes	Yes	Yes
LULUCF					
CO_2 Emissions from Forest land remaining forest land	CO_2	Yes*	Yes*	Yes*	Yes*
Land converted to Forest land	CO_2	No	No	Yes*	No
Land converted to Settlements	CO_2	No	No	No	No
Total Settlements	CO_2	No	Yes*	No	Yes*
WASTE SECTOR					
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	Yes	Yes	Yes
CH_4 Emissions from Waste Water Handling	CH_4	No	Yes	Yes	No

*Not Key category for excluding LULUCF
**Not Key category for including LULUCF

Table A1.2-18: Table 7.A3 for 1990

Table 7.A3					
Tier 1 and Tier 2 Analysis - Source Analysis Summary (Croatian Inventory, 1990)					
A	B	C	D		E
IPCC Source Categories	GHG	Key	If Column C is Yes, Criteria for Identification		Com.
ENERGY SECTOR					
CO_2 Emissions from Stationary Combustion - Coal	CO_2	Yes	L1e	L1i	
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	L1e,L2e	L1i,L2i	
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	L1e,L2e	L1i,L2i	
Non- CO_2 Emissions from Stationary Combustion	CH_4	No			
Non- CO_2 Emissions from Stationary Combustion	N_2O	Yes	L2e	L2i	
Mobile Combustion - Road Vehicles	CO_2	Yes	L1e	L1i	
Mobile Combustion - Road Vehicles	CH_4	No			
Mobile Combustion - Road Vehicles	N_2O	No			
Mobile Combustion: Water-borne Navigation	CO_2	No			
Mobile Combustion: Water-borne Navigation	CH_4	No			
Mobile Combustion: Water-borne Navigation	N_2O	No			
Mobile Combustion: Aircraft	CO_2	No			
Mobile Combustion: Aircraft	CH_4	No			
Mobile Combustion: Aircraft	N_2O	No			
Combustion: Agriculture/Forestry/Fishing	CO_2	Yes	L1e	L1i	
Combustion: Agriculture/Forestry/Fishing	CH_4	No			
Combustion: Agriculture/Forestry/Fishing	N_2O	No			
Fugitive Emissions from Coal Mining and Handling	CH_4	Yes	L2e	L2i	
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L1e,L2e	L1i,L2i	
CO2 Emissions from Natural Gas Scrubbing*	CO_2	Yes	L1e	L1i	
INDUSTRIAL SECTOR					
Emissions from Cement Production	CO_2	Yes	L1e	L1i	
Emissions from Lime Production	CO_2	No			
Emissions from Limestone and Dolomite Use	CO_2	No			
Emissions from Soda Ash Production and Use	CO_2	No			
Emissions from Ammonia Production	CO_2	Yes	L1e	L1i	
Emissions from Iron and Steel Production	CO_2	No			
Emissions from Ferroalloys Production	CO_2	No			
Emissions from Aluminium Production	CO_2	No			
Emissions from Production of Other Chemicals	CH_4	No			
Emissions from Nitric Acid Production	N_2O	Yes	L1e,L2e	L1i,L2i	
Emissions from Consumption of HFCs, PFCs, SF_6	HFC	No			
Emissions from Aluminium production	PFC	Yes	L1e,L2e	L1i,L2i	
Emissions from Other non-specified NEU	CO_2	No			
SOLVENT AND OTHER PRODUCT USE					
CO_2 Emissions from solvent and other product use	CO_2	No			
N_2O Emissions from solvent and other product use	N_2O	No			
AGRICULTURE SECTOR					
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L1e,L2e	L1i,L2i	
CH_4 Emissions from Manure Management	CH_4	Yes	L1e		
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No			
N_2O Emissions from Manure Management	N_2O	Yes	L1e,L2e	L1i,L2i	
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L1e,L2e	L1i,L2i	
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	L1e	L1i	

Table 7.A3					
Tier 1 and Tier 2 Analysis - Source Analysis Summary (Croatian Inventory, 1990)					
A	B	C	D		E
IPCC Source Categories	GHG	Key	If Column C is Yes, Criteria for Identification		Com.
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L1e,L2e	L1i,L2i	
CH_4 and N_2O Emissions from Agricultural Residue Burning	N_2O	No			
LULUCF					
Forest land remaining forest land	CO_2	Yes		L1i,L2i	
Forest land remaining forest land	CH_4	No			
Forest land remaining forest land	N_2O	No			
Land converted to Forest land	CO_2	No			
Land converted to Settlements	CO_2	No			
Total Cropland	CO_2	No			
Total grassland	CO_2	No			
Total wetlands	CO_2	No			
Total settlements	CO_2	Yes		L1i	
Total Otherland	CO_2	No			
WASTE SECTOR					
CH4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	L1e,L2e	L1i,L2i	
Emissions from Waste Water Handling	CH_4	Yes	L1e,L2e	L1i,L2i	
Emissions from Waste Water Handling	N_2O	No			
Emissions from Waste Incineration	CO_2	No			
Emissions from Waste Incineration	N_2O	No			

L1e - Level excluding LULUCF Tier1 L2e - Level excluding LULUCF Tier2
L1i - Level including LULUCF Tier1 L2i - Level including LULUCF Tier2

Table A1.2-19: Table 7.A3 for 2010

Table 7.A3							
Tier 1 and Tier 2 Analysis - Source Analysis Summary (Croatian Inventory, 2010)							
A	B	C	D				E
IPCC Source Categories	GHG	Key	If Column C is Yes, Criteria for Identification				Co
ENERGY SECTOR							
CO_2 Emissions from Stationary Combustion - Coal	CO_2	Yes	L1e	T1e	L1i		
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	L1e	T1e,T2e	L1i	T1i,T2i	
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	L1e,L2e	T1e,T2e	L1i,L2i	T1i	
Non- CO_2 Emissions from Stationary Combustion	CH_4	No					
Non- CO_2 Emissions from Stationary Combustion	N_2O	No					
Mobile Combustion - Road Vehicles	CO_2	Yes	L1e, L2e	T1e,T2e	L1i,L2i	T1i,T2i	
Mobile Combustion - Road Vehicles	CH_4	No					
Mobile Combustion - Road Vehicles	N_2O	Yes		T2e	L2i	T2i	
Mobile Combustion: Water-borne Navigation	CO_2	No					
Mobile Combustion: Water-borne Navigation	CH_4	No					
Mobile Combustion: Water-borne Navigation	N_2O	No					
Mobile Combustion: Aircraft	CO_2	Yes				T1i	
Mobile Combustion: Aircraft	CH_4	No					
Mobile Combustion: Aircraft	N_2O	No					
Combustion: Agriculture/Forestry/Fishing	CO_2	Yes	L1e		L1i	T1i	
Combustion: Agriculture/Forestry/Fishing	CH_4	No					
Combustion: Agriculture/Forestry/Fishing	N_2O	No					
Fugitive Emissions from Coal Mining and Handling	CH_4	Yes		T2e		T2i	
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L1e,L2e	T1e,T2e	L1i,L2i	T1i,T2i	
CO_2 Emissions from Natural Gas Scrubbing*	CO_2	Yes	L1e	T1e	L1i	T1i	
INDUSTRIAL SECTOR							
Emissions from Cement Production	CO_2	Yes	L1e	T1e	L1i	T1i	
Emissions from Lime Production	CO_2	No					
Emissions from Limestone and Dolomite Use	CO_2	No					
Emissions from Soda Ash Production and Use	CO_2	No					
Emissions from Ammonia Production	CO_2	Yes	L1e	T1e	L1i		
Emissions from Iron and Steel Production	CO_2	No					
Emissions from Ferroalloys Production	CO_2	Yes		T1e		T1i,T2i	
Emissions from Aluminium Production	CO_2	Yes		T1e		T1i	
Emissions from Production of Other Chemicals	CH_4	No					
Emissions from Nitric Acid Production	N_2O	Yes	L1e,L2e	T1e	L1i,L2i	T2i	
Emissions from Consumption of HFCs, PFCs, SF_6	HFC	Yes	L1e,L2e	T1e,T2e	L1i,L2i	T1i,T2i	
Emissions from Aluminium production	PFC	Yes		T1e,T2e		T1i,T2i	
Emissions from Other non-specified NEU	CO_2	No					
SOLVENT AND OTHER PRODUCT USE							
CO_2 Emissions from solvent and other product use	CO_2	No					
N_2O Emissions from solvent and other product use	N_2O	No					
AGRICULTURE SECTOR							
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L1e	T1e,T2e	L1i	T1i,T2i	
CH_4 Emissions from Manure Management	CH_4	No		.			
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No					
N_2O Emissions from Manure Management	N_2O	Yes	L1e	T1e,T2e		T1i,T2i	

Table 7.A3							
Tier 1 and Tier 2 Analysis - Source Analysis Summary (Croatian Inventory, 2010)							
A	B	C	D				E
IPCC Source Categories	GHG	Key	If Column C is Yes, Criteria for Identification				Co
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L1e,L2e		L1i,L2i	T1i,T2i	
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	L1e	T1e		T1i	
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L1e,L2e	T1e,T2e	L1i,L2i	T1i,T2i	
CH_4 and N_2O Emissions from Agricultural Residue Burning	N_2O	No					
LULUCF							
Forest land remaining forest land	CO_2	Yes			L1i,L2i	T1i,T2i	
Forest land remaining forest land	CH_4	No					
Forest land remaining forest land	N_2O	No					
Land converted to Forest land	CO_2	No					
Land converted to Settlements	CO_2	No					
Total Cropland	CO_2	No					
Total grassland	CO_2	No					
Total wetlands	CO_2	Yes					
Total settlements	CO_2	No			L1i	T1i	
Total Otherland	CO_2	No					
WASTE SECTOR							
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	L1e,L2e	T1e,T2e	L1i,L2i	T1i,T2i	
Emissions from Waste Water Handling	CH_4	Yes	L1e,L2e		L1i		
Emissions from Waste Water Handling	N_2O	No					
Emissions from Waste Incineration	CO_2	No					
Emissions from Waste Incineration	N_2O	No					

L1e - Level excluding LULUCF Tier1
L2e - Level excluding LULUCF Tier2
L1i - Level including LULUCF Tier1
L2i - Level including LULUCF Tier2
T1e - Trend excluding LULUCF Tier1
T2e - Trend excluding LULUCF Tier2
T1i - Trend including LULUCF Tier1
T2i - Trend including LULUCF Tier2

ANNEX 2

DETAILED DISCUSSION OF ACTIVITY DATA AND EMISSION FACTORS FOR ESTIMATING CO_2 EMISSIONS FROM FOSSIL FUEL COMBUSTION

Table A2-1: The GHG emissions from Thermal Power Plants

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Hard coal (1000 t)	253.7	569.9	915.0	835.9	895.8	925.0	640.3	897.5
NCV for hard coal (MJ/kg)	25.1	26.2	24.2	24.6	24.5	24.5	24.4	24.4
Fuel oil (1000 t)	570.4	283.4	284.0	311.4	423.9	331.6	304.8	15.2
NCV for fuel oil (MJ/kg)	40.4	40.5	40.3	40.4	40.2	40.2	40.2	40.2
Extra light oil (1000 t)	0.7	7.5	3.0	1.0	1.4	1.2	1.6	1.0
NCV for ex. light oil (MJ/kg)	42.3	42.0	42.3	42.3	42.3	42.3	42.1	42.8
Natural gas (1000000 m^3)	194.6	155.7	48.2	128.4	296.8	166.4	157.9	24.2
NCV for nat. gas (MJ/m^3)	33.4	33.4	33.4	33.4	33.3	33.3	33.3	33.3
Gas coke (1000000 m^3)	24.5							
NCV for gas coke (MJ/m^3)	17.6							
Total fuel consumpt. (TJ)	36347	31930	35336	37478	48938	41585	33216	23317
Emissions								
EF CO_2 – hard coal (t/TJ)	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
EF CO_2 – fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 – extra light oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 – natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
EF CO_2 – coke gas (t/TJ)	47.4							
CO_2 emission (Gg)	2739	2577	3030	3113	3896	3435	2686	2121
EF CH_4 – hard coal (kg/TJ)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
EF CH_4 – fuel oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – extra light oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF CH_4 – coke gas (kg/TJ)	1.0							
CH_4 emission (Mg)	37.4	22.9	26.1	27.5	42.2	31.4	28.4	20.7
EF N_2O – hard coal (kg/TJ)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
EF N_2O – fuel oil (kg/TJ)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
EF N_2O – extra light oil (kg/TJ)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
EF N_2O – natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O – coke gas (kg/TJ)	0.1							
N_2O emission (Mg)	17.8	28.0	39.1	37.2	41.2	40.8	29.2	35.2

Table A2-2: The GHG emissions from Public Cogeneration Plants

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Fuel oil (1000 t)	117.7	108.6	162.0	156.1	93.8	124.9	173.5	108.3
NCV for fuel oil (MJ/kg)	40.5	40.7	40.7	38.4	40.2	40.2	40.2	40.3
Extra light oil (1000 t)	0.0	0.9	0.0	0.0	0.0	0.2	0.1	0.1
NCV for extra light oil (MJ/kg)	0.0	21.4	21.4	0.0	0.0	21.4	21.4	42.8
Natural gas (1000000 m^3)	312.7	357.7	479.0	458.8	550.6	541.9	446.0	649.5
NCV for natural gas (MJ/m^3)	33.3	33.4	33.4	33.6	33.3	33.3	33.3	33.3

Table A2-2: The GHG emissions from Public Cogeneration Plants

	1990	2000	2005	2006	2007	2008	2009	2010
Total fuel consumption (TJ)	15196	16399	22567	21411	22124	23091	21854	26019
Emissions								
EF CO_2 – fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 – ex.light oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 – natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
CO_2 emission (Gg)	2739	1005	1397	1322	1313	1393	1365	1543
EF CH_4 – fuel oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – ex.light oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – nat. gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CH_4 emission (Mg)	11.6	34.4	88.6	85.2	91.8	90.3	85.2	119.8
EF N_2O – fuel oil (kg/TJ)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
EF N_2O – ex.light oil (kg/TJ)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
EF N_2O – nat. gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O emission (Mg)	17.8	2.5	3.6	3.4	3.0	3.3	3.6	3.5

Table A2-3: The GHG emissions from Public Heating Plants

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Fuel oil (1000 t)	0.0	37.0	39.0	33.4	36.9	20.8	21.6	23.1
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Light heating oil (1000 t)	0.0	-3.0	8.2	5.4	4.4	5.5	4.2	4.8
NCV for light heating oil (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Natural gas (1000000 m^3)	0.0	58.8	59.4	51.8	79.0	58.8	86.2	86.6
NCV for natural gas (MJ/m^3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
LPG (1000 t)	0.0	0.0						
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9				
Gas works gas (1000000 m^3)	0.0	0.0	1.5	1.8	1.6			
NCV for gas work gas (MJ/m^3)			21.5	30.4	27.8	0.0	0.0	0.0
Landfill Gas (1000000 m^3)					3.9	2.2	3.3	8.8
NCV for landfill gas (MJ/m^3)					17.0	17.0	17.0	17.0
Total fuel cunsumption (TJ)	0.0	3359.8	3969.7	3384.2	4467.0	3109.7	4034.9	4228.7
Emissions								
EF CO_2 - fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 - light heating oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 - natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
EF CO_2 - LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	64.4	64.4	64.4
EF CO_2 - gas work gas (t/TJ)	47.4	47.4	47.4	47.4	47.4	47.4	47.4	47.4
EF CO_2 - landfill gas (t/TJ)					54.6	54.6	54.6	54.6
CO_2 Emission (Gg)	0.0	216.2	260.0	220.3	282.9	195.0	246.4	258.7
EF CH_4 - fuel oil (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
EF CH_4 - light heating oil (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Table A2-3: The GHG emissions from Public Heating Plants (cont.)

	1990	2000	2005	2006	2007	2008	2009	2010
EF CH_4 - natural gas (kg/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EF CH_4 - LPG (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - gas work gas (t/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EF CH_4 - landfill gas (t/TJ)					1.0	1.0	1.0	1.0
CH_4 Emission (Mg)	0.0	6.1	7.8	6.5	7.8	5.3	6.1	6.5
EF N_2O - fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - light heating oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O - LPG (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - gas work gas (t/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O - landfill gas (t/TJ)					0.1	0.1	0.1	0.1
N_2O Emission (Mg)	0.0	1.0	1.4	1.1	1.3	0.8	0.9	1.0

The GHG emissions from thermal power plants and public cogeneration plants, for the whole period (from 1990 to 2009), were calculated using more detailed Tier 2 approach. Tier 2 approach is based on bottom-up fuel consumption data from every boiler or gas turbine in plant. There were available data about monthly fuel consumption and detailed fuel characteristics data (net calorific value. sulphur and ash content…). Every plant also has the equipment for continual measurements of SO_2, NO_x, CO and particulates emission.

For estimation of CO_2 emissions, default IPCC emission factors were used, while emission factors for CH_4 and N_2O are based on technology type and configuration (Tier 2). The results of GHG emission calculation, using more detailed approach are presented in tables A2-2 and A2-3 for the 1990, 2000, 2005 and last five years, on aggregated level. The GHG emissions on plant level, for the year 2010, are given in the Table A2-5.

Table A2-4: The GHG emissions from TPPs and PCPs (Tier 2), year 2010

	TE Plomin	TE Rijeka	TE Sisak	TE-TO Zagreb	EL-TO Zagreb	TE-TO Osijek	KTE Jertovec
Fuel consumption							
Hard coal (1000 t)	897.5						
NCV for hard coal (MJ/kg)	24.4						
Fuel oil (1000 t)		15.2	0.0	54.3	26.1	27.9	
NCV for fuel oil (MJ/kg)		40.2		40.2	40.3	40.3	
Extra light oil (1000 t)	0.9	0.1		0.1		0.0	0.0
NCV for ELLU (MJ/kg)	43.0	42.7		42.9		42.7	42.7
Natural gas (1000000 m^3)			0.0	461.2	152.7	35.7	24.2
NCV for nat. gas (MJ/m^3)				33.3	33.3	33.3	33.3
Total fuel consumption (TJ)	21891.6	616.1	0.0	17561.6	6143.4	2314.0	809.5

Table A2-4: The GHG emissions from TPPs and PCPs (Tier 2), year 2009 (cont.)

	TE Plomin	TE Rijeka	TE Sisak	TE-TO Zagreb	EL-TO Zagreb	TE-TO Osijek	KTE Jertovec
Emissions							
EF CO_2 – hard coal (t/TJ)	92.7						
EF CO_2 – fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 – extra light oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 – natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8
CO_2 emission (Gg)	2028.8	47.2	0.0	1025.7	364.8	152.5	45.2
EF CH_4 – hard coal (kg/TJ)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
EF CH_4 – fuel oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – extra light oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – natural gas (kg/TJ)	0.1	0.1	0.1	5.9	4.7	1.6	6.0
CH_4 emission (Mg)	15.3	0.6	0.0	92.2	24.7	2.9	4.8
EF N_2O – hard coal (kg/TJ)	1.6	1.6	1.6	1.6	1.6	1.6	1.6
EF N_2O – fuel oil (kg/TJ)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
EF N_2O – extra light oil (kg/TJ)	0.4	0.4	0.4	0.4	0.4	0.4	0.4
EF N_2O – natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O emission (Mg)	35.0	0.2	0.0	2.2	0.8	0.5	0.1

Table A2-5: The GHG emissions from Petroleum Refining

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Fuel oil (1000 t)	227.2	193.4	254.0	249.9	288.0	194.2	252.7	244.30
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.19
LPG (1000 t)	0.0	0.0	9.5	9.7	10.9	0.0	0.0	0.00
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.89
Petroleum coke (1000 t)	0.0	0.0	70.7	61.9	67.8	57.9	71.9	55.90
NCV for petroleum coke (MJ/kg)	33.6	31.0	31.0	31.0	31.0	31.0	31.0	31.00
Refinery gas (1000 t)	58.4	40.7	241.1	210.4	217.4	154.5	200.2	161.50
NCV for refinery gas (MJ/kg)	48.6	48.6	48.6	48.6	48.6	48.6	48.6	48.57
Natural gas (1000000 m^3)	7.3	0.2	1.2	0.4	18.9	86.7	30.4	16.60
NCV for natural gas (MJ/m^3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.00
Total fuel consumption (TJ)	12216	9756	24596	22650	25389	20052	23142	19960
Emissions								
EF CO_2 – fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.59
EF CO_2 – LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.44
EF CO_2 – petroleum coke (t/TJ)	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.83
EF CO_2 – refinery gas (t/TJ)	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.07
EF CO_2 – natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.82
CO_2 emission (Gg)	900.6	726.3	1804.4	1665.1	1861.7	1437.3	1.700.5	1474.7
EF CH_4 – fuel oil (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.00
EF CH_4 – LPG (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.00
EF CH_4 – petroleum coke (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.00
EF CH_4 – refinery gas (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.00

Table A2-5: The GHG emissions from Petroleum Refining (cont.)

	1990	2000	2005	2006	2007	2008	2009	2010
EF CH_4 – natural gas (kg/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CH_4 emission (Mg)	36.2	29.3	73.7	67.9	74.9	54.3	67.4	58.8
EF N_2O – fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – LPG (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – petroleum coke (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – refinery gas (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O emission (Mg)	7.2	5.9	14.7	13.6	14.9	10.6	13.4	11.7

Table A2-6: The GHG emissions from Manufacturing of Solid Fuels and Other Energy Industries

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
LPG (1000 t)	11.9	1.0						
NCV for LPG (MJ/kg)	46.9	46.9						
Coke gas (1000000 m^3)	107.4							
NCV for coke gas (MJ/m^3)	17.9							
Extra light oil (1000 t)	1.4	7.5	5.5	2.5				
NCV for ex.light oil (MJ/kg)	42.7	42.7	42.7	42.7				
Natural gas (1000000 m^3)	392.0	140.5	175.5	158.4	190.4	129.3	199.3	238.90
NCV for nat. gas (MJ/m^3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.00
Total fuel consumpt. (TJ)	15869.3	5144.2	6201.9	5492.4	6473.6	4396.2	6776.2	8122.6
Emissions								
EF CO_2 – LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
EF CO_2 – coke gas (t/TJ)	47.4	47.4	47.4	47.4	47.4	47.4	47.4	47.4
EF CO_2 – ex.light oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 – natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
CO_2 emission (Gg)	874.4	293.1	350.3	308.4	361.4	245.4	378.2	453.4
EF CH_4 – LPG (kg/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EF CH_4 – coke gas (kg/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EF CH_4 – ex.ligh oil (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
EF CH_4 – nat. gas (kg/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CH_4 emission (Mg)	16.0	5.8	6.7	5.7	6.5	4.4	6.8	8.1
EF N_2O – LPG (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O – coke gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O – ex.ligh oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – nat. gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O emission (Mg)	2.3	0.7	0.7	0.6	0.6	0.4	0.7	0.8

Table A2-7: The GHG emissions from Manufacturing Industries and Construction – liquid fuels

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Gasoline (1000 t)	0.2	7.6	6.9	7.3	7.6	7.9	7.0	5.1
NCV for gasoline (MJ/kg)	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Petroleum (1000 t)	0.1							
NCV for petroleum (MJ/kg)	44.0							
Gas/diesel oil (1000 t)	246.5	130.8	161.6	164.8	177.4	194.3	145.4	130.2
NCV for gas/diesel o.(MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Fuel oil (1000 t)	419.2	302.2	198.6	206.8	141.8	124.3	90.7	56.3
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
LPG (1000 t)	17.5	21.0	22.8	29.4	28.2	30.4	20.1	16.2
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
Lubricants (1000 t)	8.6							
NCV for lubricants (MJ/kg)	33.6							
Petroleum coke (1000 t)	0.0		172.3	215.0	200.4	191.6	140.4	116.0
NCV for petroleum coke (MJ/kg)	29.3		31.0	31.0	31.0	31.0	31.0	31.0
Total fuel consumpt. (TJ)	28498	19056	21602	23719	21151	21012	15462	12407
Emissions								
EF CO_2 – gasoline (t/TJ)	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6
EF CO_2 – petroleum (t/TJ)	71.1	71.1	71.1	71.1	71.1	71.1	71.1	71.1
EF CO_2 – gas/diesel oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 – fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 – LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
EF CO_2 – lubricants (t/TJ)	72.6	72.6	72.6	72.6	72.6	72.6	72.6	72.6
EF CO_2 – petroleum coke (t/TJ)	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8
CO_2 emission (Gg)	2135.5	1424.6	1738.5	1926.4	1718.2	1697.2	1249.3	1003.1
EF CH_4 – gasoline (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EF CH_4 – petroleum (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EF CH_4 – gas/diesel oil (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EF CH_4 – fuel oil (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EF CH_4 – LPG (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EF CH_4 – lubricants (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EF CH_4 – petroleum coke (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
CH_4 emission (Mg)	0.057	0.038	0.043	0.047	0.042	0.042	0.031	0.025
EF N_2O – gasoline (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – petroleum (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – gas/diesel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – LPG (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – lubricants (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O – petroleum coke (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
N_2O emission (Mg)	0.017	0.011	0.013	0.014	0.013	0.013	0.009	0.007

Table A2-8: The GHG emissions from Manufacturing Industries and Construction – solid fuels

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Anthracite (1000 t)	107.2		0.3	0.1	0.3	0.0	0.3	1.3
NCV for anthracite (MJ/kg)	29.3	29.3	29.3	29.3	29.3	29.3	29.3	29.3
Hard coal (1000 t)	42.0	53.2	169.3	151.0	185.1	195.7	158.1	194.6
NCV for hard coal (MJ/kg)	25.1	26.2	25.1	24.9	24.9	24.9	24.6	24.8
Brown Coal (1000 t)	261.2	28.2	56.9	61.3	53.2	47.1	36.9	41.0
NCV for brown coal (MJ/kg)	16.7	17.8	18.5	17.7	17.7	18.0	18.0	17.6
Lignite (1000 t)	73.2	14.4	0.2	0.2	0.4	0.0	0.0	0.0
NCV for lignite (MJ/kg)	10.9	12.0	12.1	12.3	11.7	-	-	-
Briquettes (1000 t)	3.3							
NCV for briquettes (MJ/kg)	16.7							
Coke oven coke (1000 t)	251.2	37.7	22.6	20.6	27.9	24.9	25.4	27.6
NCV for coke oven coke (MJ/kg)	29.3	29.3	29.3	29.3	29.3	29.3	29.3	29.3
Total fuel consumpt. (TJ)	16784	3171	5976	5448	6374	6451	5307	6390
Emissions								
EF CO_2 – anthracite (t/TJ)	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3
EF CO_2 – hard coal (t/TJ)	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
EF CO_2 – brown coal (t/TJ)	94.1	94.1	94.1	94.1	94.1	94.1	94.1	94.1
EF CO_2 – lignite (t/TJ)	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
EF CO_2 – briquettes (t/TJ)	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
EF CO_2 – coke oven coke (t/TJ)	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0
CO_2 emission (Gg)	1676.8	310.5	564.4	514.7	603.3	608.9	502.9	604.3
EF CH_4 – anthracite (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 – hard coal (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 – brown coal (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 – lignite (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 – briquettes (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 – coke oven coke (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
CH_4 emission (Mg)	0.168	0.032	0.060	0.054	0.064	0.065	0.053	0.064
EF N_2O – anthracite (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O – hard coal (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O – brown coal (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O – lignite (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O – briquettes (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O – coke oven coke (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
N_2O emission (Mg)	0.003	0.002	0.008	0.008	0.009	0.009	0.007	0.009

Table A2-9: The GHG emissions from Manufacturing Industries and Construction –gaseous fuels

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Natural gas (1000000 m3)	1056.9	984.3	931.4	912.4	985.1	990.7	852.4	685.6
NCV for natural gas (MJ/m3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Gas Works Gas (1000 t)	6.1	7.9	3.6	3.0	2.5	1.5	0.3	0.0
NCV for gas work gas (MJ/kg)	15.8	15.8	21.5	30.4	27.8	19.6	19.6	-
Coke Oven Gas (1000 t)	29.9							
NCV for COG (MJ/kg)	17.9							
Blast Furance Gas (1000 t)	418.1							
NCV for blast fur. gas (MJ/kg)	3.6							
Total fuel cunsumption (TJ)	38072	33590	31744	31112	33562	33714	28988	23310
Emissions								
EF CO_2 - natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
EF CO_2 - gas work gas (t/TJ)	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7
EF CO_2 - coke oven gas (t/TJ)	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7
EF CO_2 - blast fur. gas (t/TJ)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO_2 Emission (Gg)	2030.6	1881.6	1778.2	1740.3	1883.1	1891,5	1626.4	1301.2
EF CH_4 - natural gas (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - gas work gas (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4- coke ov. gas (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - blast fur. gas (kg/TJ)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CH_4 Emission (Mg)	0.183	0.168	0.159	0.156	0.168	0.169	0.145	0.117
EF N_2O - natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O- gas work gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O-coke ov. gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O-blast fur.. gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O Emission (Mg)	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.002

Table A2-10: The number of road motor vehicles (´000) for year 1990, 2000, and 2005 – 2010 in Croatia

	1990	2000	2005	2006	2007	2008	2009	2010
Mopeds, (´000)	18.0	44.2	73.9	75.7	76.6	82.5	80.3	76.2
Motorcycles, (´000)	12.5	28.3	58.8	72.2	87.0	107.7	111.3	107.5
Passenger Cars, (´000)	1,120.0	1,145.0	1,394.6	1,443.2	1,474.7	1,532.3	1,516.1	1,491.8
Buses, (´000)	6.5	4.7	4.9	4.9	5.0	5.1	5.0	4.9
Light and Heavy Duty Vehicles, (´000)	80.0	127.3	165.8	171.2	174.5	178.9	171.6	163.3
Total, (´000)	1,237.0	1,349.6	1,698.0	1,767.2	1,817.9	1,906.4	1,884.3	1,843.6

Table A2-10a: The mileage /km for each tipe if motor vehicles for year 1990, 2000, and 2005 – 2010 in Croatia

Sector	Subsector	Technology	1990	2000	2005	2006	2007	2008	2009	2010
Passeng. Cars	Gasoline <1,4 l	PRE ECE	12450	13985	12275	11765	12170	11505	11549	10982
Passeng. Cars	Gasoline <1,4 l	ECE 15/00-01	12450	13985	12275	11765	12170	11505	11549	10982
Passeng. Cars	Gasoline <1,4 l	ECE 15/02	12450	13985	12275	11765	12170	11505	11549	10982
Passeng. Cars	Gasoline <1,4 l	ECE 15/03	12450	13985	12275	11765	12170	11505	11549	10982
Passeng. Cars	Gasoline <1,4 l	ECE 15/04	12450	13985	12275	11765	12170	11505	11549	10982
Passeng. Cars	Gasoline <1,4 l	Improved Conv.	12500	14000	11000	11765	13500	11000	13500	13500
Passeng. Cars	Gasoline <1,4 l	Open Loop	0	0	0	0	0	0	0	0
Passeng. Cars	Gasoline <1,4 l	PC Euro 1	15500	13985	12280	11765	12170	11000	11549	10982
Passeng. Cars	Gasoline <1,4 l	PC Euro 2	15500	13985	12280	11765	12170	11000	11549	10982
Passeng. Cars	Gasoline <1,4 l	PC Euro 3	15500	13985	12280	11765	12170	11000	11549	10982
Passeng. Cars	Gasoline <1,4 l	PC Euro 4	15500	14000	12280	11765	12170	11000	11549	10982
Passeng. Cars	Gasoline <1,4 l	PC Euro 5	15500	14000	11000	0	0	11000	0	0
Passeng. Cars	Gasoline <1,4 l	PC Euro 6	0	0	0	0	0	0	0	0
Passeng. Cars	Gasoline 1,4 - 2,0 l	PRE ECE	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	ECE 15/00-01	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	ECE 15/02	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	ECE 15/03	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	ECE 15/04	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	Improved Conv.	15500	13600	11000	0	0	11000	0	0
Passeng. Cars	Gasoline 1,4 - 2,0 l	Open Loop	15500	13600	11000	0	0	11000	0	0
Passeng. Cars	Gasoline 1,4 - 2,0 l	PC Euro 1	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	PC Euro 2	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	PC Euro 3	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	PC Euro 4	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline 1,4 - 2,0 l	PC Euro 5	15500	13600	11000	0	0	12000	0	0
Passeng. Cars	Gasoline 1,4 - 2,0 l	PC Euro 6	0	0	0	0	0	0	0	0
Passeng. Cars	Gasoline >2,0 l	PRE ECE	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline >2,0 l	ECE 15/00-01	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline >2,0 l	ECE 15/02	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline >2,0 l	ECE 15/03	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline >2,0 l	ECE 15/04	15500	13600	11000	11000	11000	11000	11000	11000
Passeng. Cars	Gasoline >2,0 l	PC Euro 1	15500	13600	11000	11000	11000	11700	11000	11000
Passeng. Cars	Gasoline >2,0 l	PC Euro 2	15500	13600	11000	11000	11000	11700	11000	11000
Passeng. Cars	Gasoline >2,0 l	PC Euro 3	15500	13600	11000	11000	11000	11700	11000	11000
Passeng. Cars	Gasoline >2,0 l	PC Euro 4	15500	13600	11000	11000	11000	11700	11000	11000
Passeng. Cars	Gasoline >2,0 l	PC Euro 5	15500	13600	11000	0	0	11000	0	0
Passeng. Cars	Gasoline >2,0 l	PC Euro 6	0	0	0	0	0	0	0	0
Passeng. Cars	Diesel <2,0 l	Conventional	3320	13800	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel <2,0 l	PC Euro 1	17000	13800	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel <2,0 l	PC Euro 2	17000	13800	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel <2,0 l	PC Euro 3	17000	13750	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel <2,0 l	PC Euro 4	17000	13750	16460	18349	21120	12822	19532	18423

Sector	Subsector	Technology	1990	2000	2005	2006	2007	2008	2009	2010
Passeng. Cars	Diesel <2,0 l	PC Euro 5	17000	13750	16500	0	21120	12822	0	0
Passeng. Cars	Diesel <2,0 l	PC Euro 6	0	0	0	0	0	0	0	0
Passeng. Cars	Diesel >2,0 l	Conventional	3320	13800	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel >2,0 l	PC Euro 1	17000	13800	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel >2,0 l	PC Euro 2	17000	13800	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel >2,0 l	PC Euro 3	17000	13500	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel >2,0 l	PC Euro 4	17000	13500	16460	18349	21120	12822	19532	18423
Passeng. Cars	Diesel >2,0 l	PC Euro 5	17000	13500	16500	0	0	12822	0	0
Passeng. Cars	Diesel >2,0 l	PC Euro 6	0	0	0	0	0	0	0	0
Passeng. Cars	LPG	Conventional	17000	16170	21190	31761	41850	27220	25700	21361
Passeng. Cars	LPG	PC Euro 1	17000	16170	21190	31761	41850	27220	25700	21361
Passeng. Cars	LPG	PC Euro 2	17000	16170	21190	31761	41850	27220	25700	21361
Passeng. Cars	LPG	PC Euro 3	17000	16170	21190	31761	41850	27220	25700	21361
Passeng. Cars	LPG	PC Euro 4	17000	16170	21190	31761	41850	27220	25700	21361
Passeng. Cars	LPG	PC Euro 5	17000	16170	21180	31800	41850	27220	41850	21361
Passeng. Cars	LPG	PC Euro 6	0	0	0	0	0	0	0	0
Passeng. Cars	2-Stroke	Conventional	15500	13600	12000	11000	11000	12000	11000	11000
Passeng. Cars	Hyb. Gas. <1,4 l	PC Euro 4	0	0	0	0	0	0	0	0
Passeng. Cars	Hyb. Gas.1,4 - 2,0 l	PC Euro 4	0	0	0	0	0	0	0	0
Passeng. Cars	Hyb. Gas.e >2,0 l	PC Euro 4	0	0	0	0	0	0	0	0
LD Vehicles	Gasoline <3,5t	Conventional	31800	25000	11000	21000	21000	20000	21000	21000
LD Vehicles	Gasoline <3,5t	LD Euro 1	31800	25000	11000	21000	21000	20000	21000	21000
LD Vehicles	Gasoline <3,5t	LD Euro 2	31800	25000	11000	21000	21000	20000	21000	21000
LD Vehicles	Gasoline <3,5t	LD Euro 3	31800	25000	11000	21000	21000	20000	21000	21000
LD Vehicles	Gasoline <3,5t	LD Euro 4	31800	25000	11000	21000	21000	20000	21000	21000
LD Vehicles	Gasoline <3,5t	LD Euro 5	31800	25000	11000	27500	27500	20000	27500	27500
LD Vehicles	Gasoline <3,5t	LD Euro 6	0	0	0	0	0	0	0	0
LD Vehicles	Diesel <3,5 t	Conventional	25000	25000	30500	27500	27500	40000	27500	27500
LD Vehicles	Diesel <3,5 t	LD Euro 1	31800	25000	30500	27500	27500	40000	27500	27500
LD Vehicles	Diesel <3,5 t	LD Euro 2	31800	25000	30500	27500	27500	40000	27500	27500
LD Vehicles	Diesel <3,5 t	LD Euro 3	31800	25000	30500	27500	27500	40000	27500	27500
LD Vehicles	Diesel <3,5 t	LD Euro 4	31800	25000	30500	27500	27500	40000	27500	27500
LD Vehicles	Diesel <3,5 t	LD Euro 5	31800	25000	30500	27500	27500	30000	27500	27500
LD Vehicles	Diesel <3,5 t	LD Euro 6	0	0	0	0	0	0	0	0
HD Trucks	Gasoline >3,5 t	Conventional	50000	27300	32000	31000	31000	25000	31000	31000
HD Trucks	Diesel 3,5 - 7,5 t	Conventional	20000	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 3,5 - 7,5 t	HD Euro I	0	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 3,5 - 7,5 t	HD Euro II	0	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 3,5 - 7,5 t	HD Euro III	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 3,5 - 7,5 t	HD Euro IV	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 7,5 - 16 t	Conventional	20000	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 7,5 - 16 t	HD Euro I	0	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 7,5 - 16 t	HD Euro II	0	27300	32000	39000	40000	50000	40000	40000

Sector	Subsector	Technology	1990	2000	2005	2006	2007	2008	2009	2010
HD Trucks	Diesel 7,5 - 16 t	HD Euro III	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 7,5 - 16 t	HD Euro IV	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 16 - 32 t	Conventional	20000	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 16 - 32 t	HD Euro I	0	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 16 - 32 t	HD Euro II	0	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 16 - 32 t	HD Euro III	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel 16 - 32 t	HD Euro IV	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel >32t	Conventional	20000	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel >32t	HD Euro I	0	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel >32t	HD Euro II	0	27300	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel >32t	HD Euro III	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Diesel >32t	HD Euro IV	0	0	32000	39000	40000	50000	40000	40000
HD Trucks	Rigid <=7,5 t	Conventional	25000	27300	32000	39000	40000	49093	40000	40000
HD Trucks	Rigid <=7,5 t	HD Euro I	21000	27300	32000	39000	40000	49093	40000	40000
HD Trucks	Rigid <=7,5 t	HD Euro II	0	27300	32000	39000	40000	49093	40000	40000
HD Trucks	Rigid <=7,5 t	HD Euro III	0	0	32000	39000	40000	49093	40000	40000
HD Trucks	Rigid <=7,5 t	HD Euro IV	0	0	32000	39000	40000	49093	40000	40000
HD Trucks	Rigid <=7,5 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid <=7,5 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Rigid 7,5 - 12 t	Conventional	40000	27300	32000	40000	40000	46000	40000	40000
HD Trucks	Rigid 7,5 - 12 t	HD Euro I	0	27300	32000	40000	40000	46000	40000	40000
HD Trucks	Rigid 7,5 - 12 t	HD Euro II	0	27300	32000	40000	40000	46000	40000	40000
HD Trucks	Rigid 7,5 - 12 t	HD Euro III	0	0	32000	40000	40000	46000	40000	40000
HD Trucks	Rigid 7,5 - 12 t	HD Euro IV	0	0	32000	40000	40000	46000	40000	40000
HD Trucks	Rigid 7,5 - 12 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid 7,5 - 12 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Rigid 12 - 14 t	Conventional	40000	27300	32000	40000	40000	45000	40000	40000
HD Trucks	Rigid 12 - 14 t	HD Euro I	0	27300	32000	40000	40000	45000	40000	40000
HD Trucks	Rigid 12 - 14 t	HD Euro II	0	27300	32000	40000	40000	45000	40000	40000
HD Trucks	Rigid 12 - 14 t	HD Euro III	0	0	32000	40000	40000	45000	40000	40000
HD Trucks	Rigid 12 - 14 t	HD Euro IV	0	0	32000	40000	40000	45000	40000	40000
HD Trucks	Rigid 12 - 14 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid 12 - 14 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Rigid 14 - 20 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 14 - 20 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 14 - 20 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 14 - 20 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 14 - 20 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 14 - 20 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid 14 - 20 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Rigid 20 - 26 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 20 - 26 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 20 - 26 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000

Sector	Subsector	Technology	1990	2000	2005	2006	2007	2008	2009	2010
HD Trucks	Rigid 20 - 26 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 20 - 26 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 20 - 26 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid 20 - 26 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Rigid 26 - 28 t	Conventional	50000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 26 - 28 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 26 - 28 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 26 - 28 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 26 - 28 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 26 - 28 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid 26 - 28 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Rigid 28 - 32 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 28 - 32 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 28 - 32 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 28 - 32 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 28 - 32 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid 28 - 32 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid 28 - 32 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Rigid >32 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid >32 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid >32 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid >32 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid >32 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Rigid >32 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Rigid >32 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Artic. 14 - 20 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 14 - 20 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 14 - 20 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 14 - 20 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 14 - 20 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 14 - 20 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Artic. 14 - 20 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Artic. 20 - 28 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 20 - 28 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 20 - 28 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 20 - 28 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 20 - 28 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 20 - 28 t	HD Euro V	0	0	0	0	40000	0	40000	40000
HD Trucks	Artic. 20 - 28 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Artic. 28 - 34 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 28 - 34 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 28 - 34 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 28 - 34 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000

Sector	Subsector	Technology	1990	2000	2005	2006	2007	2008	2009	2010
HD Trucks	Artic. 28 - 34 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 28 - 34 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Artic. 28 - 34 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Artic. 34 - 40 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 34 - 40 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 34 - 40 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 34 - 40 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 34 - 40 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 34 - 40 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Artic. 34 - 40 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Artic. 40 - 50 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 40 - 50 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 40 - 50 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 40 - 50 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 40 - 50 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 40 - 50 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Artic. 40 - 50 t	HD Euro VI	0	0	0	0	0	0	0	0
HD Trucks	Artic. 50 - 60 t	Conventional	40000	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 50 - 60 t	HD Euro I	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 50 - 60 t	HD Euro II	0	27300	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 50 - 60 t	HD Euro III	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 50 - 60 t	HD Euro IV	0	0	32000	40000	40000	40000	40000	40000
HD Trucks	Artic. 50 - 60 t	HD Euro V	0	0	0	0	0	0	0	0
HD Trucks	Artic. 50 - 60 t	HD Euro VI	0	0	0	0	0	0	0	0
Buses	Urban CNG Buses	HD Euro I	0	0	0	0	0	0	0	0
Buses	Urban CNG Buses	HD Euro II	0	0	0	0	0	0	0	0
Buses	Urban CNG Buses	HD Euro III	0	0	0	0	0	0	40000	0
Buses	Urban CNG Buses	EEV	0	0	0	0	0	0	0	0
Buses	Urban Buses	Conventional	21900	45500	49000	40000	40000	50000	40000	40000
Buses	Urban Biodiesel	Conventional	0	0	0	0	0	0	0	0
Buses	Urban Biodiesel	HD Euro	0	46100	0	0	0	0	0	0
Buses	Urban Buses	HD Euro I	0	45500	49000	40000	40000	50000	40000	40000
Buses	Urban Biodiesel	HD Euro II	0	45900	0	0	40000	0	40000	40000
Buses	Urban Buses	HD Euro II	0	45500	49000	40000	40000	50000	40000	40000
Buses	Urban Buses	HD Euro III	0	0	49000	40000	40000	50000	40000	40000
Buses	Urban Biodiesel	HD Euro III	0	0	49000	0	0	0	0	0
Buses	Urban Biodiesel	HD Euro IV	0	0	0	0	0	0	0	0
Buses	Urban Buses	HD Euro IV	0	0	49000	40000	40000	50000	40000	40000
Buses	Urban Biodiesel	HD Euro V	0	0	0	0	0	0	0	0
Buses	Urban Biodiesel	HD Euro VI	0	0	0	0	0	0	0	0
Buses	UB Midi <=15 t	Conventional	42000	45500	49000	40000	40000	50000	40000	75000
Buses	UB Midi <=15 t	HD Euro I	0	45500	49000	40000	40000	50000	40000	75000
Buses	UB Midi <=15 t	HD Euro II	0	45500	49000	40000	40000	50000	40000	75000

Sector	Subsector	Technology	1990	2000	2005	2006	2007	2008	2009	2010
Buses	UB Midi <=15 t	HD Euro III	0	0	49000	40000	40000	50000	40000	75000
Buses	UB Midi <=15 t	HD Euro IV	0	0	49000	40000	40000	50000	40000	75000
Buses	UB Midi <=15 t	HD Euro V	0	0	0	0	0	0	0	0
Buses	UB Midi <=15 t	HD Euro VI	0	0	0	0	0	0	0	0
Buses	UB Stan. 15 - 18 t	Conventional	42000	45500	49000	40000	40000	50000	40000	75000
Buses	UB Stan. 15 - 18 t	HD Euro I	0	45500	49000	40000	40000	50000	40000	75000
Buses	UB Stan. 15 - 18 t	HD Euro II	0	45500	49000	40000	40000	50000	40000	75000
Buses	UB Stan. 15 - 18 t	HD Euro III	0	0	49000	40000	40000	50000	40000	75000
Buses	UB Stan. 15 - 18 t	HD Euro IV	0	0	49000	40000	40000	50000	40000	75000
Buses	UB Stan. 15 - 18 t	HD Euro V	0	0	0	0	0	0	0	0
Buses	UB Stan. 15 - 18 t	HD Euro VI	0	0	0	0	0	0	0	0
Buses	UB Art. >18 t	Conventional	42000	45500	49000	40000	40000	50000	40000	75000
Buses	UB Art. >18 t	HD Euro I	0	45500	49000	40000	40000	50000	40000	75000
Buses	UB Art. >18 t	HD Euro II	0	45500	49000	40000	40000	50000	40000	75000
Buses	UB Art. >18 t	HD Euro III	0	0	49000	40000	40000	50000	40000	75000
Buses	UB Art. >18 t	HD Euro IV	0	0	49000	40000	40000	50000	40000	75000
Buses	UB Art. >18 t	HD Euro V	0	0	0	0	0	0	0	0
Buses	UB Art. >18 t	HD Euro VI	0	0	0	0	0	0	0	0
Buses	Coaches	Conventional	42000	45500	49000	40000	40000	50000	40000	40000
Buses	Coaches	HD Euro I	0	45500	49000	40000	40000	50000	40000	40000
Buses	Coaches	HD Euro II	0	45500	49000	40000	40000	50000	40000	40000
Buses	Coaches	HD Euro III	0	0	49000	40000	40000	50000	40000	40000
Buses	Coaches	HD Euro IV	0	0	49000	40000	40000	50000	40000	40000
Buses	CS <=18 t	Conventional	42000	45500	49000	40000	40000	50000	40000	78000
Buses	CS <=18 t	HD Euro I	0	45500	49000	40000	40000	50000	40000	78000
Buses	CS <=18 t	HD Euro II	0	45500	49000	40000	40000	50000	40000	78000
Buses	CS <=18 t	HD Euro III	0	0	49000	40000	40000	50000	40000	78000
Buses	CS <=18 t	HD Euro IV	0	0	49000	40000	40000	50000	40000	78000
Buses	CS <=18 t	HD Euro V	0	0	0	0	0	0	0	0
Buses	CS <=18 t	HD Euro VI	0	0	0	0	0	0	0	0
Buses	Coaches Arti. >18 t	Conventional	42000	45500	49000	40000	40000	50000	40000	78000
Buses	Coaches Arti. >18 t	HD Euro I	0	45500	49000	40000	40000	50000	40000	78000
Buses	Coaches Arti. >18 t	HD Euro II	0	45500	49000	40000	40000	50000	40000	78000
Buses	Coaches Arti. >18 t	HD Euro III	0	0	49000	40000	40000	50000	40000	78000
Buses	Coaches Arti. >18 t	HD Euro IV	0	0	49000	40000	40000	50000	40000	78000
Buses	Coaches Arti. >18 t	HD Euro V	0	0	0	0	0	0	0	0
Buses	Coaches Arti. >18 t	HD Euro VI	0	0	0	0	0	0	0	0
Mopeds	<50 cm³	Conventional	6000	7000	3000	5000	5000	5000	5000	5000
Mopeds	<50 cm³	Mop - Euro I	6000	7000	3000	5000	5000	5000	5000	5000
Mopeds	<50 cm³	Mop - Euro II	6000	7000	3000	5000	5000	5000	5000	5000
Mopeds	<50 cm³	Mop - Euro III	0	0	0	0	0	0	0	0
Motorcycles	2-stroke >50 cm³	Conventional	9000	9000	4000	7000	7000	7000	7000	7000
Motorcycles	2-stroke >50 cm³	Mot - Euro I	9000	9000	4000	7000	7000	7000	7000	7000

Sector	Subsector	Technology	1990	2000	2005	2006	2007	2008	2009	2010
Motorcycles	2-stroke >50 cm³	Mot - Euro II	0	0	0	0	0	0	0	0
Motorcycles	2-stroke >50 cm³	Mot - Euro III	0	0	0	0	0	0	0	0
Motorcycles	4-stroke <250 cm³	Conventional	9000	9000	4000	7000	7000	7000	7000	7000
Motorcycles	4-stroke <250 cm³	Mot - Euro I	9000	9000	4000	7000	7000	7000	7000	7000
Motorcycles	4-stroke <250 cm³	Mot - Euro II	0	0	0	0	0	0	0	0
Motorcycles	4-stroke <250 cm³	Mot - Euro III	0	0	0	0	0	0	0	0
Motorcycles	4-str. 250 - 750 cm³	Conventional	9000	9000	4000	7000	7000	7000	7000	7000
Motorcycles	4-str. 250 - 750 cm³	Mot - Euro I	9000	9000	4000	7000	7000	7000	7000	7000
Motorcycles	4-str. 250 - 750 cm³	Mot - Euro II	0	0	0	0	0	0	0	0
Motorcycles	4-str. 250 - 750 cm³	Mot - Euro III	0	0	0	0	0	0	0	0
Motorcycles	4-stroke >750 cm³	Conventional	9000	9000	4000	7000	7000	7000	7000	7000
Motorcycles	4-stroke >750 cm³	Mot - Euro I	9000	9000	4000	7000	7000	7000	7000	7000
Motorcycles	4-stroke >750 cm³	Mot - Euro II	0	0	0	0	0	0	0	0
Motorcycles	4-stroke >750 cm³	Mot - Euro III	0	0	0	0	0	0	0	0

Table A2-11: Quantities of consumed fossil fuel, their net calorific values and GHG emissions for the sub-sector of Road transport (CRF 1AA3B) for the years 1990, 2000 and 2005 - 2010

	1990	2000	2005	2006	2007	2008	2009	2010
Gasoline (1000 t)	759.3	764.1	693.6	694.4	708.3	678.4	675.6	636.7
NCV for gasoline (MJ/kg)	44.59	44.59	44.59	44.59	44.59	44.59	44.59	44.59
Diesel (1000 t)	366.0	557.9	955.3	1,048.2	1,152.6	1,116.0	1,120.7	1,109.0
NCV for diesel (MJ/kg)	42.71	42.71	42.71	42.71	42.71	42.71	42.71	42.71
LPG (1000 t)	0.0	9.8	22.1	36.9	51.3	68.7	69.5	58.7
NCV for LPG (MJ/kg)	46.89	46.89	46.89	46.89	46.89	46.89	46.89	46.89
Biodiesel TJ	-	-	-	-	122.1	51.8	29.5	114.39
Total fuel cons. (TJ)	49,489.9	58,361.4	72,767.7	77,460.2	83216.7	81,137.4	81,252.7	78,510.7
Emissions								
CO_2 emission (Gg)	3,559.0	4,195.9	5,246.8	5,591.1	6,011.5	5,842.0	5,873.1	5,673.4
CH_4 emission (Gg)	1.6	1.4	0.9	0.9	0.8	0.8	0.8	0.7
N_2O emission (Gg)	0.1	0.2	0.3	0.2	0.2	0.2	0.2	0.2

Table A2-12: Fossil fuel consumption, their net calorific values, appropriate GHG emission factors and GHG emissions for sub-sector Civil aviation for years 1990, 2000 and 2005 - 2010

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption and NCV								
Gasoline (1000 t)	0.0	0.1	1.1	1.1	1.1	1.0	1.0	0.6
NCV for gasoline (MJ/kg)	NO	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Jet kerosene (1000 t)	49.7	17.6	20.3	22.4	23.3	27.4	23.9	25.5
NCV for jet kerosene (MJ/kg)	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Total fuel consumption (TJ)	2,186	776	943	1,036	1,075	1,248	1,095	1,147
Emission factors and emissions								
EF CO_2 – gasoline (t/TJ)	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6
EF CO_2 – jet kerosene (t/TJ)	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8
CO_2 emission (Gg)	154.7	55.0	66.6	73.2	76.0	88.2	77.4	81.1
EF CH_4 – gasoline (kg/TJ)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
EF CH_4 – jet kerosene (kg/TJ)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
CH_4 emission (Mg)	1.1	0.4	0.5	0.5	0.5	0.6	0.5	0.6
EF N_2O – gasoline (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EF N_2O – jet kerosene (kg/TJ)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
N_2O emission (Mg)	4.4	1.6	1.9	2.1	2.2	2.5	2.2	2.3

Table A2-13: Quantities of fossil fuel consumed, their net calorific values and appropriate GHG emission factors and GHG emissions in the sub-sector Navigation for the years 1990, 2000 and 2005 – 2010

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption and NCV								
Gasoline (1000 t)	0.1	0.3	NO	NO	NO	NO	NO	NO
NCV for gasoline (MJ/kg)	44.6	44.6	-	-	-	-	-	-
Diesel (1000 t)	38.7	25.7	31.8	33.1	34.4	40.3	46.0	34.8
NCV for diesel (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.71
Fuel oil (1000 t)	2.1	1.4	NO	NO	NO	1.5	0.4	2.0
NCV for fuel oil (MJ/kg)	40.2	40.2	-	-	-	40.2	40.2	40.19
Light heating oil (1000 t)	1.6	NO	NO	NO	NO	NO	NO	NO
NCV for light heating oil (MJ/kg)	42.7	-	-	-	-	-	-	-
Total fuel cunsumption (TJ)	1,810.1	1,167.3	1,358.2	1,413.7	1,469.2	1,781.5	1,980.7	1,566.7
Emission factors and emissions								
EF CO_2 - gasoline (t/TJ)	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6
EF CO_2 - diesel (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 - fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 - light heating oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
CO_2 Emission (Gg)	133.0	85.7	99.6	103.7	107.7	130.8	145.3	115.1
EF CH_4 - gasoline (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - diesel (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - fuel oil (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - light heating oil (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
CH_4 Emission (Mg)	9.1	5.8	6.8	7.1	7.3	8.9	9.9	7.8
EF N_2O - gasoline (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - diesel (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - light heating oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
N_2O Emission (Mg)	1.0	0.7	0.8	0.8	0.9	1.1	1.2	0.9

Table A2-14: Quantities of fossil fuel consumed their net calorific values and appropriate GHG emission factors and GHG emissions in the sub-sector Railways for the years 1990, 2000 and 2005 - 2010

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption and NCV								
Gasoline (1000 t)	0.1	0.1	NO	NO	NO	NO	NO	NO
NCV for gasoline (MJ/kg)	44.6	44.6	-	-	-	-	-	-
Diesel (1000 t)	36.1	27.2	30.5	32.3	32.6	32.3	28.5	28.5
NCV for diesel (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Fuel oil (1000 t)	0.2	NO	NO	NO	NO	NO	NO	NO
NCV for fuel oil (MJ/kg)	40.2	-	-	-	-	-	-	-

Table A2-14: Quantities of fossil fuel consumed their net calorific values and appropriate GHG emission factors and GHG emissions in the sub-sector Railways for the years 1990, 2000 and 2005 – 2010 (cont.)

	1990	2000	2005	2006	2007	2008	2009	2009
Fuel consumption and NCV								
Light heating oil (1000 t)	1.1	NO	NO	NO	NO	NO	NO	NO
NCV for light heating oil (MJ/kg)	42.7	-	-	-	-	-	-	-
Brown coal (1000 t)	10.0	NO	NO	NO	NO	NO	NO	NO
NCV for brown coal (MJ/kg)	16.7	-	-	-	-	-	-	-
Lignite (1000 t)	4.3	NO	NO	NO	NO	NO	NO	NO
NCV for lignite (MJ/kg)	10.9	-	-	-	-	-	-	-
Jet Kerosene (1000 t)	0.1	NO	NO	NO	NO	NO	NO	NO
NCV for jet kerosene (MJ/m3)	43.9	-	-	-	-	-	-	-
Petroleum (1000 t)	NO	NO	NO	NO	NO	NO	NO	NO
NCV for petroleum (MJ/m3)	-	-	-	-	-	-	-	-
Total fuel cunsumption (TJ)	1,820.0	1,166.2	1,302.7	1,379.5	1,392.4	1,379.5	1,217.2	1,217.2
Emission factors and emissions								
EF CO_2 - gasoline (t/TJ)	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6
EF CO_2 - diesel (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 - fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 - light heating oil (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 - brown coal (t/TJ)	94.1	94.1	94.1	94.1	94.1	94.1	94.1	94.1
EF CO_2 - lignite (t/TJ)	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
EF CO_2 - jet kerosene (t/TJ)	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8
EF CO_2 - petroleum (t/TJ)	71.1	71.1	71.1	71.1	71.1	71.1	71.1	71.1
CO_2 Emission (Gg)	138.1	85.5	95.5	101.2	102.1	101.2	89.3	89.3
EF CH_4 - gasoline (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - diesel (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - fuel oil (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - light heating oil (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - brown coal (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - lignite (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - jet kerosene (t/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - petroleum (t/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
CH_4 Emission (Mg)	10.2	5.8	6.5	6.9	7.0	6.9	6.1	6.1
EF N_2O - gasoline (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - diesel (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - light heating oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - brown coal (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - lignite (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - jet kerosene (t/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - petroleum (t/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
N_2O Emission (Mg)	1.3	0.7	0.8	0.8	0.8	0.8	0.7	0.7

Table A2-15: The GHG emissions from Commercial/Institutional

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Petroleum (1000 t)	3.8							
NCV for jet kerosene (MJ/kg)	43.9							
Light heating oil (1000 t)	92.0	120.5	131.6	112.5	91.6	87.2	78.3	73.8
NCV for light heating oil (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Fuel oil (1000 t)	67.6	3.9	6.6	4.5	3.6	3.2	8.4	8.0
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
LPG (1000 t)	4.3	13.9	20.1	21.1	9.4	10.4	11.9	12.9
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
Anthracite (1000 t)								0.0
NCV for anthracite (MJ/kg)								
Brown coal (1000 t)	24.5	9.5	0.2	4.5	2.4	1.7	3.8	2.2
NCV for brown coal (MJ/kg)	16.74	17.80	18.50	17.73	19.03	18.0	18.0	17.6
Lignite (1000 t)	40.0	1.2	0.6	0.2	0.1	0.1	0.4	0.3
NCV for lignite (MJ/kg)	10.9	12.0	12.1	12.3	11.7	11.8	11.7	11.6
Briquettes (1000 t)	2.9							
NCV for briquettes (MJ/kg)	16.7							
Gas work gas (1000000 m3)	4.9	1.5	3.4	3.3	2.9	2.4	3.1	2.8
NCV for gas work gas (MJ/m3)	15.8	19.5	21.5	30.4	27.8	19.6	18.7	18.7
Natural gas (1000000 m3)	82.0	98.2	151.2	147.0	144.2	160.4	162.5	192.7
NCV for natural gas (MJ/m3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Gasoline (1000 t)								
NCV for gasoline (MJ/kg)								
Petroleum coke (1000 t)	1.5							
NCV for petroleum coke (MJ/kg)	29.31							
Solid Biomass-Wood (TJ)					90.0	80.3	125.60	112.1
Bio gass (TJ)						170.9	116.7	102.3
Total fuel cunsumption (TJ)	10819	9507	12054	11157	9617	10125	10139	10940
Emissions								
EF CO_2 - petroleum (t/TJ)	73.3	73.3	73.3	73.3	74.3	74.3	74.3	74.3
EF CO_2 - diesel (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 - fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 - LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
EF CO_2 - anthracite (t/TJ)	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3
EF CO_2 - brown coal (t/TJ)	94.1	94.1	94.1	94.1	94.1	94.1	94.1	94.1
EF CO_2 - lignite (t/TJ)	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
EF CO_2 - briquettes (t/TJ)	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
EF CO_2 - gas work gas (t/TJ)	47.4	47.4	47.4	47.4	47.4	47.4	47.4	47.4

Table A2-15: The GHG emissions from Commercial/Institutional (cont.)

	1990	2000	2005	2006	2007	2008	2009	2010
EF CO_2 - natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
EF CO_2 - gasoline (t/TJ)	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6
EF CO_2 – petroleum coke (t/TJ)	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8
EF CO2 - solid biomass wood (t/TJ)	107.4	107.4	107.4	107.4	107.4	107.4	107.4	107.4
EF CO2 - landfill gas(t/TJ)	54.6	54.6	54.6	54.6	54.6	54.6	54.6	54.6
CO_2 Emission (Gg)	771.2	635.2	782.8	719.5	617.0	641.0	643.9	683.4
EF CH_4 - petroleum (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - diesel (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - fuel oil (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - LPG (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - anthracite (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - brown coal (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - lignite (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - briquettes (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - gas work gas (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - natural gas (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - gasoline (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - petroleum coke (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
EF CH4 -solid biomass wood (kg/TJ)	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
EF CH4 - landfill gas (t/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CH_4 Emission (Mg)	93.6	78.2	94.5	86.1	97.4	95.5	108.8	108.0
EF N_2O - petroleum (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - diesel (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - LPG (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - anthracite (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - brown coal (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - lignite (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - briquettes (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - gas work gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O - natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O - gasoline (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - petroleum coke (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - solid biomass wood (kg/TJ)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
EF N_2O - landfill gas (t/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O Emission (Mg)	5.8	4.2	4.6	4.2	3.6	3.5	3.7	3.6

Table A2-16: The GHG emissions from Residential sector

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Petroleum (1000 t)		1.6	1	0.9	1.2	1.1	0.9	0.9
NCV for petroleum (MJ/kg)		44.0	44.0	44.0	44.0	44.0	44.0	44.0
Light heating oil (1000 t)	215.9	231.5	252.8	218.5	177.7	151.0	147.3	138.8
NCV for light heating oil (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Fuel oil (1000 t)	48.7	8.1	15.4	10.6	8.6	4.5	10.8	10.4
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
LPG (1000 t)	97.9	51.9	60.9	63.5	61.8	74.0	77.8	72.2
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
Brown coal (1000 t)	123.1	12.0	14	7.5	4	3.8	2.2	6.1
NCV for brown coal (MJ/kg)	16.7	17.8	18.5	17.7	19.0	18.0	18.0	17.6
Lignite (1000 t)	207.3	15.0	11.7	10.6	5	8.1	5.7	9.4
NCV for lignite (MJ/kg)	10.9	12.0	12.1	12.3	11.7	11.8	11.7	11.6
Briquettes (1000 t)	6.1							
NCV for briquettes (MJ/kg)	16.7							
Gas work gas (1000000 m^3)	24.4	9.9	10.24	9.0	7.7	6.4	6.8	7.2
NCV for gas work gas (MJ/m^3)	15.8	19.5	21.5	30.4	27.8	19.6	18.7	17.2
Natural gas (1000000 m^3)	230.0	496.6	687.8	651.7	622.5	682.7	699.5	732.9
NCV for natural gas (MJ/m^3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Biomass (TJ)	19080	13410	12510	12600	10620	11055	11720	13462
Total fuel consumption (TJ)	47477	43598	50831	48069	43019	44705	46149	48492
Emissions								
EF CO_2 - petroleum (t/TJ)	71.1	71.1	71.1	71.1	71.1	71.1	71.1	71.1
EF CO_2 - diesel (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 - fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6
EF CO_2 - LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
EF CO_2 - brown coal (t/TJ)	94.1	94.1	94.1	94.1	94.1	94.1	94.1	94.1
EF CO_2 - lignite (t/TJ)	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
EF CO_2 - briquettes (t/TJ)	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
EF CO_2 - gas work gas (t/TJ)	47.4	47.4	47.4	47.4	47.4	47.4	47.4	47.4
EF CO_2 - natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
EF CO_2 - biomass (t/TJ)	107.4	107.4	107.4	107.4	107.4	107.4	107.4	107.4
CO_2 Emission (Gg)	4045.3	3337.3	3718.8	3534.7	3113.2	3212.2	3328.3	3545.0
EF CH_4 - petroleum (k/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - diesel (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - fuel oil (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - LPG (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - brown coal (kg/TJ)	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
EF CH_4 - lignite (kg/TJ)	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
EF CH_4 - briquettes (kg/TJ)	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
EF CH_4 - gas work gas (kg/TJ)	1.0	1.0	1.0	1.0	1.0	5.0	5.0	5.0

Table A2-16: The GHG emissions from Residential sector (cont.)

	1990	2000	2005	2006	2007	2008	2009	2010
EF CH_4 - natural gas (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - biomass (kg/TJ)	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
CH_4 Emission (Mg)	7249.4	4353.6	4134.4	4099.0	3442.2	3584.0	3771.6	4326.6
EF N_2O - petroleum (k/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - diesel (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - LPG (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - brown coal (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - lignite (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - briquettes (kg/TJ)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
EF N_2O - gas work gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O - natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O - biomass (kg/TJ)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
N_2O Emission (Mg)	92.8	63.5	61.6	60.7	51.3	52.9	55.7	62.5

Table A2-17: The GHG emissions from Agriculture/Forestry/Fishing

	1990	2000	2005	2006	2007	2008	2009	2010
Fuel consumption								
Gasoline (1000 t)	4.0	12.1	8.1	11.2	8.4	8.9	8.5	8.2
NCV for gasoline (MJ/kg)	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6
Other kerosene (1000 t)	0.1							
NCV for other kerosene (MJ/kg)	44.4							
Extra light oil (1000 t)	232.6	237.6	197.4	203.5	204.5	216.7	207.3	200.1
NCV for extra light oil (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Fuel consumption - mobile (TJ)	10117	10687	8792	9191	9109	9869	9233	8911.9
Fuel oil (1000 t)	12.3	13.4	4.7	4.5	4.5	4.6	4.6	4.4
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
LPG (1000 t)	4.4	2.6	2.7	2.8	2.7	2.8	2.8	2.7
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
Gas work gas (1000000 m3)								
NCV for gas work gas (MJ/m3)								
Natural gas (1000000 m3)	25.0	14.5	23.2	18.9	17.9	20.8	19.6	22.2
NCV for natural gas (MJ/m3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Fuel consum. - stationary (TJ)	1550.7	1153.5	1104.3	954.7	916.1	1023.4	982.6	1,058.2
Total fuel consumption (TJ)	11668	11841	9896	10146	10025	10892	10215	9970
Emissions								
EF CO_2 - gasoline (t/TJ)	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6
EF CO_2 - other kerosene (t/TJ)	71.1	71.1	71.1	71.1	71.1	71.1	71.1	71.1
EF CO_2 - diesel (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
CO_2 emission (Gg) - mobile	741.0	781.1	643.0	671.6	666.1	721.8	675.2	651.7
EF CO_2 - fuel oil (t/TJ)	76.6	76.6	76.6	76.6	76.6	76.6	76.6	76.6

Table A2-17: The GHG emissions from Agriculture/Forestry/Fishing (cont.)

	1990	2000	2005	2006	2007	2008	2009	2010
EF CO_2 - LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
EF CO_2 - gas work gas (t/TJ)	47.4				47.4	47.4	47.4	47.4
EF CO_2 - natural gas (t/TJ)	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
CO_2 emission (Gg) - stationary	98.2	76.4	66.4	57.9	55.7	61.8	59.6	63.6
Total CO_2 emission (Gg)	839.2	857.5	709.4	729.5	721.9	783.6	734.8	715.3
EF CH_4 - gasoline (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - other kerosene (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EF CH_4 - diesel (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
CH_4 emission (Mg) - mobile	50.6	53.4	44.0	46.0	45.5	49.3	46.2	44.6
EF CH_4 - fuel oil (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - LPG (kg/TJ)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
EF CH_4 - gas work gas (kg/TJ)	1.0	1.0	1.0	1.0	1.0	5.0	5.0	5.0
EF CH_4 - natural gas (kg/TJ)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
CH_4 emission (Mg) - stationary	11.3	9.1	7.1	6.3	6.1	6.7	6.5	6.8
Total CH_4 emission (Mg)	61.8	62.5	51.1	52.3	51.7	56.0	52.7	51.4
EF N_2O - gasoline (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - other kerosene (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - diesel (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
N_2O emission (Mg) - mobile	6.1	6.4	5.3	5.5	5.5	5.9	5.5	5.3
EF N_2O - fuel oil (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - LPG (kg/TJ)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
EF N_2O - gas work gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EF N_2O - natural gas (kg/TJ)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O emission (Mg) - stationary	0.5	0.4	0.3	0.3	0.2	0.3	0.3	0.3
Total N_2O emission (Mg)	6.6	6.9	5.5	5.8	5.7	6.2	5.8	5.6

Table A2-18: Methane emissions from Coal Mining and Handling from 1990 to 1999

Source and Sink Categories			Activity Data Production (PJ)	Emission Estimates CH_4 /(Gg)	Emission Factor $kgCH_4/t$	Emission Factor m^3CH_4/t
Year 1990						
1B 1a	Underground mines			**2.32**		
		Mining	0.174	2.04	5.86	17.50
		Post-Mining	0.174	0.29	0.82	2.45
Year 1991						
1B 1a	Underground mines			**2.07**		
		Mining	0.155	1.82	5.86	17.50
		Post-Mining	0.155	0.25	0.82	2.45
Year 1992						
1B 1a	Underground mines			**1.61**		
		Mining	0.120	1.41	5.86	17.50
		Post-Mining	0.120	0.20	0.82	2.45

Table A2-18: Methane emissions from Coal Mining and Handling from 1990 to 1999 (cont.)

Source and Sink Categories			Activity Data Production (PJ)	Emission Estimates CH_4 /(Gg)	Emission Factor $kgCH_4/t$	Emission Factor m^3CH_4/t
Year 1993						
1B 1a	Underground mines			**1.54**		
		Mining	0.115	1.35	5.86	17.50
		Post-Mining	0.115	0.19	0.82	2.45
Year 1994						
1B 1a	Underground mines			**1.38**		
		Mining	0.103	1.21	5.86	17.50
		Post-Mining	0.103	0.17	0.82	2.45
Year 1995						
1B 1a	Underground mines			**1.10**		
		Mining	0.082	0.96	5.86	17.50
		Post-Mining	0.082	0.13	0.82	2.45
Year 1996						
1B 1a	Underground Mines			**0.89**		
		Mining	0.066	0.78	5.86	17.50
		Post-Mining	0.066	0.11	0.82	2.45
Year 1997						
1B 1a	Underground Mines			**0.65**		
		Mining	0.049	0.57	5.86	17.50
		Post-Mining	0.049	0.08	0.82	2.45
Year 1998						
1B 1a	Underground Mines			**0.68**		
		Mining	0.051	0.60	5.86	17.50
		Post-Mining	0.051	0.08	0.82	2.45
Year 1999						
1B 1a	Underground Mines			**0.20**		
		Mining	0.015	0.18	5.86	17.50
		Post-Mining	0.015	0.03	0.82	2.45

* - 0.67 kg/m^3 – Methane density at 20°C and pressure 1 atm.

Table A2-19: Methane emissions from Oil and Gas Activities. years 1990, 1995, 2000, 2010

Source and Sink Categories			Activity data Fuel Quantity PJ	Emission Estimates CH_4 /(Gg)	Emission Factor $kgCH_4/PJ$
Year 1990					
1B 2a	Oil			**0.68**	
		Production	112.9	0.30	2650
		Transport	174.1	0.13	745
		Refining	287.3	0.21	135
		Storage	287.3	0.04	135

Table A2-19: Methane emissions from Oil and Gas Activities. years 1990, 1995, 2000, 2010 (cont.)

Source and Sink Categories			Activity data Fuel Quantity PJ	Emission Estimates CH_4 /(Gg)	Emission Factor kgCH₄/PJ
1B 2b	Natural gas			**54.59**	
		Prod./Process./Trans./Distrib.	67.40	30.87 [1)]	458000
		Other Leakage (non-residential)	83.52	23.34 [2)]	279500
		Other Leakage (residential)	7.82	1.09 [3)]	139500
1B 2c	Venting and flaring				
		Gas	67.4	1.21	18000
Year 1995					
1B 2a	Oil			**0.49**	
		Production	62.8	0.17	2650
		Transport	159.3	0.12	745
		Refining	227.6	0.17	135
		Storage	227.6	0.03	135
1B 2b	Natural gas			**50.60**	
		Prod./Process./Trans./Distrib.	69.12	31.66 [1)]	458000
		Other Leakage (non-residential)	69.81	19.51 [2)]	279500
		Other Leakage (residential)	12.96	1.81 [3)]	139500
1B 2c	Venting and flaring			**1.20**	
		Gas	66.9	1.20	18000
Year 2000					
1B 2a	Oil			**0.45**	
		Production	51.4	0.14	2650
		Transport	165.6	0.12	745
		Refining	218.4	0.16	135
		Storage	218.4	0.03	135
1B 2b	Natural Gas			**51.39**	
		Prod./Process./Trans./Distrib.	59.40	27.21 [1)]	458000
		Other Leakage(non-residential)	78.09	21.83 [2)]	279500
		Other Leakage (residential)	16.88	2.36 [3)]	139500
1B 2c	Venting and Flaring			**1.07**	
		Gas	59.4	1.07	18000
Year 2010					
1B 2a	Oil				
		Production	30.69	0.08	2650
		Transport	150.64	0.11	745
		Refining	181.78	0.02	135
		Storage	181.78	0.14	745
1B 2b	Natural Gas				
		Prod./Process./Trans./Distrib.	93.88	43.00 [1)]	458000
		Other Leakage(non-residential)	86.45	24.16 [2)]	279500
		Other Leakage (residential)	24.92	3.48 [3)]	139500
1B 2c	Venting and Flaring				
		Gas	93.88	1.69	18000

[1)] – Methane emissions from Processing. Transmission and Distribution
[2)] – Other Leakage at Industrial Plants and Power Stations
[3)] – Other Leakage in Residential and Commercial Sectors

ANNEX 3

CO_2 REFERENCE APPROACH AND COMPARISON WITH SECTORAL APPROACH, AND RELEVANT INFORMATION ON THE NATIONAL ENERGY BALANCE

Table A3-1: Fuel combustion CO_2 emissions (Reference and Sectoral Approach)

YEAR	FUEL TYPES	Reference approach		Sectoral approach		Difference	
		Energy	CO_2	Energy	CO_2	Energy	CO_2
1990	Liquid Fuels	182.19	12,845.26	181.24	13,253.24	0.52	-3.08
	Solid Fuels	34.27	3,102.87	28.67	2,800.86	19.54	10.78
	Gaseous Fuels	85.99	5,075.40	82.84	4,505.99	3.79	12.64
	Total	***302.45***	***21,023.53***	***292.76***	***20,560.08***	***3.31***	***2.25***
1991	Liquid Fuels	125.85	9,007.48	129.17	9,456.05	-2.57	-4.74
	Solid Fuels	21.07	1,850.52	17.41	1,692.68	21.06	9.32
	Gaseous Fuels	79.15	4,682.34	71.54	3,927.11	10.64	19.23
	Total	***226.08***	***15,540.35***	***218.12***	***15,075.84***	***3.65***	***3.08***
1992	Liquid Fuels	119.35	8,509.32	122.55	9,014.75	-2.61	-5.61
	Solid Fuels	17.25	1,476.32	13.47	1,284.85	28.08	14.90
	Gaseous Fuels	79.86	4,809.57	73.97	4,095.82	7.96	17.43
	Total	***216.47***	***14,795.22***	***209.99***	***14,395.42***	***3.08***	***2.78***
1993	Liquid Fuels	117.56	8,510.98	126.98	9,322.59	-7.42	-8.71
	Solid Fuels	14.71	1,225.37	10.98	1,043.62	33.97	17.41
	Gaseous Fuels	94.66	5,559.00	82.60	4,591.99	14.61	21.06
	Total	***226.94***	***15,295.35***	***220.56***	***14,958.20***	***2.89***	***2.25***
1994	Liquid Fuels	121.93	9,050.93	126.49	9,235.11	-3.60	-2.19
	Solid Fuels	9.20	771.63	6.83	660.54	34.72	16.82
	Gaseous Fuels	80.52	4,777.49	76.54	4,261.47	5.19	12.11
	Total	***211.64***	***14,600.04***	***209.85***	***14,175.12***	***0.85***	***3.00***
1995	Liquid Fuels	136.27	9,987.52	143.44	10,514.94	-5.00	-5.02
	Solid Fuels	7.71	735.29	7.63	728.68	1.04	0.91
	Gaseous Fuels	72.59	4,339.43	67.37	3,760.38	7.76	15.40
	Total	***216.57***	***15,062.24***	***218.44***	***15,004.00***	***-0.85***	***0.39***
1996	Liquid Fuels	147.34	10,575.61	146.15	10,710.66	0.81	-1.26
	Solid Fuels	6.21	591.97	6.18	589.91	0.42	0.35
	Gaseous Fuels	81.58	4,867.77	75.01	4,189.67	8.75	16.19
	Total	***235.13***	***16,035.35***	***227.34***	***15,490.24***	***3.42***	***3.52***
1997	Liquid Fuels	147.43	10,562.81	151.38	11,076.96	-2.61	-4.64
	Solid Fuels	10.17	960.12	10.19	962.07	-0.17	-0.20
	Gaseous Fuels	84.09	5,037.38	78.95	4,412.26	6.51	14.17
	Total	***241.70***	***16,560.32***	***240.53***	***16,451.30***	***0.49***	***0.66***
1998	Liquid Fuels	163.14	11,767.02	164.47	12,069.30	-0.81	-2.50
	Solid Fuels	9.87	929.44	9.86	928.38	0.11	0.11
	Gaseous Fuels	82.84	4,879.69	78.23	4,369.71	5.89	11.67
	Total	***255.85***	***17,576.16***	***252.56***	***17,367.39***	***1.30***	***1.20***
1999	Liquid Fuels	171.92	12,728.11	174.00	12,795.72	-1.20	-0.53
	Solid Fuels	8.63	810.25	8.52	800.49	1.23	1.22
	Gaseous Fuels	82.21	4,914.30	77.69	4,339.74	5.82	13.24
	Total	***262.76***	***18,452.65***	***260.22***	***17,935.95***	***0.98***	***2.88***
2000	Liquid Fuels	148.90	11,068.00	153.02	11,171.42	-2.69	-0.93
	Solid Fuels	18.65	1,747.47	18.68	1,750.18	-0.16	-0.16
	Gaseous Fuels	82.90	4,957.53	78.45	4,383.98	5.67	13.08
	Total	***250.46***	***17,772.99***	***250.16***	***17,305.59***	***0.12***	***2.70***

Table A3-1: Fuel combustion CO_2 emissions (Reference and Sectoral Approach) - cont.

YEAR	FUEL TYPES	Reference approach		Sectoral approach		Difference	
		Energy Consump. excluding non-energy (PJ)	CO_2 emissions (Gg)	Energy Consump. (PJ)	CO_2 emission (Gg)	Energy Consump. (%)	CO_2 emission (%)
2001	Liquid Fuels	155.14	11,533.06	158.19	11,584.95	-1.93	-0.45
	Solid Fuels	19.83	1,849.61	19.69	1,836.17	0.74	0.73
	Gaseous Fuels	89.07	5,236.00	83.37	4,653.78	6.84	12.51
	Total	***264.04***	***18.618.68***	***261.24***	***18,074.91***	***1.07***	***3.01***
2002	Liquid Fuels	169.08	12,533.70	164.87	12,077.01	2.56	3.78
	Solid Fuels	24.43	2,277.22	24.04	2,239.90	1.64	1.67
	Gaseous Fuels	92.10	5,377.83	86.92	4,850.52	5.96	10.87
	Total	***285.61***	***20,188.75***	***275.83***	***19,167.44***	***3.55***	***5.33***
2003	Liquid Fuels	179.28	13,302.49	181.12	13,265.33	-1.02	0.28
	Solid Fuels	27.20	2,532.94	27.03	2,516.83	0.64	0.64
	Gaseous Fuels	90.70	5,329.75	86.07	4,802.30	5.38	10.98
	Total	***297.17***	***21,165.17***	***294.21***	***20,584.45***	***1.01***	***2.82***
2004	Liquid Fuels	166.44	12,383.85	166.91	12,225.24	-0.28	1.30
	Solid Fuels	28.88	2,687.52	29.01	2,699.99	-0.46	-0.46
	Gaseous Fuels	93.33	5,536.73	89.45	4,996.18	4.33	10.82
	Total	***288.65***	***20,608.11***	***285.37***	***19,921.41***	***1.15***	***3.45***
2005	Liquid Fuels	173.51	12,962.09	173.09	12,779.76	0.24	1.43
	Solid Fuels	28.64	2,667.30	28.55	2,658.30	0.34	0.34
	Gaseous Fuels	90.13	5,351.48	86.99	4,859.52	3.60	10.12
	Total	***292.28***	***20,980.87***	***288.63***	***20,297.58***	***1.26***	***3.37***
2006	Liquid Fuels	174.83	13,053.17	176.27	13,046.36	-0.82	0.05
	Solid Fuels	26.56	2,472.98	26.39	2,457.31	0.64	0.64
	Gaseous Fuels	89.21	5,293.81	86.09	4,805.78	3.62	10.16
	Total	***290.04***	***20,819.96***	***288.76***	***20,309.46***	***0.64***	***2.51***
2007	Liquid Fuels	179.52	13,421.81	180.39	13,347.70	-0.48	0.56
	Solid Fuels	28.96	2,695.65	28.50	2,655.36	1.59	1.52
	Gaseous Fuels	102.90	6,091.12	99.08	5,537.49	3.85	10.00
	Total	***311.37***	***22,208.59***	***307.97***	***21,540.55***	***1.10***	***3.10***
2008	Liquid Fuels	169.62	12,549.53	167.81	12,387.01	1.08	1.31
	Solid Fuels	29.69	2,722.73	29.31	2,728.85	1.30	-0.22
	Gaseous Fuels	99.30	5,595.52	96.22	5,378.92	3.20	9.60
	Total	***298.61***	***21,167.77***	***293.33***	***20,494.78***	***1.80***	***3.28***
2009	Liquid Fuels	166.87	12,396.16	166.53	12,255.64	0.20	1.15
	Solid Fuels	21.24	1,980.39	21.12	1,969.36	0.56	0.56
	Gaseous Fuels	92.49	5,458.09	90.02	5,031.72	2.75	8.47
	Total	***280.60***	***19,834.64***	***277.67***	***19,256.72***	***1.06***	***3.00***
2010	Liquid Fuels	143.19	10,576.13	143.46	10,523.21	-0.19	0.50
	Solid Fuels	27.67	2,555.88	28.94	2,696.20	-4.41	-5.20
	Gaseous Fuels	101.29	5,978.75	96.97	5,417.65	4.46	10.36
	Total	**272.15**	**19,110.76**	**269.37**	**18,637.06**	**1.03**	**2.54**

Table A3-2: Net calorific values for different fossil fuels from 1990 to 2010

			Net calorific values 1990- 2010 MJ/kg(m³)
Liquid Fossil	Primary Fuel	Crude Oil	41.87-42.60
	Secondary Fuel	Motor Gasoline	44.59
		Jet Kerosene	43.96
		Gas/Diesel Oil	42.71
		Residual Fuel Oil	40.19
		LPG	46.89
		Naphtha	44.59
		Bitumen	33.50
		Lubricants	33.50
		Refinery Gas	48.57
		Petroleum Coke	29.31-31.00
		Ethane	49.31
Solid Fossil	Primary Fuel	Anthracite	29.29-29.31
		Other Bituminous Coal	24.30-26.90
		Sub Bituminous Coal	16.74-18.73
		Lignite	10.52-12.15
	Secondary Fuel	Gas Work Gas	15.82-22.63
		Coke Oven Coke	29.31
			TJ/Mm³
Natural Gas		Natural Gas	34.00
Biomass		Solid Biomass Fuel Wood	9.00

Table A3-3: National energy balance for 2010

ENERGY BALANCE 2010 natural units	Anthracite	Hard coal	Brown coal	Lignite	Crude oil	Natural gas
	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^6 m^3
Production					720.4	2727.2
Import	1.3	1139.7	49.5	9.7	3536.2	1069.6
Export			0.1			484.1
Import-processing						
Export-processing						
Stock change		-29.5	-0.1		10.5	-71.2
Bunkers						
Energy supplied	**1.3**	**1110.2**	**49.3**	**9.7**	**4267.1**	**3241.5**
Production						
hydro power plants						
– small HPP						
Wind power plants						
Solar power plants						
Geothermal power plants						
thermal power plants						
public cogeneration plants						
public heating plants						
industrial cogeneration plants						
– in rafineries						
– in gas production						
Industrial heating plants						
Petroleum refineries						
NGL-plant						
Coke plant						
Gas works						
Total production						
Transformation sector						
hydro power plants						
– small HPP						
Wind power plants						
Solar power plants						
Geothermal power plants						
thermal power plants		915.6				24.0
public cogeneration plants						649.9
public heating plants						86.5
industrial cogeneration plants			39.9			293.5
– in rafineries						
– in gas production						45.3
Industrial heating plants						75.2
Petroleum refineries					4162.9	10.5
NGL-plant					104.2	6.3
Coke plant						
Gas works						5.3
Total transformation sector		**915.6**	**39.9**		**4267.1**	**1151.2**
Energy sector own use						
Oil and gas extraction						176.7
Coal production						
Electric energy supply industry						
hydro power plants						
thermal power plants						
public cogeneration plants						
industrial cogeneration plants						
Industrial heating plants						
Petroleum refineries						16.6
NGL-plant						16.9
Gas works						
Total energy sector own use						**210.2**
Losses						**60.8**
Final energy demand	**1.3**	**194.6**	**9.4**	**9.7**		**1819.3**
Energy consumption	**1.3**	**194.6**	**9.4**	**9.7**		**1315.4**
Industry	**1.3**	**194.6**	**1.1**			**365.4**
Iron and steel	0.6					32.8
Non-ferrous metals						0.4
Non-metallic minerals						53.0
Chemical		1.2				74.7
Construction materials		193.4	1.1			76.4
Pulp and paper						8.3
Food production	0.7					74.2
Not elsewhere specified						45.6
Transport						**5.4**
Rail						
Road						0.7
Air						
– international						
– domestic						
Sea and River						
Public transport						1.9
Not elsewhere specified						2.8
Other sectors			**8.3**	**9.7**		**944.6**
Households			6.1	9.4		732.9
Services			2.2	0.3		189.5
Agriculture						22.2
Construction						

Table A3-3: National energy balance for 2010 (continue)

ENERGY BALANCE 2010 natural units	Hydro energy	Fuel wood	Wind energy	Solar energy	Geothermal energy	Landfill gas	Biofuels	Other biomass
	TJ	10^3 m^3	TJ	TJ	TJ	10^3 m^3	10^3 t	TJ
Production	79706.1	1761.0	1314.4	218.8	284.9	15842.0	13.8	4108.5
Import		5.7						144.4
Export		246.5					11.6	1872.3
Import-processing								
Export-processing								
Stock change							1.1	-12.8
Bunkers								
Energy supplied	**79706.1**	**1520.2**	**1314.4**	**218.8**	**284.9**	**15842.0**	**3.3**	**2367.8**
Production								
hydro power plants								
– small HPP								
Wind power plants								
Solar power plants								
Geothermal power plants								
thermal power plants								
public cogeneration plants								
public heating plants								
industrial cogeneration plants								
– in rafineries								
– in gas production								
Industrial heating plants								
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total production								
Transformation sector								
hydro power plants	79706.1							
– small HPP	1172.6							
Wind power plants			1314.4					
Solar power plants				0.9				
Geothermal power plants								
thermal power plants						1129.0		
public cogeneration plants						7700.0		1.9
public heating plants								
industrial cogeneration plants						7013.0		86.9
– in rafineries								
– in gas production								
Industrial heating plants								1521.6
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total transformation sector	**79706.1**		**1314.4**	**0.9**		**15842.0**		**1610.4**
Energy sector own use								
Oil and gas extraction								
Coal production								
Electric energy supply industry								
hydro power plants								
thermal power plants								
public cogeneration plants								
industrial cogeneration plants								
Industrial heating plants								
Petroleum refineries								
NGL-plant								
Gas works								
Total energy sector own use								
Losses								
Final energy demand		**1520.2**		**217.9**	**284.9**		**3.3**	**757.4**
Energy consumption		**1520.2**		**217.9**	**284.9**		**3.3**	**757.4**
Industry		**54.9**						**370.6**
Iron and steel		0.8						
Non-ferrous metals		0.6						
Non-metallic minerals								
Chemical		0.1						
Construction materials		0.3						370.6
Pulp and paper		13.2						
Food production		0.5						
Not elsewhere specified		39.4						
Transport							**3.1**	
Rail								
Road							3.1	
Air								
– international								
– domestic								
Sea and River								
Public transport								
Not elsewhere specified								
Other sectors		**1465.3**		**217.9**	**284.9**		**0.2**	**386.8**
Households		1455.0		217.9				367.4
Services		10.3			284.9			19.4
Agriculture							0.1	
Construction							0.1	

Table A3-3: National energy balance for 2010 (continue)

ENERGY BALANCE 2010 natural units	Coke oven coke	Liquefied petroleum gases	Unleaded motor gasoline	Standard motor gasoline	Petroleum	Jet fuel	Diesel oil	Light heating oil	Low sulphur fuel oil	Standard fuel oil
	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t
Production		301.8	986.1	107.7	0.1	94.5	1079.0	227.7	26.6	841.6
Import	28.3	13.7	229.7	0.6	0.8	11.5	691.1	76.9		56.8
Export	0.8	155.7	554.4	109.8		5.4	323.9	49.6	19.9	381.8
Import-processing										
Export-processing										
Stock change	0.1	2.9	-11.5	2.1		2.7	20.0	5.9	-6.7	-39.0
Bunkers							0.7			5.6
Energy supplied	**27.6**	**162.7**	**649.9**	**0.6**	**0.9**	**103.3**	**1465.5**	**260.9**	**0.0**	**472.0**
Production										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants										
public cogeneration plants										
public heating plants										
industrial cogeneration plants										
– in rafineries										
– in gas production										
Industrial heating plants										
Petroleum refineries		245.7	986.1	107.7	0.1	94.5	1079.0	227.7	26.6	841.6
NGL-plant		56.1								
Coke plant										
Gas works										
Total production		**301.8**	**986.1**	**107.7**	**0.1**	**94.5**	**1079.0**	**227.7**	**26.6**	**841.6**
Transformation sector										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants								0.9		15.1
public cogeneration plants								0.1		108.3
public heating plants								4.9		23.2
industrial cogeneration plants										191.4
– in rafineries										185.9
– in gas production										
Industrial heating plants										21.7
Petroleum refineries										
NGL-plant										
Coke plant										
Gas works										
Total transformation sector								**5.9**		**359.7**
Energy sector own use										
Oil and gas extraction										
Coal production										
Electric energy supply industry										
hydro power plants										
thermal power plants										
public cogeneration plants										
industrial cogeneration plants										
Industrial heating plants										
Petroleum refineries										58.5
NGL-plant										
Gas works										
Total energy sector own use										**58.5**
Losses										
Final energy demand	**27.6**	**162.7**	**649.9**	**0.6**	**0.9**	**103.3**	**1465.5**	**255.0**	**0.0**	**53.8**
Energy consumption	**27.6**	**162.7**	**649.9**	**0.6**	**0.9**	**103.3**	**1465.5**	**255.0**	**0.0**	**53.8**
Industry	**27.6**	**13.9**					**14.3**	**21.0**		**29.0**
Iron and steel	3.7	1.4						0.9		0.3
Non-ferrous metals		3.1						0.1		1.2
Non-metallic minerals	0.1	0.2								2.2
Chemical		0.1						0.4		0.6
Construction materials	17.3	3.2					14.3	4.3		7.3
Pulp and paper		0.1						0.1		0.1
Food production	6.4	1.3						10.0		13.5
Not elsewhere specified	0.1	4.5						5.2		3.8
Transport		**58.7**	**636.6**	**0.6**		**103.3**	**1163.3**			**2.0**
Rail							28.5			
Road		58.7	636.6				1073.5			
Air				0.6		103.3				
– international						52.7				
– domestic				0.6		50.6				
Sea and River							34.8			2.0
Public transport							26.5			
Not elsewhere specified										
Other sectors		**90.1**	**13.3**		**0.9**		**287.9**	**234.0**		**22.8**
Households		72.2			0.9			138.8		10.4
Services		12.9						73.8		8.0
Agriculture		2.7	8.2				185.7	14.4		4.4
Construction		2.3	5.1				102.2	7.0		

Table A3-3: National energy balance for 2010(continue)

ENERGY BALANCE 2010 natural units	Naphta	White spirit	Bitumen	Other oils	Lubricants	Petroleum coke	Etan	Other derivates	Refinery gas	Refinery semiproducts	Aditives
	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t	10^3 t
Production	89.3		66.5	13.3		101.7	44.9	213.4	161.5		
Import		3.4	70.4	28.0	8.0	117.7		2.9		12.6	69.1
Export	74.0	0.1	10.6	8.6	0.1	53.1		177.7			
Import-processing											
Export-processing											
Stock change	7.6		-0.1	0.5		5.6		-38.6		-7.0	-1.5
Bunkers											
Energy supplied	**22.9**	**3.3**	**126.2**	**33.2**	**7.9**	**171.9**	**44.9**	**0.0**	**161.5**	**5.6**	**67.6**
Production											
hydro power plants											
– small HPP											
Wind power plants											
Solar power plants											
Geothermal power plants											
thermal power plants											
public cogeneration plants											
public heating plants											
industrial cogeneration plants											
– in rafineries											
– in gas production											
Industrial heating plants											
Petroleum refineries	66.2		66.5	13.3		101.7		213.4	161.5		
NGL-plant	23.1						44.9				
Coke plant											
Gas works											
Total production	**89.3**		**66.5**	**13.3**		**101.7**	**44.9**	**213.4**	**161.5**		
Transformation sector											
hydro power plants											
– small HPP											
Wind power plants											
Solar power plants											
Geothermal power plants											
thermal power plants											
public cogeneration plants											
public heating plants											
industrial cogeneration plants						4.8			9.0		
– in rafineries						4.8			9.0		
– in gas production											
Industrial heating plants											
Petroleum refineries	22.9									5.6	67.6
NGL-plant											
Coke plant											
Gas works											
Total transformation sector	**22.9**					**4.8**			**9.0**	**5.6**	**67.6**
Energy sector own use											
Oil and gas extraction											
Coal production											
Electric energy supply industry											
hydro power plants											
thermal power plants											
public cogeneration plants											
industrial cogeneration plants											
Industrial heating plants											
Petroleum refineries						51.1			152.5		
NGL-plant											
Gas works											
Total energy sector own use						**51.1**			**152.5**		
Losses											
Final energy demand	**0.0**	**3.3**	**126.2**	**33.2**	**7.9**	**116.0**	**44.9**	**0.0**		**0.0**	
Energy consumption	**0.0**					**116.0**		**0.0**		**0.0**	
Industry						**116.0**					
Iron and steel						0.7					
Non-ferrous metals											
Non-metallic minerals											
Chemical											
Construction materials						115.3					
Pulp and paper											
Food production											
Not elsewhere specified											
Transport											
Rail											
Road											
Air											
– international											
– domestic											
Sea and River											
Public transport											
Not elsewhere specified											
Other sectors											
Households											
Services											
Agriculture											
Construction											

Table A3-3: National energy balance for 2010 (continue)

ENERGY BALANCE 2010 natural units	Gas works gas	Electricity	Steam and hot water
	10^3 m^3	GWh	TJ
Production	10287.5	14105.0	32011.3
Import		6682.4	
Export		1917.4	
Import-processing			
Export-processing			
Stock change			
Bunkers			
Energy supplied	**10287.5**	**18870.0**	**32011.3**
Production			
hydro power plants		8435.2	
– small HPP		124.1	
Wind power plants		139.1	
Solar power plants		0.1	
Geothermal power plants			
thermal power plants		2494.8	
public cogeneration plants		2589.0	9411.1
public heating plants			3092.3
industrial cogeneration plants		446.8	13697.9
– in rafineries		113.0	6288.4
– in gas production		60.8	1021.0
Industrial heating plants			4099.2
Petroleum refineries			
NGL-plant			
Coke plant			
Gas works	10287.5		
Total production	**10287.5**	**14105.0**	**30300.5**
Transformation sector			
hydro power plants			
– small HPP			
Wind power plants			
Solar power plants			
Geothermal power plants			
thermal power plants			
public cogeneration plants			
public heating plants			
industrial cogeneration plants			
– in rafineries			
– in gas production			
Industrial heating plants			
Petroleum refineries			
NGL-plant			
Coke plant			
Gas works			
Total transformation sector			
Energy sector own use			
Oil and gas extraction		106.8	729.0
Coal production		0.4	49.2
Electric energy supply industry		32.0	
hydro power plants		261.5	
thermal power plants		232.9	
public cogeneration plants		104.5	678.9
industrial cogeneration plants			
Industrial heating plants			
Petroleum refineries		254.8	6288.4
NGL-plant		11.7	292.0
Gas works			
Total energy sector own use		**1004.6**	**8037.5**
Losses	**241.0**	**2021.9**	**1533.6**
Final energy demand	**10046.5**	**15843.5**	**22440.2**
Energy consumption	**10046.5**	**15843.5**	**22440.2**
Industry		**3382.3**	**12224.7**
Iron and steel		329.5	95.1
Non-ferrous metals		70.9	
Non-metallic minerals		118.7	92.0
Chemical		482.0	4197.2
Construction materials		552.8	0.9
Pulp and paper		252.7	1713.1
Food production		642.0	3869.5
Not elsewhere specified		933.7	2256.9
Transport		**312.0**	
Rail		174.1	
Road			
Air		22.7	
– international			
– domestic		22.7	
Sea and River		23.1	
Public transport		69.5	
Not elsewhere specified		22.6	
Other sectors	**10046.5**	**12149.2**	**10215.5**
Households	7202.3	6651.0	8154.9
Services	2844.2	5194.2	2011.7
Agriculture		68.2	48.9
Construction		235.8	

Table A3-3: National energy balance for 2010 (continue)

PJ	Anthracite	Hard coal	Brown coal	Lignite	Crude oil	Natural gas
PRIMARNA BILANCA						
Production	-	-	-	-	30.69	93.881
Import	0.04	27.63	0.87	0.11	150.64	36.366
Export	-	-	0.00	-	-	16.459
Import-processing	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-
Stock change	-	-0.71	-0.00	-	0.45	-2.421
Bunkers	-	-	-	-	-	-
Energy supplied	**0.04**	**26.91**	**0.87**	**0.11**	**181.78**	**111.37**
Production	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-
– in rafineries	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-
Gas works	-	-	-	-	-	-
Total production	**-**	**-**	**-**	**-**	**-**	**-**
Gross production	**0.04**	**26.91**	**0.87**	**0.11**	**181.78**	**111.37**
Transformation sector	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-
thermal power plants	-	22.09	-	-	-	0.82
public cogeneration plants	-	-	-	-	-	22.10
public heating plants	-	-	-	-	-	2.94
industrial cogeneration plants	-	-	0.70	-	-	9.98
– in rafineries	-	-	-	-	-	-
– in gas production	-	-	-	-	-	1.54
Industrial heating plants	-	-	-	-	-	2.56
Petroleum refineries	-	-	-	-	177.34	0.36
NGL-plant	-	-	-	-	4.44	1.37
Coke plant	-	-	-	-	-	-
Gas works	-	-	-	-	-	0.18
Total transformation sector	**-**	**22.09**	**0.70**	**-**	**181.78**	**40.30**
Energy sector own use	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	6.01
Coal production	-	-	-	-	-	-
Electric energy supply industry	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	0.56
NGL-plant	-	-	-	-	-	0.57
Gas works	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**7.15**
Losses	-	-	-	-	-	2.07
Final energy demand	**0.04**	**4.82**	**0.17**	**0.11**	**0.00**	**61.86**
Energy consumption	**0.04**	**4.82**	**0.17**	**0.11**	**0.00**	**44.72**
Industry	**0.04**	**4.82**	**0.02**	**-**	**-**	**12.42**
Iron and steel	0.02	-	-	-	-	1.12
Non-ferrous metals	-	-	-	-	-	0.01
Non-metallic minerals	-	-	-	-	-	1.80
Chemical	-	0.03	-	-	-	2.54
Construction materials	-	4.79	0.02	-	-	2.60
Pulp and paper	-	-	-	-	-	0.28
Food production	0.02	-	-	-	-	2.52
Not elsewhere specified	-	-	-	-	-	1.55
Transport	**-**	**-**	**-**	**-**	**-**	**0.18**
Rail	-	-	-	-	-	-
Road	-	-	-	-	-	0.02
Air	-	-	-	-	-	-
– international	-	-	-	-	-	-
– domestic	-	-	-	-	-	-
Sea and River	-	-	-	-	-	-
Public transport	-	-	-	-	-	0.06
Not elsewhere specified	-	-	-	-	-	0.10
Other sectors	**-**	**-**	**0.15**	**0.11**	**-**	**32.12**
Households	-	-	0.11	0.11	-	24.92
Services	-	-	0.04	0.00	-	6.44
Agriculture	-	-	-	-	-	0.75
Construction	-	-	-	-	-	-

Table A3-3: National energy balance for 2010 (continue)

PJ	Hydro energy	Fuel wood	Wind energy	Solar energy	Geothermal energy	Landfill gas	Biofuels	Other biomass
PRIMARNA BILANCA								
Production	79.71	15.849	1.314	0.219	0.285	0.2981	0.509	4.109
Import	-	0.05	-	-	-	-	-	0.14
Export	-	2.22	-	-	-	-	0.43	1.87
Import-processing	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-
Stock change	-	-	-	-	-	-	0.04	- 0.01
Bunkers	-	-	-	-	-	-	-	-
Energy supplied	**79.71**	**13.68**	**1.31**	**0.22**	**0.28**	**0.2981**	**0.12**	**2.37**
Production	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-	-	-
– in rafineries	-	-	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-
Total production	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Gross production	**79.71**	**13.68**	**1.31**	**0.22**	**0.28**	**0.2981**	**0.12**	**2.37**
Transformation sector	-	-	-	-	-	-	-	-
hydro power plants	79.71	-	-	-	-	-	-	-
– small HPP	1.17	-	-	-	-	-	-	-
Wind power plants	-	-	1.31	-	-	-	-	-
Solar power plants	-	-	-	0.00	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	0.0192	-	-
public cogeneration plants	-	-	-	-	-	0.1386	-	0.00
public heating plants	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	0.1403	-	0.09
– in rafineries	-	-	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	1.52
Petroleum refineries	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-
Total transformation sector	**79.71**	**-**	**1.31**	**0.00**	**-**	**0.2981**	**-**	**1.61**
Energy sector own use	-	-	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	-	-	-
Coal production	-	-	-	-	-	-	-	-
Electric energy supply industry	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Losses	-	-	-	-	-	-	-	-
Final energy demand	**-**	**13.68**	**-**	**0.22**	**0.28**	**-**	**0.12**	**0.76**
Energy consumption	**-**	**13.68**	**-**	**0.22**	**0.28**	**-**	**0.12**	**0.76**
Industry	**-**	**0.49**	**-**	**-**	**-**	**-**	**-**	**0.37**
Iron and steel	-	0.01	-	-	-	-	-	-
Non-ferrous metals	-	0.01	-	-	-	-	-	-
Non-metallic minerals	-	-	-	-	-	-	-	-
Chemical	-	0.00	-	-	-	-	-	-
Construction materials	-	0.00	-	-	-	-	-	0.37
Pulp and paper	-	0.12	-	-	-	-	-	-
Food production	-	0.00	-	-	-	-	-	-
Not elsewhere specified	-	0.35	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**0.11**	**-**
Rail	-	-	-	-	-	-	-	-
Road	-	-	-	-	-	-	0.11	-
Air	-	-	-	-	-	-	-	-
– international	-	-	-	-	-	-	-	-
– domestic	-	-	-	-	-	-	-	-
Sea and River	-	-	-	-	-	-	-	-
Public transport	-	-	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-
Other sectors	**-**	**13.19**	**-**	**0.22**	**0.28**	**-**	**0.01**	**0.39**
Households	-	13.10	-	0.22	-	-	-	0.37
Services	-	0.09	-	-	0.28	-	-	0.02
Agriculture	-	-	-	-	-	-	0.00	-
Construction	-	-	-	-	-	-	0.00	-

Table A3-3: National energy balance for 2010 (continue)

PJ	Coke oven coke	Liquefied petroleum gases	Unleaded motor gasoline	Standard motor gasoline	Petroleum	Jet fuel	Diesel oil	Light heating oil	Low sulphur fuel oil	Standard fuel oil
PRIMARNA BILANCA										
Production	-	-	-	-	-	-	-	-	-	-
Import	0.83	0.64	10.24	0.03	0.04	0.51	29.52	3.28	-	2.28
Export	0.02	7.30	24.72	4.90	-	0.24	13.83	2.12	0.80	15.34
Import-processing	-	-	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-	-	-
Stock change	0.00	0.14	-0.51	0.09	-	0.12	0.85	0.25	-0.27	-1.57
Bunkers	-	-	-	-	-	-	0.03	-	-	0.23
Energy supplied	**0.81**	**-6.52**	**-14.99**	**-4.78**	**0.04**	**0.39**	**16.51**	**1.42**	**-1.07**	**-14.85**
Production	-	-	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	-
– in rafineries	-	-	-	-	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	-	11.52	43.97	4.80	0.00	4.15	46.08	9.73	1.07	33.82
NGL-plant	-	2.63	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-
Total production	**-**	**14.15**	**43.97**	**4.80**	**0.00**	**4.15**	**46.08**	**9.73**	**1.07**	**33.82**
Gross production	**0.81**	**7.63**	**28.98**	**0.03**	**0.04**	**4.54**	**62.59**	**11.14**	**-**	**18.97**
Transformation sector	-	-	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	0.04	-	0.61
public cogeneration plants	-	-	-	-	-	-	-	0.00	-	4.35
public heating plants	-	-	-	-	-	-	-	0.21	-	0.93
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	7.69
– in rafineries	-	-	-	-	-	-	-	-	-	7.47
– in gas production	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	0.87
Petroleum refineries	-	-	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-
Total transformation sector	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.25**	**-**	**14.46**
Energy sector own use	-	-	-	-	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	-	-	-	-	-
Coal production	-	-	-	-	-	-	-	-	-	-
Electric energy supply industry	-	-	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-	-	-	-	2.35
NGL-plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.35**
Losses	-	-	-	-	-	-	-	-	-	-
Final energy demand	**0.81**	**7.63**	**28.98**	**0.03**	**0.04**	**4.54**	**62.59**	**10.89**	**-**	**2.16**
Energy consumption	**0.81**	**7.63**	**28.98**	**0.03**	**0.04**	**4.54**	**62.59**	**10.89**	**-**	**2.16**
Industry	**0.81**	**0.65**	**-**	**-**	**-**	**-**	**0.61**	**0.90**	**-**	**1.17**
Iron and steel	0.11	0.07	-	-	-	-	-	0.04	-	0.01
Non-ferrous metals	-	0.15	-	-	-	-	-	0.00	-	0.05
Non-metallic minerals	0.00	0.01	-	-	-	-	-	-	-	0.09
Chemical	-	0.00	-	-	-	-	-	0.02	-	0.02
Construction materials	0.51	0.15	-	-	-	-	0.61	0.18	-	0.29
Pulp and paper	-	0.00	-	-	-	-	-	0.00	-	0.00
Food production	0.19	0.06	-	-	-	-	-	0.43	-	0.54
Not elsewhere specified	0.00	0.21	-	-	-	-	-	0.22	-	0.15
Transport	**-**	**2.75**	**28.39**	**0.03**	**-**	**4.54**	**49.68**	**-**	**-**	**0.08**
Rail	-	-	-	-	-	-	1.22	-	-	-
Road	-	2.75	28.39	-	-	-	45.85	-	-	-
Air	-	-	-	0.03	-	4.54	-	-	-	-
– international	-	-	-	-	-	2.32	-	-	-	-
– domestic	-	-	-	0.03	-	2.22	-	-	-	-
Sea and River	-	-	-	-	-	-	1.49	-	-	0.08
Public transport	-	-	-	-	-	-	1.13	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-
Other sectors	**-**	**4.22**	**0.59**	**-**	**0.04**	**-**	**12.30**	**9.99**	**-**	**0.92**
Households	-	3.39	-	-	0.04	-	-	5.93	-	0.42
Services	-	0.60	-	-	-	-	-	3.15	-	0.32
Agriculture	-	0.13	0.37	-	-	-	7.93	0.62	-	0.18
Construction	-	0.11	0.23	-	-	-	4.36	0.30	-	-

Table A3-3: National energy balance for 2010 (continue)

PJ	Naphta	White spirit	Bitumen	Other oils	Lubricants	Petroleum coke	Etan	Other derivates	Refinery gas	Refinery semiproducts	Aditives
PRIMARNA BILANCA											
Production	-	-	-	-	-	-	-	-	-	-	-
Import	-	0.11	2.36	0.94	0.27	3.65	-	0.12	-	0.54	2.94
Export	3.30	0.00	0.36	0.29	0.00	1.65	-	7.14	-	-	-
Import-processing	-	-	-	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-	-	-	-
Stock change	0.34	-	- 0.00	0.02	-	0.17	-	- 1.55	-	- 0.30	- 0.06
Bunkers	-	-	-	-	-	-	-	-	-	-	-
Energy supplied	**- 2.96**	**0.11**	**2.00**	**0.67**	**0.26**	**2.18**	**-**	**- 8.58**	**-**	**0.24**	**2.88**
Production	-	-	-	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	-	-
– in rafineries	-	-	-	-	-	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	2.95	-	2.23	0.45	-	3.15	-	8.58	7.84	-	-
NGL-plant	1.03	-	-	-	-	-	2.12	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total production	**3.98**	**-**	**2.23**	**0.45**	**-**	**3.15**	**2.12**	**8.58**	**7.84**	**-**	**-**
Gross production	**1.02**	**0.11**	**4.23**	**1.11**	**0.26**	**5.33**	**2.12**	**-**	**7.84**	**0.24**	**2.88**
Transformation sector	-	-	-	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	0.15	-	-	0.44	-	-
– in rafineries	-	-	-	-	-	0.15	-	-	0.44	-	-
– in gas production	-	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	1.02	-	-	-	-	-	-	-	-	0.24	2.88
NGL-plant	-	-	-	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total transformation sector	**1.02**	**-**	**-**	**-**	**-**	**0.15**	**-**	**-**	**0.44**	**0.24**	**2.88**
Energy sector own use	-	-	-	-	-	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	-	-	-	-	-	-
Coal production	-	-	-	-	-	-	-	-	-	-	-
Electric energy supply industry	-	-	-	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	1.58	-	-	7.41	-	-
NGL-plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**1.58**	**-**	**-**	**7.41**	**-**	**-**
Losses	-	-	-	-	-	-	-	-	-	-	-
Final energy demand	**0.00**	**0.11**	**4.23**	**1.11**	**0.26**	**3.60**	**2.12**	**-**	**-**	**0.00**	**0.00**
Energy consumption	**0.00**	**-**	**-**	**-**	**-**	**3.60**	**-**	**-**	**-**	**0.00**	**0.00**
Industry	**-**	**-**	**-**	**-**	**-**	**3.60**	**-**	**-**	**-**	**-**	**-**
Iron and steel	-	-	-	-	-	0.02	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-	-	-	-	-	-
Non-metallic minerals	-	-	-	-	-	-	-	-	-	-	-
Chemical	-	-	-	-	-	-	-	-	-	-	-
Construction materials	-	-	-	-	-	3.57	-	-	-	-	-
Pulp and paper	-	-	-	-	-	-	-	-	-	-	-
Food production	-	-	-	-	-	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Rail	-	-	-	-	-	-	-	-	-	-	-
Road	-	-	-	-	-	-	-	-	-	-	-
Air	-	-	-	-	-	-	-	-	-	-	-
– international	-	-	-	-	-	-	-	-	-	-	-
– domestic	-	-	-	-	-	-	-	-	-	-	-
Sea and River	-	-	-	-	-	-	-	-	-	-	-
Public transport	-	-	-	-	-	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-	-
Other sectors	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Households	-	-	-	-	-	-	-	-	-	-	-
Services	-	-	-	-	-	-	-	-	-	-	-
Agriculture	-	-	-	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-	-	-	-

Table A3-3: National energy balance for 2010 (continue)

PJ	Gas works gas	Electricity	Steam and hot water
PRIMARNA BILANCA			
Production	-	-	1.71
Import	-	24.06	-
Export	-	6.90	-
Import-processing	-	-	-
Export-processing	-	-	-
Stock change	-	-	-
Bunkers	-	-	-
Energy supplied	**-**	**17.15**	**1.71**
Production	-	-	-
hydro power plants	-	30.37	-
– small HPP	-	0.45	-
Wind power plants	-	0.50	-
Solar power plants	-	0.00	-
Geothermal power plants	-	-	-
thermal power plants	-	8.98	-
public cogeneration plants	-	9.32	9.41
public heating plants	-	-	3.09
industrial cogeneration plants	-	1.61	13.70
– in rafineries	-	0.41	6.29
– in gas production	-	0.22	1.02
Industrial heating plants	-	-	4.10
Petroleum refineries	-	-	-
NGL-plant	-	-	-
Coke plant	-	-	-
Gas works	0.18	-	-
Total production	**0.18**	**50.78**	**30.30**
Gross production	**0.18**	**67.93**	**32.01**
Transformation sector	-	-	-
hydro power plants	-	-	-
– small HPP	-	-	-
Wind power plants	-	-	-
Solar power plants	-	-	-
Geothermal power plants	-	-	-
thermal power plants	-	-	-
public cogeneration plants	-	-	-
public heating plants	-	-	-
industrial cogeneration plants	-	-	-
– in rafineries	-	-	-
– in gas production	-	-	-
Industrial heating plants	-	-	-
Petroleum refineries	-	-	-
NGL-plant	-	-	-
Coke plant	-	-	-
Gas works	-	-	-
Total transformation sector	**-**	**-**	**-**
Energy sector own use	-	-	-
Oil and gas extraction	-	0.38	0.73
Coal production	-	0.00	0.05
Electric energy supply industry	-	0.12	-
hydro power plants	-	0.94	-
thermal power plants	-	0.84	-
public cogeneration plants	-	0.38	0.68
industrial cogeneration plants	-	-	-
Industrial heating plants	-	-	-
Petroleum refineries	-	0.92	6.29
NGL-plant	-	0.04	0.29
Gas works	-	-	-
Total energy sector own use	**-**	**3.62**	**8.04**
Losses	0.00	7.28	1.53
Final energy demand	**0.17**	**57.04**	**22.44**
Energy consumption	**0.17**	**57.04**	**22.44**
Industry	**-**	**12.18**	**12.22**
Iron and steel	-	1.19	0.10
Non-ferrous metals	-	0.26	-
Non-metallic minerals	-	0.43	0.09
Chemical	-	1.74	4.20
Construction materials	-	1.99	0.00
Pulp and paper	-	0.91	1.71
Food production	-	2.31	3.87
Not elsewhere specified	-	3.36	2.26
Transport	**-**	**1.12**	**-**
Rail	-	0.63	-
Road	-	-	-
Air	-	0.08	-
– international	-	-	-
– domestic	-	0.08	-
Sea and River	-	0.08	-
Public transport	-	0.25	-
Not elsewhere specified	-	0.08	-
Other sectors	**0.17**	**43.74**	**10.22**
Households	0.12	23.94	8.15
Services	0.05	18.70	2.01
Agriculture	-	0.25	0.05
Construction	-	0.85	-

ANNEX 4

ASSESSMENT OF COMPLETENESS AND (POTENTIAL) SOURCES AND SINKS OF GREENHOUSE GAS EMISSIONS AND REMOVALS EXCLUDED

Table A4-1 shows source/sink categories of GHGs that are not estimated in the Croatian GHG inventory, and the explanations for those categories being omitted. This table is taken from the CRF Table9a.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory

GHG	Sector	Source/sink category	Explanation
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Dificulies in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Dificulies in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.1 Forest Land converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Dificulies in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Dificulies in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Dificulties in collecting adequate activity data.
CH4	1 Energy	1.B.2.A.1 Exploration	Activity data and emission factors were not available
CH4	1 Energy	1.B.2.B.1 Exploration	Activity data and emission factors were not available
CH4	2 Industrial Processes	2.A.7.1 Glass Production	The IPCC Guidelines do not provide methodology for the calculation of CH4 emission.
CH4	2 Industrial Processes	2.C.1.1 Steel	The IPCC Guidelines do not provide methodology for the calculation of CH4 emission.
CH4	2 Industrial Processes	2.B.5 Propylene	IPCC Guidelines do not provide methodology for the calculation of CH4 emission.
CH4	2 Industrial Processes	2.B.5 Polyvinilchloride	IPCC Guidelines do not provide methodology for the calculation of CH4 emission.
CH4	2 Industrial Processes	2.B.5 Polystyrene	IPCC Guidelines do not provide methodology for the calculation of CH4 emission.
CH4	2 Industrial Processes	2.B.5 Polyethene low density	IPCC Guidelines do not provide methodology for the calculation of CH4 emission.
CH4	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulies in collecting adequate activity data.
CH4	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulies in collecting adequate activity data.
CH4	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Dificulies in collecting adequate activity data.
CH4	5 LULUCF	5.E.1 Settlements remaining Settlements	Dificulies in collecting adequate activity data.
CH4	5 LULUCF	5.E.2 Land converted to Settlements	Dificulies in collecting adequate activity data.
CH4	5 LULUCF	5.F.2 Land converted to Other Land	Dificulties in collecting adequate activity data.
CH4	5 LULUCF	5.G Harvested Wood Products	Dificulies in collecting adequate activity data.
CH4	6 Waste	6.B.1 6.B.1 Industrial Wastewater	CH4 emission has not been estimated because activity data are not available.
CH4	6 Waste	6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	CH4 emission has not been estimated because activity data are not available.
CH4	6 Waste	6.C.2 Incineration of hospital wastes	IPCC Guidelines do not provide default emission factor for CH4 emission calculation from incineration of clinical waste. There is no national information on these data. Information on type of incineration technology is lacking.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory(cont.)

GHG	Sector	Source/sink category	Explanation
CH4	6 Waste	6.C.2 Incineration of hazardous waste	IPCC Guidelines do not provide default emission factor for CH4 emission calculation from incineration of hazardous waste. There is no national information on these data. Information about categorisation of waste types and type of incineration technology is lacking.
CH4	6 Waste	6.C.2 Incineration of sewage sludge	IPCC Guidelines do not provide default emission factor for CH4 emission calculation from incineration of sewage sludge. There is no national information on these data. Information about categorisation of sludge and type of incineration technology is lacking.
CO2	2 Industrial Processes	2.A.5 Asphalt Roofing	IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	2 Industrial Processes	2.A.6 Road Paving with Asphalt	The IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	2 Industrial Processes	2.A.7.1 Glass Production	The IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	2 Industrial Processes	2.B.5.2 Ethylene	IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	2 Industrial Processes	2.D.2 Food and Drink	CO2 from Food and Drink Production (e.g. gasification of water) can be of biogenic or non-biogenic origin. Only information on CO2 emission of non-biogenic origin should be reported.
CO2	2 Industrial Processes	2.B.5 Propylene	IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	2 Industrial Processes	2.B.5 Polyvinilchloride	IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	2 Industrial Processes	2.B.5 Polystyrene	IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	2 Industrial Processes	2.B.5 Polyethene low density	IPCC Guidelines do not provide methodology for the calculation of CO2 emission.
CO2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulies in collecting adequate activity data.
CO2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulies in collecting adequate activity data.
CO2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulies in collecting adequate activity data.
CO2	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulies in collecting adequate activity data.
CO2	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulies in collecting adequate activity data.
CO2	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulies in collecting adequate activity data.
CO2	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Dificulies in collecting adequate activity data.
CO2	5 LULUCF	5.G Harvested Wood Products	Dificulies in collecting adequate activity data.
CO2	6 Waste	6.A.1 Managed Waste Disposal on Land	IPCC Guidelines do not provide methodology for the calculation of CO2 emission from Solid Waste Disposal on Land.
CO2	6 Waste	6.C.2 Incineration of sewage sludge	CO2 emission has not been estimated because default EF proposed by IPCC Guidelines amounts zero. Information about categorisation of sewage sludge and type of incineration technology is lacking.
N2O	2 Industrial Processes	2.A.7.1 Glass Production	The IPCC Guidelines do not provide methodology for the calculation of N2O emission.
N2O	2 Industrial Processes	2.B.5.2 Ethylene	IPCC Guidelines do not provide methodology for the calculation of N2O emission.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory(cont.)

GHG	Sector	Source/sink category	Explanation
N2O	2 Industrial Processes	2.B.5 Propylene	IPCC Guidelines do not provide methodology for the calculation of N2O emission.
N2O	2 Industrial Processes	2.B.5 Polyvinilchloride	IPCC Guidelines do not provide methodology for the calculation of N2O emission.
N2O	2 Industrial Processes	2.B.5 Polystyrene	IPCC Guidelines do not provide methodology for the calculation of N2O emission.
N2O	2 Industrial Processes	2.B.5 Polyethene low density	IPCC Guidelines do not provide methodology for the calculation of N2O emission.
N2O	3 Solvent and Other Product Use	3.B Degreasing and Dry Cleaning	IPCC Guidelines do not provide methodology for the calculation of N2O emission from Degreasing and Dry Cleaning.
N2O	3 Solvent and Other Product Use	3.D.2 Fire Extinguishers	N2O emission has not been estimated because activity data are not available.
N2O	3 Solvent and Other Product Use	3.D.4 Other Use of N2O	N2O emission has not been estimated because activity data are not available.
N2O	3 Solvent and Other Product Use	3.D.5 Other Solvent Use (SNAP 0604)	IPCC Guidelines do not provide methodology for the calculation of N2O emission.
N2O	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.E.1 Settlements remaining Settlements	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.E.2 Land converted to Settlements	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.F.2 Land converted to Other Land	Dificulties in collecting adequate activity data.
N2O	5 LULUCF	5.G Harvested Wood Products	Dificulies in collecting adequate activity data.
N2O	6 Waste	6.B.1 6.B.1 Industrial Wastewater	IPCC Guidelines do not provide methodology for the calculation of N2O emission from Industrial Wastewater.
N2O	6 Waste	6.B.1 6.B.1 Industrial Wastewater	IPCC Guidelines do not provide methodology for the calculation of N2O emission from Industrial Wastewater - Sludge.
N2O	6 Waste	6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	IPCC Guidelines do not provide methodology for the calculation of N2O emission from Domestic Wastewater.
N2O	6 Waste	6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	IPCC Guidelines do not provide methodologies for the calculation of N2O emission from Sludge (Domestic and Commercial Wastewater).
N2O	6 Waste	6.C.2 Incineration of hospital wastes	IPCC Guidelines do not provide default emission factor for N2O emission calculation from incineration of clinical waste. There is no national information on these data. Information on type of incineration technology is lacking.
N2O	6 Waste	6.C.2 Incineration of hazardous waste	IPCC Guidelines do not provide default emission factor for N2O emission calculation from incineration of hazardous waste. There is no national information on these data. Information on categorisation of waste types and type of incineration technology is lacking.
N2O	6 Waste	6.C.2 Incineration of sewage sludge	IPCC Guidelines do not provide default emission factor for N2O emission calculation from incineration of sewage sludge. There is no national information on these data. Information about categorisation of sludge and type of incineration technology is lacking.

ANNEX 5

UNCERTAINTY ANALYSIS

A.5. METHODOLOGY FOR UNCERTAINTY ANALYSIS

Uncertainty estimates are calculated using two methods: Approach 1 (error propagation) and Approach 2 (Monte Carlo simulation). Use of the terminology Approach 1 and Approach 2 follows that defined in the IPCC's General Guidance and Reporting: 2006 IPCC Guidelines for National Greenhouse gas *Inventorie*s (2006 Guidelines) and 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000 GPG).
The Monte Carlo method was reviewed and revised in this submission, taking into account guidance from the 2006 Good Practice Guidance (IPCC, 2006). It will be discussed later in the chapter.

Uncertainty analysis using Approach 2 method was calculated for all key sources, those which represent more than 95% of the total annual emissions in the last reported year or belonging to the total trend, when ranked from contributing the largest to smallest share in annual total and in the trend.

Approach 2 method was calculated only for key sources because the analysis is very detail and because of lack of data for each source category, that are needed to determine uncertainty of input data; which implies the determination of appropriate distribution of input parameters.

Categories that were included in the model are those that were calculated for key sources using level assessment or trend assessment.
Sources that are included in the uncertainty model contribute to total emissions more than 97%.

Uncertainty estimates were calculated in Excel spreadsheet application. Data have been divided into six sectors according to modus how the inventory work is organized (Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land Use, Land-Use Change and Forestry and Waste).
Every sector has been divided into sources.Each source was evaluated regarding uncertainties (%) on activity data (AD), emission factors (EF) or direct emissions (EM).

A.5.1. ESTIMATION OF UNCERTAINTY BY MONTE CARLO SIMULATION (APPROACH 2)

A.5.1.1. Overview of the method

The Monte Carlo analysis is suitable for detailed category-by-category assessment of uncertainty, particularly where uncertainties are large, distribution is non-normal, distribution functions are complex and/or there are correlations between some of the activity sets, emissions factors, or both.

The principle of Monte Carlo analysis is to select random values of emission factor, activity data and other estimation parameters from within their individual probability density functions, and to calculate the corresponding emission values.
This procedure is repeated many times, using a computer, and the results of each calculation run build up the overall emission probability density function.
Monte Carlo analysis can be performed at the category level, for aggregations of categories or for the inventory as a whole.

Detailed procedure:

- A probability distribution function (PDF) was allocated to each emission factor and activity data. The PDFs were mostly normal, log-normal or triangle. The parameters of the PDFs were set by analysing the available data on emission factors and activity data or by expert judgement.
  If there was a lack of data for some emission source, associated uncertainties were extracted from the IPCC guidelines which imply that default uncertainty parameters were set.
- Using the software tool @RISK 5.7, each PDF was sampled 10,000 times and the emission calculations performed to produce a converged output distribution.
- The uncertainty in the trend between 1990 and the latest reported year, according to gas, was also estimated.

A.5.1.2. Uncertainty Distributions

Distributions

All of the input paramaters in inventory are modelled using normal (97%), triangle and log-normal distributions.

Correlations

The Monte Carlo model contains a number of correlations. Omitting these correlations would lead to the uncertainties being underestimated.
The trend uncertainty in the Monte Carlo model is particularly sensitive to some correlations.

Activity data and Emission factor uncertainty

If for activity data or emission factor uncertainty default value from IPCC guidance was used, average value from range of given uncertainty was set.
For some pollutants and source categories, no information on uncertainty ranges were available in the Guidline so uncertainty estimates derive from expert judgment or were taken from other inventories (Japan).

Uncertainty in the Emissions excluding LULUCF

The overall uncertainty of the key source emission was estimated at around 17% in year 2009 and 12% in year 1990 (bottom of the Table A5-2).

The central estimate of CO_2-eq emissions in 2010 was estimated at 28,597.88 Gg CO_2-eq.

The central estimate of CO_2-eq emissions in 1990 was estimated at 31,448.7 Gg CO_2-eq.

All key sources (level/trend) represent 96.24% (27,524.5 Gg CO_2-eq.) of the total inventory emission for the year 2010, and 97.28% for the year 1990.

Monte Carlo analysis shows that with a certainty of 95% we can say that the total emissions of all key categories for the year 2010 varies between 23,191 Gg CO_2-eq (2.5% percentile) and 31,887 Gg CO_2-eq (97.5% percentile).

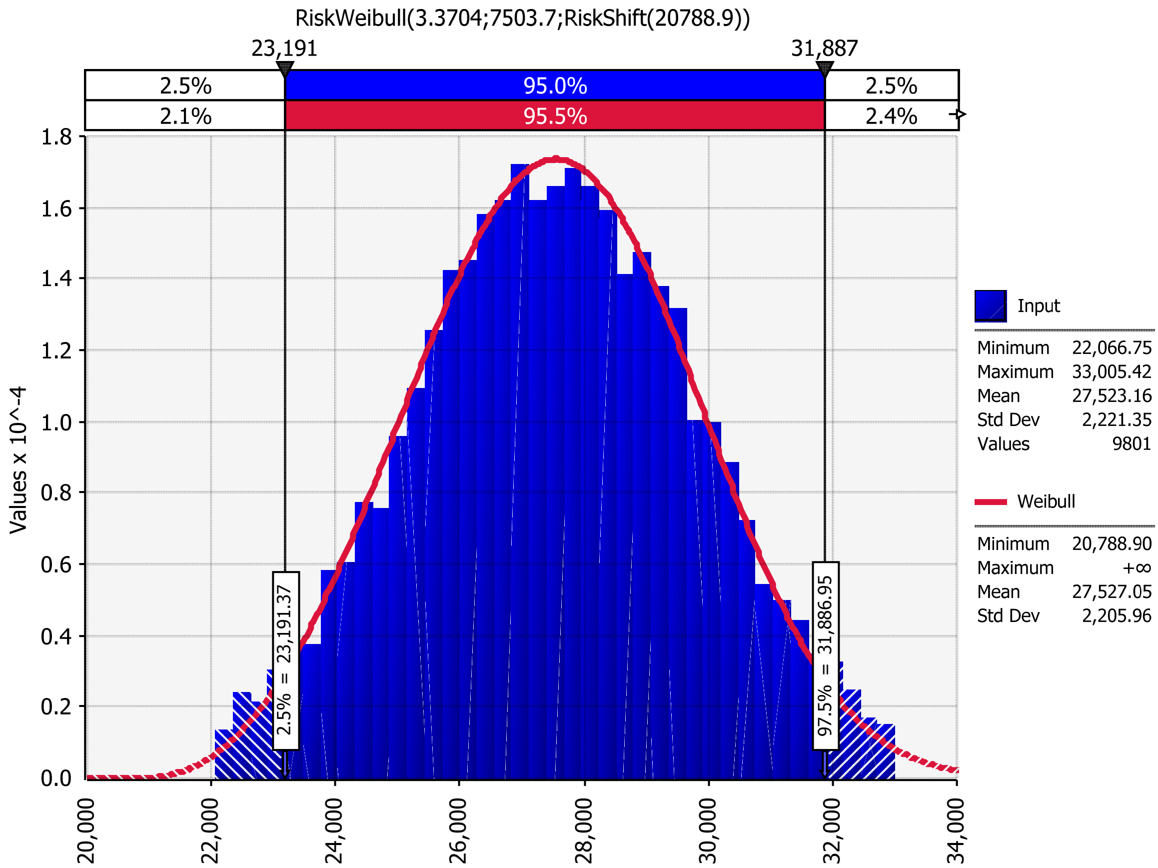

Figure A5.1-1: Distribution of total C0$_2$ emission for year 2010

Figure A5.1-1 shows the distribution of total C0$_2$ emission for year 2010 with a corresponding probability density function (red line) that best matches the simulation results.

Monte Carlo analysis shows that with a certainty of 95% we can say that the total emissions of all key categories for the year 1990 varies between 27,152 Gg CO_2-eq (2.5% percentile) and 34,084 Gg CO_2-eq (97.5%percentile) (12%).

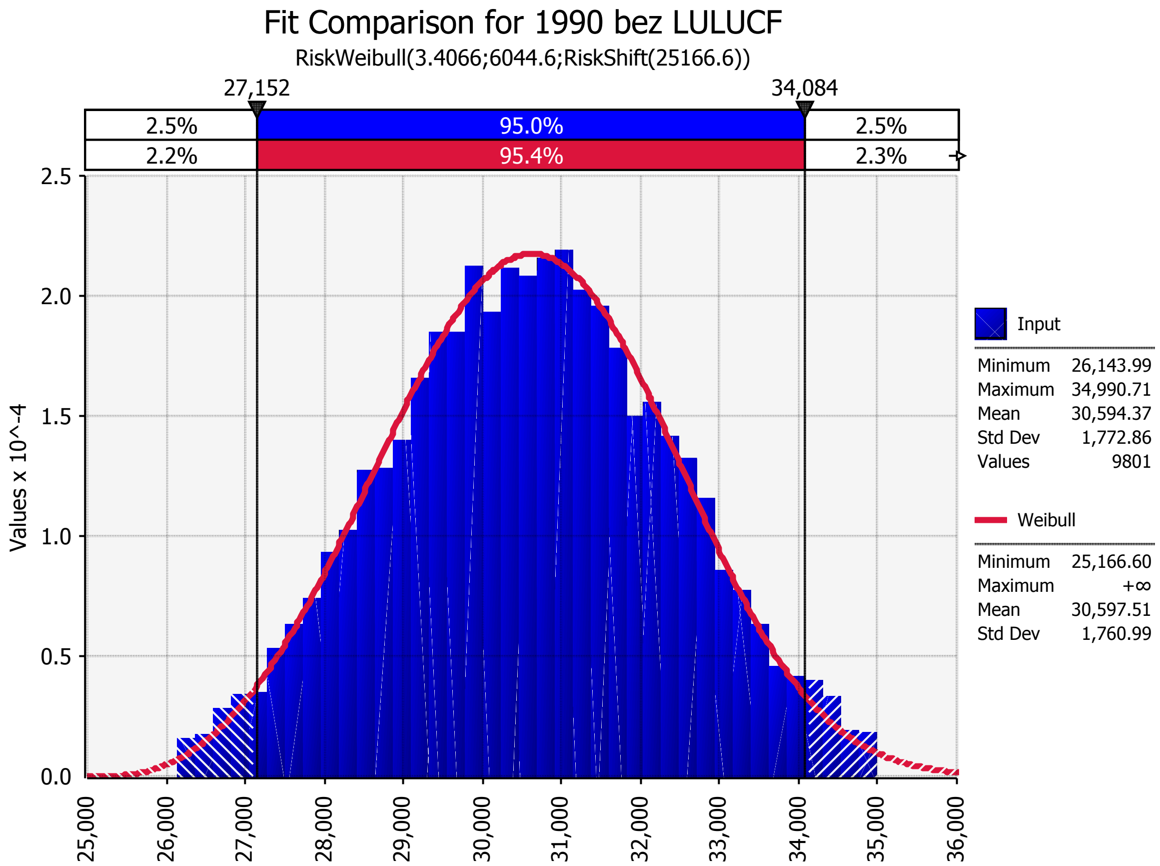

Figure A5.1-2: Distribution of total CO_2 emission for year 1990

Figure A5.1-2 shows the distribution of total CO_2 emission for year 1990 with a corresponding probability density function (red line) that best matches the simulation results.

Uncertainty in the Trend excluding LULUCF

The uncertainty in the trend between 1990 and 2010 was estimated. In running this simulation it was necessary to make assumptions about the degree of correlation between sources in year 1990 and 2010.
If source emission factors are correlated this will have the effect of reducing the trend uncertainty.

The assumptions were as follows:

- Activity data are not correlated;

- Emission factors of some similar fuels are correlated;
- Land Use Change and forestry emission factors are correlated;
- Emission factors for agriculture are all default and the same for 1990 and 2010 for all the activities except for: CH_4 emissions from enteric fermentation (dairy cattle). They are separately calculated which implies that they are different every year;
- Energy emission factors are not correlated;
- In Industry sector emission factors for categories Nitric Acid Production and CH_4 Production of Chemicals are correlated for both years, but for categories $C0_2$ Emissions from Cement Production and CO_2 Emissions from Lime Production are not correlated;
- In Solvent sector there is no correlation between years;
- In Waste sector in category Solid Waste Disposal there isn't correlation between years and in category Waste Water Handling there is correlation.

The trend in the inventory is estimated for each category and for the total summary emission (all categories included) with the following forumula:

$$Mean\,Trend\,(\%) = \left(\frac{Year\,t\,emissions - Base\,year\,emissions}{Base\,year\,emissions} \right) \bullet 100 \;.$$

For the 'total' at the foot of the Table A5.1-2, the overall uncertainty in the trend for the entire key source activities is given.

The Inventory trend is -10%, and the 95% probability range of the trend is -27.7 % (2.5% percentile) to 9.7 % (97.5% percentile), so the uncertainty in trend is from -17.6% to 19.75% with respect to the base year emissions.

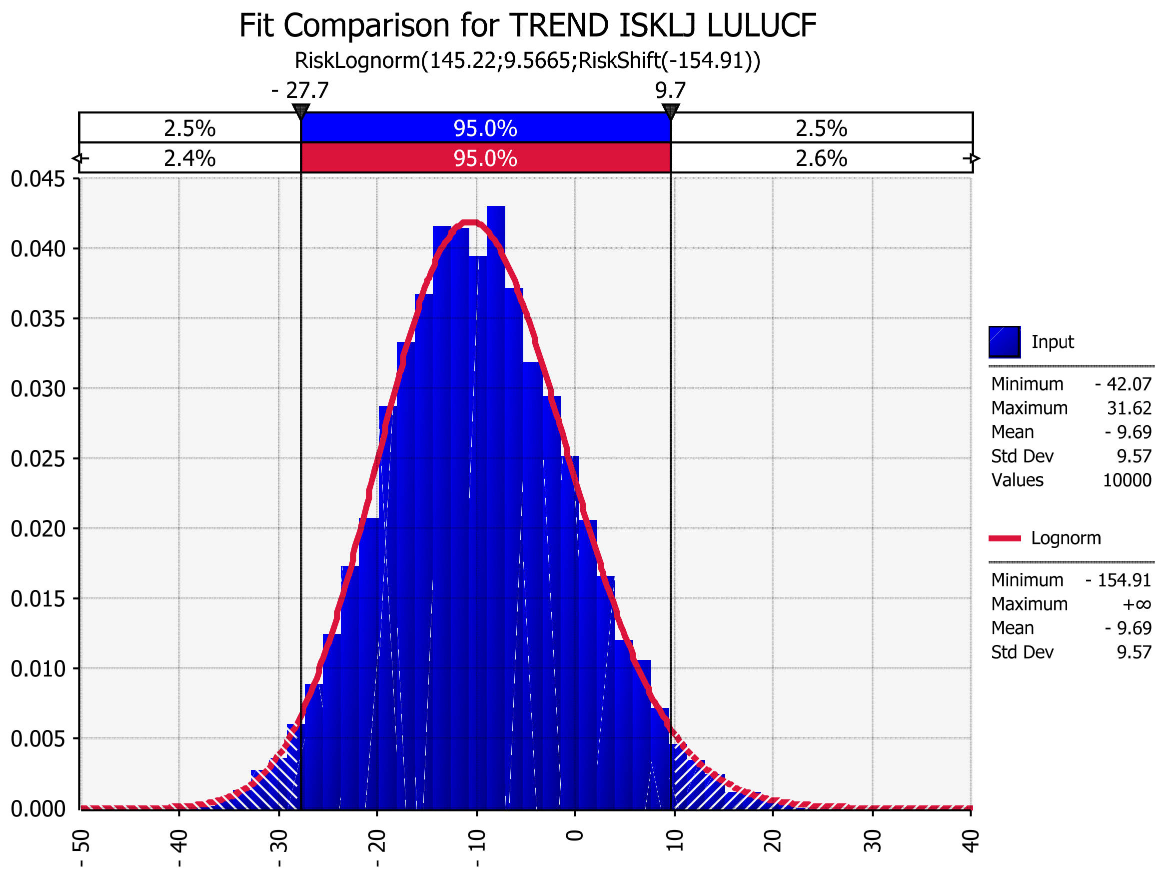

Figure A5.1-3: Distribution of trend for year 2010 respect to year 1990

Figure A5.1-3: shows the distribution of trend for year 2010 respect to year 1990 with a corresponding probability density function (red line) that best matches the simulation results.

Uncertainty in the Emissions including LULUCF

The overall uncertainty of the key source emission was estimated at around 26% in year 2010 and 17% in year 1990 (bottom of the Table A5.1-3).

The central estimate of CO_2-eq emissions in 2010 was estimated at 24,541.5 Gg CO_2-eq including LULUCF.

The central estimate of CO_2-eq emissions in 1990 was estimated at 19904.3 Gg CO_2-eq including LULUCF.

All key sources (level/trend) represent 94.24% (Gg CO_2-eq.) of the total inventory emission for the year 2010, and 96.6% for the year 1990.

Monte Carlo analysis shows that with a certainty of 95% we can say that the total emissions of all key categories (18,758 Gg CO_2-eq) for the year 2010 varies between 13,916 Gg CO_2-eq and 23,633 Gg CO_2-eq (+/-26%).

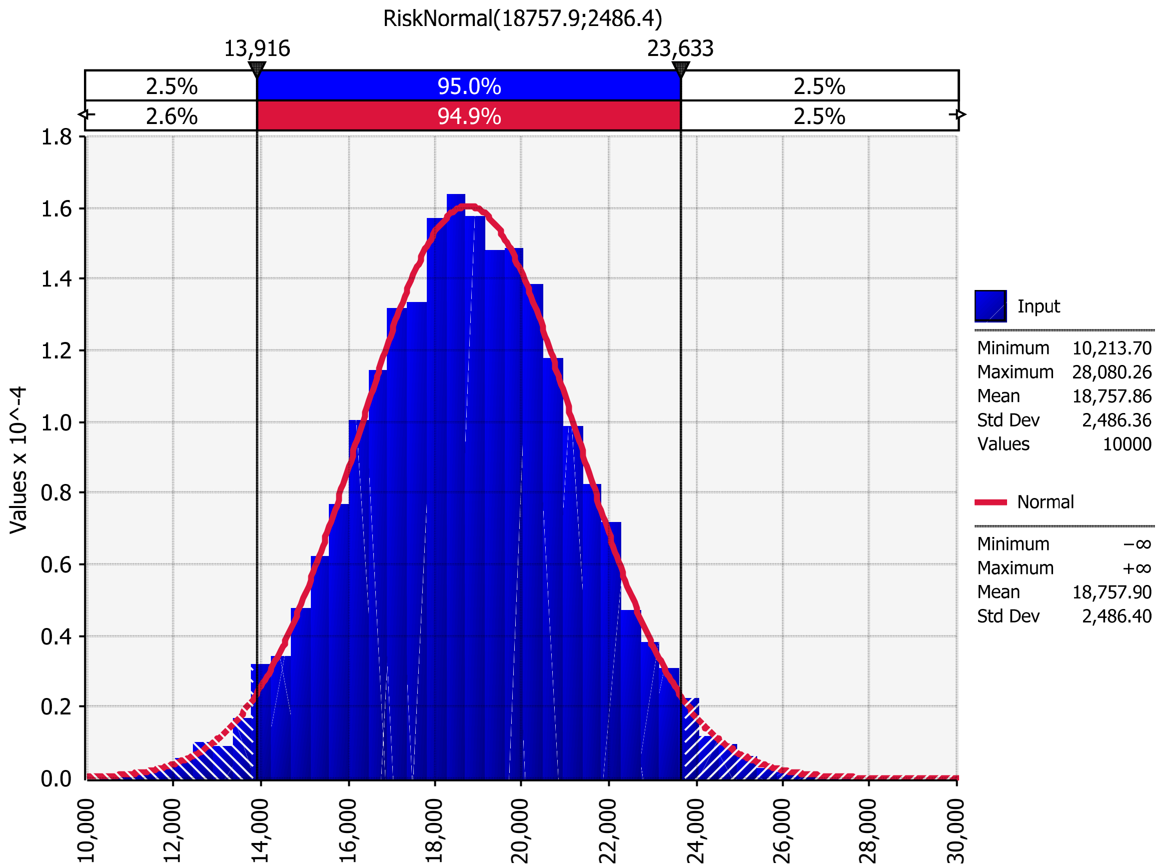

Figure A5.1-4: Distribution of total $C0_2$ emission for year 2010

Figure A5.1-4 shows the distribution of total $C0_2$ emission for year 2010 with a corresponding probability density function (red line) that best matches the simulation results.

Monte Carlo analysis shows that with a certainty of 95% we can say that the total emissions of all key categories for the year 1990 (23,706.78 Gg CO_2-eq) varies between 19,758.93 Gg CO_2-eq and 27,616.4 Gg CO_2-eq (+/-17%).

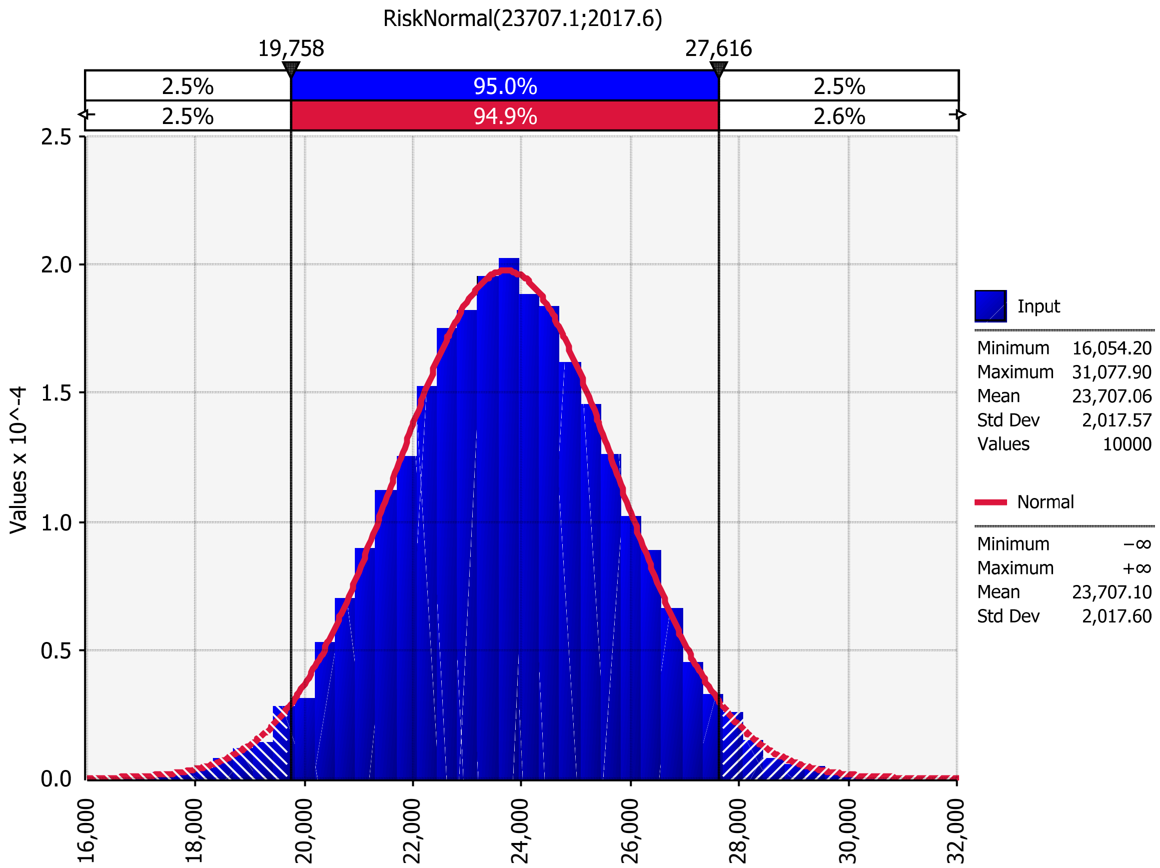

Figure A5.1-5: Distribution of total $C0_2$ emission for year 1990

Figure A5.1-5 shows the distribution of total $C0_2$ emission for year 1990 with a corresponding probability density function (red line) that best matches the simulation results.

Uncertainty in the Trend including LULUCF

The Inventory trend is -20.9%, and the 95% probability range of the trend is -43.2 % to 6.1 %, so the uncertainty in trend is from -22.32% to 26.92% with respect to the base year emissions.

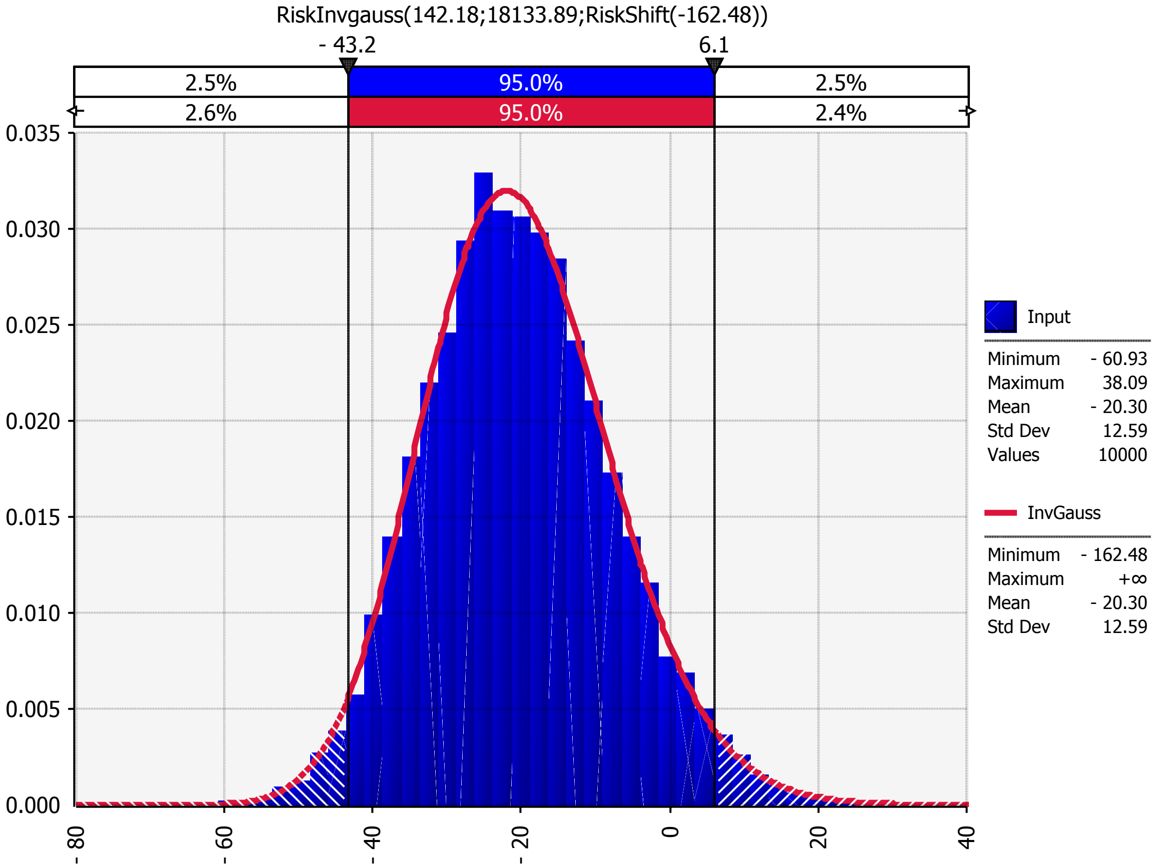

Figure A5.1-6: Distribution of trend for year 2010 respect to year 1990

Figure A5.1-6: shows the distribution of trend for year 2010 respect to year 1990 with a corresponding probability density function (red line) that best matches the simulation results.

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
1	**ENERGY SECTOR**													
1.1	**CO2 Emissions from Stationary Combustion: Coal**	CO2	2780.45	2696.20										
	1.A.1. Energy Industries	CO2												
	a. Public Electricity and Heat Production	CO2	589.30	2067.00	1.50	1.50	2.00	2.00	2.46	2.55	250.75	-24.78	27.81	
	1.A.2 Manufacturing Industries and Construction	CO2												
	a. Iron and Steel	CO2	IE,NO	13.19	2.50	2.50	5.00	5.00	5.60	5.66				5,6
	c. Chemicals	CO2	IE,NO	2.76	2.50	2.50	5.00	5.00	5.60	5.66				5,6
	e. Food Processing, Beverages and Tobacco	CO2	IE,NO	87.97	4.00	4.00	5.00	5.00	6.24	6.51				5,6
	Mineral industry	CO2	IE	500.37	2.50	2.50	5.00	5.00	5.55	5.61				5,6
	Manufacturing Industries and Construction Total (1990-2000)	CO2	1676.79	IE										1,5
	1.A.4 Other Sectors	CO2												
	a. Commercial/Institutional	CO2	86.49	3.99	4.00	4.00	5.00	5.00	6.26	6.44	-95.39	-0.39	0.44	
	b. Residential	CO2	427.86	20.92	4.00	4.00	5.00	5.00	6.43	6.51	-95.11	-0.43	0.46	
	Summary results for a given category	**CO2**	2780.45	2696.20					2.17	2.26	-3.03	-4.00	4.31	
1.2	**CO2 Emissions from Stationary Combustion: Oil**	CO2	8497.04	3891.11										
	1.A.1. Energy Industries													
	a. Public Electricity and Heat Production	CO2	2132.15	470.41	5.00	5.00	5.00	5.00	6.97	6.98	-77.94	-2.11	2.34	
	b. Petroleum Refining	CO2	2552.06	1443.23	2.50	2.50	5.00	5.00	5.51	5.56	-43.45	-4.27	4.66	
	c. Manufacture of Solid Fuels and Other Energy Industries	CO2	39.22	IE	4.00	4.00	5.00	5.00						
	1.A.2 Manufacturing Industries and Construction	CO2												
	a. Iron and Steel	CO2	IE,NO	12.78	2.50	2.50	5.00	5.00	5.59	5.62				5,6
	b. Non-Ferrous Metals	CO2	IE,NO	13.08	2.50	2.50	5.00	5.00	5.57	5.58				5,6

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

	REPORTING OF APPROACH 2 UNCERTAINTY ANALYSIS USING GENERAL REPORTING TABLE FOR UNCERTAINTY Emissions, removals and uncertainties are from National Inventory of Croatia for year 2009													
	YEAR 2009													
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2009	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
	c. Chemicals	CO2	IE,NO	12.63	4.0	4.0	5.0	5.0	6.2	6.5				5,6
	d. Pulp, Paper and Print	CO2	IE,NO	29.85	4.0	4.0	5.0	5.0	6.5	6.5				5,6
	e. Food Processing, Beverages and Tobacco	CO2	IE,NO	105.62	4.0	4.0	5.0	5.0	6.4	6.4				5,6
	Mineral industry	CO2	IE,NO	829.11	2.5	2.5	5.0	5.0	5.6	5.7				5,6
	Manufacturing Industries and Construction Total (1990-2000)	CO2	2135.51	IE										1,5
	1.A.4 Other Sectors													
	a. Commercial/Institutional	CO2	525.43	293.52	4.0	4.0	5.0	5.0	6.4	6.5	-44.14	-4.80	5.38	
	b. Residential	CO2	1112.67	680.89	4.0	4.0	5.0	5.0	6.4	6.6	-38.81	-5.24	5.79	
	Summary results for a given category	**CO2**	8497.04	3891.11					2.8	2.8	-54.21	-1.86	1.94	
1.3	**CO2 Emissions from Stationary Combustion: Gas**	CO2	4458.54	5375.52										
	1.A.1. Energy Industries	CO2												
	a. Public Electricity and Heat Production	CO2	964.76	1418.24	5.00	5.00	5.00	5.00	6.88	7.16	47.00	-13.80	-15.18	
	b. Petroleum Refining	CO2	13.85	31.50	2.50	2.50	5.00	5.00	5.52	5.61	127.40	-17.29	-18.86	
	c. Manufacture of Solid Fuels and Other Energy Industries	CO2	835.19	453.40	4.00	4.00	5.00	5.00	6.43	6.44	-45.71	-4.67	-5.13	
	1.A.2 Manufacturing Industries and Construction	CO2												
	a. Iron and Steel	CO2	IE,NO	66.43	2.50	2.50	5.00	5.00	5.48	5.63				5,6
	b. Non-Ferrous Metals	CO2	IE,NO	0.76	2.50	2.50	5.00	5.00	5.60	5.59				5,6
	c. Chemicals	CO2	IE,NO	431.95	4.00	4.00	5.00	5.00	6.26	6.44				5,6
	d. Pulp, Paper and Print	CO2	IE,NO	130.57	4.00	4.00	5.00	5.00	6.41	6.53				5,6
	e. Food Processing, Beverages and Tobacco	CO2	IE,NO	316.18	4.00	4.00	5.00	5.00	6.43	6.49				5,6
	Mineral industry	CO2	IE	355.28	2.50	2.50	5.00	5.00	5.58	5.55				5,6

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
	Manufacturing Industries and Construction Total (1990-2000)	CO2	1635.00	IE										1,5
	Petrochemical Production	CO2	395.62	406.14	4.00	4.00	5.00	5.00	6.31	6.55	2.66	-8.89	9.68	
	1.A.4 Other Sectors	CO2												
	a. Commercial/Institutional	CO2	159.30	368.24	4.00	4.00	5.00	5.00	6.22	6.42	131.16	-20.02	22.02	
	b. Residential	CO2	454.82	1396.82	4.00	4.00	5.00	5.00	6.38	6.38	207.12	-26.61	28.72	
	Summary results for a given category	**CO2**	4458.54	5375.52					2.76	2.74	20.57	-4.75	4.87	
1.4	**Mobile Combustion: Road Vehicles**	CO2	3559.72	5673.40										
	Gasoline	CO2	2417.71	1998.37	3.00	3.00	3.00	5.00	4.19	4.29	-17.34	-4.75	5.13	
	Diesel	CO2	1142.00	3459.96	3.00	3.00	2.00	1.00	3.61	3.68	202.97	-15.08	15.98	
	LPG	CO2		215.07	3.00	3.00	2.00	4.00	3.53	3.58				1,5
	Summary results for a given category		3559.72	5673.40					2.67	2.66	59.38	-6.38	6.70	
1.5	**Combustion: Agriculture/Forestry/Fishing**	**CO2**	839.19	715.33										
	Gasoline	CO2	12.24	25.09	3.00	3.00	3.00	5.00	4.19	4.18	105.00	-8.69	8.87	
	Other kerosene	CO2	0.32		3.00	3.00	2.00	2.00						5.00
	Diesel	CO2	728.45	626.66	3.00	3.00	2.00	1.00	3.57	3.59	-13.97	-4.26	4.52	
	Fuel oil	CO2	37.86	13.54	3.00	3.00	3.00	2.00	4.20	4.25	-64.23	-2.10	2.24	
	LPG	CO2	12.88	7.90	3.00	3.00	2.00	4.00	3.62	3.62	-38.64	-3.11	3.27	
	Natural gas	CO2	47.45	42.13	3.00	3.00	3.00	4.00	4.19	4.28	-11.20	-3.71	3.85	
	Summary results for a given category		839.19	715.33					3.14	3.17	-14.76	-3.72	3.88	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
1.6	**Mobile Combustion: Aircraft**	CO2												
	Jet Gasoline	CO2	NO	1.88	3.0	3.0	4.0	4.0	5.0	4.9		-3.02	3.24	
	Jet kerosene	CO2	154.72	79.23	3.0	3.0	3.0	4.0	4.2	4.3	-48.79	-3.02	3.24	
	Summary results for a given category		154.72	77.42					4.1	4.2	-47.58	-3.05	3.27	
1.7	**Fugitive Emissions from Oil and Gas Operations**	CH4	1201.18	1526.27	5.0	5.0	300.0	300.0						2,4
	Summary results for a given category		1201.18	1526.27					300.1	300.1	27.06	-1744.45	1528.40	2,4
1.8	**CO2 Emissions from Natural Gas Scrubbing**	CO2	415.95	487.26										
	b. Natural Gas	CO2	415.95	487.26	10.0	10.0	3.0	3.0						3,4
	ii Production	CO2		487.26										3,4
	Summary results for a given category		415.95	487.26					10.3	10.3	-77.43	-3.07	3.53	3,4

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
2	**INDUSTRIAL PROCESSES**													
2.1	**2(I)A.1. CO2 Emissions from Cement Production**	CO2	1085.79	1198.26										
	Portland cement		1071.58	1169.93	3.00	3.00	3.00	3.00	4.18	4.27	9.18	-6.41	6.81	
	Aluminate cement		14.21	28.33	3.00	3.00	3.00	3.00	4.21	4.26	99.34	-11.77	12.20	
	Summary results for a given category		**1085.79**	**1198.26**					**4.09**	**4.17**	**10.36**	**-6.35**	**6.78**	
2.2	**2(I)A.2. CO2 Emissions from Lime Production**	CO2	153.44	151.53										
	Quicklime		146.94	67.94	3.00	3.00	3.00	3.00	4.29	4.20	-53.76	-2.70	2.88	
	Dolomitic lime		6.50	83.59	3.00	3.00	3.00	3.00	4.20	4.24	1186.35	-75.53	78.18	
	Summary results for a given category		**153.44**	**151.53**					**2.98**	**2.99**	-1.24	-4.86	5.20	
2.3	**2(I)B.1. CO2 Emissions from Ammonia Production**	CO2	466.01	501.33										
	Natural gas consumption in process				3.00	3.00	5.00	5.00	5.72	5.83	7.58	-8.57	9.22	
	Summary results for a given category		**466.01**	**501.33**					**5.72**	**5.83**	**7.58**	**-8.57**	**9.22**	
2.4.	**2(I)C.2. CO2 Emissions from Ferroalloys Production**	CO2	118.84											
	Coke from coal		112.27		7.50	7.50	30.00	30.00						5.00
	Coal electrode		6.57		7.50	7.50	30.00	30.00						5.00
	Summary results for a given category		118.84											
2.5.	**2(I)C.3. CO2 Emissions from Aluminium Production**	CO2	111.37											5.00
	Aluminium production				3.00	3.00	30.00	30.00						5.00
	Summary results for a given category		111.37											5.00
2.6.	**2(I)B.5.CH4 Emissions from Production of Other Chemicals**	CH4	15.80	0.84										
	Carbon black		7.07		7.50	7.50	30.00	30.00	#DIV/0!	#DIV/0!	-100.00			
	Ethylene		1.53	0.84	7.50	7.50	30.00	30.00	30.71	31.11	-50.06	-5.03	5.60	
	Dichloroethylene		0.61		7.50	7.50	30.00	30.00			-100.00			5.00
	Styrene		0.75		7.50	7.50	30.00	30.00			-100.00			5.00
	Coke		5.84		7.50	7.50	30.00	30.00			-100.00			5.00
	Summary results for a given category		**15.80**	**0.84**					**30.71**	**31.11**	**-95.18**	**-1.49**	**1.74**	
2.7.	**2(I)B.2. N2O Emissions from Nitric Acid Production**	N2O	803.89	815.30										
	Nitric acid production				3.00	3.00	30.00	30.00	29.81	30.23	1.30	-4.28	4.45	
	Summary results for a given category		**803.89**	**815.30**					**29.81**	**30.23**	**1.30**	**-4.28**	**4.45**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010(cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
2.8.	**2(II)F(a) HFC Emissions from Consumption of HFCs, PFCs, SF6**		10.95	480.04										
	2(II)F(a)1.Refrigeration and air conditioning equipment													
	Domestic Refrigeration													
	HFC-134a	HFC-134a		0.37	50.00	50.00	50.00	50.00	62.57	77.82				5
	Commercial Refrigeration			86.06										5
	HFC-125	HFC-125		32.52	50.00	50.00	50.00	50.00	62.13	78.25				5
	HFC-134a	HFC-134a		1.37	50.00	50.00	50.00	50.00	62.49	79.81				5
	HFC-143a	HFC-143a		52.17	50.00	50.00	50.00	50.00	62.34	80.33				5
	Transport Refrigeration													5
	HFC-134a	HFC-134a		187.59	50.00	50.00	50.00	50.00	61.43	80.63				5
	Industrial Refrigeration			21.05										5
	HFC-125	HFC-125		13.55	50.00	50.00	50.00	50.00	62.43	78.49				5
	HFC-134a	HFC-134a		4.43	50.00	50.00	50.00	50.00	62.06	80.34				5
	HFC-32	HFC-32		3.06	50.00	50.00	50.00	50.00	61.98	80.40				5
	Stationary Air-Conditioning			19.33										5
	HFC-125	HFC-125		12.46	50.00	50.00	50.00	50.00	62.91	79.15				5
	HFC-134a	HFC-134a		4.06	50.00	50.00	50.00	50.00	62.59	82.17				5
	HFC-32	HFC-32		2.81	50.00	50.00	50.00	50.00	62.70	81.82				5
	Mobile Air-Conditioning													5
	HFC-134a	HFC-134a		139.62	50.00	50.00	50.00	50.00	62.06	80.11				5
	2(II)F(a)1. Refrigeration and Air Conditioning Equipment - potential													5
	PFC-218	PFC-218		0.01	50.00	50.00	50.00	50.00	50.00	49.98				5
	2(II)F(a)3. Fire Extinguishers			1.74										5
	HFC-227ea	HFC-227ea		1.62	50.00	50.00	50.00	50.00						5
	HFC-125	HFC-125		0.11	50.00	50.00	50.00	50.00	61.92	81.64				5
	2(II)F(a)4. Aerosols/Metered Dose Inhalers													5
	HFC-134a	HFC-134a		10.15	50.00	50.00	50.00	50.00	50.03	49.97				
	2(II)F(a)8. Electrical Equipment													
	SF6	SF6	10.95	14.11	50.00	50.00	50.00	50.00	50.02	49.96	28.82	-71.61	154.97	
	Summary results for a given category		**10.95**	**480.04**					**33.55**	**39.01**	**4282.52**	**-1933.82**	**4820.80**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
2.9	**2.(I)C.3. PFC Emissions from Aluminium Production**	N2O	936.56											
	Aluminium production													
	CF4	CF4	820.44	NO	3.00	3.00	30.00	30.00						5
	C2F6	C2F6	116.12	NO	3.00	3.00	30.00	30.00						5
	Summary results for a given category		936.56											**5**
	Swine	N2O												
3	**3.CO2 Emissions from Solvent and Other Product use**	CO2	82.42	119.65										
	3.A. Paint application	CO2	16.08	12.01	50.00	50.00	50.00	50.00	62.59	79.99	-25.32	-50.97	157.09	
	3.B.Degreasing and dry cleaning	CO2	15.40	14.28	50.00	50.00	50.00	50.00	50.01	49.98	-7.30	-51.39	111.27	
	3.C. Chemical products	CO2	8.43	4.69	50.00	50.00	50.00	50.00	62.07	80.66	-44.35	-37.33	112.91	
	3.D. Other use of solvent	CO2	42.51	88.71	50.00	50.00	50.00	50.00	62.72	79.45	108.68	-139.91	427.82	
	Summary results for a given category		**82.42**	**119.65**					**47.22**	**59.97**	**45.22**	**-75.54**	**135.65**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
4	**AGRICULTURE SECTOR**													
4.1	**4.A.CH4 Emissions from Enteric Fermentation in Domestic Livestock**	CH4												
	Dairy Cattle	CH4	751.97	398.99	10.00	10.00	20.00	20.00	21.92	23.49	-46.94	-14.52	20.20	
	Mature non-dairy	CH4	66.13	65.61	10.00	10.00	20.00	20.00	21.86	22.94	-0.78	-27.18	37.67	
	Young	CH4	275.56	183.35	10.00	10.00	20.00	20.00	21.97	23.00	-33.46	-18.16	25.68	
	Sheep	CH4	78.86	105.75	10.00	10.00	20.00	20.00	21.76	23.10	34.10	-36.69	51.62	
	Goats	CH4	18.06	7.90	10.00	10.00	20.00	20.00	22.03	23.14	-56.27	-11.99	16.77	
	Horses	CH4	14.74	7.30	10.00	10.00	20.00	20.00	21.67	23.03	-50.50	-13.60	18.35	
	Mules & Asses	CH4	3.57	0.52	10.00	10.00	20.00	20.00	21.83	23.08	-85.37	-4.02	5.56	
	Swine	CH4	33.03	38.76	10.00	10.00	20.00	20.00	21.49	23.02	17.35	-32.09	43.94	
	Poultry	CH4												5.00
	Summary results for a given category		1241.92	808.18					12.35	12.87	-34.93	-11.36	14.21	
4.2.	**4.B(a) CH4 Emissions from Manure Management**		228.62	167.17										
	Dairy Cattle	CH4	58.01	22.99	10.00	10.00	20.00	20.00	21.71	22.98	-60.37	-10.77	14.89	
	Mature non-dairy	CH4	4.03	4.00	10.00	10.00	20.00	20.00	21.95	23.31	-0.78	-27.51	37.70	
	Young	CH4	27.05	18.00	10.00	10.00	20.00	20.00	21.82	22.78	-33.46	-18.55	25.06	
	Sheep	CH4	1.58	2.51	10.00	10.00	20.00	20.00	21.86	23.22	59.25	-43.39	60.43	
	Goats	CH4	0.40	0.19	10.00	10.00	20.00	20.00	21.78	23.15	-52.29	-12.92	17.87	
	Horses	CH4	0.90	0.57	10.00	10.00	20.00	20.00	21.71	23.04	-37.00	-17.33	24.26	
	Mules & Asses	CH4	0.21	0.04	10.00	10.00	20.00	20.00	21.64	22.95	-81.47	-5.12	7.04	
	Swine	CH4	132.13	103.37	10.00	10.00	20.00	20.00	21.66	23.31	-21.77	-21.33	29.88	
	Poultry	CH4	4.31	15.51	10.00	10.00	20.00	20.00	22.16	22.56	259.91	-98.10	132.94	
	Summary results for a given category		228.62	172.36					14.10	14.93	-26.88	-13.66	16.92	
4.3.	**4.B(b) N2O Emissions from Manure Management**	N2O	381.84	203.53										
	Anaerobic lagoons	N2O	0.72	0.51										
	Mature non-dairy	N2O	0.09	0.09	10.00	10.00	50.00	100.00	50.38	81.23	-0.78	-13.16	15.05	
	Young	N2O	0.63	0.42	10.00	10.00	50.00	100.00	50.14	82.13	-33.46	-8.85	10.16	
	Liquid systems	N2O	12.18	7.86										
	Dairy Cattle	N2O	2.83	1.12	10.00	10.00	50.00	100.00	50.07	80.38	-60.37	-5.20	6.05	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
	Mature non-dairy	N2O	0.46	0.45	10.00	10.00	50.00	100.00	50.52	81.44	-0.78	-13.10	15.05	
	Young	N2O	3.06	2.04	10.00	10.00	50.00	100.00	50.53	80.92	-33.46	-8.74	10.15	
	Swine	N2O	4.44	3.48	10.00	10.00	50.00	100.00	49.96	79.04	-21.77	-10.44	11.87	
	Poultry	N2O	1.40	0.77	10.00	10.00	50.00	100.00	50.06	80.26	-44.63	-7.41	8.52	
	Solid storage & drylot	N2O	307.25	150.95										
	Dairy Cattle	N2O	213.52	84.61	10.00	10.00	50.00	100.00	50.38	81.77	-60.37	-5.19	6.04	
	Mature non-dairy	N2O	12.16	12.06	10.00	10.00	50.00	100.00	50.31	79.65	-0.78	-13.11	15.06	
	Young	N2O	81.57	54.27	10.00	10.00	50.00	100.00	50.66	80.11	-33.46	-8.78	10.11	
	Other	N2O	61.69	44.22										
	Mature non-dairy	N2O	0.06	0.06	10.00	10.00	50.00	100.00	58.15	103.27	-0.78	-13.16	15.01	
	Young	N2O	0.39	0.26	10.00	10.00	50.00	100.00	58.23	102.55	-33.46	-8.84	10.29	
	Sheep	N2O	7.90	6.62	10.00	10.00	50.00	100.00	58.23	104.56	-16.19	-10.99	12.97	
	Goats	N2O	0.84	0.37	10.00	10.00	50.00	100.00	58.30	103.41	-56.27	-5.78	6.73	
	Horses	N2O	0.19	0.09	10.00	10.00	50.00	100.00	57.89	103.13	-50.50	-6.49	7.63	
	Mules & Asses	N2O	0.08	0.01	10.00	10.00	50.00	100.00	58.21	103.36	-85.37	-1.92	2.23	
	Swine	N2O	34.48	26.98	10.00	10.00	50.00	100.00	57.98	102.80	-21.77	-10.42	12.10	
	Poultry	N2O	17.75	9.83	10.00	10.00	50.00	100.00	58.07	102.93	-44.63	-7.27	8.40	
	Summary results for a given category		**381.84**	**212.24**					**29.77**	**39.08**	**-46.70**	**-6.58**	**7.54**	
4.4.	**4.D Agricultural Soils**													
	Direct N2O Emissions from Agricultural Soils	N2O	1333.13	1165.25										
	Synthetic fertiliser (FSN)	N2O	616.15	605.55	30.00		80.00	80.00	81.03	90.25	-1.72	-40.92	106.38	
	Animal waste (FAW)	N2O	407.63	248.22	10.00	10.00	80.00	80.00	80.22	80.93	-39.11	-8.14	9.23	
	N-fixing crops (FBN)	N2O	105.36	105.21	10.00	10.00	80.00	80.00	80.34	82.85	-0.14	-12.95	15.13	
	Crop residue (FCR)	N2O	198.25	200.51	10.00	10.00	80.00	80.00	80.20	82.08	1.14	-13.26	15.66	
	Histosols	N2O	5.74	5.74	20.00	20.00	60.00	60.00	61.06	67.55		-24.92	33.57	
	Sewage sludge (NSLUDGE)	N2O		0.02	50.00	50.00	80.00	80.00	83.12	109.05				5.00
	Summary results for a given category		**1333.13**	**1165.25**					**47.02**	**52.12**	**-12.59**	**-21.33**	**35.91**	
	N2O Emissions from Pasture Range and Paddock Manure	N2O	261.13	174.84										
	Dairy Cattle	N2O	40.82	16.18	10.00	10.00	63.00	63.00	63.06	64.82	-60.37	-5.22	6.15	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
	Goats	N2O	38.54	16.85	10.00	10.00	63.00	63.00	63.23	64.47	-56.27	-5.86	6.72	
	Horses	N2O	8.74	4.33	10.00	10.00	63.00	63.00	63.59	64.31	-50.50	-6.52	7.61	
	Mules & Asses	N2O	3.81	0.56	10.00	10.00	63.00	63.00	62.58	65.84	-85.37	-1.92	2.19	
	Swine	N2O	82.76	64.74	10.00	10.00	63.00	63.00	63.40	65.39	-21.77	-10.43	11.70	
	Poultry	N2O	1.00	0.55	10.00	10.00	63.00	63.00	63.41	64.40	-44.63	-7.15	8.31	
	Summary results for a given category	**N2O**	**261.13**	**177.39**					**35.74**	**36.54**	**-33.05**	**-7.83**	**7.75**	
	Indirect N2O Emissions from Nitrogen Used in Agriculture	**N2O**	**934.07**	**746.12**										
	Deposition	N2O	137.97	103.66					64.34	80.37	-24.87	-8.61	12.33	4,7
	Synthetic fertiliser	N2O	30.34	36.53										
	Livestock excretion	N2O	107.64	67.13										
	Leaching	N2O	796.09	642.46					89.59	292.61	-20.12	-19.10	29.86	4,7
	Synthetic fertiliser	N2O	392.44	390.73										
	Livestock excretion	N2O	403.65	251.73										
	Summary results for a given category	**N2O**	**934.07**	**746.12**					**78.86**	**251.66**	**-20.82**	**-16.16**	**23.01**	**4,7**

Table A5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010(cont.) including LULUCF

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
5	**LULUCF****													
5.1	**5.A.Forest land remaining forest land**	CO2-eq	-7043.99	-8756.92										
	State forests - Croatian Forests	CO2	-4929.87	-4633.33										
	Increment		-11387.50	-11799.22	10.00	10.00	2.00	2.00	10.21	10.19	3.62	-13.99	16.16	
	Fellings		6457.63	7165.89	10.00	10.00	2.00	2.00	10.20	10.19	10.97	-15.03	16.94	
	State forests - Other	CO2	-199.30	-638.91										
	Increment		-246.82	-638.91	10.00	10.00	2.00	2.00	10.20	10.19	158.85	-64.79	115.72	
	Fellings		47.52		NA	NA	2.00	2.00						5
	Private forests	CO2	-1930.18	-3486.31										
	Increment		-2133.26	-3770.13	10.00	10.00	2.00	2.00	10.20	10.20	76.73	-33.20	47.43	
	Fellings		203.08	283.82	"0"	30.00	2.00	2.00	8.80	13.96	-5.36	-15.26	18.02	
	Biomass burning - All forests	CH4	12.50	1.32										
	Area				40.00	40.00	70.00	70.00	80.67	80.61	-89.47	-38.53	65.31	
	Biomass burning - All forests	N2O	2.86	0.30										
	Area				40.00	40.00	70.00	70.00	80.65	80.57	-89.47	-39.64	61.64	
	Summary results for a given category		**-7043.99**	**-8756.92**					**16.42**	**16.48**	**25.71**	**-28.00**	**39.86**	
5.2	**5.A.Land converted to Forest land**	**CO2**												
	Increment				50.00	50.00	2.00	2.00						
	Summary results for a given category		**-0.23**	**-3.72**					**50.06**	**50.01**	**1540.38**	**-907.56**	**2029.31**	
	5.E Settlements	CO2												
5.3	**Land converted to Settlements**	**CO2**												
	Growing stock				40.00	40.00	2.00	2.00						
	Summary results for a given category		**136.80**	**67.00**					**40.08**	**40.02**	**-51.02**	**-22.61**	**39.95**	

Table A5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2010 (cont.) including LULUCF

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2010														
YEAR 2010														
	A	B	C	D	E		F		G		I	J		K
	IPCC Source Category	Greenhouse Gas	Year 1990 emissions or removals	Year t emissions or removals 2010	Activity data uncertainty		Emission factor uncertainty		Combined uncertainty		Inventory trend in national emissions for year t increase with respect to year 1990 (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to year 1990		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(% of year 1990)	(-)%	(+)%	Approach 2
6	**WASTE SECTOR**													
6.1.	**6 A.CH4 Emissions from Solid Waste Disposal Sites**		242.62	757.78										
	Managed SWDS	CH4	12.01	654.73	50.00	50.00	50.00	50.00	66.42	86.19	5351.10	-3844.79	11683.95	
	Unmanaged SWDS > 5m	CH4	150.54	86.75	50.00	50.00	50.00	50.00	62.06	79.91	-42.37	-38.40	115.47	
	Unmanaged SWDS < 5m	CH4	80.07	16.30	50.00	50.00	50.00	50.00	62.52	80.86	-79.64	-13.80	43.19	
	Summary results for a given category		**242.62**	**757.78**					**58.56**	**75.32**	**212.33**	**-198.07**	**399.96**	
6.2.	**6 B.CH4 Emissions from Wastewater Handling**		278.73	209.82										
	6 B 1. Industrial Wastewater	CH4	179.88	125.00	50.00	50.00	30.00	30.00	53.64	63.60	-30.51	-38.82	82.54	
	6 B.2 Domestic and Commercial Wastewater	CH4	98.85	84.83	50.00	50.00	30.00	30.00	54.07	63.13	-14.19	-46.93	105.97	
	Summary results for a given category		**278.73**	**209.82**					**39.66**	**45.01**	**-24.72**	**-31.50**	**54.99**	

Approach and Comments:

1. Manufacturing Industries and Construction Total (1990-2000) is emission category which existed till 2000 year; afterwards its emission was included in other source categories.

2. Fugitive Emissions from Oil and Gas Operations: for this category wasn't enough data to calculate combine uncertainty with Monte-Carlo method, therefore combine uncertainty data from tier 1 method was implied in model.

3. CO_2 Emissions from Natural Gas Scrubbing: for this category wasn't enough data to calculate combine uncertainty with Monte-Carlo method, therefore combine uncertainty data from tier 1 method was implied in model.

4. A more complex method for estimation of uncertainties is used, and therefore activity data and emission factor uncertainties are left blank. Only combined uncertainty and trend uncertainty is shown in model.

5. Trend not calculated, when base year or year t emissions are zero or included elsewhere

6. Emission is included in category Other Manufacturing Industries and Construction Total (1990-2000).There were no disaggregated data till 2000.

7. Because of the existence of variables in model with triangle distribution there is a slight deviation of emission in model and in CRF-REPORTER

**Left value is "real" value form crf reporter and right value is mean value of variable with its distribution*

Table A5.1-2: Summary uncertainty table for year 1990 and 2010 excluding LULUCF

IPCC Source Category	Greenhouse Gas	1990 Emissions	2010 Emissions	Uncertainty in 1990 emissions as % of emissions in category		Uncertainty introduced on national total in 1990		Uncertainty in 2010 emissions as % of emissions in category		Uncertainty introduced on national total in 2010		% change in emissions between 2010 and 1990	Range of likely % change between 2010 and 1990	
		Gg CO_2 equivalent	Gg CO_2 equivalent	2.5 percentile	97.5 percentile	(-)%	(+)%	2.5 percentile	97.5 percentile	(-)%	(+)%	%	2.5 percentile	97.5 percentile
		Gg CO_2 equivalent	Gg CO_2 equivalent	Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	%	Gg CO_2 equivalent	Gg CO_2 equivalent
ENERGY SECTOR														
CO2 Emissions from Stationary Combustion: Coal	CO2	2780.45	2696.20	2679.14	2884.90	4%	4%	2637.69	2757.02	2%	2%	-3.03	-7.03	1.28
CO2 Emissions from Stationary Combustion: Oil	CO2	8497.04	3891.11	8248.22	8749.29	3%	3%	3783.27	4002.48	3%	3%	-54.21	-56.04	-52.37
CO2 Emissions from Stationary Combustion: Gas	CO2	4458.54	5375.52	4327.28	4592.26	3%	3%	5228.90	5525.75	3%	3%	20.57	15.73	25.41
Mobile Combustion: Road Vehicles	CO2	3559.72	5673.40	3451.55	3668.68	3%	3%	5527.43	5825.81	3%	3%	59.38	53.09	65.88
Combustion: Agriculture/Forestry/Fishing	CO2	839.19	715.33	813.14	865.33	3%	3%	692.59	738.01	3%	3%	-14.76	-18.49	-10.89
Fugitive Emissions from Oil and Gas Operations	CH4	1201.18	1526.27	-2404.01	4805.40	300%	300%	-3055.22	6103.93	300%	300%	27.06	-1637.39	1596.16
CO2 Emissions from Natural Gas Scrubbing	CO2	415.95	487.26	373.10	458.75	10%	10%	84.21	103.54	10%	10%	-77.43	-80.47	-73.97
Mobile Combustion: Aircraft	CO2	154.72	81.10	148.14	161.39	4%	4%	77.78	84.56	4%	4%	-47.58	-50.59	-44.32
INDUSTRIAL PROCESSES														
CO_2 Emissions from Cement Production	CO2	1085.79	1198.26	1040.30	1131.43	4%	4%	1148.59	1247.50	4%	4%	10.36	3.96	17.02
CO_2 Emissions from Lime Production	CO2	153.44	151.53	147.24	159.69	4%	4%	146.97	156.09	3%	3%	-1.24	-6.12	3.95
CO_2 Emissions from Ammonia Production	CO2	466.01	501.33	438.87	493.46	6%	6%	472.44	530.49	6%	6%	7.58	-0.91	17.07
CO_2 Emissions from Ferroalloys Production	CO2	118.84		84.45	153.63	29%	29%							
CO_2 Emissions from Aluminium Production	CO2	111.37		78.01	145.14	30%	30%							
CH4 Emissions from Production of Other Chemicals	CH4	15.80	0.84	12.95	18.65	18%	18%	0.53	1.00	31%	31%	-95.18	-96.68	-93.43
N_2O Emissions from Nitric Acid Production	N20	803.89	815.30	560.25	1046.23	30%	30%	569.66	1058.91	30%	30%	1.30	-2.92	5.64
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	10.95	480.07	5.48	16.43	50%	50%	320.40	666.60	33%	39%	4282.52	2326.18	9187.51
PFC Emissions from Aluminium production		936.56		687.76	1185.82	27%	27%							
SOLVENT AND OTHER PRODUCT USE														
CO_2 Emissions from solvent and other product use	CO2	82.42	119.65	51.62	119.92	37%	45%	63.61	191.89	47%	60%	45.22	-30.36	182.83
AGRICULTURE SECTOR														
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.92	808.18	1065.36	1427.86	14%	15%	709.34	911.90	12%	13%	-34.93	-46.23	-20.81
CH4 Emissions from Manure Management	CH4	228.62	167.17	196.61	261.99	14%	15%	143.27	191.64	14%	15%	-26.88	-40.20	-10.35
N2O Emissions from Manure Management	N20	381.84	203.53	258.69	561.87	32%	47%	144.14	284.83	29%	40%	-46.70	-53.29	-39.26
Direct N2O Emissions from Agricultural Soils	N20	1333.13	1165.25	685.25	2094.24	49%	57%	599.94	1792.30	49%	54%	-12.59	-33.63	22.61
N2O Emissions from Pasture Range and Paddock Manure	N20	261.13	174.84	178.81	345.52	32%	32%	112.35	238.72	36%	37%	-33.05	-40.87	-25.30
Indirect N2O Emissions from Nitrogen Used in Agriculture	N20	934.07	746.12			79%	254%			79%	252%	-20.82	-36.98	2.19
LULUCF**														
WASTE SECTOR														
CH_4 Emissions from Solid Waste Disposal Sites	CH4	242.62	757.78	132.48	377.98	45%	56%	315.78	1333.98	58%	76%	212.33	17.93	612.70
CH_4 Emissions from Wastewater Handling	CH4	278.73	209.82	165.44	407.90	41%	46%	125.30	304.96	40%	45%	-24.72	-56.72	31.07
TOTAL		30593.98	27524.46	26900.02	34352.78	12%	12%	22809.73	32203.40	17%	17%	-10.03	-27.61	10.29

Table A5.1-3: Summary uncertainty table for year 1990 and 2010 including LULUCF

IPCC Source Category	Greenhouse Gas	1990 Emissions	2010 Emissions	Uncertainty in 1990 emissions as % of emissions in category		Uncertainty introduced on national total in 1990		Uncertainty in 2010 emissions as % of emissions in category		Uncertainty introduced on national total in 2010		% change in emissions between 2010 and 1990	Range of likely % change between 2010 and 1990	
		Gg CO_2 equivalent	Gg CO_2 equivalent	2.5 percentile	97.5 percentile	(-)%	(+)%	2.5 percentile	97.5 percentile	(-)%	(+)%	%	2.5 percentile	97.5 percentile
		Gg CO_2 equivalent	Gg CO_2 equivalent	Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	%	Gg CO_2 equivalent	Gg CO_2 equivalent
ENERGY SECTOR														
CO2 Emissions from Stationary Combustion: Coal	CO2	2780.45	2696.20	2677.60	2883.17	4%	4%	2637.36	2755.46	2%	2%	-3.03	-7.05	1.30
CO2 Emissions from Stationary Combustion: Oil	CO2	8497.04	3891.11	8249.37	8746.25	3%	3%	3782.50	4001.15	3%	3%	-54.21	-56.06	-52.27
CO2 Emissions from Stationary Combustion: Gas	CO2	4458.54	5375.52	4329.84	4588.52	3%	3%	5227.22	5522.56	3%	3%	20.57	15.82	25.44
Mobile Combustion: Road Vehicles	CO2	3559.72	5673.40	3450.18	3672.26	3%	3%	5521.80	5824.50	3%	3%	59.38	52.99	66.08
Combustion: Agriculture/Forestry/Fishing	CO2	839.19	715.33	812.89	865.63	3%	3%	692.87	738.04	3%	3%	-14.76	-18.48	-10.88
Fugitive Emissions from Oil and Gas Operations	CH4	1201.18	1526.27	-2403.58	4804.31	300%	300%	-3054.40	6105.97	300%	300%	27.06	-1717.39	1555.46
CO2 Emissions from Natural Gas Scrubbing	CO2	415.95	487.26	373.09	458.76	10%	10%	84.21	103.55	10%	10%	-77.43	-80.50	-73.89
Mobile Combustion: Aircraft	CO2	154.72	81.10	148.31	161.47	4%	4%	77.76	84.48	4%	4%	-47.58	-50.63	-44.31
INDUSTRIAL PROCESSES		0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0%	0%	0.00	0.00	0.00
CO_2 Emissions from Cement Production	CO2	1085.79	1198.26	1041.03	1132.20	4%	4%	1149.30	1248.20	4%	4%	10.36	4.00	17.14
CO_2 Emissions from Lime Production	CO2	153.44	151.53	147.18	159.81	4%	4%	147.01	156.07	3%	3%	-1.24	-6.11	3.95
CO_2 Emissions from Ammonia Production	CO2	466.01	501.33	439.13	493.48	6%	6%	472.67	530.56	6%	6%	7.58	-0.99	16.80
CO_2 Emissions from Ferroalloys Production	CO2	118.84	0.00	84.55	153.77	29%	29%	0.00	0.00	0%	0%	0.00	0.00	0.00
CO_2 Emissions from Aluminium Production	CO2	111.37	0.00	77.66	144.78	30%	30%	0.00	0.00	0%	0%	0.00	0.00	0.00
CH4 Emissions from Production of Other Chemicals	CH4	15.80	0.84	12.91	18.70	18%	18%	0.53	1.00	31%	31%	-95.18	-96.67	-93.44
N_2O Emissions from Nitric Acid Production	N20	803.89	815.30	561.70	1046.74	30%	30%	571.59	1060.52	30%	30%	1.30	-2.98	5.75
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	10.95	480.07	5.47	16.43	50%	50%	319.02	667.37	34%	39%	4282.52	2348.70	9103.32
PFC Emissions from Aluminium production	PFC	936.56	0.00	686.52	1185.62	27%	27%	0.00	0.00	0%	0%	0.00	0.00	0.00
SOLVENT AND OTHER PRODUCT USE		0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0%	0%	0.00	0.00	0.00
CO_2 Emissions from solvent and other product use	CO2	82.42	119.65	51.67	120.62	37%	46%	63.17	191.47	47%	60%	45.22	-30.33	180.87
AGRICULTURE SECTOR		0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0%	0%	0.00	0.00	0.00
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.92	808.18	1065.39	1426.70	14%	15%	708.40	912.16	12%	13%	-34.93	-46.28	-20.72
CH4 Emissions from Manure Management	CH4	228.62	167.17	196.69	262.63	14%	15%	143.59	192.12	14%	15%	-26.88	-40.54	-9.96
N2O Emissions from Manure Management	N20	381.84	203.53	255.89	562.89	33%	47%	142.95	283.08	30%	39%	-46.70	-53.28	-39.15
Direct N2O Emissions from Agricultural Soils	N20	1333.13	1165.25	700.50	2090.88	47%	57%	617.33	1772.63	47%	52%	-12.59	-33.92	23.32
N2O Emissions from Pasture Range and Paddock Manure	N20	261.13	174.84	179.01	346.86	31%	33%	113.08	238.85	35%	37%	-33.05	-40.91	-25.32
Indirect N2O Emissions from Nitrogen Used in Agriculture	N20	934.07	746.12	0.00	0.00	79%	263%	0.00	0.00	79%	258%	-20.82	-36.82	1.55
LULUCF**														
Forest land remaining forest land	CO2,CH4,N20	-7043.99	-8756.92	-8431.17	-5617.30	20%	20%	-10279.06	-7374.74	16%	16%	25.71	-2.30	65.56
Land converted to Forest land	CO2	-0.23	-3.72	-0.34	-0.11	50%	50%	-5.58	-1.86	50%	50%	1540.38	632.82	3569.69
Land converted to Settlements	CO2	136.80	67.00	82.01	191.56	40%	40%	40.15	93.81	40%	40%	-51.02	-73.64	-11.07
WASTE SECTOR														
CH_4 Emissions from Solid Waste Disposal Sites	CH4	242.62	757.78	131.02	382.12	46%	57%	314.09	1328.64	59%	75%	212.33	14.26	612.29
CH_4 Emissions from Wastewater Handling	CH4	278.73	209.82	166.66	411.15	40%	48%	126.60	304.27	40%	45%	-24.72	-56.23	30.27
TOTAL		23706.78	18758.33	19757.53	27616.33	17%	16%	13915.96	23632.85	26%	26%	-20.87	-43.20	6.05

A.5.2. ESTIMATION OF UNCERTAINTIES USING AN ERROR PROPAGATION APPROACH (APPROACH 1)

A.5.2.1. Overview of the method

In the Approach 1, an uncertainty in an emission can be propagated from uncertainties in the activity data and the emission factor through the error propagation equation (Mandel 1984, Belington and Robinson 1992).
This method is presented in the current 1996 IPCC Guidelines for National Greenhouse Gas Inventories (officially in use), where the conditions imposed for use of the method are:

- The uncertainties are relatively small, the standard deviation divided by the mean (coefficient of variation) value being less than 0.3;
- Input parameters (emission factor, activity data) have Gaussian (normal) distributions. Uncertainty is symmetric with respect to the mean value. The length of the range from mean to upper larger value (97.5% percentile) is equal to the length of the range from mean to lower, smaller value (2.5% percentile).
- The correlation between the input data in model between years doesn't exist.

Under these conditions, the uncertainty calculated for the emission rate is appropriate.
Summary uncertainty value is calculated for all emission sources and separately for key source categories (gray shaded area in Table A5.2.-1) that were included in Monte-Carlo analysis (Tier 2).
The results of the error propagation approach are shown in Table A5.2.-1.
The uncertainties used and calculated in the error propagation approach are not exactly the same as those used in the Monte Carlo Simulation since the error propagation source categorisation is far less detailed.
However, the values used were chosen to agree approximately with those used in the Monte Carlo Simulation.

A.5.2.2. Review of changes made to the error propagation model since the last inventory (NIR 2011)

Calculation of trend uncertainty using tier 1 method is based on the essential assumption that the input uncertainty of emission factors and activity data for 1990 and 2010 are equal. With that assumption, we can use the default 3.2. Table from 2006 IPCC Guidelines. Formulas in columns K and L are used as they are given. That kind of assumption is not expected in real life.
Uncertainties for 1990 and 2010 are not equal (activity data uncertainty, emission factor uncertainty).
Therefore, the formulas in columns K, L of the 3.2. Table should change the default format, according to existence of new different activity data and emission factor uncertainty into:

Column K

Under the assumption that the same emission factor is used in both years and the actual emission factors are fully correlated, the percent error introduced by it is equal in both years. Therefore the formula for the uncertainty introduced on the trend by the emission factor is:
K= ***I*F= sensitivityA *uncertainty of emission factor***

In case no correlation between emission factors is assumed, sensitivity B should be used and the result needs to be increased by $\sqrt{uncertainty(emission\ factor,\ base\ year)^2 + uncertainty(emission\ factor,\ year\ t)^2}$.

J=sensitivityB
K=J* $\sqrt{uncertainty(emission\ factor,\ base\ year)^2 + uncertainty(emission\ factor,\ year\ t)^2}$

Column L

The trend is the difference between the emissions in the base year and in the year t. Therefore the uncertainty of the activity data of the base year and year t has to be taken into account.
Since activity data in both years are assumed to be independent, Column L equals:
L = sensitivity B • combined uncertainty of activity data of both years
= J * $\sqrt{uncertainty(activity\ data,\ base\ year)^2 + uncertainty(activity\ data,\ year\ t)^2}$

In case correlation between activity data is assumed what is not expected in real life, sensitivity A should be used and the final formula is: L= I * E.

Two columns (O and P) reflecting uncertainty of emission factors and activity data for year 1990 have been added in Table A5.2-1 and Table A5.2-2.

Activity data and emission factor uncertainty in tables – (Table A5.2-1, Table A5.2-2) for the key source activities that have been checked and calculated in detail using Monte Carlo analysis have been updated.

IPCC Source category Mobile Combustion: Agriculture/Forestry/Fishing has been changed to Combustion: Agriculture/Forestry/Fishing because the emission value includes both mobile and stationary sources.

IPCC Source category Mobile Combustion: Agriculture/Forestry/Fishing has been changed to Combustion: Agriculture/Forestry/Fishing because the emission value includes both mobile and stationary sources.

Uncertainty in the Emissions

The error propagation analysis, including LULUCF emissions, shows an uncertainty of +/- 26% in the combined GWP total emission in 2010, the latest reported year in this inventory.

The error propagation analysis, excluding LULUCF emissions, shows an uncertainty of +/- 17% in the combined GWP total emission in 2010, the latest reported year in this inventory.

Uncertainty in the Trend

The analysis, including LULUCF emissions, estimates an uncertainty of +/- 28% in the trend between the year 1990 and 2010, the latest reported year in this inventory.

The analysis, excluding LULUCF emissions, estimates an uncertainty of +/- 20% in the trend between the year 1990 and 2010, the latest reported year in this inventory.

Table A5.2-1: Tier 1 Uncertainty Calculation and Reporting – excluding LULUCF (Table 6.1 – IPCC Good Practice Guidance)

A	B	C	D	E	F	G	H	I	J	K	L	M	O	P
IPCC Source Category	Greenhouse Gas	Base year emissions 1990	Year t emissions 2010	Activity data uncertainty 2010	Emission factor uncertainty 2010	Combined uncertainty 2010	Combined uncertainty as % of total emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Activity data uncertainty 1990	Emission factor uncertainty 1990
		Gg CO2 ekvivalent	Gg CO2 ekvivalent							I*F or Note C	J*SQRT(E²+O²) or Note D			
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447145	2696.202773	1.24862734	1.802654151	2.192859371	0.206742338	0.00533103	0.085733365	0.325595548	0.185162157	0.374563059	1.762221823	3.342677104
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.043518	3891.112143	1.4665626	2.406383956	2.818064869	0.38343418	-0.12163752	0.123728876	0.423636243	0.27045172	0.502605013	1.620832352	2.435664137
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539387	5375.516537	1.781223623	2.085502748	2.742640937	0.515531548	0.04194997	0.170929697	0.545419371	0.420524446	0.688711187	1.697032334	2.415059776
Mobile Combustion - Road Vehicles	CO2	3559.716481	5673.398126	2.090589413	1.628666724	2.650116864	0.525744064	0.07738362	0.180401681	0.485267182	0.552940118	0.735681325	2.241420433	2.140828546
Mobile Combustion: Water-borne Navigation	CO2	132.9799557	115.1415657	5	5	7.071067812	0.028469722	-0.0001839	0.003661251	0.025888951	0.025888951	0.036612506	5	5
Mobile Combustion: Domestic Aviation	CO2	154.7238583	81.10413105	2.922121316	2.939742246	4.144982203	0.011755246	-0.00189487	0.002578934	0.010832122	0.010803581	0.015298766	3.001717764	2.999976879
Mobile Combustion: Railways	CO2	138.1421391	89.25497361	5	5	7.071067812	0.022069044	-0.00115626	0.002838113	0.020068492	0.020068492	0.028381134	5	5
Combustion - Agriculture/Forestry/Fishing	CO2	839.1893711	715.3307369	2.577602521	1.770936273	3.12733913	0.07822543	-0.0015191	0.022745957	0.056594874	0.082315147	0.099893759	2.540145699	1.747733
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	487.261397	10	3	10.44030651	0.177885827	0.00346608	0.015493849	0.010398232	0.154938492	0.155287023		
CO2 Emissions from Cement Production	CO2	1085.789849	1198.26	2.894294597	2.932000437	4.119899001	0.172625012	0.00670374	0.038102053	0.158716047	0.157260981	0.223431868	2.942478334	2.958916785
CO2 Emissions from Lime Production	CO2	153.4398697	151.5300882	2.136704089	2.157586887	3.036558173	0.016089649	0.00038154	0.004818326	0.017337017	0.017426012	0.024581254	2.917939621	2.879485599
CO2 Emissions from Limestone and Dolomite Use	CO2	51.4905	36.75847112	7.5	30	30.92329219	0.039747448	-0.00032002	0.001168839	0.049589646	0.012397412	0.051115838	7.5	30
CO2 Emissions from Soda Ash Production and Use	CO2	25.73996	19.9453	7.5	30	30.92329219	0.021567132	-0.00011006	0.000634217	0.026907549	0.006726887	0.027735667	7.5	30
CO2 Emissions from Iron and Steel Production	CO2	21.44681309	27.27	7.5	30	30.92329219	0.029487432	0.00024698	0.000867126	0.036789062	0.009197265	0.037921297	7.5	30
CO2 Emissions from Ammonia Production	CO2	466.0087331	501.3281562	3.001488525	5.004134535	5.835263132	0.10229364	0.00246597	0.015941141	0.11278089	0.067656533	0.131517815	3.000640354	5.001187693
CO2 Emissions from Ferroalloys Production	CO2	118.836		7.5	30	30.92329219		-0.00343606					7.13003663	28.29008781
Aluminium Production	CO2	111.372		3	30	30.14962686		-0.00322025					3.00096993	30.00627638
Emissions from Waste Incineration	CO2	0.043223273	0.09899945	50	30	58.30951895	0.000201854	1.8982E-06	3.14797E-06	5.69445E-05	0.000222595	0.000229763	50	30
Total Solvent and Other Product Use	CO2	82.41669965	119.6457318	31.25861885	43.5970421	53.64516132	0.224436691	0.00142133	0.003804473	0.226194584	0.193851915	0.297896886	40.23899066	40.42503399
Other non-specified NEU	CO2			5	50	50.24937811							5	50
	CO2 Total	23093.3145	21179.15913											
Fuel Combustion - Stationary Sources	CH4	168.6405735	104.2430964	5	50	50.24937811	0.183165673	-0.00156152	0.003314703	0.234384897	0.02343849	0.235553907	5	50
Mobile Combustion - Road Vehicles	CH4	34.11705025	14.20344183	2.090589413	40	40.05459479	0.019893538	-0.00053486	0.000451638	0.025548529	0.002447637	0.025665508	5	40
Mobile Combustion: Water-borne Navigation	CH4	0.190057455	0.16450224	5	40	40.31128874	0.000231881	-2.6477E-07	5.23081E-06	0.000295899	3.69874E-05	0.000298202	5	40
Mobile Combustion: Aircraft	CH4	0.022951197	0.012039541	5	40	40.31128874	1.69708E-05	-2.8081E-07	3.82831E-07	2.16562E-05	2.70702E-06	2.18247E-05	5	40
Mobile Combustion: Railways	CH4	0.213595515	0.15337161	5	40	40.31128874	0.000216191	-1.2993E-06	4.87688E-06	0.000275878	3.44848E-05	0.000278025	5	40
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.29868284	1.078726635	5	40	40.31128874	0.001520562	-3.2507E-06	3.43012E-05	0.001940366	0.000242546	0.001955467	5	40
Fugitive Emissions from Coal Mining and Handling	CH4	48.75698205		5	250	250.049995		-0.0014098					5	250
Fugitive Emissions from Oil and Gas Operations	CH4	1201.179639	1526.2651	5	300	300.0416638	16.01318163	0.01379409	0.0485319	20.5903413	0.343172355	20.59320087	5	300
Production of Chemicals	CH4	15.7980942	0.840042	7.501429833	30.01016315	30.9334987	0.000908649	-0.00043009	2.67115E-05	0.000938216	0.000253519	0.000971865	5.814462967	18.25072075
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.91959	808.1777737	5.853596164	12.76473034	14.04289602	0.396853006	-0.01020823	0.02569829	0.492223697	0.203422108	0.532601842	5.328700276	14.28059418
CH4 Emissions from Manure Management	CH4	228.623136	167.1725107	8.061214158	14.96639447	16.99929813	0.099371523	-0.0012949	0.005315721	0.114363724	0.062128249	0.130149839	8.46273117	15.45541201
Solid Waste Disposal Sites	CH4	242.6230166	757.7820382	41.70492001	47.59525467	63.28197706	1.676835413	0.01707897	0.024095815	1.489766164	1.302446411	1.978830432	34.38612208	39.46187834
Emissions from Waste Water Handling	CH4	278.7322216	209.8233974	49.33584897	29.4854434	57.47536312	0.421698183	-0.00138759	0.006671926	-0.040913774	0.465648272	0.467442242	49.3651936	39.24439824
	CH4 Total	3462.11559	3589.91604											

Table A5.2-1: Tier 1 Uncertainty Calculation and Reporting – excluding LULUCF (Table 6.1 – IPCC Good Practice Guidance) (cont.)

A	B	C	D	E	F	G	H	I	J	K	L	M	O	P
IPCC Source Category	Greenhouse Gas	Base year emissions 1990	Year t emissions 2010	Activity data uncertainty 2010	Emission factor uncertainty 2010	Combined uncertainty 2010	Combined uncertainty as % of total emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Activity data uncertainty 1990	Emission factor uncertainty 1990
		Gg CO2 ekvivalent	Gg CO2 ekvivalent							I*F or Note C	J*SQRT(E²+O²) or Note D			
Fuel Combustion - Stationary Sources	N2O	62.36534997	46.0037484	5	200	200.0624902	0.321828856	-0.00034049	0.001462819	0.413747643	0.010343691	0.413876919	5	200
Mobile Combustion - Road Vehicles	N2O	40.24668859	60.36169213	2.090589413	200	200.0109261	0.422164021	0.00075561	0.00191937	0.542879846	0.010401953	0.542979491	5	200
Mobile Combustion: Water-borne Navigation	N2O	0.336673206	0.291403968	5	200	200.0624902	0.002038577	-4.6902E-07	9.26601E-06	0.002620823	6.55206E-05	0.002621642	5	200
Mobile Combustion: Aircraft	N2O	1.355213564	0.710906251	5	200	200.0624902	0.004973294	-1.6581E-05	2.26053E-05	0.006393735	0.000159843	0.006395733	5	200
Mobile Combustion: Railways	N2O	0.391653938	0.60374856	5	200	200.0624902	0.004223649	7.8731E-06	1.91979E-05	0.005429982	0.00013575	0.005431679	5	200
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.03845243	1.737453528	5	200	200.0624902	0.01215472	-3.6953E-06	5.52472E-05	0.015626277	0.000390657	0.015631159	5	200
Nitric Acid Production	N2O	803.885862	815.3	3.001880061	30.00926407	30.15903205	0.859806913	0.00267943	0.025924761	0.080407723	0.110057197	0.136301095	3.001815794	30.00926407
Total Solvent and Other Product Use	N2O	34.72	31.06665	50	50	70.71067812	0.076814909	-1.6089E-05	0.000987852	0.069851662	0.069851662	0.098785168	50	50
N2O Emissions from Manure Management	N2O	381.8439137	203.531586	5.717565459	35.12262098	35.58495552	0.253258678	-0.00456874	0.00647186	-0.160466044	0.053533313	0.169160181	5.977502188	33.08984317
Direct N2O Emissions from Agricultural Soils	N2O	1333.134496	1165.251293	15.94600089	46.07878566	48.75991624	1.986774768	-0.00149498	0.037052449	-0.068886706	1.047527439	1.049790033	23.34526621	45.08453458
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.1304071	174.8372658	8.282750364	35.32261292	36.28072405	0.221807406	-0.00199107	0.005559444	-0.07032979	0.066398632	0.096721547	8.604692672	31.94706167
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.0662738	746.1158482	37.70025385	156.599485	161.07361	4.202393814	-0.00328303	0.023724856	-0.514120497	1.28644037	1.385369521	38.97254028	145.395093
Emissions from Waste Water Handling	N2O	90.23517838	102.9266762	10	30	31.6227766	0.113813568	0.00066364	0.003272844	0.01990927	0.046285	0.050385318	10	30
	N2O Total	3945.750163	3348.738272											
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.95424235	480.07112	25.3283895	29.21231254	38.66376234	0.649046458	0.01494842	0.015265214	0.639202329	0.543263066	0.838876854	25	30
PFC Emissions from Aluminium production	PFC	936.564272		3	27	27.16615541		-0.02707303					2.115822133	26.57099686
	HFC/PFC/SF6 Total	947.5185144	480.07112											
Total GHG Emissions	CO2-eq	31448.69877	28597.88456											
Total Uncertainties (Level/Trend)							**16.84203249**					**20.84293206**		

Note C **K=J*** $\sqrt{\text{uncertainty(emission factor, base year)}^2 + \text{uncertainty(emission factor, year t)}^2} = \sqrt{F^2 + P^2}$

Note D **L=I*E**

Table A5.2-2: Tier 1 Uncertainty Calculation and Reporting – including LULUCF (Table 6.1 – IPCC Good Practice Guidance)

A	B	C	D	E	F	G	H	I	J	K	L	M	O	P
IPCC Source Category	Greenhouse Gas	Base year emissions 1990	Year t emissions 2010	Activity data uncertainty 2010	Emission factor uncertainty 2010	Combined uncertainty 2010	Combined uncertainty as % of total emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Activity data uncertainty 1990	Emission factor uncertainty 1990
		Gg CO2 ekvivalent	Gg CO2 ekvivalent							I*F or Note C	J*SQRT(E²+O²) or Note D			
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447145	2696.202773	1.24862734	1.802654151	2.192859371	0.297041264	0.017954705	0.109862868	0.417233836	0.237275717	0.479983167	1.762221823	3.342677104
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.043518	3891.112143	1.4665626	2.406383956	2.818064869	0.550906866	-0.121835107	0.158552148	0.542867911	0.346569876	0.644062301	1.620832352	2.435664137
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539387	5375.516537	1.781223623	2.085502748	2.742640937	0.740700449	0.071562371	0.219037556	0.698926683	0.538880303	0.882547727	1.697032334	2.415059776
Mobile Combustion - Road Vehicles	CO2	3559.716481	5673.398126	2.090589413	1.628666724	2.650116864	0.755373488	0.113369968	0.231175413	0.621844767	0.708564131	0.942737526	2.241420433	2.140828546
Mobile Combustion: Water-borne Navigation	CO2	132.9799557	115.1415657	5	5	7.071067812	0.040904453	0.000296984	0.004691703	0.03317535	0.03317535	0.04691703	5	5
Mobile Combustion: Domestic Aviation	CO2	154.7238583	81.10413105	2.922121316	2.939742246	4.144982203	0.01688959	-0.001808407	0.003304771	0.013880803	0.01384423	0.019604576	3.001717764	2.999976879
Mobile Combustion: Railways	CO2	138.1421391	89.25497361	5	5	7.071067812	0.031708148	-0.000928354	0.003636895	0.025716734	0.025716734	0.036368954	5	5
Combustion - Agriculture/Forestry/Fishing	CO2	839.1893711	715.3307369	2.577602521	1.770936273	3.12733913	0.112391979	0.001413871	0.029147766	0.072523401	0.105482598	0.12800868	2.540145699	1.747733
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	487.261397	10	3	10.44030651	0.255581083	0.006107307	0.019854566	0.084235788	0.280785959	0.293149147	10	3
CO2 Emissions from Cement Production	CO2	1085.789849	1198.26	2.894294597	2.932000437	4.119899001	0.248022501	0.012937056	0.048825809	0.203386396	0.201521804	0.286316369	2.942478334	2.958916785
CO2 Emissions from Lime Production	CO2	153.4398697	151.5300882	2.136704089	2.157586887	3.036558173	0.023117131	0.001103508	0.006174436	0.022216489	0.022330532	0.031499604	2.917939621	2.879485599
CO2 Emissions from Limestone and Dolomite Use	CO2	51.4905	36.75847112	7.5	30	30.92329219	0.057107956	-0.00020384	0.001497807	0.063546564	0.015886641	0.065502299	7.5	30
CO2 Emissions from Soda Ash Production and Use	CO2	25.73996	19.9453	7.5	30	30.92329219	0.030987015	-3.79339E-05	0.000812716	0.034480631	0.008620158	0.035541821	7.5	30
CO2 Emissions from Iron and Steel Production	CO2	21.44681309	27.27	7.5	30	30.92329219	0.042366668	0.000402403	0.001111178	0.047143278	0.011785819	0.048594178	7.5	30
CO2 Emissions from Ammonia Production	CO2	466.0087331	501.3281562	3.001488525	5.004134535	5.835263132	0.14697247	0.005026203	0.020427747	0.144522871	0.086698344	0.16853327	3.000640354	5.001187693
CO2 Emissions from Ferroalloys Production	CO2	118.836		7.5	30	30.92329219		-0.003927085					7.13003663	28.29008781
Aluminium Production	CO2	111.372		3	30	30.14962686		-0.003680439					3.00096993	30.00627638
Forest land remaining forest land	CO2	-7059.3	-8758.5	16.6	2	16.72004785	-7.357337891	-0.12394664	-0.356884853	-0.24789328	-5.924288568	5.929472668	19	2
Land converted to Forest land	CO2	-0.22670835	-3.71888165	50	2	50.03998401	-0.009349383	-0.000144042	-0.000151534	-0.000288084	-0.007576711	0.007582186	50	2
Land converted to Settlements	CO2	137	67	40	2	40.04996879	0.134812585	-0.00179739	0.002730066	-0.00359478	0.10920265	0.109261801	40	2
Emissions from Waste Incineration	CO2	0.043223273	0.09899945	50	30	58.30951895	0.000290018	2.60552E-06	4.03396E-06	0.000171146	0.000285244	0.000332649	50	30
Total Solvent and Other Product Use	CO2	82.41669965	119.6457318	31.25861885	43.5970421	53.64516132	0.322463986	0.002151468	0.004875235	0.289856648	0.248411191	0.381739435	40.23899066	40.42503399
Other non-specified NEU	CO2			5	50	50.24937811							5	50
	CO2 Total	16170.78779	12483.94025											
Fuel Combustion - Stationary Sources	CH4	168.6405735	104.2430964	5	50	50.24937811	0.26316701	-0.001325498	0.00424762	0.30035211	0.030035211	0.301850135	5	50
Mobile Combustion - Road Vehicles	CH4	34.11705025	14.20344183	2.090589413	40	40.05459479	0.028582446	-0.000548736	0.000578751	0.032739117	0.00313652	0.032889019	5	40
Mobile Combustion: Water-borne Navigation	CH4	0.190057455	0.16450224	5	40	40.31128874	0.000333159	4.22023E-07	6.70302E-06	0.00037918	4.73975E-05	0.000382131	5	40
Mobile Combustion: Aircraft	CH4	0.022951197	0.012039541	5	40	40.31128874	2.43832E-05	-2.6791E-07	4.90578E-07	2.77513E-05	3.46891E-06	2.79673E-05	5	40
Mobile Combustion: Railways	CH4	0.213595515	0.15337161	5	40	40.31128874	0.000310617	-8.09402E-07	6.24947E-06	0.000353524	4.41904E-05	0.000356275	5	40
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.29868284	1.078726635	5	40	40.31128874	0.002184699	1.03647E-06	4.39552E-05	0.002486479	0.00031081	0.002505829	5	40
Fugitive Emissions from Coal Mining and Handling	CH4	48.75698205		5	250	250.049995		-0.001611282					5	250
Fugitive Emissions from Oil and Gas Operations	CH4	1201.179639	1526.2651	5	300	300.0416638	23.00726475	0.022483698	0.062191117	26.38545625	0.439757604	26.38912064	5	300
Production of Other Chemicals	CH4	15.7980942	0.840042	7.501429833	30.01016315	30.9334987	0.00130552	-0.000487861	3.42294E-05	-0.014640777	0.000324872	0.014644381	5.814462967	18.25072075
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.91959	808.1777737	5.853596164	12.76473034	14.04289602	0.570186636	-0.008107651	0.032931028	0.630759181	0.260674899	0.682501683	5.328700276	14.28059418
CH4 Emissions from Manure Management	CH4	228.623136	167.1725107	8.061214158	14.96639447	16.99929813	0.142774059	-0.000743614	0.006811821	0.14655119	0.079614134	0.16678028	8.46273117	15.45541201
Forest land remaining forest land	CH4	12.49851028	1.31667228	60		60	0.003969012	-0.000359396	5.36508E-05		0.003219047	0.003219047	60	
Solid Waste Disposal Sites	CH4	242.6230166	757.7820382	41.70492001	47.59525467	63.28197706	2.409227421	0.022857109	0.03087754	1.909058202	1.669017638	2.535768739	34.38612208	39.46187834
Emissions from Waste Water Handling	CH4	278.7322216	209.8233974	49.33584897	29.4854434	57.47536312	0.60588345	-0.0006617	0.008549728	-0.019510509	0.59670415	0.597023034	49.3651936	39.24439824
	CH4 Total	3474.614101	3591.232712											

Table A5.2-2: Tier 1 Uncertainty Calculation and Reporting – including LULUCF (Table 6.1 – IPCC Good Practice Guidance) (cont)

A	B	C	D	E	F	G	H	I	J	K	L	M	O	P
IPCC Source Category	Greenhouse Gas	Base year emissions 1990	Year t emissions 2010	Activity data uncertainty 2010	Emission factor uncertainty 2010	Combined uncertainty 2010	Combined uncertainty as % of total emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Activity data uncertainty 1990	Emission factor uncertainty 1990
		Gg CO2 ekvivalent	Gg CO2 ekvivalent							I*F or Note C	J*SQRT(E²+O²) or Note D			
Fuel Combustion - Stationary Sources	N2O	62.36534997	46.0037484	5	200	200.0624902	0.462394161	-0.00018651	0.001874527	0.530196181	0.013254905	0.530361841	5	200
Mobile Combustion - Road Vehicles	N2O	40.24668859	60.36169213	2.090589413	200	200.0109261	0.606552753	0.001129488	0.002459573	0.695672413	0.013329564	0.695800103	5	200
Mobile Combustion: Water-borne Navigation	N2O	0.336673206	0.291403968	5	200	200.0624902	0.002928968	7.47584E-07	1.18739E-05	0.00335845	8.39612E-05	0.003359499	5	200
Mobile Combustion: Aircraft	N2O	1.355213564	0.710906251	5	200	200.0624902	0.007145481	-1.58194E-05	2.89675E-05	0.008193241	0.000204831	0.008195801	5	200
Mobile Combustion: Railways	N2O	0.391653938	0.60374856	5	200	200.0624902	0.006068414	1.16578E-05	2.46011E-05	0.006958241	0.000173956	0.006960415	5	200
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.03845243	1.737453528	5	200	200.0624902	0.017463541	3.42998E-06	7.07965E-05	0.020024264	0.000500607	0.020030521	5	200
Nitric Acid Production	N2O	803.885862	815.3	3.001880061	30.00926407	30.15903205	1.235345088	0.006652354	0.033221239	0.199632255	0.141032599	0.244424285	3.001815794	30.00926407
Total Solvent and Other Product Use	N2O	34.72	31.06665	50	50	70.71067812	0.110365384	0.000118457	0.001265881	0.089511289	0.089511289	0.126588078	50	50
N2O Emissions from Manure Management	N2O	381.8439137	203.531586	5.717565459	35.12262098	35.58495552	0.363874562	-0.004325096	0.008293354	-0.151908725	0.068600169	0.166680064	5.977502188	33.08984317
Direct N2O Emissions from Agricultural Soils	N2O	1333.134496	1165.251293	15.94600089	46.07878566	48.75991624	2.8545391	0.003421696	0.047480794	0.157667615	1.342352174	1.351579977	23.34526621	45.08453458
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.1304071	174.8372658	8.282750364	35.32261292	36.28072405	0.318686307	-0.001505501	0.007124139	-0.05317824	0.085086408	0.100337541	8.604692672	31.94706167
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.0662738	746.1158482	37.70025385	156.599485	161.07361	6.037874877	-0.000466537	0.030402174	6.49662044	1.648506725	6.70251084	38.97254028	145.395093
Forest land remaining forest land	N2O	2.858478876	0.30113028	45	30	54.08326913	0.000818221	-8.21963E-05	1.22702E-05	-0.002465888	0.00055216	0.002526952	45	30
Emissions from Waste Water Handling	N2O	90.23517838	102.9266762	10	30	31.6227766	0.163523962	0.001211856	0.00419398	0.177935492	0.059311831	0.187560477	10	30
	N2O Total	3948.608642	3349.039403											
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.95424235	480.07112	25.3283895	29.21231254	38.66376234	0.932530714	0.019199482	0.019561581	0.819104688	0.69616349	1.074977253	25	30
PFC Emissions from Aluminium production	PFC	936.564272		3	27	27.16615541		-0.030939636					2.115822133	26.57099686
	HFC/PFC/SF6 Total	947.5185144	480.07112											
Total GHG Emissions	CO2-eq	24541.52905	19904.28348											
Total Uncertainties (Level/Trend)							**25.1774929**					**28.11415582**		

Note C **K=J*** $\sqrt{uncertainty\,(emission\,factor,\,base\,year)^2 + uncertainty\,(emission\,factor,\,year\,t)^2} = \sqrt{F^2 + P^2}$

Note D **L=I*E**

A.5.3 COMPARISON OF UNCERTAINTIES FROM THE ERROR PROPAGATION AND MONTE CARLO ANALYSES

Where the conditions for applicability are met (relatively low uncertainty, no correlation between sources except those dealt with explicitly by Approach 1, symmetrical distributions), Approach 1 and Approach 2 will give identical results.

Comparing the results of the error propagation approach, and the Monte Carlo estimation of uncertainty by simulation, is a useful quality control check on the behaviour of the Monte Carlo model.

The reason that the error propagation approach is used as a reference is because the mathematical approach to the error propagation approach has been defined and revised in the 2000 GPG and the 2006 Guidelines.

The implementation of uncertainty estimation by simulation cannot be prescriptive, and will depend on the Monte Carlo software a country chooses to use, how the country constructs its model, and the correlations included within that model.
Therefore, there is a greater possibility of errors being introduced in the model used to estimate uncertainty by simulation.
If all the distributions in the Monte Carlo model were normal, and there were no correlations between sources, the estimated errors on the trend from the Monte Carlo model should be identical to those estimated by the error propagation approach.
In reality there will be correlations between sources, and some distributions are not normal and are heavily skewed.The error propagation approach does not account for the correlations, and so we might expect the trend uncertainty estimated by this method to be greater than obtained value.
The assumption of equivalence between the two methods relies on the fact that the distributions of individual uncertainties in the activity data and emissions factors in the two approaches are both normal. However, there are a number of lognormal and triangle distributions in the Monte Carlo model and the effects of these can not be fully reproduced in the error propagation model. These log-normal and triangle distributions will have the effect of increasing the uncertainty on the trend as the distributions are more skewed.

In Monte Carlo model used in this inventory, we were concentrated on uncertainties of key source categories that contribute 98% (97.77%) to total emissions.
Only the key sources were considered because for them we had enough data to set model mathematically correct.
Model is set up so that each sector is divided in its category, and each category is divided into subcategories. Accordingly, uncertainty would not be underestimated.

But, for some subcategories, uncertainty has been estimated on the basis of expert judgement or default uncertainty from the 2000 GPG has been used.
It is not expected that the central estimates from the two methods will be identical, which could be mathematically explained.
For some variables that could only assume negative values, in the Monte Carlo model for the definition of distribution of input parameters risk truncate function was used which resulted in slight change in mean value. The same slight change in mean value cause alse log-normally distributed variables.

Total uncertainty for all key sources is **approximately equal (+/-17%)** for error propagation approach and approach 2 (Monte Carlo) for year 2010 (excluding LULUCF).
Total uncertainty for all key sources is **approximately equal (+/-26%)** for error propagation approach and approach 2 (Monte Carlo) for year 2010 (Including LULUCF).

Trend uncertainty (variability) using Monte Carlo simulation model is lower (+/- 1%) than trend uncertainty using error propagation error.

One of the reasons for that is because error propagation model deals with variables that have normal distributions, which implies symmetrical uncertainties for activity data and emission factor.

In Monte Carlo model some variables have log-normal or triangle distribution, which means that their value can vary plus infinite.

Because of asymmetry of some input variables, it should not be expected for the final result (trend) to vary symmetrically. Also the uncertainty of input data for the year 1990 is not equal to the uncertainty for the year 2010, which also affects the changes in the variability of the trend.

Key category Indirect N2O Emissions from Nitrogen Used in Agriculture has created problems in defining the distribution functions which resulted in lower summary emission.

It was due to the large asymmetry of variability of input values that are included in the calculation of emission of this source category.

We should point out also categories CO2 Emissions from Ferroalloys Production, CO2 Emissions from Aluminium Production and PFC Emissions from Aluminium production and few subcategories which emission was zero in year 2010, but in year 1990 they had emission which varied in accordance with the uncertainty of input parameters.

ANNEX 6

ARCHIVING

INVENTORY DATA RECORD SHEET, UNFCCC SEF APPLICATION

Table A6-1: An example of Inventory Data Record Sheet for 2010 in Waste

INVENTORY DATA RECORD SHEET

Year: 2010

MODULE: WASTE	
SUBMODULE: METHANE EMISSIONS FROM SOLID WASTE DISPOSAL SITES	
WORKSHEET: 6-1	**SHEET**: 1 OF 1 CH_4 EMISSIONS
STEP: 1 TO 4	**PAGE**: 1 of 2
DIRECT DATA SOURCE: **A. ACTIVITY DATA:** *Cadastre of Waste - Municipal Solid Waste, Report 2010,* Croatian Environmental Agency. Assessment of inappropriate activity data on quantities of MSW disposed to different types of SWDs - *Guidelines Development for starting implementation of Waste Management Plan in the Republic of Croatia,* EKONERG Ltd. Quantities of MSW disposed to SWDSs: Managed: 1,289.06 Gg Unmamaged – deep: 213.51 Gg Unmanaged – shallow: 80.23 Gg Country-specific methane correction factor (MCF): 0.882 Country-specific fraction of degradable organic carbon (DOC): 0.16 Recovered methane: 2.47 Gg **B. METHODOLOGY/EMISSION FACTOR:** Publications: IPCC/UNEP/OECD/IEA (1997), *Greenhouse Gas Inventory Workbook*, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2. IPCC/UNEP/OECD/IEA (1997), *Greenhouse Gas Inventory Reference Manual*, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3. IPCC (2000), *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* Methodology: First Order Decay method (Tier 2) Methane generation rate constant k=0.05 Fraction of DOC which really degrades: 0.55 (0.5-0.6) Fraction of carbon released as methane: 0.5	
ORIGINAL DATA SOURCE: **A. ACTIVITY DATA:** Ministry of Environmental and Nature Protection (2006) *Guidelines Development for starting implementation of Waste Management Plan in the Republic of Croatia,* EKONERG Ltd., Zagreb Ministry of Environmental and Nature Protection (2007) *Waste Management Plan in the Republic of Croatia (2007-2015),* Zagreb	
METHOD: bottom-up (see publications in original data source)	
ADDITIONAL INTERCALCULATION: Evaluation and compiling of data coming from original data source and adjusting to recommended Intergovernmental Panel on Climate Change (IPCC) methodology.	

MODULE: WASTE	
SUBMODULE: METHANE EMISSIONS FROM SOLID WASTE DISPOSAL SITES	
WORKSHEET: 6-1	**SHEET**: 1 OF 1 CH_4 EMISSIONS
STEP: 1 TO 4	**PAGE**: 2 of 2

DATA ARCHIVATION:

Publications:

Fundurulja, D., Mužinić, M. (2000) *Estimation of the Quantities of Municipal Solid Waste in the Republic of Croatia in the period 1990 – 1998 and 1998 – 2010.*

Potočnik, V. (2000), Report: The basis for methane emission estimation in Croatia 1990-1998, B. Data on Municipal Solid Waste in Croatia 1990-1998

Schaller, A. (2000), Republic of Croatia: First National Communication, Waste Management Review – Waste Disposal Sites.

DATA GAPS:

Quantites on MSW were in most cases gained by test weighing in order to estimate average volumes of waste delivered by vehicles and density of MSW.

SUGGESTION FOR THE FUTURE:

- Equipping the major landfills with automatic weigh-bridges in order to accurately estimate the quantities of delivered MSW
- Providing methodology to determine country-specific MSW composition
- Periodic analysis of waste composition at major landfills according to provided methodology
- Modification of Environmental Pollution Register (ROO) Reporting Forms regarding to MSW with additional information on waste quantities and composition
- Adjustment of country-specific to IPCC SWDSs classification, in order to accurately MCF estimation.

NOTES:

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RESPONSIBILITY:

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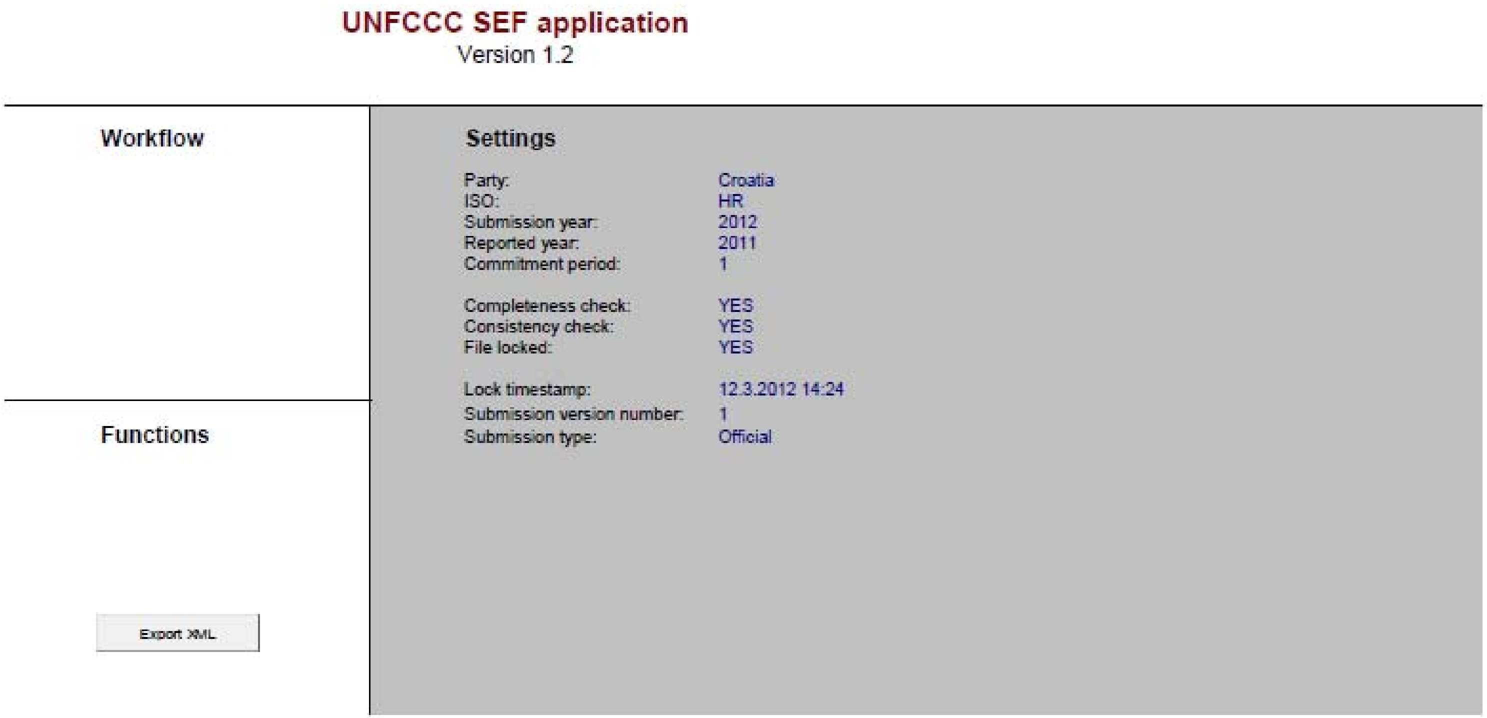
UNFCCC SEF application
Version 1.2
Workflow
Functions
Export XML
Settings
Party: Croatia
ISO: HR
Submission year: 2012
Reported year: 2011
Commitment period: 1
Completeness check: YES
Consistency check: YES
File locked: YES
Lock timestamp: 12.3.2012 14:24
Submission version number: 1
Submission type: Official

Party	Croatia
Submission year	2012
Reported year	2011
Commitment period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	NO	NO	NO	NO	NO	NO
Entity holding accounts	NO	NO	NO	NO	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	NO	NO	NO	NO	NO	NO

File: SEF_HR_2012_1_14-24-30 12-3-2012.xls - Printed: 12.3.2012. 14:28:31

Party	Croatia
Submission year	2012
Reported year	2011
Commitment period	1

Table 2 (a). Annual internal transactions

Transaction type	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Article 6 issuance and conversion												
Party-verified projects		NO					NO		NO			
Independently verifed projects		NO					NO		NO			
Article 3.3 and 3.4 issuance or cancellation												
3.3 Afforestation and reforestation			NO				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	NO	NO		
3.4 Forest management			NO				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Article 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							NO	NO	NO	NO	NO	NO
Sub-total		NO	NO				NO	NO	NO	NO	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	NO	NO	NO	NO	NO	NO

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Party	Croatia
Submission year	2012
Reported year	2011
Commitment period	1

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
Sub-total												

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

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Party	Croatia
Submission year	2012
Reported year	2011
Commitment period	1

Table 3. Expiry, cancellation and replacement

Transaction or event type	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

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Party	Croatia
Submission year	2012
Reported year	2011
Commitment period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	NO	NO	NO	NO	NO	NO
Entity holding accounts	NO	NO	NO	NO	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	NO	NO	NO	NO	NO	NO

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Party	Croatia
Submission year	2012
Reported year	2011
Commitment period	1

Table 5 (a). Summary information on additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Issuance pursuant to Article 3.7 and 3.8	NO											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Sub-total	NO	NO		NO			NO	NO	NO	NO		
Annual transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 5 (b). Summary information on replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table 5 (c). Summary information on retirement

	Retirement					
	Unit type					
Year	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO

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Party	Croatia
Submission year	2012
Reported year	2011
Commitment period	1

Table 6 (a). Memo item: Corrective transactions relating to additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 (b). Memo item: Corrective transactions relating to replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 (c). Memo item: Corrective transactions relating to retirement

	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

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ANNEX 7

GHG EMISSION TREND

Table A7-1: GHG emission in Croatia, Base year

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Base year	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20582.79**	**69.13**	**1451.68**	**0.37**	**114.52**	**NO**	**22148.99**	**70.71**
A. Fuel Comb (Sectoral Appr.)	20166.84	9.61	201.74	0.55	114.52	NO	20483.11	65.40
1. Energy Industries	7126.54	0.17	3.61	0.07	13.80	NO	7143.95	22.81
2. Man. Ind. and Constr.	5447.30	0.48	10.08	0.09	17.96	NO	5475.33	17.48
3. Transport	3987.25	1.55	32.56	0.24	50.17	NO	4069.97	12.99
4. Comm./Inst, Resid., Agric.	3605.76	7.40	155.50	0.16	32.59	NO	3793.85	12.11
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	415.95	59.52	1249.94	NO	NO	NO	1665.89	5.32
1. Solid Fuels	NO	NO	48.76	NO	NO	NO	48.76	NO
2. Oil and Natural Gas	415.95	57.20	1201.18	NO	NO	NO	1617.13	5.16
2. Industrial Processes	**2417.36**	**0.78**	**16.45**	**2.59**	**804.08**	**947.58**	**4185.46**	**13.36**
A. Mineral Products	1315.38	NE,NO	NE,NO	NE,NO	NE,NO	NO	1315.38	4.20
B. Chemical Industry	870.99	16.45	16.45	2.59	804.08	NO	1691.52	5.40
C. Metal Production	230.99	NE,NO	NE,NO	NO	NO	936.56	1167.56	3.73
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	11.01	11.01	0.04
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**80.21**	**NO**	**NO**	**NE**	**NE**	**NO**	**80.21**	**0.26**
4. Agriculture	**NO**	**69.42**	**1457.81**	**9.26**	**2870.60**	**NO**	**4328.40**	**13.82**
A. Enteric Fermentation	NO	58.54	1229.36	0.00	0.00	NO	1229.36	3.92
B. Manure Management	NO	10.88	228.44	1.22	378.74	NO	607.18	1.94
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	8.04	2491.86	NO	2491.86	7.96
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NE,NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-4184.93**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-4184.92**	**-13.36**
A. Forest Land	-4184.93	0.00	0.01	0.00	0.00	NO	-4184.92	-13.36
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.09**	**23.81**	**499.94**	**0.25**	**78.69**	**NO**	**578.72**	**1.85**
A. Solid Waste Disp. on Land	NE,NO	10.53	221.21	0.00	0.00	NO	221.21	0.71
B. Waste-water Handling	0.00	13.27	278.73	0.25	78.69	NO	357.42	1.14
C. Waste Incineration	0.09	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.09	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	18895.52	163.14	3425.89	12.48	3867.89	947.58	27136.87	86.64
Total Emissions without LUCF	23080.45	163.14	3425.89	12.48	3867.89	947.58	31321.79	100.0
Share of Gases in Total Em./Rem.	69.63		12.62		14.25		100.00	
Share of Gases in Total Emissions	73.69		10.94		12.35		100.00	
Memo Items:								
International Bunkers	451.83	0.01	0.20	0.01	3.28	NO	455.31	
Aviation	343.29	0.00	0.05	0.01	3.01	NO	346.35	
Marine	108.54	0.01	0.15	0.00	0.27	NO	108.96	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	2,436.76	NO	NO	NO	NO	NO	2436.76	

Table A7-1: GHG emission in Croatia, 1990

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1990	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20976.73**	**69.26**	**1454.42**	**0.34**	**106.73**	**NO**	**22537.88**	**71.62**
A. Fuel Comb (Sectoral Appr.)	20560.78	9.74	204.48	0.51	106.73	NO	20872.00	66.32
1. Energy Industries	7126.54	0.17	3.61	0.06	13.63	NO	7143.78	22.70
2. Man. Ind. and Constr.	5842.92	0.52	10.83	0.09	18.18	NO	5871.93	18.66
3. Transport	3985.56	1.64	34.54	0.20	42.33	NO	4062.44	12.91
4. Comm./Inst, Resid., Agric.	3605.76	7.40	155.50	0.16	32.59	NO	3793.85	12.06
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	415.95	59.52	1249.94	NO	NO	NO	1665.89	5.29
1. Solid Fuels	NO	NO	48.76	NO	NO	NO	48.76	NO
2. Oil and Natural Gas	415.95	57.20	1201.18	NO	NO	NO	1617.13	5.14
2. Industrial Processes	**2034.12**	**1.74**	**36.57**	**2.59**	**803.89**	**947.52**	**3822.10**	**12.15**
A. Mineral Products	1316.46	NE,NO	NE,NO	NE,NO	NE,NO	NO	1316.46	4.18
B. Chemical Industry	466.01	36.57	36.57	2.59	803.89	NO	1306.46	4.15
C. Metal Production	251.65	NE,NO	NE,NO	NO	NO	936.56	1188.22	3.78
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	10.95	10.95	0.03
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**82.42**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**117.14**	**0.37**
4. Agriculture	**NO**	**70.03**	**1470.54**	**9.39**	**2910.18**	**NO**	**4380.72**	**13.92**
A. Enteric Fermentation	NO	59.14	1241.92	0.00	0.00	NO	1241.92	3.95
B. Manure Management	NO	10.89	228.62	1.23	381.84	NO	610.47	1.94
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	8.16	2528.33	NO	2528.33	8.03
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NE,NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6745.76**	**12.50**	**262.47**	**2.87**	**890.92**	**NO**	**-5592.37**	**-17.77**
A. Forest Land	-7146.54	12.50	262.47	2.86	886.13	NO	-5997.94	-19.06
B. Cropland	71.23	NE,NO	NE,NO	4.79	4.79	NO	76.02	NO
C. Grassland	-162.12	NE,NO	NE,NO	NE,NO	NE,NO	NO	-162.12	NO
D. Wetlands	41.55	NE,NO	NE,NO	NE,NO	NE,NO	NO	41.55	NO
E. Settlements	450.11	NE,NO	NE,NO	NE,NO	NE,NO	NO	450.11	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**24.83**	**521.36**	**0.29**	**90.24**	**NO**	**611.63**	**1.94**
A. Solid Waste Disp. on Land	NE,NO	11.55	242.62	0.00	0.00	NO	242.62	0.77
B. Waste-water Handling	0.00	13.27	278.73	0.29	90.24	NO	368.97	1.17
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**16347.55**	**178.35**	**3745.36**	**15.49**	**4801.95**	**947.52**	**25877.09**	**82.23**
Total Emissions without LUCF	**23093.31**	**165.85**	**3745.36**	**15.49**	**4801.95**	**947.52**	**31469.47**	**100.0**
Share of Gases in Total Em./Rem.	**63.17**		**14.47**		**18.56**		**100.00**	
Share of Gases in Total Emissions	**73.38**		**11.90**		**15.26**		**100.00**	
Memo Items:								
International Bunkers	451.83	0.01	0.20	0.01	3.28	NO	455.31	
Aviation	343.29	0.00	0.05	0.01	3.01	NO	346.35	
Marine	108.54	0.01	0.15	0.00	0.27	NO	108.96	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	2,436.76	NO	NO	NO	NO	NO	2436.76	

Table A7-1: GHG emission in Croatia, 1991

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1991	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**15491.81**	**62.14**	**1304.98**	**0.24**	**73.95**	**NO**	**16870.74**	**68.13**
A. Fuel Comb (Sectoral Appr.)	15075.86	6.42	134.79	0.35	73.95	NO	15284.60	61.73
1. Energy Industries	4768.18	0.11	2.27	0.04	9.03	NO	4779.47	19.30
2. Man. Ind. and Constr.	4344.22	0.41	8.58	0.06	13.36	NO	4366.16	17.63
3. Transport	2927.60	1.24	26.05	0.14	29.78	NO	2983.43	12.05
4. Comm./Inst, Resid., Agric.	3035.86	4.66	97.89	0.10	21.77	NO	3155.53	12.74
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	415.95	55.72	1170.19	NO	NO	NO	1586.14	6.41
1. Solid Fuels	NO	NO	43.45	NO	NO	NO	43.45	NO
2. Oil and Natural Gas	415.95	53.65	1126.74	NO	NO	NO	1542.69	6.23
2. Industrial Processes	**1551.14**	**1.13**	**23.76**	**2.28**	**706.05**	**653.27**	**2934.22**	**11.85**
A. Mineral Products	870.63	NE,NO	NE,NO	NE,NO	NE,NO	NO	870.63	3.52
B. Chemical Industry	447.00	23.76	23.76	2.28	706.05	NO	1176.81	4.75
C. Metal Production	233.51	NE,NO	NE,NO	NO	NO	642.44	875.96	3.54
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	10.83	10.83	0.04
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**85.42**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**120.14**	**0.49**
4. Agriculture	**NO**	**64.92**	**1363.31**	**9.23**	**2862.62**	**NO**	**4225.93**	**17.07**
A. Enteric Fermentation	NO	54.23	1138.74	0.00	0.00	NO	1138.74	4.60
B. Manure Management	NO	10.69	224.57	1.15	354.98	NO	579.54	2.34
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	8.09	2507.64	NO	2507.64	10.13
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6650.56**	**12.50**	**262.47**	**2.87**	**890.75**	**NO**	**-5497.34**	**-22.20**
A. Forest Land	-7004.50	12.50	262.47	2.86	886.13	NO	-5855.90	-23.65
B. Cropland	60.04	NE,NO	NE,NO	4.62	4.62	NO	64.66	NO
C. Grassland	-138.91	NE,NO	NE,NO	NE,NO	NE,NO	NO	-138.91	NO
D. Wetlands	42.69	NE,NO	NE,NO	NE,NO	NE,NO	NO	42.69	NO
E. Settlements	390.12	NE,NO	NE,NO	NE,NO	NE,NO	NO	390.12	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**25.03**	**525.58**	**0.27**	**84.27**	**NO**	**609.89**	**2.46**
A. Solid Waste Disp. on Land	NE,NO	12.09	253.95	0.00	0.00	NO	253.95	1.03
B. Waste-water Handling	0.00	12.93	271.63	0.27	84.27	NO	355.90	1.44
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**10477.85**	**165.72**	**3480.10**	**14.90**	**4617.64**	**653.27**	**19263.59**	**77.80**
Total Emissions without LUCF	**17128.41**	**153.22**	**3480.10**	**14.90**	**4617.64**	**653.27**	**24760.92**	**100.0**
Share of Gases in Total Em./Rem.	**54.39**		**18.07**		**23.97**		**100.00**	
Share of Gases in Total Emissions	**69.18**		**14.05**		**18.65**		**100.00**	
Memo Items:								
International Bunkers	139.53	0.01	0.11	0.00	0.77	NO	140.41	
Aviation	68.19	0.00	0.01	0.00	0.60	NO	68.80	
Marine	71.34	0.00	0.10	0.00	0.18	NO	71.61	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,680.37	NO	NO	NO	NO	NO	1680.37	

Table A7-1: GHG emission in Croatia, 1992

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1992	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**14872.26**	**60.92**	**1279.35**	**0.21**	**66.32**	**NO**	**16217.93**	**70.19**
A. Fuel Comb (Sectoral Appr.)	14394.92	5.26	110.41	0.32	66.32	NO	14571.65	63.06
1. Energy Industries	5338.81	0.11	2.35	0.05	9.79	NO	5350.95	23.16
2. Man. Ind. and Constr.	3680.56	0.35	7.39	0.05	10.30	NO	3698.25	16.01
3. Transport	2826.40	1.10	23.17	0.13	27.80	NO	2877.38	12.45
4. Comm./Inst, Resid., Agric.	2549.15	3.69	77.50	0.09	18.43	NO	2645.07	11.45
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	477.33	55.66	1168.94	NO	NO	NO	1646.27	7.12
1. Solid Fuels	NO	NO	33.77	NO	NO	NO	33.77	NO
2. Oil and Natural Gas	477.33	54.06	1135.18	NO	NO	NO	1612.51	6.98
2. Industrial Processes	**1598.95**	**0.86**	**18.12**	**2.98**	**923.19**	**10.92**	**2551.17**	**11.04**
A. Mineral Products	928.74	NE,NO	NE,NO	NE,NO	NE,NO	NO	928.74	4.02
B. Chemical Industry	575.22	18.12	18.12	2.98	923.19	NO	1516.52	6.56
C. Metal Production	94.99	NE,NO	NE,NO	NO	NO	NO	94.99	0.41
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	10.92	10.92	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**68.08**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**102.80**	**0.44**
4. Agriculture	**NO**	**51.17**	**1074.54**	**8.23**	**2551.75**	**NO**	**3626.30**	**15.69**
A. Enteric Fermentation	NO	43.08	904.73	0.00	0.00	NO	904.73	3.92
B. Manure Management	NO	8.09	169.82	0.91	282.53	NO	452.34	1.96
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.32	2269.23	NO	2269.23	9.82
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6782.36**	**2.85**	**59.76**	**0.67**	**206.23**	**NO**	**-6516.37**	**-28.20**
A. Forest Land	-7015.86	2.85	59.76	0.65	201.77	NO	-6754.32	-29.23
B. Cropland	52.93	NE,NO	NE,NO	4.46	4.46	NO	57.39	NO
C. Grassland	-136.92	NE,NO	NE,NO	NE,NO	NE,NO	NO	-136.92	NO
D. Wetlands	45.38	NE,NO	NE,NO	NE,NO	NE,NO	NO	45.38	NO
E. Settlements	272.11	NE,NO	NE,NO	NE,NO	NE,NO	NO	272.11	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**25.23**	**529.77**	**0.25**	**78.34**	**NO**	**608.15**	**2.63**
A. Solid Waste Disp. on Land	NE,NO	12.63	265.23	0.00	0.00	NO	265.23	1.15
B. Waste-water Handling	0.00	12.60	264.54	0.25	78.34	NO	342.87	1.48
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	9756.96	141.03	2961.54	12.34	3825.82	10.92	16589.97	71.80
Total Emissions without LUCF	16539.32	138.18	2961.54	12.34	3825.82	10.92	23106.34	100.0
Share of Gases in Total Em./Rem.	58.81		17.85		23.06		100.00	
Share of Gases in Total Emissions	71.58		12.82		16.56		100.00	
Memo Items:								
International Bunkers	137.25	0.01	0.12	0.00	0.70	NO	138.1	
Aviation	56.62	0.00	0.01	0.00	0.50	NO	57.1	
Marine	80.62	0.01	0.11	0.00	0.20	NO	80.9	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,459.04	NO	NO	NO	NO	NO	1459.0	

Table A7-1: GHG emission in Croatia, 1993

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1993	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**15634.37**	**67.12**	**1409.52**	**0.24**	**74.41**	**NO**	**17118.29**	**73.94**
A. Fuel Comb (Sectoral Appr.)	14958.25	4.99	104.85	0.35	74.41	NO	15137.51	65.39
1. Energy Industries	5918.93	0.14	2.93	0.05	10.07	NO	5931.93	25.62
2. Man. Ind. and Constr.	3515.57	0.34	7.04	0.05	9.82	NO	3532.42	15.26
3. Transport	2992.55	1.09	22.82	0.18	37.12	NO	3052.49	13.19
4. Comm./Inst, Resid., Agric.	2531.21	3.43	72.06	0.08	17.40	NO	2620.67	11.32
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	676.12	62.13	1304.66	NO	NO	NO	1980.78	8.56
1. Solid Fuels	NO	NO	32.31	NO	NO	NO	32.31	NO
2. Oil and Natural Gas	676.12	60.59	1272.35	NO	NO	NO	1948.47	8.42
2. Industrial Processes	**1282.66**	**1.02**	**21.51**	**2.24**	**695.91**	**11.04**	**2011.12**	**8.69**
A. Mineral Products	797.10	NE,NO	NE,NO	NE,NO	NE,NO	NO	797.10	3.44
B. Chemical Industry	446.83	21.51	21.51	2.24	695.91	NO	1164.25	5.03
C. Metal Production	38.74	NE,NO	NE,NO	NO	NO	NO	38.74	0.17
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	11.04	11.04	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**75.32**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**110.04**	**0.48**
4. Agriculture	**NO**	**50.27**	**1055.75**	**7.23**	**2242.72**	**NO**	**3298.47**	**14.25**
A. Enteric Fermentation	NO	41.96	881.07	0.00	0.00	NO	881.07	3.81
B. Manure Management	NO	8.32	174.68	0.89	276.21	NO	450.89	1.95
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.34	1966.50	NO	1966.50	8.49
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6542.18**	**24.20**	**508.12**	**5.55**	**1719.76**	**NO**	**-4314.30**	**-18.64**
A. Forest Land	-6838.80	24.20	508.12	5.53	1715.47	NO	-4615.21	-19.94
B. Cropland	66.76	NE,NO	NE,NO	4.29	4.29	NO	71.06	NO
C. Grassland	-160.87	NE,NO	NE,NO	NE,NO	NE,NO	NO	-160.87	NO
D. Wetlands	48.06	NE,NO	NE,NO	NE,NO	NE,NO	NO	48.06	NO
E. Settlements	342.67	NE,NO	NE,NO	NE,NO	NE,NO	NO	342.67	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**25.46**	**534.59**	**0.25**	**77.64**	**NO**	**612.27**	**2.64**
A. Solid Waste Disp. on Land	NE,NO	13.20	277.15	0.00	0.00	NO	277.15	1.20
B. Waste-water Handling	0.00	12.26	257.44	0.25	77.64	NO	335.08	1.45
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**10450.22**	**168.07**	**3529.49**	**15.52**	**4810.43**	**11.04**	**18835.90**	**81.36**
Total Emissions without LUCF	**16992.40**	**143.87**	**3529.49**	**15.52**	**4810.43**	**11.04**	**23150.19**	**100.0**
Share of Gases in Total Em./Rem.	**55.48**		**18.74**		**25.54**		**100.00**	
Share of Gases in Total Emissions	**73.40**		**15.25**		**20.78**		**100.00**	
Memo Items:								
International Bunkers	253.72	0.01	0.18	0.00	1.50	NO	255.40	
Aviation	139.18	0.00	0.02	0.00	1.22	NO	140.42	
Marine	114.54	0.01	0.16	0.00	0.28	NO	114.98	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,388.13	NO	NO	NO	NO	NO	1388.13	

Table A7-1: GHG emission in Croatia, 1994

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1994	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**14770.75**	**60.75**	**1275.77**	**0.25**	**76.00**	**NO**	**16122.52**	**72.56**
A. Fuel Comb (Sectoral Appr.)	14165.88	5.25	110.27	0.36	76.00	NO	14352.15	64.60
1. Energy Industries	4671.23	0.12	2.48	0.04	7.45	NO	4681.17	21.07
2. Man. Ind. and Constr.	3700.16	0.33	6.88	0.04	9.25	NO	3716.28	16.73
3. Transport	3178.69	1.18	24.80	0.19	40.72	NO	3244.21	14.60
4. Comm./Inst, Resid., Agric.	2615.80	3.62	76.11	0.09	18.58	NO	2710.49	12.20
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	604.87	55.50	1165.50	NO	NO	NO	1770.37	7.97
1. Solid Fuels	NO	NO	28.97	NO	NO	NO	28.97	NO
2. Oil and Natural Gas	604.87	54.12	1136.53	NO	NO	NO	1741.40	7.84
2. Industrial Processes	**1451.31**	**1.16**	**24.32**	**2.43**	**752.57**	**11.16**	**2239.35**	**10.08**
A. Mineral Products	964.11	NE,NO	NE,NO	NE,NO	NE,NO	NO	964.11	4.34
B. Chemical Industry	450.03	24.32	24.32	2.43	752.57	NO	1226.92	5.52
C. Metal Production	37.17	NE,NO	NE,NO	NO	NO	NO	37.17	0.17
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	11.16	11.16	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**76.66**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**111.38**	**0.50**
4. Agriculture	**NO**	**46.29**	**972.03**	**7.25**	**2247.09**	**NO**	**3219.12**	**14.49**
A. Enteric Fermentation	NO	37.94	796.64	0.00	0.00	NO	796.64	3.59
B. Manure Management	NO	8.35	175.38	0.83	257.44	NO	432.82	1.95
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.42	1989.65	NO	1989.65	8.95
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6691.96**	**10.99**	**230.81**	**2.53**	**783.37**	**NO**	**-5677.78**	**-25.55**
A. Forest Land	-7000.97	10.99	230.81	2.51	779.25	NO	-5990.92	-26.96
B. Cropland	71.70	NE,NO	NE,NO	4.13	4.13	NO	75.83	NO
C. Grassland	-164.38	NE,NO	NE,NO	NE,NO	NE,NO	NO	-164.38	NO
D. Wetlands	50.75	NE,NO	NE,NO	NE,NO	NE,NO	NO	50.75	NO
E. Settlements	350.95	NE,NO	NE,NO	NE,NO	NE,NO	NO	350.95	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**21.26**	**446.56**	**0.26**	**79.49**	**NO**	**526.09**	**2.37**
A. Solid Waste Disp. on Land	NE,NO	13.82	290.13	0.00	0.00	NO	290.13	1.31
B. Waste-water Handling	0.00	7.45	156.42	0.26	79.49	NO	235.91	1.06
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**9606.79**	**140.45**	**2949.48**	**12.70**	**3938.52**	**11.16**	**16540.67**	**74.45**
Total Emissions without LUCF	**16298.75**	**129.46**	**2949.48**	**12.70**	**3938.52**	**11.16**	**22218.45**	**100.0**
Share of Gases in Total Em./Rem.	**58.08**		**17.83**		**23.81**		**100.00**	
Share of Gases in Total Emissions	**73.36**		**13.27**		**17.73**		**100.00**	
Memo Items:								
International Bunkers	326.50	0.01	0.22	0.01	1.99	NO	328.71	
Aviation	188.18	0.00	0.03	0.01	1.65	NO	189.85	
Marine	138.33	0.01	0.19	0.00	0.34	NO	138.86	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,403.18	NO	NO	NO	NO	NO	1403.18	

Table A7-1: GHG emission in Croatia, 1995

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1995	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**15744.06**	**61.21**	**1285.48**	**0.23**	**72.40**	**NO**	**17101.95**	**74.23**
A. Fuel Comb (Sectoral Appr.)	15004.80	5.41	113.56	0.34	72.40	NO	15190.76	65.93
1. Energy Industries	5262.45	0.14	2.93	0.05	9.58	NO	5274.96	22.90
2. Man. Ind. and Constr.	3540.91	0.32	6.71	0.04	9.13	NO	3556.75	15.44
3. Transport	3375.88	1.23	25.92	0.16	34.61	NO	3436.42	14.92
4. Comm./Inst, Resid., Agric.	2825.55	3.71	78.00	0.09	19.09	NO	2922.64	12.69
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	739.27	55.81	1171.92	NO	NO	NO	1911.19	8.30
1. Solid Fuels	NO	NO	23.07	NO	NO	NO	23.07	NO
2. Oil and Natural Gas	739.27	54.71	1148.84	NO	NO	NO	1888.11	8.20
2. Industrial Processes	**1218.13**	**1.28**	**26.78**	**2.33**	**723.70**	**61.02**	**2029.63**	**8.81**
A. Mineral Products	743.24	NE,NO	NE,NO	NE,NO	NE,NO	NO	743.24	3.23
B. Chemical Industry	438.77	26.78	26.78	2.33	723.70	NO	1189.25	5.16
C. Metal Production	36.12	NE,NO	NE,NO	NO	NO	NO	36.12	0.16
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	61.02	61.02	0.26
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**74.59**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**109.31**	**0.47**
4. Agriculture	**NO**	**43.70**	**917.65**	**6.89**	**2137.18**	**NO**	**3054.84**	**13.26**
A. Enteric Fermentation	NO	36.20	760.22	0.00	0.00	NO	760.22	3.30
B. Manure Management	NO	7.50	157.43	0.78	241.97	NO	399.41	1.73
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.11	1895.21	NO	1895.21	8.23
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6839.70**	**1.87**	**39.24**	**0.44**	**136.45**	**NO**	**-6664.01**	**-28.92**
A. Forest Land	-7022.88	1.87	39.24	0.43	132.49	NO	-6851.14	-29.74
B. Cropland	85.32	NE,NO	NE,NO	3.96	3.96	NO	89.28	NO
C. Grassland	-188.72	NE,NO	NE,NO	NE,NO	NE,NO	NO	-188.72	NO
D. Wetlands	53.43	NE,NO	NE,NO	NE,NO	NE,NO	NO	53.43	NO
E. Settlements	233.15	NE,NO	NE,NO	NE,NO	NE,NO	NO	233.15	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**31.33**	**657.95**	**0.28**	**85.67**	**NO**	**743.67**	**3.23**
A. Solid Waste Disp. on Land	NE,NO	14.54	305.26	0.00	0.00	NO	305.26	1.32
B. Waste-water Handling	0.00	16.80	352.70	0.28	85.67	NO	438.37	1.90
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**10197.12**	**139.39**	**2927.11**	**10.18**	**3155.41**	**61.02**	**16375.39**	**71.08**
Total Emissions without LUCF	**17036.82**	**137.52**	**2927.11**	**10.18**	**3155.41**	**61.02**	**23039.39**	**100.0**
Share of Gases in Total Em./Rem.	**62.27**		**17.88**		**19.27**		**100.00**	
Share of Gases in Total Emissions	**73.95**		**12.70**		**13.70**		**100.00**	
Memo Items:								
International Bunkers	288.76	0.01	0.17	0.01	1.89	NO	290.82	
Aviation	186.75	0.00	0.03	0.01	1.64	NO	188.42	
Marine	102.01	0.01	0.14	0.00	0.25	NO	102.40	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,452.60	NO	NO	NO	NO	NO	1452.60	

Table A7-1: GHG emission in Croatia, 1996

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1996	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**16207.05**	**61.86**	**1299.04**	**0.34**	**104.39**	**NO**	**17610.5**	**74.63**
A. Fuel Comb (Sectoral Appr.)	15490.65	6.32	132.74	0.50	104.39	NO	15727.8	66.65
1. Energy Industries	5110.49	0.13	2.80	0.04	8.83	NO	5122.1	21.71
2. Man. Ind. and Constr.	3507.98	0.31	6.58	0.04	9.06	NO	3523.6	14.93
3. Transport	3643.13	1.33	27.94	0.30	63.48	NO	3734.6	15.83
4. Comm./Inst, Resid., Agric.	3229.05	4.54	95.42	0.11	23.03	NO	3347.5	14.19
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	716.40	55.54	1166.30	NO	NO	NO	1882.7	7.98
1. Solid Fuels	NO	NO	18.61	NO	NO	NO	18.6	NO
2. Oil and Natural Gas	716.40	54.65	1147.69	NO	NO	NO	1864.1	7.90
2. Industrial Processes	**1324.00**	**1.24**	**26.05**	**2.17**	**673.86**	**80.45**	**2104.4**	**8.92**
A. Mineral Products	829.13	NE,NO	NE,NO	NE,NO	NE,NO	NO	829.1	3.51
B. Chemical Industry	476.59	26.05	26.05	2.17	673.86	NO	1176.5	4.99
C. Metal Production	18.28	NE,NO	NE,NO	NO	NO	NO	18.3	0.08
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	80.45	80.4	0.34
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**88.55**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**123.3**	**0.52**
4. Agriculture	**NO**	**41.89**	**879.69**	**6.96**	**2158.43**	**NO**	**3038.1**	**12.87**
A. Enteric Fermentation	NO	34.50	724.43	0.00	0.00	NO	724.4	3.07
B. Manure Management	NO	7.39	155.26	0.73	227.56	NO	382.8	1.62
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.23	1930.88	NO	1930.9	8.18
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6386.28**	**7.53**	**158.09**	**1.73**	**537.52**	**NO**	**-5690.7**	**-24.12**
A. Forest Land	-6566.75	7.53	158.09	1.72	533.73	NO	-5874.9	-24.90
B. Cropland	81.06	NE,NO	NE,NO	3.79	3.79	NO	84.9	NO
C. Grassland	-204.88	NE,NO	NE,NO	NE,NO	NE,NO	NO	-204.9	NO
D. Wetlands	56.11	NE,NO	NE,NO	NE,NO	NE,NO	NO	56.1	NO
E. Settlements	248.17	NE,NO	NE,NO	NE,NO	NE,NO	NO	248.2	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**30.47**	**639.96**	**0.26**	**81.19**	**NO**	**721.2**	**3.06**
A. Solid Waste Disp. on Land	NE,NO	15.32	321.80	0.00	0.00	NO	321.8	1.36
B. Waste-water Handling	0.00	15.15	318.16	0.26	81.19	NO	399.3	1.69
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.0	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	11233.37	142.99	3002.82	11.47	3555.39	80.45	17906.7	75.88
Total Emissions without LUCF	17619.65	135.46	3002.82	11.47	3555.39	80.45	23597.4	100.0
Share of Gases in Total Em./Rem.	62.73		16.77		19.86		100.0	
Share of Gases in Total Emissions	74.67		12.73		15.07		100.0	
Memo Items:								
International Bunkers	290.93	0.01	0.19	0.01	1.83	NO	292.9	
Aviation	176.02	0.00	0.03	0.00	1.54	NO	177.6	
Marine	114.91	0.01	0.16	0.00	0.28	NO	115.4	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,734.09	NO	NO	NO	NO	NO	1734.1	

Table A7-1: GHG emission in Croatia, 1997

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1997	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**17118.86**	**64.94**	**1363.74**	**0.37**	**115.39**	**NO**	**18597.99**	**74.45**
A. Fuel Comb (Sectoral Appr.)	16451.69	6.38	134.06	0.55	115.39	NO	16701.14	66.86
1. Energy Industries	5593.57	0.12	2.62	0.05	10.65	NO	5606.84	22.45
2. Man. Ind. and Constr.	3594.79	0.34	7.24	0.05	9.74	NO	3611.77	14.46
3. Transport	3983.08	1.41	29.54	0.34	72.05	NO	4084.67	16.35
4. Comm./Inst, Resid., Agric.	3280.24	4.51	94.67	0.11	22.95	NO	3397.86	13.60
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	667.17	58.56	1229.68	NO	NO	NO	1896.85	7.59
1. Solid Fuels	NO	NO	13.61	NO	NO	NO	13.61	NO
2. Oil and Natural Gas	667.17	57.91	1216.07	NO	NO	NO	1883.23	7.54
2. Industrial Processes	**1503.75**	**1.12**	**23.44**	**2.28**	**708.21**	**102.85**	**2338.26**	**9.36**
A. Mineral Products	938.32	NE,NO	NE,NO	NE,NO	NE,NO	NO	938.32	3.76
B. Chemical Industry	517.83	23.44	23.44	2.28	708.21	NO	1249.48	5.00
C. Metal Production	47.61	NE,NO	NE,NO	NO	NO	NO	47.61	0.19
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	102.85	102.85	0.41
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**78.72**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**113.44**	**0.45**
4. Agriculture	**NO**	**41.61**	**873.86**	**7.76**	**2404.80**	**NO**	**3278.66**	**13.13**
A. Enteric Fermentation	NO	34.35	721.36	0.00	0.00	NO	721.36	2.89
B. Manure Management	NO	7.26	152.50	0.72	223.66	NO	376.16	1.51
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.04	2181.14	NO	2181.14	8.73
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6521.21**	**11.88**	**249.57**	**2.73**	**846.22**	**NO**	**-5425.42**	**-21.72**
A. Forest Land	-6719.62	11.88	249.57	2.72	842.59	NO	-5627.45	-22.53
B. Cropland	89.78	NE,NO	NE,NO	3.63	3.63	NO	93.40	NO
C. Grassland	-209.76	NE,NO	NE,NO	NE,NO	NE,NO	NO	-209.76	NO
D. Wetlands	58.80	NE,NO	NE,NO	NE,NO	NE,NO	NO	58.80	NO
E. Settlements	259.59	NE,NO	NE,NO	NE,NO	NE,NO	NO	259.59	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**27.13**	**569.72**	**0.26**	**81.55**	**NO**	**651.32**	**2.61**
A. Solid Waste Disp. on Land	NE,NO	16.20	340.30	0.00	0.00	NO	340.30	1.36
B. Waste-water Handling	0.00	10.92	229.42	0.26	81.55	NO	310.97	1.24
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	12180.16	146.68	3080.34	13.41	4156.18	102.85	19554.25	78.28
Total Emissions without LUCF	18701.37	134.80	3080.34	13.41	4156.18	102.85	24979.66	100.0
Share of Gases in Total Em./Rem.	62.29		15.75		21.25		100.00	
Share of Gases in Total Emissions	74.87		12.33		16.64		100.00	
Memo Items:								
International Bunkers	263.80	0.01	0.13	0.01	1.85	NO	265.78	
Aviation	190.17	0.00	0.03	0.01	1.67	NO	191.87	
Marine	73.63	0.00	0.10	0.00	0.18	NO	73.92	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,793.72	NO	NO	NO	NO	NO	1793.72	

Table A7-1: GHG emission in Croatia, 1998

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1998	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**17957.72**	**57.25**	**1202.23**	**0.30**	**92.10**	**NO**	**19252.05**	**76.70**
A. Fuel Comb (Sectoral Appr.)	17368.55	6.16	129.41	0.44	92.10	NO	17590.06	70.08
1. Energy Industries	6272.23	0.14	2.88	0.06	11.67	NO	6286.78	25.05
2. Man. Ind. and Constr.	3770.72	0.34	7.10	0.05	9.85	NO	3787.68	15.09
3. Transport	4184.40	1.45	30.39	0.23	49.12	NO	4263.91	16.99
4. Comm./Inst, Resid., Agric.	3141.20	4.24	89.03	0.10	21.45	NO	3251.69	12.95
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	589.17	51.09	1072.83	NO	NO	NO	1661.99	6.62
1. Solid Fuels	NO	NO	14.26	NO	NO	NO	14.26	NO
2. Oil and Natural Gas	589.17	50.41	1058.57	NO	NO	NO	1647.73	6.56
2. Industrial Processes	**1431.44**	**1.11**	**23.36**	**1.72**	**533.19**	**130.76**	**2118.75**	**8.44**
A. Mineral Products	1013.66	NE,NO	NE,NO	NE,NO	NE,NO	NO	1013.66	4.04
B. Chemical Industry	388.43	23.36	23.36	1.72	533.19	NO	944.98	3.76
C. Metal Production	29.36	NE,NO	NE,NO	NO	NO	NO	29.36	0.12
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	130.76	130.76	0.52
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**77.26**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**111.98**	**0.45**
4. Agriculture	**NO**	**41.08**	**862.71**	**6.91**	**2143.02**	**NO**	**3005.73**	**11.97**
A. Enteric Fermentation	NO	33.93	712.46	0.00	0.00	NO	712.46	2.84
B. Manure Management	NO	7.15	150.25	0.70	217.88	NO	368.13	1.47
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.21	1925.14	NO	1925.14	7.67
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6566.51**	**22.29**	**468.15**	**5.11**	**1583.99**	**NO**	**-4514.37**	**-17.99**
A. Forest Land	-6786.08	22.29	468.15	5.10	1580.53	NO	-4737.40	-18.87
B. Cropland	110.28	NE,NO	NE,NO	3.46	3.46	NO	113.74	NO
C. Grassland	-228.72	NE,NO	NE,NO	NE,NO	NE,NO	NO	-228.72	NO
D. Wetlands	61.48	NE,NO	NE,NO	NE,NO	NE,NO	NO	61.48	NO
E. Settlements	276.52	NE,NO	NE,NO	NE,NO	NE,NO	NO	276.52	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**25.33**	**531.86**	**0.26**	**79.65**	**NO**	**611.55**	**2.44**
A. Solid Waste Disp. on Land	NE,NO	17.13	359.75	0.00	0.00	NO	359.75	1.43
B. Waste-water Handling	0.00	8.20	172.11	0.26	79.65	NO	251.76	1.00
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	12899.95	147.06	3088.32	14.30	4431.95	130.76	20585.69	82.01
Total Emissions without LUCF	19466.46	124.77	3088.32	14.30	4431.95	130.76	25100.06	100.0
Share of Gases in Total Em./Rem.	62.66		15.00		21.53		100.00	
Share of Gases in Total Emissions	77.56		12.30		17.66		100.00	
Memo Items:								
International Bunkers	287.83	0.01	0.14	0.01	2.01	NO	289.98	
Aviation	206.83	0.00	0.03	0.01	1.81	NO	208.67	
Marine	81.00	0.01	0.11	0.00	0.20	NO	81.31	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,678.97	NO	NO	NO	NO	NO	1678.97	

Table A7-1: GHG emission in Croatia, 1999

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 1999	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**18516.34**	**56.03**	**1176.58**	**0.44**	**137.93**	**NO**	**19830.85**	**75.19**
A. Fuel Comb (Sectoral Appr.)	17937.01	5.92	124.39	0.66	137.93	NO	18199.34	69.00
1. Energy Industries	6467.65	0.14	2.94	0.06	11.81	NO	6482.41	24.58
2. Man. Ind. and Constr.	3506.30	0.30	6.26	0.04	8.37	NO	3520.93	13.35
3. Transport	4413.89	1.48	31.00	0.46	96.75	NO	4541.65	17.22
4. Comm./Inst, Resid., Agric.	3549.17	4.01	84.19	0.10	20.99	NO	3654.36	13.86
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	579.32	50.10	1052.18	NO	NO	NO	1631.50	6.19
1. Solid Fuels	NO	NO	4.29	NO	NO	NO	4.29	NO
2. Oil and Natural Gas	579.32	49.90	1047.89	NO	NO	NO	1627.21	6.17
2. Industrial Processes	**1782.98**	**0.96**	**20.18**	**2.03**	**629.16**	**155.19**	**2587.50**	**9.81**
A. Mineral Products	1262.38	NE,NO	NE,NO	NE,NO	NE,NO	NO	1262.38	4.79
B. Chemical Industry	492.14	20.18	20.18	2.03	629.16	NO	1141.48	4.33
C. Metal Production	28.45	NE,NO	NE,NO	NO	NO	NO	28.45	0.11
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	155.19	155.19	0.59
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**72.72**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**107.44**	**0.41**
4. Agriculture	**NO**	**41.75**	**876.80**	**7.52**	**2329.87**	**NO**	**3206.66**	**12.16**
A. Enteric Fermentation	NO	33.82	710.19	0.00	0.00	NO	710.19	2.69
B. Manure Management	NO	7.93	166.61	0.72	222.78	NO	389.39	1.48
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.80	2107.08	NO	2107.08	7.99
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6938.04**	**1.39**	**29.27**	**0.33**	**102.12**	**NO**	**-6806.65**	**-25.81**
A. Forest Land	-7167.14	1.39	29.27	0.32	98.83	NO	-7039.04	-26.69
B. Cropland	101.97	NE,NO	NE,NO	3.30	3.30	NO	105.26	NO
C. Grassland	-239.72	NE,NO	NE,NO	NE,NO	NE,NO	NO	-239.72	NO
D. Wetlands	64.17	NE,NO	NE,NO	NE,NO	NE,NO	NO	64.17	NO
E. Settlements	302.68	NE,NO	NE,NO	NE,NO	NE,NO	NO	302.68	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**26.56**	**557.70**	**0.28**	**85.38**	**NO**	**643.12**	**2.44**
A. Solid Waste Disp. on Land	NE,NO	18.18	381.84	0.00	0.00	NO	381.84	1.45
B. Waste-water Handling	0.00	8.37	175.86	0.28	85.38	NO	261.24	0.99
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**13434.03**	**126.69**	**2660.53**	**10.60**	**3284.46**	**155.19**	**19568.92**	**74.19**
Total Emissions without LUCF	**20372.07**	**125.30**	**2660.53**	**10.60**	**3284.46**	**155.19**	**26375.57**	**100.0**
Share of Gases in Total Em./Rem.	**68.65**		**13.60**		**16.78**		**100.00**	
Share of Gases in Total Emissions	**77.24**		**10.09**		**12.45**		**100.00**	
Memo Items:								
International Bunkers	263.26	0.01	0.12	0.01	1.89	NO	265.28	
Aviation	197.59	0.00	0.03	0.01	1.73	NO	199.35	
Marine	65.68	0.00	0.09	0.00	0.16	NO	65.94	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,495.79	NO	NO	NO	NO	NO	1495.79	

Table A7-1: GHG emission in Croatia, 2000

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2000	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**17937.65**	**59.28**	**1244.84**	**0.48**	**149.99**	**NO**	**19332.48**	**74.09**
A. Fuel Comb (Sectoral Appr.)	17304.63	6.37	133.72	0.71	149.99	NO	17588.35	67.41
1. Energy Industries	5877.45	0.14	3.00	0.07	14.56	NO	5895.01	22.59
2. Man. Ind. and Constr.	3616.74	0.30	6.40	0.04	8.72	NO	3631.87	13.92
3. Transport	4421.28	1.43	29.95	0.49	103.60	NO	4554.83	17.46
4. Comm./Inst, Resid., Agric.	3389.15	4.49	94.38	0.11	23.11	NO	3506.65	13.44
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	633.02	52.91	1111.11	NO	NO	NO	1744.13	6.68
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	633.02	52.91	1111.11	NO	NO	NO	1744.13	6.68
2. Industrial Processes	**1923.20**	**0.95**	**19.86**	**2.39**	**740.39**	**182.86**	**2866.31**	**10.98**
A. Mineral Products	1407.60	NE,NO	NE,NO	NE,NO	NE,NO	NO	1407.60	5.39
B. Chemical Industry	497.96	19.86	19.86	2.39	740.39	NO	1258.22	4.82
C. Metal Production	17.64	NE,NO	NE,NO	NO	NO	NO	17.64	0.07
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	182.86	182.86	0.70
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**74.21**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**108.93**	**0.42**
4. Agriculture	**NO**	**40.65**	**853.60**	**7.34**	**2276.56**	**NO**	**3130.16**	**12.00**
A. Enteric Fermentation	NO	33.28	698.87	0.00	0.00	NO	698.87	2.68
B. Manure Management	NO	7.37	154.73	0.70	216.04	NO	370.76	1.42
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.65	2060.53	NO	2060.53	7.90
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6538.08**	**50.70**	**1064.73**	**11.61**	**3597.79**	**NO**	**-1875.56**	**-7.19**
A. Forest Land	-6859.92	50.70	1064.73	11.60	3594.66	NO	-2200.53	-8.43
B. Cropland	159.26	NE,NO	NE,NO	3.13	3.13	NO	162.39	NO
C. Grassland	-240.39	NE,NO	NE,NO	NE,NO	NE,NO	NO	-240.39	NO
D. Wetlands	66.85	NE,NO	NE,NO	NE,NO	NE,NO	NO	66.85	NO
E. Settlements	336.12	NE,NO	NE,NO	NE,NO	NE,NO	NO	336.12	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**27.26**	**572.49**	**0.27**	**83.10**	**NO**	**655.64**	**2.51**
A. Solid Waste Disp. on Land	NE,NO	19.24	404.11	0.00	0.00	NO	404.11	1.55
B. Waste-water Handling	0.00	8.02	168.39	0.27	83.10	NO	251.49	0.96
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**13397.01**	**178.83**	**3755.52**	**22.09**	**6847.85**	**182.86**	**24217.96**	**92.81**
Total Emissions without LUCF	**19935.09**	**128.13**	**3755.52**	**22.09**	**6847.85**	**182.86**	**26093.52**	**100.0**
Share of Gases in Total Em./Rem.	**55.32**		**15.51**		**28.28**		**100.00**	
Share of Gases in Total Emissions	**76.40**		**14.39**		**26.24**		**100.00**	
Memo Items:								
International Bunkers	226.42	0.00	0.10	0.01	1.62	NO	228.15	
Aviation	169.40	0.00	0.03	0.00	1.48	NO	170.91	
Marine	57.02	0.00	0.08	0.00	0.14	NO	57.24	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,680.11	NO	NO	NO	NO	NO	1680.11	

Table A7-1: GHG emission in Croatia, 2001

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2001	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**18762.45**	**64.31**	**1350.58**	**0.46**	**141.37**	**NO**	**20254.40**	**74.22**
A. Fuel Comb (Sectoral Appr.)	18074.81	5.19	108.99	0.67	141.37	NO	18325.17	67.15
1. Energy Industries	6376.36	0.16	3.42	0.07	15.23	NO	6395.01	23.43
2. Man. Ind. and Constr.	3613.71	0.29	6.10	0.04	8.67	NO	3628.47	13.30
3. Transport	4479.06	1.22	25.71	0.47	98.17	NO	4602.94	16.87
4. Comm./Inst, Resid., Agric.	3605.68	3.51	73.76	0.09	19.30	NO	3698.74	13.55
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	687.64	59.12	1241.59	NO	NO	NO	1929.23	7.07
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	687.64	59.12	1241.59	NO	NO	NO	1929.23	7.07
2. Industrial Processes	**2037.43**	**1.01**	**21.13**	**2.01**	**622.72**	**205.67**	**2886.96**	**10.58**
A. Mineral Products	1624.44	NE,NO	NE,NO	NE,NO	NE,NO	NO	1624.44	5.95
B. Chemical Industry	403.70	21.13	21.13	2.01	622.72	NO	1047.55	3.84
C. Metal Production	9.29	NE,NO	NE,NO	NO	NO	NO	9.29	0.03
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	205.67	205.67	0.75
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**80.58**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**115.30**	**0.42**
4. Agriculture	**NO**	**41.54**	**872.37**	**7.90**	**2449.50**	**NO**	**3321.87**	**12.17**
A. Enteric Fermentation	NO	34.13	716.79	0.00	0.00	NO	716.79	2.63
B. Manure Management	NO	7.41	155.59	0.70	218.27	NO	373.86	1.37
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.20	2231.23	NO	2231.23	8.18
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7075.49**	**10.37**	**217.85**	**2.38**	**739.12**	**NO**	**-6118.52**	**-22.42**
A. Forest Land	-7447.96	10.37	217.85	2.37	735.47	NO	-6494.64	-23.80
B. Cropland	186.00	NE,NO	NE,NO	3.65	3.65	NO	189.65	NO
C. Grassland	-286.47	NE,NO	NE,NO	NE,NO	NE,NO	NO	-286.47	NO
D. Wetlands	56.47	NE,NO	NE,NO	NE,NO	NE,NO	NO	56.47	NO
E. Settlements	416.48	NE,NO	NE,NO	NE,NO	NE,NO	NO	416.48	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**29.55**	**620.60**	**0.29**	**89.30**	**NO**	**709.94**	**2.60**
A. Solid Waste Disp. on Land	NE,NO	20.47	429.83	0.00	0.00	NO	429.83	1.58
B. Waste-water Handling	0.00	9.08	190.77	0.29	89.30	NO	280.08	1.03
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**13805.02**	**146.79**	**3082.53**	**13.04**	**4042.01**	**205.67**	**21169.96**	**77.58**
Total Emissions without LUCF	**20880.51**	**136.41**	**3082.53**	**13.04**	**4042.01**	**205.67**	**27288.48**	**100.0**
Share of Gases in Total Em./Rem.	**65.21**		**14.56**		**19.09**		**100.00**	
Share of Gases in Total Emissions	**76.52**		**11.30**		**14.81**		**100.00**	
Memo Items:								
International Bunkers	258.85	0.01	0.15	0.01	1.71	NO	260.70	
Aviation	169.48	0.00	0.03	0.00	1.48	NO	170.99	
Marine	89.37	0.01	0.13	0.00	0.22	NO	89.71	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,315.01	NO	NO	NO	NO	NO	1315.01	

Table A7-1: GHG emission in Croatia, 2002

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2002	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**19855.69**	**66.79**	**1402.67**	**0.33**	**102.60**	**NO**	**21360.95**	**75.39**
A. Fuel Comb (Sectoral Appr.)	19153.61	5.24	110.04	0.49	102.60	NO	19366.25	68.35
1. Energy Industries	7247.35	0.19	3.94	0.08	17.84	NO	7269.12	25.66
2. Man. Ind. and Constr.	3436.58	0.28	5.86	0.04	8.51	NO	3450.96	12.18
3. Transport	4777.87	1.19	24.92	0.27	56.50	NO	4859.29	17.15
4. Comm./Inst, Resid., Agric.	3691.81	3.59	75.33	0.09	19.75	NO	3786.89	13.37
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	702.08	61.55	1292.62	NO	NO	NO	1994.70	7.04
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	702.08	61.55	1292.62	NO	NO	NO	1994.70	7.04
2. Industrial Processes	**1987.35**	**1.25**	**26.21**	**1.95**	**604.48**	**237.70**	**2855.73**	**10.08**
A. Mineral Products	1618.41	NE,NO	NE,NO	NE,NO	NE,NO	NO	1618.41	5.71
B. Chemical Industry	363.78	26.21	26.21	1.95	604.48	NO	994.47	3.51
C. Metal Production	5.16	NE,NO	NE,NO	NO	NO	NO	5.16	0.02
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	237.70	237.70	0.84
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**105.48**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**140.20**	**0.49**
4. Agriculture	**NO**	**41.25**	**866.16**	**7.83**	**2426.07**	**NO**	**3292.23**	**11.62**
A. Enteric Fermentation	NO	33.72	708.14	0.00	0.00	NO	708.14	2.50
B. Manure Management	NO	7.52	158.02	0.69	212.82	NO	370.84	1.31
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.14	2213.25	NO	2213.25	7.81
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7274.15**	**5.22**	**109.67**	**1.21**	**374.43**	**NO**	**-6790.05**	**-23.97**
A. Forest Land	-7644.01	5.22	109.67	1.19	370.26	NO	-7164.07	-25.29
B. Cropland	156.45	NE,NO	NE,NO	4.17	4.17	NO	160.62	NO
C. Grassland	-274.35	NE,NO	NE,NO	NE,NO	NE,NO	NO	-274.35	NO
D. Wetlands	53.44	NE,NO	NE,NO	NE,NO	NE,NO	NO	53.44	NO
E. Settlements	434.31	NE,NO	NE,NO	NE,NO	NE,NO	NO	434.31	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**28.03**	**588.56**	**0.31**	**94.86**	**NO**	**683.46**	**2.41**
A. Solid Waste Disp. on Land	NE,NO	21.85	458.90	0.00	0.00	NO	458.90	1.62
B. Waste-water Handling	0.00	6.17	129.66	0.31	94.86	NO	224.53	0.79
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**14674.40**	**142.54**	**2993.26**	**11.62**	**3602.45**	**237.70**	**21542.53**	**76.03**
Total Emissions without LUCF	**21948.55**	**137.31**	**2993.26**	**11.62**	**3602.45**	**237.70**	**28332.57**	**100.0**
Share of Gases in Total Em./Rem.	**68.12**		**13.89**		**16.72**		**100.00**	
Share of Gases in Total Emissions	**77.47**		**10.56**		**12.71**		**100.00**	
Memo Items:								
International Bunkers	236.22	0.01	0.13	0.01	1.61	NO	237.96	
Aviation	162.99	0.00	0.02	0.00	1.43	NO	164.44	
Marine	73.24	0.00	0.10	0.00	0.18	NO	73.52	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,331.36	NO	NO	NO	NO	NO	1331.36	

Table A7-1: GHG emission in Croatia, 2003

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year2003	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**21241.22**	**68.28**	**1433.93**	**0.36**	**111.84**	**NO**	**22786.99**	**76.19**
A. Fuel Comb (Sectoral Appr.)	20583.71	6.23	130.85	0.53	111.84	NO	20826.39	69.64
1. Energy Industries	7924.83	0.22	4.55	0.09	19.72	NO	7949.10	26.58
2. Man. Ind. and Constr.	3575.58	0.31	6.54	0.05	9.56	NO	3591.68	12.01
3. Transport	5163.20	1.14	23.91	0.28	58.69	NO	5245.80	17.54
4. Comm./Inst, Resid., Agric.	3920.10	4.56	95.85	0.11	23.86	NO	4039.81	13.51
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	657.51	62.05	1303.08	NO	NO	NO	1960.59	6.56
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	657.51	62.05	1303.08	NO	NO	NO	1960.59	6.56
2. Industrial Processes	**2019.73**	**1.28**	**26.79**	**1.84**	**569.79**	**275.90**	**2892.20**	**9.67**
A. Mineral Products	1601.84	NE,NO	NE,NO	NE,NO	NE,NO	NO	1601.84	5.36
B. Chemical Industry	409.38	26.79	26.79	1.84	569.79	NO	1005.96	3.36
C. Metal Production	8.51	NE,NO	NE,NO	NO	NO	NO	8.51	0.03
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	275.90	275.90	0.92
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**113.88**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**148.60**	**0.50**
4. Agriculture	**NO**	**43.16**	**906.46**	**7.40**	**2295.26**	**NO**	**3201.72**	**10.71**
A. Enteric Fermentation	NO	35.28	740.85	0.00	0.00	NO	740.85	2.48
B. Manure Management	NO	7.89	165.62	0.72	222.75	NO	388.37	1.30
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.69	2072.50	NO	2072.50	6.93
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7251.93**	**24.42**	**512.77**	**5.60**	**1735.85**	**NO**	**-5003.31**	**-16.73**
A. Forest Land	-7619.28	24.42	512.77	5.58	1731.17	NO	-5375.34	-17.97
B. Cropland	135.78	NE,NO	NE,NO	4.69	4.69	NO	140.47	NO
C. Grassland	-272.76	NE,NO	NE,NO	NE,NO	NE,NO	NO	-272.76	NO
D. Wetlands	50.42	NE,NO	NE,NO	NE,NO	NE,NO	NO	50.42	NO
E. Settlements	453.90	NE,NO	NE,NO	NE,NO	NE,NO	NO	453.90	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**37.24**	**781.94**	**0.31**	**95.37**	**NO**	**877.35**	**2.93**
A. Solid Waste Disp. on Land	NE,NO	23.39	491.15	0.00	0.00	NO	491.15	1.64
B. Waste-water Handling	0.00	13.85	290.79	0.31	95.37	NO	386.16	1.29
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	16122.94	174.38	3661.89	15.51	4808.11	275.90	24903.55	83.27
Total Emissions without LUCF	23374.88	149.96	3661.89	15.51	4808.11	275.90	29906.87	100.0
Share of Gases in Total Em./Rem.	64.74		14.70		19.31		100.00	
Share of Gases in Total Emissions	78.16		12.24		16.08		100.00	
Memo Items:								
International Bunkers	230.13	0.01	0.12	0.01	1.58	NO	231.83	
Aviation	161.46	0.00	0.02	0.00	1.41	NO	162.90	
Marine	68.67	0.00	0.10	0.00	0.17	NO	68.93	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,714.51	NO	NO	NO	NO	NO	1714.51	

Table A7-1: GHG emission in Croatia, 2004

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2004	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20638.64**	**69.44**	**1458.34**	**0.52**	**162.50**	**NO**	**22259.48**	**74.31**
A. Fuel Comb (Sectoral Appr.)	19929.06	6.06	127.25	0.77	162.50	NO	20218.81	67.49
1. Energy Industries	6821.48	0.21	4.40	0.08	17.79	NO	6843.66	22.85
2. Man. Ind. and Constr.	3976.89	0.36	7.55	0.05	11.36	NO	3995.80	13.34
3. Transport	5297.17	1.07	22.38	0.52	110.16	NO	5429.71	18.13
4. Comm./Inst, Resid., Agric.	3833.52	4.42	92.92	0.11	23.20	NO	3949.64	13.18
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	709.58	63.39	1331.09	NO	NO	NO	2040.67	6.81
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	709.58	63.39	1331.09	NO	NO	NO	2040.67	6.81
2. Industrial Processes	**2216.22**	**0.59**	**12.30**	**2.24**	**695.34**	**313.28**	**3237.14**	**10.81**
A. Mineral Products	1705.90	NE,NO	NE,NO	NE,NO	NE,NO	NO	1705.90	5.69
B. Chemical Industry	495.43	12.30	12.30	2.24	695.34	NO	1203.07	4.02
C. Metal Production	14.89	NE,NO	NE,NO	NO	NO	NO	14.89	0.05
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	313.28	313.28	1.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**141.80**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**176.52**	**0.59**
4. Agriculture	**NO**	**45.20**	**949.30**	**8.05**	**2495.74**	**NO**	**3445.04**	**11.50**
A. Enteric Fermentation	NO	36.70	770.70	0.00	0.00	NO	770.70	2.57
B. Manure Management	NO	8.50	178.60	0.73	227.71	NO	406.31	1.36
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.32	2268.03	NO	2268.03	7.57
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7613.71**	**1.05**	**22.01**	**0.26**	**79.51**	**NO**	**-7512.19**	**-25.08**
A. Forest Land	-8102.84	1.05	22.01	0.24	74.30	NO	-8006.53	-26.73
B. Cropland	139.39	NE,NO	NE,NO	5.20	5.20	NO	144.59	NO
C. Grassland	-290.58	NE,NO	NE,NO	NE,NO	NE,NO	NO	-290.58	NO
D. Wetlands	47.40	NE,NO	NE,NO	NE,NO	NE,NO	NO	47.40	NO
E. Settlements	592.93	NE,NO	NE,NO	NE,NO	NE,NO	NO	592.93	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**35.40**	**743.44**	**0.31**	**95.09**	**NO**	**838.57**	**2.80**
A. Solid Waste Disp. on Land	NE,NO	25.07	526.39	0.00	0.00	NO	526.39	1.76
B. Waste-water Handling	0.00	10.34	217.05	0.31	95.09	NO	312.14	1.04
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**15383.00**	**151.69**	**3185.39**	**11.38**	**3528.17**	**313.28**	**22444.56**	**74.92**
Total Emissions without LUCF	**22996.70**	**150.64**	**3185.39**	**11.38**	**3528.17**	**313.28**	**29956.75**	**100.0**
Share of Gases in Total Em./Rem.	**68.54**		**14.19**		**15.72**		**100.00**	
Share of Gases in Total Emissions	**76.77**		**10.63**		**11.78**		**100.00**	
Memo Items:								
International Bunkers	260.46	0.01	0.13	0.01	1.82	NO	262.41	
Aviation	187.39	0.00	0.03	0.01	1.64	NO	189.06	
Marine	73.06	0.00	0.10	0.00	0.18	NO	73.35	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,704.33	NO	NO	NO	NO	NO	1704.33	

Table A7-1: GHG emission in Croatia, 2005

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2005	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20926.97**	**69.08**	**1450.74**	**0.51**	**159.38**	**NO**	**22537.09**	**74.52**
A. Fuel Comb (Sectoral Appr.)	20235.73	5.72	120.22	0.76	159.38	NO	20515.33	67.83
1. Energy Industries	6779.24	0.20	4.25	0.09	18.12	NO	6801.61	22.49
2. Man. Ind. and Constr.	4081.03	0.33	6.92	0.05	10.39	NO	4098.34	13.55
3. Transport	5508.50	0.91	19.17	0.52	108.63	NO	5636.31	18.64
4. Comm./Inst, Resid., Agric.	3866.95	4.28	89.88	0.11	22.24	NO	3979.06	13.16
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	691.25	63.36	1330.52	NO	NO	NO	2021.76	6.68
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	691.25	63.36	1330.52	NO	NO	NO	2021.76	6.68
2. Industrial Processes	**2247.68**	**0.53**	**11.20**	**2.19**	**678.84**	**347.09**	**3284.81**	**10.86**
A. Mineral Products	1751.79	NE,NO	NE,NO	NE,NO	NE,NO	NO	1751.79	5.79
B. Chemical Industry	484.65	11.20	11.20	2.19	678.84	NO	1174.69	3.88
C. Metal Production	11.24	NE,NO	NE,NO	NO	NO	NO	11.24	0.04
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	347.09	347.09	1.15
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**161.78**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**196.50**	**0.65**
4. Agriculture	**NO**	**45.77**	**961.15**	**8.12**	**2516.55**	**NO**	**3477.70**	**11.50**
A. Enteric Fermentation	NO	38.36	805.58	0.00	0.00	NO	805.58	2.66
B. Manure Management	NO	7.41	155.57	0.72	224.02	NO	379.59	1.26
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.40	2292.53	NO	2292.53	7.58
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7771.73**	**1.12**	**23.62**	**0.28**	**85.47**	**NO**	**-7662.64**	**-25.34**
A. Forest Land	-8218.10	1.12	23.62	0.26	79.75	NO	-8114.74	-26.83
B. Cropland	114.48	NE,NO	NE,NO	5.72	5.72	NO	120.21	NO
C. Grassland	-279.70	NE,NO	NE,NO	NE,NO	NE,NO	NO	-279.70	NO
D. Wetlands	44.38	NE,NO	NE,NO	NE,NO	NE,NO	NO	44.38	NO
E. Settlements	567.22	NE,NO	NE,NO	NE,NO	NE,NO	NO	567.22	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.03**	**31.06**	**652.18**	**0.31**	**95.92**	**NO**	**748.13**	**2.47**
A. Solid Waste Disp. on Land	NE,NO	24.25	509.26	0.00	0.00	NO	509.26	1.68
B. Waste-water Handling	0.00	6.81	142.92	0.31	95.92	NO	238.84	0.79
C. Waste Incineration	0.03	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.03	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	15564.73	147.57	3098.88	11.41	3536.16	347.09	22581.58	74.66
Total Emissions without LUCF	23336.46	146.44	3098.88	11.41	3536.16	347.09	30244.22	100.0
Share of Gases in Total Em./Rem.	68.93		13.72		15.66		100.00	
Share of Gases in Total Emissions	77.16		10.25		11.69		100.00	
Memo Items:								
International Bunkers	305.13	0.01	0.14	0.01	2.18	NO	307.45	
Aviation	226.15	0.00	0.03	0.01	1.98	NO	228.16	
Marine	78.98	0.01	0.11	0.00	0.19	NO	79.29	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,586.57	NO	NO	NO	NO	NO	1586.57	

Table A7-1: GHG emission in Croatia, 2006

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2006	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**21009.44**	**75.80**	**1591.74**	**0.37**	**114.87**	**NO**	**22716.05**	**73.88**
A. Fuel Comb (Sectoral Appr.)	20309.19	5.71	120.00	0.55	114.87	NO	20544.06	66.82
1. Energy Industries	6628.38	0.19	4.05	0.08	17.31	NO	6649.74	21.63
2. Man. Ind. and Constr.	4181.48	0.34	7.10	0.05	11.07	NO	4199.64	13.66
3. Transport	5869.45	0.95	19.87	0.31	64.60	NO	5953.91	19.36
4. Comm./Inst, Resid., Agric.	3629.88	4.24	88.99	0.10	21.90	NO	3740.77	12.17
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	700.25	70.08	1471.74	NO	NO	NO	2171.99	7.06
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	700.25	70.08	1471.74	NO	NO	NO	2171.99	7.06
2. Industrial Processes	**2371.18**	**1.21**	**25.50**	**2.17**	**671.21**	**378.60**	**3446.49**	**11.21**
A. Mineral Products	1880.58	NE,NO	NE,NO	NE,NO	NE,NO	NO	1880.58	6.12
B. Chemical Industry	477.34	25.50	25.50	2.17	671.21	NO	1174.06	3.82
C. Metal Production	13.25	NE,NO	NE,NO	NO	NO	NO	13.25	0.04
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	378.60	378.60	1.23
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**189.26**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**223.98**	**0.73**
4. Agriculture	**NO**	**47.66**	**1000.88**	**8.05**	**2496.68**	**NO**	**3497.55**	**11.38**
A. Enteric Fermentation	NO	39.10	821.00	0.00	0.00	NO	821.00	2.67
B. Manure Management	NO	8.57	179.88	0.75	231.79	NO	411.67	1.34
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.31	2264.89	NO	2264.89	7.37
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7895.37**	**1.50**	**31.43**	**0.36**	**112.36**	**NO**	**-7751.58**	**-25.21**
A. Forest Land	-8308.90	1.50	31.43	0.34	106.12	NO	-8171.35	-26.58
B. Cropland	91.55	NE,NO	NE,NO	6.24	6.24	NO	97.79	NO
C. Grassland	-285.98	NE,NO	NE,NO	NE,NO	NE,NO	NO	-285.98	NO
D. Wetlands	41.35	NE,NO	NE,NO	NE,NO	NE,NO	NO	41.35	NO
E. Settlements	566.61	NE,NO	NE,NO	NE,NO	NE,NO	NO	566.61	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**36.30**	**762.29**	**0.32**	**100.42**	**NO**	**862.75**	**2.81**
A. Solid Waste Disp. on Land	NE,NO	27.14	569.94	0.00	0.00	NO	569.94	1.85
B. Waste-water Handling	0.00	9.16	192.35	0.32	100.42	NO	292.77	0.95
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	15674.55	162.47	3411.84	11.28	3495.54	378.60	22995.24	74.79
Total Emissions without LUCF	23569.92	160.97	3411.84	11.28	3495.54	378.60	30746.82	100.0
Share of Gases in Total Em./Rem.	68.16		14.84		15.20		100.00	
Share of Gases in Total Emissions	76.66		11.10		11.37		100.00	
Memo Items:								
International Bunkers	290.81	0.01	0.12	0.01	2.16	NO	293.09	
Aviation	229.82	0.00	0.03	0.01	2.01	NO	231.87	
Marine	60.98	0.00	0.08	0.00	0.15	NO	61.22	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,641.97	NO	NO	NO	NO	NO	1641.97	

Table A7-1: GHG emission in Croatia, 2007

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2007	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**22203.39**	**82.11**	**1724.39**	**0.38**	**117.66**	**NO**	**24045.44**	**74.19**
A. Fuel Comb (Sectoral Appr.)	21540.06	5.08	106.58	0.56	117.66	NO	21764.31	67.16
1. Energy Industries	7737.05	0.22	4.69	0.09	18.94	NO	7760.68	23.95
2. Man. Ind. and Constr.	4204.52	0.35	7.39	0.05	10.97	NO	4222.89	13.03
3. Transport	6297.07	0.91	19.09	0.33	68.95	NO	6385.10	19.70
4. Comm./Inst, Resid., Agric.	3301.42	3.59	75.41	0.09	18.81	NO	3395.64	10.48
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	663.33	77.04	1617.80	NO	NO	NO	2281.13	7.04
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	663.33	77.04	1617.80	NO	NO	NO	2281.13	7.04
2. Industrial Processes	**2444.42**	**1.10**	**23.04**	**2.39**	**741.40**	**418.75**	**3627.61**	**11.19**
A. Mineral Products	1910.49	NE,NO	NE,NO	NE,NO	NE,NO	NO	1910.49	5.90
B. Chemical Industry	521.51	23.04	23.04	2.39	741.40	NO	1285.95	3.97
C. Metal Production	12.42	NE,NO	NE,NO	NO	NO	NO	12.42	0.04
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	418.75	418.75	1.29
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**211.22**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**245.94**	**0.76**
4. Agriculture	**NO**	**45.59**	**957.33**	**8.52**	**2639.87**	**NO**	**3597.19**	**11.10**
A. Enteric Fermentation	NO	37.66	790.93	0.00	0.00	NO	790.93	2.44
B. Manure Management	NO	7.92	166.40	0.72	222.14	NO	388.53	1.20
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.80	2417.73	NO	2417.73	7.46
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8196.78**	**5.01**	**105.27**	**1.17**	**362.16**	**NO**	**-7729.34**	**-23.85**
A. Forest Land	-8534.44	5.01	105.27	1.15	355.40	NO	-8073.77	-24.91
B. Cropland	10.50	NE,NO	NE,NO	6.76	6.76	NO	17.26	NO
C. Grassland	-281.57	NE,NO	NE,NO	NE,NO	NE,NO	NO	-281.57	NO
D. Wetlands	38.33	NE,NO	NE,NO	NE,NO	NE,NO	NO	38.33	NO
E. Settlements	570.41	NE,NO	NE,NO	NE,NO	NE,NO	NO	570.41	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.08**	**37.67**	**791.10**	**0.33**	**101.09**	**NO**	**892.27**	**2.75**
A. Solid Waste Disp. on Land	NE,NO	29.14	611.87	0.00	0.00	NO	611.87	1.89
B. Waste-water Handling	0.00	8.53	179.23	0.33	101.09	NO	280.32	0.86
C. Waste Incineration	0.08	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.08	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**16662.34**	**171.48**	**3601.12**	**12.78**	**3962.18**	**418.75**	**24679.11**	**76.15**
Total Emissions without LUCF	**24859.11**	**166.47**	**3601.12**	**12.78**	**3962.18**	**418.75**	**32408.45**	**100.0**
Share of Gases in Total Em./Rem.	**67.52**		**14.59**		**16.05**		**100.00**	
Share of Gases in Total Emissions	**76.71**		**11.11**		**12.23**		**100.00**	
Memo Items:								
International Bunkers	312.94	0.01	0.21	0.01	3.30	NO	316.45	
Aviation	237.29	0.01	0.11	0.01	3.12	NO	240.51	
Marine	75.65	0.00	0.10	0.00	0.19	NO	75.94	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,442.73	NO	NO	NO	NO	NO	1442.73	

Table A7-1: GHG emission in Croatia, 2008

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2008	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**21079.89**	**77.79**	**1633.52**	**0.36**	**112.82**	**NO**	**22826.23**	**73.52**
A. Fuel Comb (Sectoral Appr.)	20504.07	5.09	106.93	0.54	112.82	NO	20723.82	66.75
1. Energy Industries	6705.03	0.19	3.90	0.08	17.36	NO	6726.30	21.66
2. Man. Ind. and Constr.	4197.67	0.33	6.95	0.05	10.07	NO	4214.68	13.57
3. Transport	6186.21	0.84	17.66	0.31	66.02	NO	6269.89	20.19
4. Comm./Inst, Resid., Agric.	3415.17	3.73	78.42	0.09	19.36	NO	3512.95	11.31
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	575.82	72.69	1526.58	NO	NO	NO	2102.41	6.77
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	575.82	72.69	1526.58	NO	NO	NO	2102.41	6.77
2. Industrial Processes	**2378.74**	**0.20**	**4.25**	**2.44**	**756.66**	**436.90**	**3576.55**	**11.52**
A. Mineral Products	1824.85	NE,NO	NE,NO	NE,NO	NE,NO	NO	1824.85	5.88
B. Chemical Industry	530.39	4.25	4.25	2.44	756.66	NO	1291.30	4.16
C. Metal Production	23.51	NE,NO	NE,NO	NO	NO	NO	23.51	0.08
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	436.90	436.90	1.41
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**201.52**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**236.24**	**0.76**
4. Agriculture	**NO**	**46.62**	**978.97**	**8.06**	**2499.15**	**NO**	**3478.12**	**11.20**
A. Enteric Fermentation	NO	39.03	819.54	0.00	0.00	NO	819.54	2.64
B. Manure Management	NO	7.59	159.43	0.68	209.79	NO	369.22	1.19
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.39	2289.36	NO	2289.36	7.37
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8327.20**	**3.83**	**80.53**	**0.90**	**279.17**	**NO**	**-7967.50**	**-25.66**
A. Forest Land	-8717.59	3.83	80.53	0.88	271.89	NO	-8365.16	-26.94
B. Cropland	-29.27	NE,NO	NE,NO	7.28	7.28	NO	-21.99	NO
C. Grassland	-283.71	NE,NO	NE,NO	NE,NO	NE,NO	NO	-283.71	NO
D. Wetlands	35.31	NE,NO	NE,NO	NE,NO	NE,NO	NO	35.31	NO
E. Settlements	668.06	NE,NO	NE,NO	NE,NO	NE,NO	NO	668.06	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.25**	**39.51**	**829.80**	**0.33**	**101.79**	**NO**	**931.84**	**3.00**
A. Solid Waste Disp. on Land	NE,NO	31.61	663.71	0.00	0.00	NO	663.71	2.14
B. Waste-water Handling	0.00	7.91	166.09	0.33	101.79	NO	267.88	0.86
C. Waste Incineration	0.25	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.25	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**15333.21**	**167.96**	**3527.07**	**12.10**	**3749.58**	**436.90**	**23081.48**	**74.34**
Total Emissions without LUCF	**23660.41**	**164.12**	**3527.07**	**12.10**	**3749.58**	**436.90**	**31048.98**	**100.0**
Share of Gases in Total Em./Rem.	**66.43**		**15.28**		**16.24**		**100.00**	
Share of Gases in Total Emissions	**76.20**		**11.36**		**12.08**		**100.00**	
Memo Items:								
International Bunkers	332.32	0.01	0.29	0.02	4.81	NO	337.42	
Aviation	265.52	0.01	0.20	0.02	4.65	NO	270.37	
Marine	66.80	0.00	0.09	0.00	0.16	NO	67.05	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,412.76	NO	NO	NO	NO	NO	1412.76	

Table A7-1: GHG emission in Croatia, 2009

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2009	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**19881.25**	**75.32**	**1581.76**	**0.36**	**110.89**	**NO**	**21573.90**	**74.25**
A. Fuel Comb (Sectoral Appr.)	19364.81	5.20	109.17	0.53	110.89	NO	19584.88	67.40
1. Energy Industries	6373.34	0.19	4.07	0.07	14.82	NO	6392.23	22.00
2. Man. Ind. and Constr.	3378.56	0.30	6.20	0.04	8.83	NO	3393.59	11.68
3. Transport	6185.07	0.78	16.30	0.32	67.04	NO	6268.41	21.57
4. Comm./Inst, Resid., Agric.	3427.84	3.93	82.59	0.10	20.21	NO	3530.65	12.15
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	516.44	70.12	1472.58	NO	NO	NO	1989.02	6.85
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	516.44	70.12	1472.58	NO	NO	NO	1989.02	6.85
2. Industrial Processes	**1893.13**	**0.00**	**0.06**	**2.04**	**632.40**	**443.05**	**2968.64**	**10.22**
A. Mineral Products	1436.63	NE,NO	NE,NO	NE,NO	NE,NO	NO	1436.63	4.94
B. Chemical Industry	445.19	0.06	0.06	2.04	632.40	NO	1077.64	3.71
C. Metal Production	11.30	NE,NO	NE,NO	NO	NO	NO	11.30	0.04
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	443.05	443.05	1.52
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**117.19**	**NO**	**NO**	**0.11**	**33.59**	**NO**	**150.78**	**0.52**
4. Agriculture	**NO**	**47.02**	**987.44**	**7.67**	**2378.14**	**NO**	**3365.58**	**11.58**
A. Enteric Fermentation	NO	38.81	815.09	0.00	0.00	NO	815.09	2.81
B. Manure Management	NO	8.21	172.35	0.68	212.23	NO	384.58	1.32
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.99	2165.90	NO	2165.90	7.45
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7935.82**	**1.91**	**40.05**	**0.46**	**143.01**	**NO**	**-7752.76**	**-26.68**
A. Forest Land	-8310.30	1.91	40.05	0.44	135.21	NO	-8135.04	-28.00
B. Cropland	-48.78	NE,NO	NE,NO	7.80	7.80	NO	-40.98	NO
C. Grassland	-279.73	NE,NO	NE,NO	NE,NO	NE,NO	NO	-279.73	NO
D. Wetlands	32.29	NE,NO	NE,NO	NE,NO	NE,NO	NO	32.29	NO
E. Settlements	670.71	NE,NO	NE,NO	NE,NO	NE,NO	NO	670.71	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.13**	**42.62**	**895.03**	**0.33**	**102.43**	**NO**	**997.58**	**3.43**
A. Solid Waste Disp. on Land	NE,NO	34.25	719.28	0.00	0.00	NO	719.28	2.48
B. Waste-water Handling	0.00	8.37	175.75	0.33	102.43	NO	278.17	0.96
C. Waste Incineration	0.13	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.13	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	13955.88	166.87	3504.33	10.86	3366.87	443.05	21303.72	73.32
Total Emissions without LUCF	21891.70	164.97	3504.33	10.86	3366.87	443.05	29056.48	100.0
Share of Gases in Total Em./Rem.	65.51		16.45		15.80		100.00	
Share of Gases in Total Emissions	75.34		12.06		11.59		100.00	
Memo Items:								
International Bunkers	248.79	0.01	0.20	0.01	4.03	NO	253.02	
Aviation	227.17	0.01	0.17	0.01	3.98	NO	231.31	
Marine	21.62	0.00	0.03	0.00	0.05	NO	21.71	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,541.07	NO	NO	NO	NO	NO	1541.07	

Table A7-1: GHG emission in Croatia, 2010

Croatia	CO_2	CH_4		N_2O		HFC,PFC,SF_6	Total	Share
Year 2010	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**19124.32**	**78.39**	**1646.12**	**0.35**	**109.71**	**NO**	**20880.15**	**73.02**
A. Fuel Comb (Sectoral Appr.)	18637.06	5.71	119.86	0.52	109.71	NO	18866.63	65.97
1. Energy Industries	5883.79	0.21	4.50	0.08	16.41	NO	5904.69	20.65
2. Man. Ind. and Constr.	3314.66	0.32	6.62	0.04	9.09	NO	3330.38	11.65
3. Transport	5958.90	0.69	14.53	0.30	61.97	NO	6035.40	21.10
4. Comm./Inst, Resid., Agric.	3479.71	4.49	94.20	0.11	22.24	NO	3596.16	12.58
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	487.26	72.68	1526.27	NO	NO	NO	2013.53	7.04
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	487.26	72.68	1526.27	NO	NO	NO	2013.53	7.04
2. Industrial Processes	**1935.09**	**0.00**	**0.00**	**2.63**	**815.30**	**480.05**	**3230.44**	**11.30**
A. Mineral Products	1406.49	NE,NO	NE,NO	NE,NO	NE,NO	NO	1406.49	4.92
B. Chemical Industry	501.33	0.00	0.00	2.63	815.30	NO	1316.63	4.60
C. Metal Production	27.27	NE,NO	NE,NO	NO	NO	NO	27.27	0.10
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	480.05	480.05	1.68
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**119.65**	**NO**	**NO**	**0.10**	**31.07**	**NO**	**150.71**	**0.53**
4. Agriculture	**NO**	**46.45**	**975.35**	**7.39**	**2289.74**	**NO**	**3265.09**	**11.42**
A. Enteric Fermentation	NO	38.48	808.18	0.00	0.00	NO	808.18	2.83
B. Manure Management	NO	7.96	167.17	0.66	203.53	NO	370.70	1.30
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.73	2086.20	NO	2086.20	7.30
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8412.82**	**1.32**	**27.65**	**0.33**	**101.67**	**NO**	**-8283.50**	**-28.97**
A. Forest Land	-8875.43	1.32	27.65	0.30	93.35	NO	-8754.43	-30.61
B. Cropland	-21.25	NE,NO	NE,NO	8.32	8.32	NO	-12.93	NO
C. Grassland	-258.23	NE,NO	NE,NO	NE,NO	NE,NO	NO	-258.23	NO
D. Wetlands	29.26	NE,NO	NE,NO	NE,NO	NE,NO	NO	29.26	NO
E. Settlements	712.82	NE,NO	NE,NO	NE,NO	NE,NO	NO	712.82	NO
F. Other Land	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.10**	**46.08**	**967.61**	**0.33**	**102.93**	**NO**	**1070.63**	**3.74**
A. Solid Waste Disp. on Land	NE,NO	36.08	757.78	0.00	0.00	NO	757.78	2.65
B. Waste-water Handling	0.00	9.99	209.82	0.33	102.93	NO	312.75	1.09
C. Waste Incineration	0.10	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.10	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	12766.34	172.23	3616.73	11.03	3419.34	480.05	20313.52	71.03
Total Emissions without LUCF	21179.16	170.91	3616.73	11.03	3419.34	480.05	28597.03	100.0
Share of Gases in Total Em./Rem.	62.85		17.80		16.83		100.00	
Share of Gases in Total Emissions	74.06		12.65		11.96		100.00	
Memo Items:								
International Bunkers	261.64	0.01	0.21	0.01	4.29	NO	266.14	
Aviation	242.21	0.01	0.18	0.01	4.24	NO	246.63	
Marine	19.43	0.00	0.03	0.00	0.05	NO	19.50	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1,746.18	NO	NO	NO	NO	NO	1746.18	

ANNEX 8

CO_2 EMISSION FACTORS, OXIDATION FACTORS AND NATIONAL NET CALORIFIC VALUES
(needed for monitoring and reporting on CO_2 emission)

Table 8-1: National net calorific values, CO_2 emission factors and oxidation factors for 1990 and 2010

Fuel	Net Caloric Value			Carbon emission factor[25] (t C/TJ)	CO_2 emission factor (t CO_2/TJ) (with OF=1.0)	Real oxidation factor (OF)
	Unit	1990	2010			
SOLID FUELS						
Anthracite	TJ/Gg	29.29	29.31	26.8	98.27	0.98
Other Bituminous Coal	TJ/Gg	25.14	24.77	25.8	94.60	0.98
Sub-Bituminous Coal	TJ/Gg	16.74	17.60	26.2	96.07	0.98
Lignite	TJ/Gg	10.90	11.60	27.6	101.20	0.98
Brown Coal Briquettes	TJ/Gg	16.74	-	26.6	97.53	0.98
Coke oven Coke	TJ/Gg	29.31	29.31	29.5	108.17	0.98
LIQUID FUELS						
Motor gasoline	TJ/Gg	44.60	44.59	18.9	69.30	0.99
Aviation gasoline	TJ/Gg	44.60	44.59	18.9	69.30	0.99
Jet Kerosene	TJ/Gg	44.00	43.96	19.5	71.50	0.99
Gas/Diesel oil	TJ/Gg	42.71	42.71	20.2	74.07	0.99
Residual Fuel Oil	TJ/Gg	40.19	40.19	21.1	77.37	0.99
Liquefied Petroleum Gases	TJ/Gg	46.89	46.89	17.2	63.07	0.99
Petroleum Coke	TJ/Gg	29.31	31.00	27.5	100.83	0.99
Petroleum	TJ/Gg	44.00	43.96	19.6	71.87	0.99
Lubricants	TJ/Gg	33.57	33.50	20.0	73.33	0.99
GASEOUS FUELS						
Natural Gas	$TJ/10^6m^3$	34.00	34.00	15.3	56.10	0.995
Gas Works Gas	$TJ/10^6m^3$	15.82	17. 20	13.0	47.67	0.995
Coke Oven Gas	$TJ/10^6m^3$	17.9	-	13.0	47.67	0.995
BIOMASS FUELS						
Wood biomass	TJ/Gg	-	9.00	29.9	109.63	0.98
Industrial waste	TJ/Gg	-	-	29.9	109.63	0.98

[25] IPCC default (from *"Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories:Workbook"*)