MINISTRY OF ENVIRONMENTAL PROTECTION, PHYSICAL PLANNING AND CONSTRUCTION

CROATIAN ENVIRONMENT AGENCY

NATIONAL INVENTORY REPORT 2011
Croatian greenhouse gas inventory for the period 1990-2009

Submission to the UNFCCC and the Kyoto Protocol

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Preparation:
EKONERG – Energy and Environmental Protection Institute

CONTENT:

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
MEPPPC	- Ministry of Environmental Protection, Physical Planning and Construction
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.

[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 Protection, Physical Planning and Construction 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 Protection, Physical Planning and Construction as a national focal point has decided to enforce regulation which shall stipulate institutional and procedural arrangements for greenhouse gas monitoring and reporting in Croatia. In this regard, the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia came into force on 2 January 2007 (Official Gazette, No. 1/07) stipulated by Article 46. of the Air Protection Act (Official Gazette No. 178/04). It is important to emphasize that this inventory submission is the first which was prepared under the provisions of new Regulation.

In this NIR, the inventory of the emissions and removals of the greenhouse gases is reported for the period from 1990 to 2009. 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 six reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005, 2006,2009 and 2010. 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 Protection, Physical Planning and Construction, 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 Protection, Physical Planning and Construction (MEPPPC) 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 Research and Environmental Protection Institute was selected as Authorised Institution for preparation of 2011 inventory submission.

ES.1.2. BACKGROUND INFORMATION ON 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 Protection, Physical Planning and Construction (MEPPPC), 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, MEPPPC 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 Regional Development, Forestry and Water Management and the Ministry of Environmental Protection, Physical Planning and Construction 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 only used to fill the gaps in reporting.

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 2008. 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 1990-2009 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 1990-2009 (Gg CO_2-eq)

Source	Emissions and removals of GHG (Gg CO_2-eq)							
	1990	1995	2000	2005	2006	2007	2008	2009
Energy	22,534	17,056	19,281	22,599	22,675	24,044	22,813	21,462
Industrial Processes	3,809	2,012	2,854	3,271	3,421	3,604	3,570	2,962
Solvent and Other Product Use	107	98	90	177	205	228	219	131
Agriculture	4,378	3,067	3,135	3,478	3,498	3,439	3,427	3,314
Waste	612	744	656	748	863	892	932	996
Total emission (excluding net CO_2 from LULUCF)	**31,440**	**22,976**	**26,016**	**30,273**	**30,662**	**32,208**	**30,961**	**28,865**
Removals (LULUCF)	-6,934	-6,863	-7,218	-8,100	-8,215	-8,506	-8,643	-8,712
Total emission (including LULUCF)	24,506	16,113	18,799	22,173	22,447	23,702	22,318	20,153

Table ES.3-2: Emissions/removals of GHG by gases for the period 1990-2009 (Gg CO_2-eq)

Source	Emissions and removals of GHG (Gg CO_2-eq)							
	1990	1995	2000	2005	2006	2007	2008	2009
Carbon dioxide (CO_2)	23,090	16,983	19,919	23,371	23,507	24,837	23,626	21,755
Methane (CH_4)	3,461	2,876	2,679	3,070	3,360	3,479	3,446	3,463
Nitrous oxide (N_2O)	3,942	3,056	3,236	3,486	3,416	3,473	3,451	3,204
HFCs, PFCs and SF_6	948	61	183	347	379	419	437	443
Total emission (excluding net CO_2 from LULUCF)	**31,440**	**22,976**	**26,016**	**30,273**	**30,662**	**32,208**	**30,961**	**28,865**
Removals (LULUCF)	-6,934	-6,863	-7,218	-8,100	-8,215	-8,506	-8,643	-8,712
Total emission (including LULUCF)	24,506	16,113	18,799	22,173	22,447	23,702	22,318	20,153

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 2009 has the Energy Sector with 74.4 percent, followed by Agriculture with 11.5 percent, Industrial Processes with 10.3 percent, Waste with 3.5 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 2009. In the year 2009, the amount of removed emissions of the greenhouse gases by CO_2 from the forestry sector was 30.2 percent.

Energy sector is the largest contributor to greenhouse gas emissions. In the year 2009, the greenhouse gas emission from Energy sector was 6 percent lower in relation to 2008. The total energy consumption in 2009 was 1.6 percent lower than in the previous year. This reduction is the results of decreased consumption of coal and coke (28.8 percent), natural gas (7.3 percent), liquid fuels (1.2 percent) and imported electricity (13.6 percent). It is also due to increase in hydro power utilization (by 31 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 and 2009, cattle number decreased. Compared to 2008, in 2009 CH_4 emission decreased by about 0.7 percent. As for Manure management emissions, both CH_4 and N_2O emission increased in 2009 compared to 2008 by about 8 percent and 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 2009 compared to 2008 by about 5 percent. Overall, in 2009 emission from agriculture sector decreased by about 3 percent compared to 2008.

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 2009. 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, cement production was decreased by 22.5 percent. 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 2009, 2.5 millions of tons of clinker was produced. The ammonia production in 2009 was 15.7 percent lower in comparison to the previous year. Also, the nitric acid production in 2008 was 16.4 percent lower in comparison to 2008. 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 2009 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* and *Waste Management Plan in the Republic of Croatia* 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 2005-2009 have been included in emission estimation. It should be emphasized that Solid Waste Disposal on Land contributes with 72.1 percent in total sectoral emission in 2009. Waste sector contributes to total greenhouse gas emissions with 3.5 percent in 2009.

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 1990-2009 (Gg CO_2)

Sector	1990	1995	2000	2005	2006	2007	2008	2009
Energy	20,976	15,701	17,939	20,989	20,972	22,206	21,071	19,773
Industrial processes	2,041	1,219	1,925	2,240	2,364	2,437	2,371	1,885
Solvent and Other Product Use	72	63	56	143	171	194	184	98
LULUCF	-6,934	-6,863	-7,218	-8,100	-8,215	-8,506	-8,643	-8,712
Total CO_2 emission	23,090	16,983	19,919	23,371	23,507	24,837	23,626	21,755
Net CO_2 emission	16,156	10,120	12,701	15,271	15,292	16,331	14,983	13,043

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 74.4 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 1990-2009 (Gg CO_2)

Source	1990	1995	2000	2005	2006	2007	2008	2009
Energy Industries	7,127	5,262	5,878	6,841	6,629	7,737	6,704	6,373
Manufacturing Industries & Constr.	5,843	3,541	3,617	4,081	4,181	4,205	4,198	3,379
Transport	3,985	3,375	4,422	5,509	5,869	6,297	6,162	6,077
Comm./Inst., Resid., Agr /For./Fish.	3,606	2,826	3,389	3,867	3,630	3,301	3,431	3,428
Fugitive emissions	416	697	633	691	663	665	576	516
Total CO_2 emission	20,976	15,701	17,939	20,989	20,972	22,206	21,071	19,773

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
Reference appr.	21,024	15,062	17,773	20,981	20,820	22,209	21,168	19,835
Sectoral appr.	20,560	15,004	17,306	20,297	20,310	21,541	20,495	19,257
Relative Diff (%)	**2.25**	**0.39**	**2.70**	**3.37**	**2.51**	**3.10**	**3.28**	**3.00**

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 CO2 emission sources. This sector includes emission from road transport, civil aviation, railways and navigation. In the year 2009, the CO2 emission from Transport sector contributed with 27.9 percent to the national total CO2 emission. The largest part of the CO2 emission from Transport sector arises from road transport (94.9 percent of CO2 emission from transport sector in 2009) 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 1990-2009 (Gg CO_2)

Source	1990	1995	2000	2005	2006	2007	2008	2009
Cement production	1,086	629	1,244	1,500	1,588	1,612	1,527	1,224
Lime production	161	83	138	198	245	255	251	156
Limestone and dolomite use	52	17	16	27	24	22	24	30
Soda ash production and use	26	14	12	19	17	16	16	17
Ammonia production	466	439	498	485	477	522	530	445
Ferroalloys production	119	4	12	NO	NO	NO	NO	NO
Aluminium production	111	0	0	NO	NO	NO	NO	NO
Iron and steel production	22	4	5	11	13	12	24	11
Total CO_2 emission	**2,041**	**1,191**	**1,925**	**2,240**	**2,364**	**2,438**	**2,371**	**1,885**

The most significant CO_2 industrial processes emission sources are production of cement, ammonia and lime. In 2009, cement production contributes in total sectoral CO_2 emission with 41.3 percent, lime production with 5.3 percent and ammonia production with 15 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 has been dropped by 17 percent average, regarding 2008. In 2009, cement production was decreased by 22.5 percent, lime production by 35.7 percent, ammonia production by 15.7 percent and iron and steel production by 66.7 percent, regarding 2008.

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.

The Republic of Croatia reports data for Forest land and Settlements category. Data needed for calculations of emissions/removals for other land categories are partly available but not enough adequate, consistent and complete.

The methodology used for CO_2 removal calculation is taken from the IPCC and it is based on data on increment and fellings. GHG emissions are estimated only for aboveground and belowground biomass for *Forest land remaining forest land*, *(Other) Land converted to forest land* and *(Forest) Land converted to settlements*. Other carbon pools, dead wood, litter and soil, are not included due to lack of activity data. 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. In 2009, the share of total national removal in total national emission is about 30%. Moreover, data analysis indicates low significance of land conversion to forest land in the total removal (on average 1%). 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: CO_2 emission removal in forestry sector from 1990-2009 (Gg CO_2)

	1990	1995	2000	2005	2006	2007	2008	2009
Removals	6,934	6,863	7,218	8,100	8,215	8,506	8,643	8,712

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 1990-2009 (Gg CH_4)

Source	1990	1995	2000	2005	2006	2007	2008	2009
Energy	69	61	59	69	76	82	78	75
Industrial Processes	0.8	0.4	0.3	0.3	0.3	0.3	0.2	0.1
Agriculture	70	44	41	46	48	46	47	47
Waste	25	31	27	31	36	38	40	43
Total CH_4 emission	165	137	128	146	160	166	164	165

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 41.3 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 1990-2009(Gg N_2O)

Source	1990	1995	2000	2005	2006	2007	2008	2009
Energy	0.3	0.2	0.3	0.5	0.4	0.4	0.4	0.3
Industrial Processes	2.6	2.3	2.4	2.2	2.2	2.4	2.4	2.0
Solvent and Other Product Use	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	9.4	6.9	7.4	8.1	8.1	8.0	7.9	7.5
Waste	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total N_2O emission	12.7	9.9	10.4	11.2	11.0	11.2	11.1	10.3

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 55.8 percent of total emission from agricultural soils in 2009. 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 Protection, Physical Planning and Construction (MEPPPC) 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 MEPPPC, 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 1990-2009 (Gg CO_2-eq)

	1990	1995	2000	2005	2006	2007	2008	2009
HFC, PFC and SF_6 emission	948	61	183	347	379	419	437	443

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 2009* Submission to the Convention on Long-range Transboundary Air Pollution'.

The calculations of aggregated results for the emissions of indirect gases in the period 1990-2009 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
NO_x Emission	**89.21**	**63.62**	**72.22**	**72.94**	**73.03**	**78.59**	**75.97**	**70.09**
Energy Industries	13.96	12.25	12.11	12.04	11.15	13.41	10.03	11.16
Manufacturing Ind. & Construction	17.49	8.92	9.15	9.91	11.04	14.51	15.36	12.61
Transport	39.77	31.87	35.54	35.50	35.47	35.41	34.66	31.38
Other Energy (fuel combustion)	15.03	8.13	12.85	13.15	13.24	12.86	13.51	13.29
Fugitive Emission from Fuels	0.49	0.30	0.30	0.30	0.25	0.30	0.24	0.29
Industrial Processes	2.32	2.16	2.28	2.04	1.87	2.11	2.17	1.36
Agriculture	0.15	NO	NO	NO	NO	NO	NO	NO
LULUCF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO Emission	**586.09**	**401.82**	**441.53**	**350.55**	**351.20**	**332.17**	**289.59**	**286.89**
Energy Industries	1.70	1.22	1.23	0.93	1.35	1.90	1.14	0.96
Manufacturing Ind. & Construction.	40.44	41.20	36.43	32.93	33.47	34.94	36.51	34.71
Transport	238.74	175.68	173.24	111.95	99.22	91.29	80.99	72.55
Other Energy (fuel combustion)	203.95	116.68	146.39	132.96	133.47	115.58	120.06	126.15
Fugitive Emission from Fuels	50.06	34.51	54.07	54.42	44.43	53.47	41.61	51.91
Industrial Processes	46.85	32.51	30.13	17.36	39.25	35.00	9.28	0.60
Agriculture	4.34	NO	NO	NO	NO	NO	NO	NO
LULUCF	0.01	0.001	0.04	0.001	0.001	0.004	0.003	0.001

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
NMVOC Emission	**111.25**	**75.23**	**78.54**	**106.14**	**104.90**	**108.51**	**102.59**	**70.39**
Energy Industries	0.33	0.26	0.29	0.37	0.27	0.28	0.28	0.33
Manufacturing Ind. & Construction	1.70	1.36	1.43	1.76	1.86	2.01	2.14	1.75
Transport	38.38	28.35	31.92	19.10	18.39	17.01	15.36	13.50
Other Energy (fuel combustion)	12.14	6.91	9.01	8.29	8.37	7.41	7.72	8.01
Fugitive Emission from Fuels	8.50	6.73	9.06	8.45	8.34	8.24	7.47	7.95
Industrial Processes	25.57	10.17	7.86	9.95	9.46	7.48	6.92	5.56
Solvent and Other Product Use	24.64	21.46	18.97	58.21	58.21	66.07	62.70	33.29
SO_2 Emission	**166.61**	**81.01**	**61.77**	**66.72**	**59.30**	**75.29**	**56.90**	**66.64**
Energy Industries	78.91	45.69	25.39	32.76	30.22	38.69	25.13	36.73
Manufacturing Ind. & Construction	53.32	24.54	18.94	10.34	10.64	17.53	14.95	13.72
Transport	5.87	3.54	5.98	9.15	8.45	9.22	7.49	6.79
Other Energy (fuel combustion)	23.87	4.65	6.50	5.82	5.82	4.85	4.27	4.51
Fugitive Emission from Fuels	1.80	1.24	3.11	6.78	2.54	3.17	2.83	3.27
Industrial Processes	2.83	1.35	1.85	1.88	1.64	1.83	2.24	1.61

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 Protection, Physical Planning and Construction 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 Protection, Physical Planning and Construction as a national focal point has decided to enforce regulation which shall stipulate institutional and procedural arrangements for greenhouse gas monitoring and reporting in Croatia. In this regard, the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia came into force on 2 January 2007 (Official Gazette, No. 1/07) stipulated by Article 46. of the Air Protection Act (Official Gazette No. 178/04). It is important to emphasize that this inventory submission is the first which was prepared under the provisions of new Regulation.

In this NIR, the inventory of the emissions and removals of the greenhouse gases is reported for the period from 1990 to 2009. 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

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, MEPPPC 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 Regional Development, Forestry and Water Management and the Ministry of Environmental Protection, Physical Planning and Construction 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 only used to fill the gaps in reporting.

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 Protection, Physical Planning and Construction, 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 Protection, Physical Planning and Construction (MEPPPC) 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 Research and Environmental Protection Institute was selected as Authorised Institution for preparation of 2011 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 Protection, Physical Planning and Construction (MEPPPC), 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.

Further on in order to have independent review of the NIR and continuous involvement of the sectorial experts in all stages of preparation, evaluation, and review of the NIR, we are undertaking the process of reorganization of the National System Committee (expert group). Reorganization is envisaged in respect of expanding the number of members so that all sectorial institutions would be involved and the tasks defined in a way that the Committee be included in all steps of the inventory with respect to the timely delivery of accurate information needed to discharge the obligation of reporting, control, calculation of emissions based on the submitted data, timely submission of correct answers to question from the expert team for audit, control methodologies for calculating greenhouse gas emissions, the consideration of the request in terms of improving the quality of reporting and transition to a higher level, ie the detailed reporting, consider the effects of emission reduction measures, control of execution from reduction commitments sector and other. Above mentioned reorganizationed National System Committee will be introduced to the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia (Official Gazette, No. 1/07) by the amnedmends that are envisaged to be adopted till the end of this year.

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 six reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005, 2006, 2009 and 2010. 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 2008* 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, Labour and Entrepreneurship 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 Protection, Physical Planning and Construction
	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
	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
LULUCF	Activity data on areas of different land use categories, annual increment and annual cut, fuel wood and wildfires	Ministry of Regional Development, Forestry and Water Management with assistance of public company "Hrvatske šume"
Waste	Activity data on municipal solid waste disposed to different types of SWDSs	Ministry of Environmental Protection, Physical Planning and Construction; 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 2009 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 2009 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 2009 using Approach 1 and Approach 2. Some changes in the Key Categories based on the level and trend of emission occurred in NIR 2011 in relation to NIR 2010. 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, stipulated by Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol, which includes: QA/QC programme, Quality objectives document and QA/QC plan.

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, MEPPPC, Authorized Institution
Approval of QA/QC plan	CEA, MEPPPC
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, MEPPPC - 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 Protection, Physical Planning and Construction, 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 Protection, Physical Planning and Construction. 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 16.47%, while the total uncertainty including LULUCF is 24.78%.

According to the Tier 2 Monte Carlo uncertainty analysis the total uncertainty excluding LULUCF for all key source activities is 16.1%, while the total uncertainty including LULUCF is 24.41%.

According to the Tier 1, the uncertainty introduced into the trend in total national emissions excluding LULUCF is estimated to be 4.16% and including LULUCF 8.81%.

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% to +19.9% and including LULUCF is estimated to be from -21.86% to +26.23%.

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 1990-2009.

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 2009, excluding removals by sinks, amounted to 28.865 mil. t CO_2-eq (equivalent CO_2 emissions), which represents 8.19 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, emission has been reduced by 6.8 percent in 2009 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 2009 are favourable hydrological conditions which leaded to increase in hydro power utilisation by 23.7 percent, decrease in consumption of coal and coke due to decrease of working hours in TPP Plomin 2 (for 46.6 percent in relation to 2008). Due to decreasing of economic activity within 2009, which influenced decreasing of cement, lime, ammonia, and steel production, emissions has been dropped by 17 percent average, regarding 2008. In 2009, cement production was decreased by 22.5 percent, lime production by 35.7 percent, ammonia production by 15.7 percent and iron and steel production by 66.7 percent, regarding 2008.

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 2009, the shares of GHG emissions were as follows: 75.4 percent CO_2, 12.0 percent CH_4, 11.1 percent N_2O, 1.5 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 (1990-2009)

Gas	Emissions and removals of GHG (Gg CO_2-eq)							
	1990	1995	2000	2005	2006	2007	2008	2009
CO_2	23,090	16,983	19,919	23,371	23,507	24,837	23,626	21,755
CH_4 as CO_2-eq	3,461	2,876	2,679	3,070	3,360	3,479	3,446	3,463
N_2O as CO_2-eq	3,942	3,056	3,236	3,486	3,416	3,473	3,451	3,204
HFCs as CO_2-eq	0	49	171	334	365	405	423	429
PFCs as CO_2-eq	937	0	0	0	0	0	0	0
SF_6 as CO_2-eq	11	12	12	14	14	14	14	14
Total GHG emission	**31,440**	**22,976**	**26,016**	**30,273**	**30,662**	**32,208**	**30,961**	**28,865**
Removals (CO_2)	-6,934	-6,863	-7,218	-8,100	-8,215	-8,506	-8,643	-8,712
Total emission (including LULUCF)	24,506	16,113	18,799	22,173	22,447	23,702	22,318	20,153

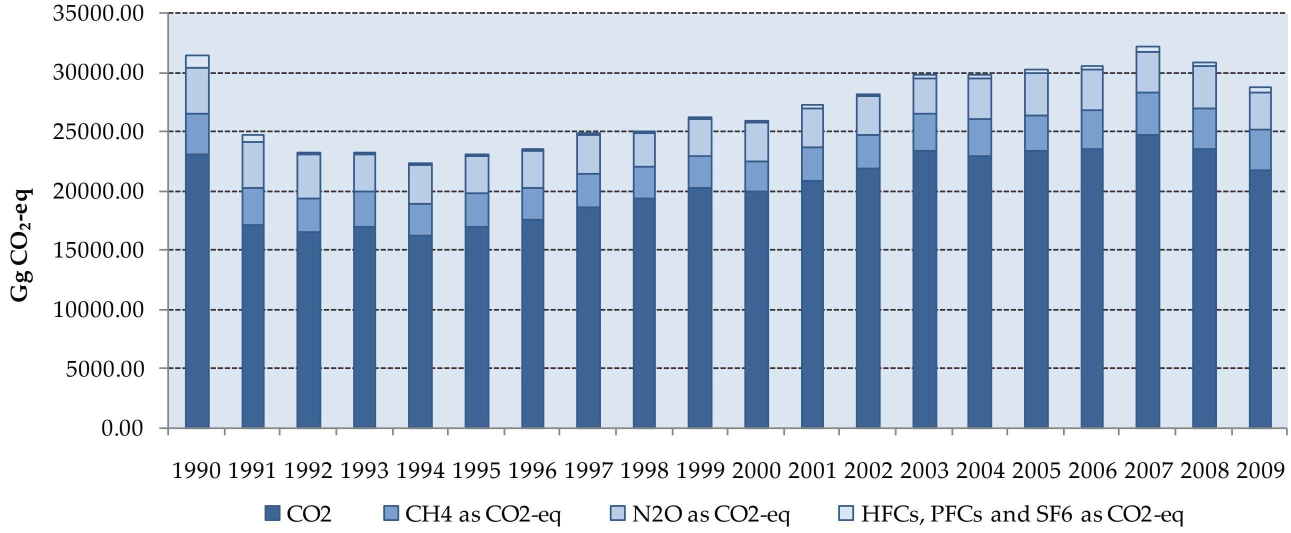

Figure 2.2-1: Trend of GHG emissions, by gases

2.2.1. CARBON DIOXIDE – CO_2

The most significant anthropogenic greenhouse gas is carbon dioxide (CO_2). In 2009, CO_2 emission was 8.2 percent lower than in 1990. CO_2 removals by sinks were almost 55 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 2009 was almost equal to the emission in 1990, largely due to emission trend in Agriculture.

2.2.3. NITROUS OXIDE – N_2O

The N_2O emission in 2009 was 18.7 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 2008 was approximately 1.5 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 2009 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 (1990-2009)

Source	Emissions and removals of GHG (Gg CO_2-eq)							
	1990	1995	2000	2005	2006	2007	2008	2009
Energy	22,534	17,056	19,281	22,599	22,675	24,044	22,813	21,462
Industrial Processes	3,809	2,012	2,854	3,271	3,421	3,604	3,570	2,962
Solvent and Other Product Use	107	98	90	177	205	228	219	131
Agriculture	4,378	3,067	3,135	3,478	3,498	3,439	3,427	3,314
Waste	612	744	656	748	863	892	932	996
Total GHG emission	**31,440**	**22,976**	**26,016**	**30,273**	**30,662**	**32,208**	**30,961**	**28,865**
Removals (LULUCF)	-6,934	-6,863	-7,218	-8,100	-8,215	-8,506	-8,643	-8,712
Total emission (including LULUCF)	24,506	16,113	18,799	22,173	22,447	23,702	22,318	20,153

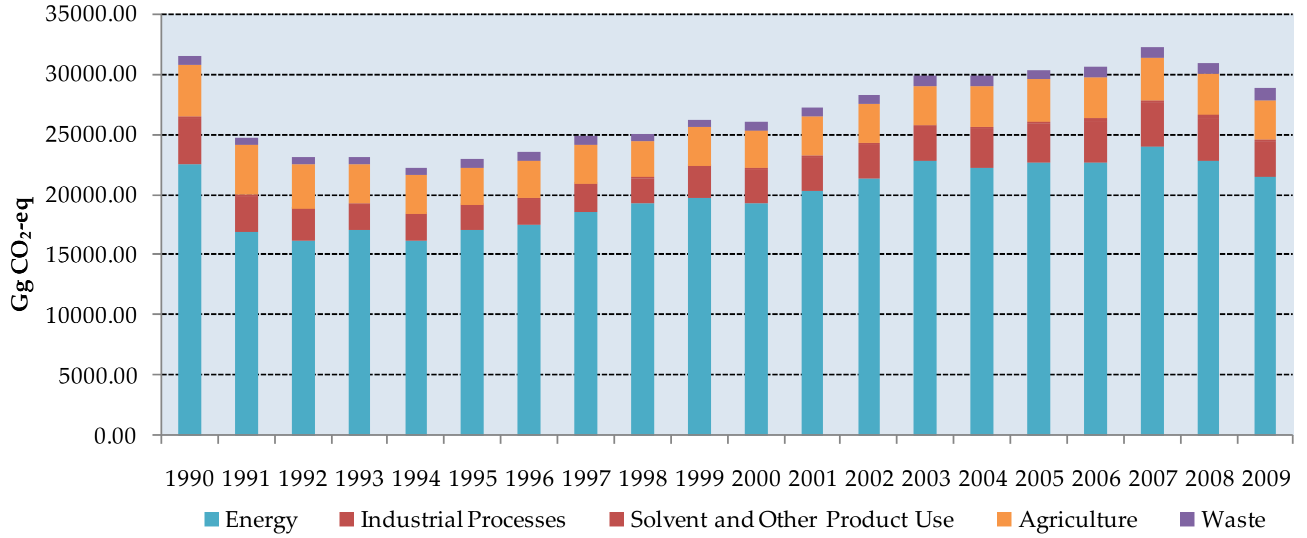

Figure 2.3-1: Trend of GHG emissions, by sectors

2.3.1. ENERGY

The most important IPCC sector in Croatia is Energy sector. The Energy sector accounted for some 74.4 percent of the total national GHG emissions (presented as equivalent emission of CO_2). In 2009, the GHG emission from Energy sector was 4.8 percent smaller than emission in 1990.

The main reasons of GHG emission decrease in 2009 were favourable hydrological conditions which leaded to increase in hydro power utilisation by 23.7 percent and decrease in consumption of coal and coke due to decrease of working hours in TPP Plomin 2 (for 46.6 percent in relation to 2008). 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 has been dropped by 17 percent average, regarding 2008. In 2009, cement production was decreased by 22.5 percent, lime production by 35.7 percent, ammonia production by 15.7 percent and iron and steel production by 66.7 percent, regarding 2008. The GHG emission in 2009 was approximately 22 percent lower than emission in 1990.

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 2009 was 23 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 2009 was about 24 percent lower in comparison with 1990 emission. According to estimation of Croatian experts for agriculture, approximately 10.5 percent of total GHG emissions belong to Agriculture.

2.3.5. WASTE

Emissions from Waste sector have been constantly increasing in the period 1990-2009. Increasing emissions are a consequence of greater quantities of waste, activities in wastewater handling and waste incineration. The GHG emission in 2009 was 62.9 percent larger in comparison with 1990 emission. Contribution of waste sector to the total GHG emission is 3.5 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
NO_x Emission	**89.21**	**63.62**	**72.22**	**72.94**	**73.03**	**78.59**	**75.97**	**70.09**
Energy Industries	13.96	12.25	12.11	12.04	11.15	13.41	10.03	11.16
Manufacturing Ind. & Construction	17.49	8.92	9.15	9.91	11.04	14.51	15.36	12.61
Transport	39.77	31.87	35.54	35.50	35.47	35.41	34.66	31.38
Other Energy (fuel combustion)	15.03	8.13	12.85	13.15	13.24	12.86	13.51	13.29
Fugitive Emission from Fuels	0.49	0.30	0.30	0.30	0.25	0.30	0.24	0.29
Industrial Processes	2.32	2.16	2.28	2.04	1.87	2.11	2.17	1.36
Agriculture	0.15	NO	NO	NO	NO	NO	NO	NO
LULUCF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO Emission	**586.09**	**401.82**	**441.53**	**350.55**	**351.20**	**332.17**	**289.59**	**286.89**
Energy Industries	1.70	1.22	1.23	0.93	1.35	1.90	1.14	0.96
Manufacturing Ind. & Construction.	40.44	41.20	36.43	32.93	33.47	34.94	36.51	34.71
Transport	238.74	175.68	173.24	111.95	99.22	91.29	80.99	72.55
Other Energy (fuel combustion)	203.95	116.68	146.39	132.96	133.47	115.58	120.06	126.15
Fugitive Emission from Fuels	50.06	34.51	54.07	54.42	44.43	53.47	41.61	51.91
Industrial Processes	46.85	32.51	30.13	17.36	39.25	35.00	9.28	0.60
Agriculture	4.34	NO	NO	NO	NO	NO	NO	NO
LULUCF	0.01	0.001	0.04	0.001	0.001	0.004	0.003	0.001

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
NMVOC Emission	**111.25**	**75.23**	**78.54**	**106.14**	**104.90**	**108.51**	**102.59**	**70.39**
Energy Industries	0.33	0.26	0.29	0.37	0.27	0.28	0.28	0.33
Manufacturing Ind. & Construction	1.70	1.36	1.43	1.76	1.86	2.01	2.14	1.75
Transport	38.38	28.35	31.92	19.10	18.39	17.01	15.36	13.50
Other Energy (fuel combustion)	12.14	6.91	9.01	8.29	8.37	7.41	7.72	8.01
Fugitive Emission from Fuels	8.50	6.73	9.06	8.45	8.34	8.24	7.47	7.95
Industrial Processes	25.57	10.17	7.86	9.95	9.46	7.48	6.92	5.56
Solvent and Other Product Use	24.64	21.46	18.97	58.21	58.21	66.07	62.70	33.29
SO_2 Emission	**166.61**	**81.01**	**61.77**	**66.72**	**59.30**	**75.29**	**56.90**	**66.64**
Energy Industries	78.91	45.69	25.39	32.76	30.22	38.69	25.13	36.73
Manufacturing Ind. & Construction	53.32	24.54	18.94	10.34	10.64	17.53	14.95	13.72
Transport	5.87	3.54	5.98	9.15	8.45	9.22	7.49	6.79
Other Energy (fuel combustion)	23.87	4.65	6.50	5.82	5.82	4.85	4.27	4.51
Fugitive Emission from Fuels	1.80	1.24	3.11	6.78	2.54	3.17	2.83	3.27
Industrial Processes	2.83	1.35	1.85	1.88	1.64	1.83	2.24	1.61

3. ENERGY (CRF sector 1)

3.1. OVERVIEW

3.1.1. OVERVIEW OF THE ENERGY SITUATION

Primary energy production

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 2009 is presented in the Table 3.1-1.

Table 3.1-1: Primary energy production

PJ	1990	1995	2000	2005	2006	2007	2008	2009
Coal and coke	4.21	1.96	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
Crude oil	104.54	62.81	51.35	40.11	38.90	37.27	35.42	33.07
Natural gas	74.27	69.12	59.4	79.76	94.27	100.12	94.05	93.50
Hydro power	38.55	51.75	56.93	62.40	58.18	42.21	50.19	65.77
Renewables	0.00	0.00	0.00	0.20	0.24	0.71	1.03	1.34
Total	**244.25**	**199.16**	**183.32**	**197.24**	**208.77**	**195.42**	**197.28**	**211.64**

Figure 3.1-1 presents the trends in the primary energy production from 1990 to 2009.

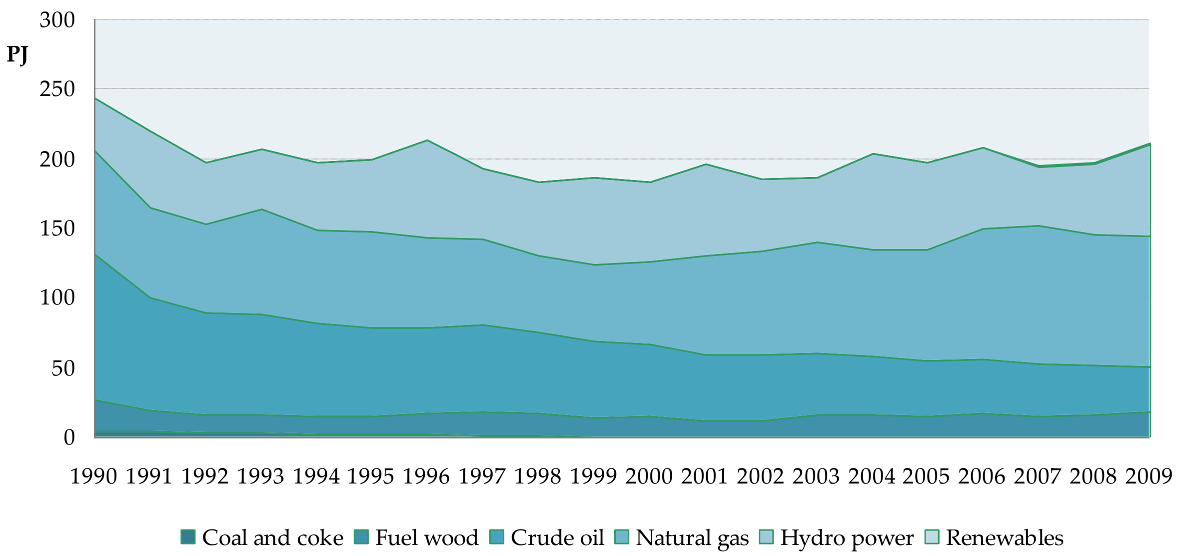

Figure 3.1-1: Trends in primary energy production for the period from 1990 to 2009

In 1990 primary energy production was about 244 PJ, which is 13,4% higher comparing to 2009. In 2009, the total primary energy production increased by 6.8% with relation to the 2008. Comparing to 2008, the energy production from renewable sources increased 1.3 times in 2009. The production of natural gas decreased 0.6% as well as production of crude oil (7.1%) while production of fuel wood increased by 7.7%. Hydro power utilization increased by 31%.

While in 1990 the share of crude oil in primary energy production was the highest one with 42.8%, in 2009 its' share was only 15.6%. In 2009, the share of natural gas (44.2%) was the highest one. It was followed by hydro power with the share of 31.1%. The comparison of shares in primary energy productions for the 1990 and 2009 are presented in Figure 3.1-2.

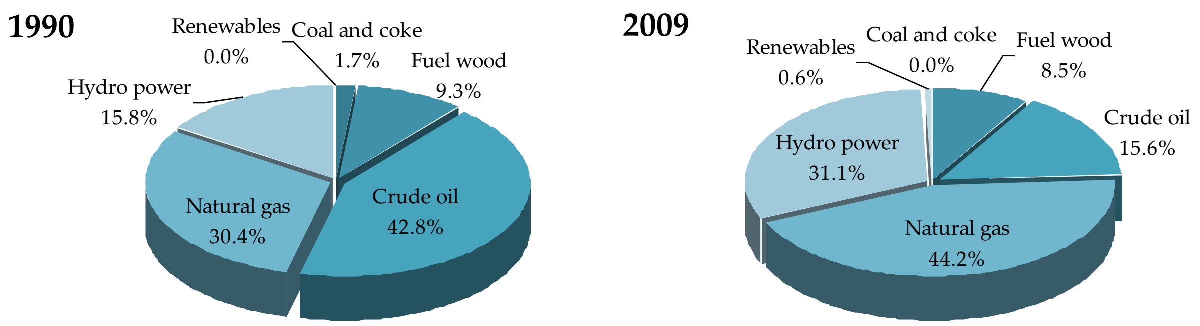

Figure 3.1-2: Shares of individual energy forms in the total production for the 1990 and 2009

Primary energy supply

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
Coal and coke	34.07	7.42	17.15	32.95	31.61	33.74	34.65	24.66
Fuel wood	22.68	13.52	15.64	14.77	15.28	13.31	13.38	14.42
Liquid fuels	192.6	146.03	160.52	181.88	185.15	189.70	180.15	178.04
Natural gas	98.22	82.77	94.98	101.06	99.86	114.22	110.22	102.15
Hydro power	38.55	51.75	56.93	62.40	58.18	42.21	50.19	65.77
Electricity	25.42	12.59	14.4	18.41	20.24	22.90	23.68	20.46
Renewables	0.00	0.00	0.00	0.20	0.24	0.69	0.97	1.43
Total	**411.54**	**314.08**	**359.62**	**411.67**	**410.56**	**416.77**	**413.24**	**406.92**

Figure 3.1-3 presents the trends in the primary energy supply from 1990 to 2009.

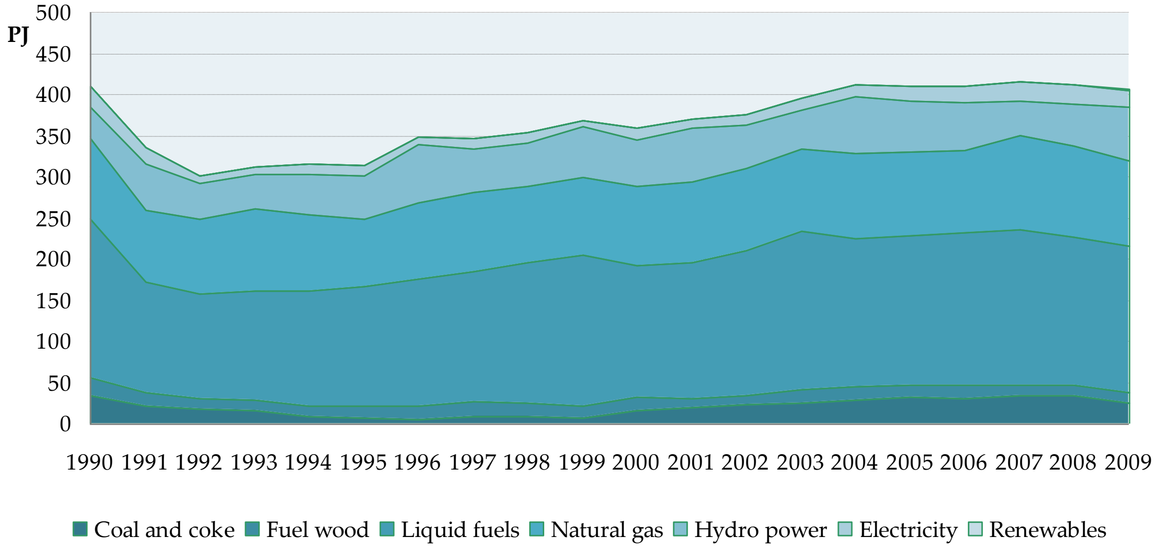

Figure 3.1-3: Trends in primary energy supply for the period from 1990 to 2009

In 1990 primary energy supply was about 412 PJ, which is 1.1% higher comparing to 2009. In 2009, the total primary energy supply decreased by 1.5% with relation to the previous year. There was an increase in fuel wood and renewable energy sources while consumption of coal and coke, natural gas, liquid fuels and electricity decreased. Due to good hydrology conditions, hydro power energy supply increased by 31.0% with relation to the 2008. Figure 3.1-4 presents comparison of the shares of individual energy forms in the total primary energy supply for the 1990 and 2009.

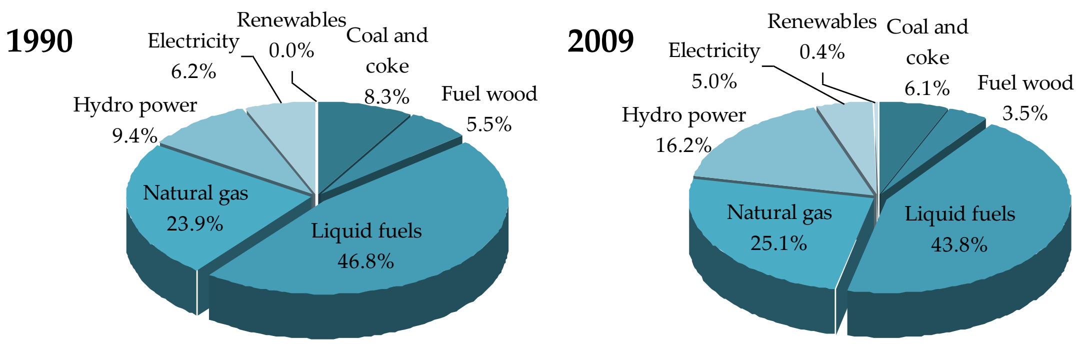

Figure 3.1-4: Comparison of the shares of individual energy forms for the 1990 and 2009

Liquid fuels had the largest share in total primary energy supply in 1990 as well as in 2009 (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.

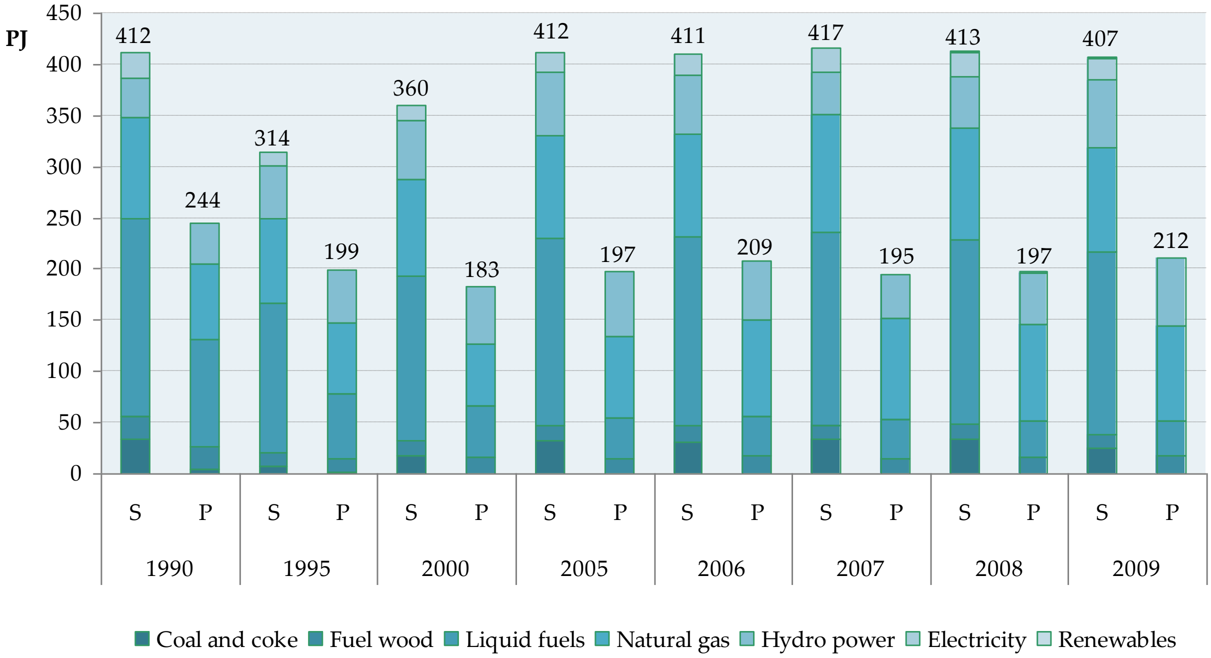

Figure 3.1-5: Total primary energy supply (S) and production (P)

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 2009 amounted 52.1%. Total hydro power and fuel wood supply were fully covered from the territory of Croatia. Own natural gas supply in 2009 amounted 91.5% while own oil supply amounted 18.6%. 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 2009 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 2009

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	2009			
SOLID FUELS						
Anthracite	TJ/Gg	29.29	29.31	26.8	98.27	0.98
Other Bituminous Coal	TJ/Gg	25.14	24.60	25.8	94.60	0.98
Sub-Bituminous Coal	TJ/Gg	16.74	18.00	26.2	96.07	0.98
Lignite	TJ/Gg	10.90	11.70	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	18.72	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	-	9.00	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 2009 is shown in Figure 3.1-6.

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

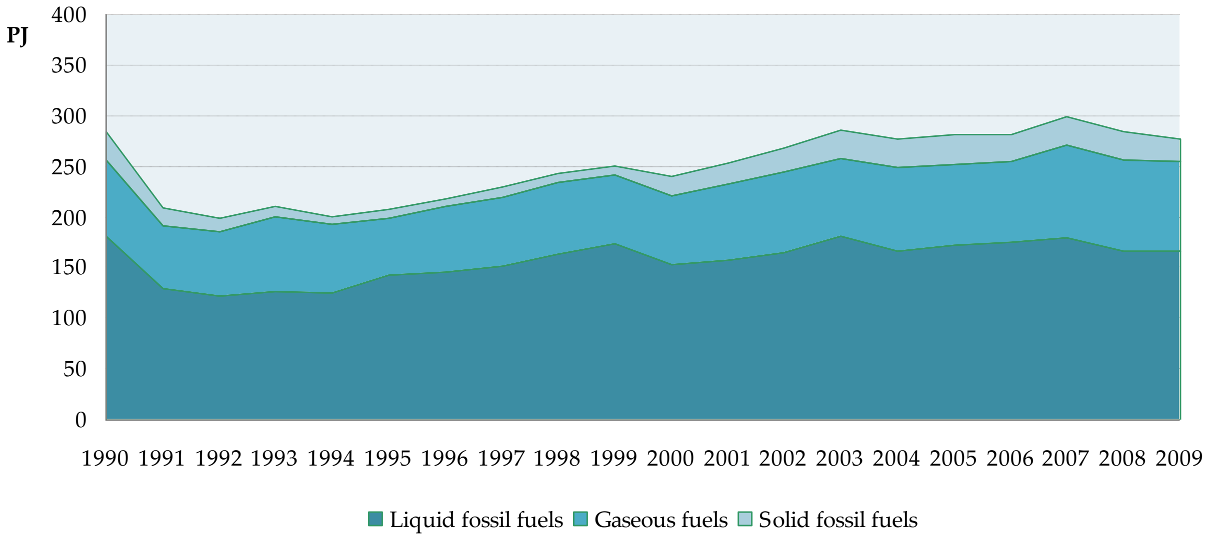

Figure 3.1-6: Structure of energy consumption

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 (2009), is presented in the Table 3.1-4 while contribution of individual subsectors to GHG emission for the period 1990-2009 is presented in Figure 3.1-7.

Table 3.1-4: Contribution of individual subsectors to emission of greenhouse gases, for 2009

GHG categories	Gg			Total	
	CO_2	CH_4	N_2O	CO_2-eq (Gg)	%
ENERGY	**19,773.15**	**75.27**	**0.35**	**21,461.67**	100.00
A. Fuel combustion activities	19,256.72	5.14	0.35	19,472.65	90.73
1. Energy industries	6,373.45	0.19	0.05	6,392.34	29.78
a) Electricity and heat production	4,294.72	0.12	0.03	4,307.59	20.07
b) Petroleum refining	1,700.48	0.07	0.01	1,706.04	7.95
c) Manufacture of solid fuels	378.24	0.01	0.001	378.60	1.76
2. Manufacturing ind. and constr.	3,378.56	0.30	0.03	3,393.59	15.81
3. Transport	6,076.86	0.72	0.21	6,156.08	28.68
a) Civil aviation	77.42	0.00	0.002	78.11	0.36
b) Road transport	5,764.90	0.70	0.20	5,842.49	27.22
c) Railways	89.25	0.01	0.001	89.61	0.42
d) Navigation (domestic)	145.29	0.01	0.001	145.87	0.68
4. Other sectors	3,427.84	3.93	0.07	3,530.65	16.45
5. Other	NO	NO	NO	-	-
B. Fugitive emissions from fuels	516.44	70.12	NO	1,989.02	9.27
1. Solid fuels	NO	NO	NO	-	-
2. Oil and natural gas	516.44	70.12	NO	1,989.02	9.27

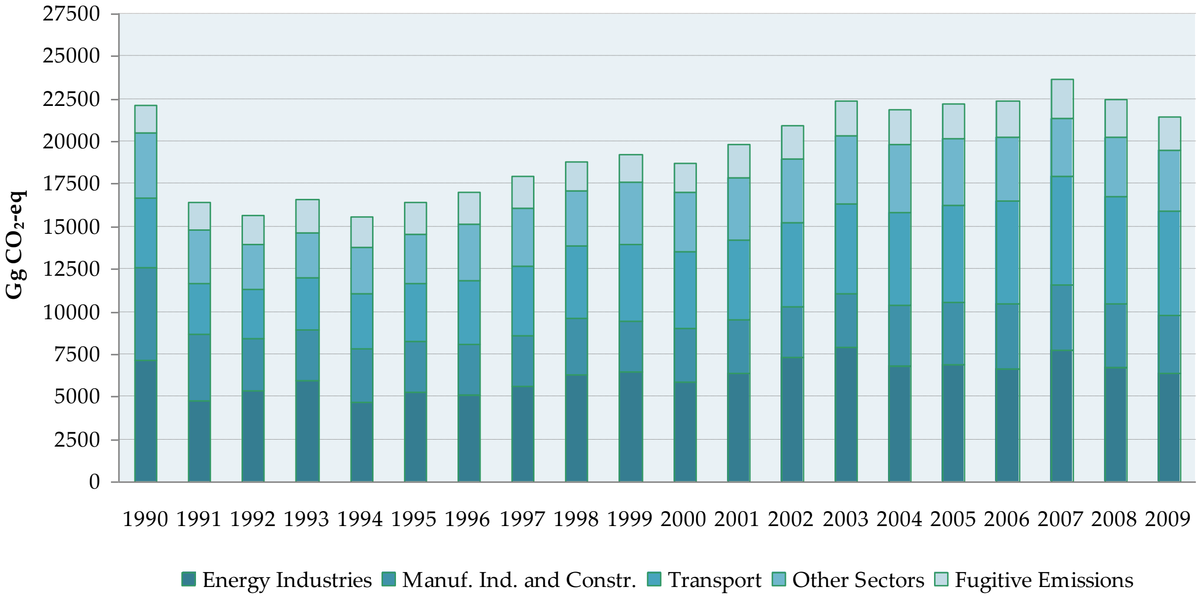

Figure 3.1-7: CO_2-eq emissions from Energy sector by subsectors in 1990-2009

The largest part (29 to 36 percent) of the emissions are a consequence of fuel combustion in Energy Industries, then the combustion in Transport with increasing trend (18 percent in 1990; 29 percent in 2009) and the combustion in Manufacturing Industries and Construction with decreasing trend (25 percent in 1990; 16 percent in 2009). 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 2009[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 L2e - Level excluding LULUCF Tier 2
L1i - Level including LULUCF Tier 1 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

[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
Fuel cons. (PJ)								
Reference appr.	302.45	216.57	250.46	292.28	290.60	311.37	298.61	280,60
Sectoral appr.	292.76	218.44	250.16	288.63	288.76	307.97	293.33	277.67
Relative Dif. (%)	**3.31**	**-0.85**	**0.12**	**1.26**	**0.64**	**1.10**	**1.80**	**1.06**
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
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
Relative Dif (%)	**2.25**	**0.39**	**2.70**	**3.37**	**2.51**	**3.10**	**3.28**	**3.00**

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 2009 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 2009 amounted to 253.02 Gg which is 25.01% lower than in 2008 as a result of reduced fuel consumption especially in the Marine bunkers (-67.34%), but also in Aviation bunkers (-14.45%).

In comparison with 1990, the emission of CO_2-eq in 2009 was for a 44.43% lower as a result of reduced fuel consumption especially in the Marine bunkers (-80.28%), but also in Aviation bunkers (-33.83%).

International marine bunkers are included in national energy balance for the period from 1994 to 2008, 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 2009

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

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 1990-2009, 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
Public El. and Heat Prod.	3,694	2,988	3,809	4,703	4,671	5,531	5,038	4,308
Petroleum Refining	2,575	1,892	1,792	1,811	1,671	1,868	1,442	1,706
Other Energy Industries	875	395	293	351	309	362	246	379
Total Energy Industries	7,144	5,275	5,895	6,864	6,650	7,761	6,725	6,392

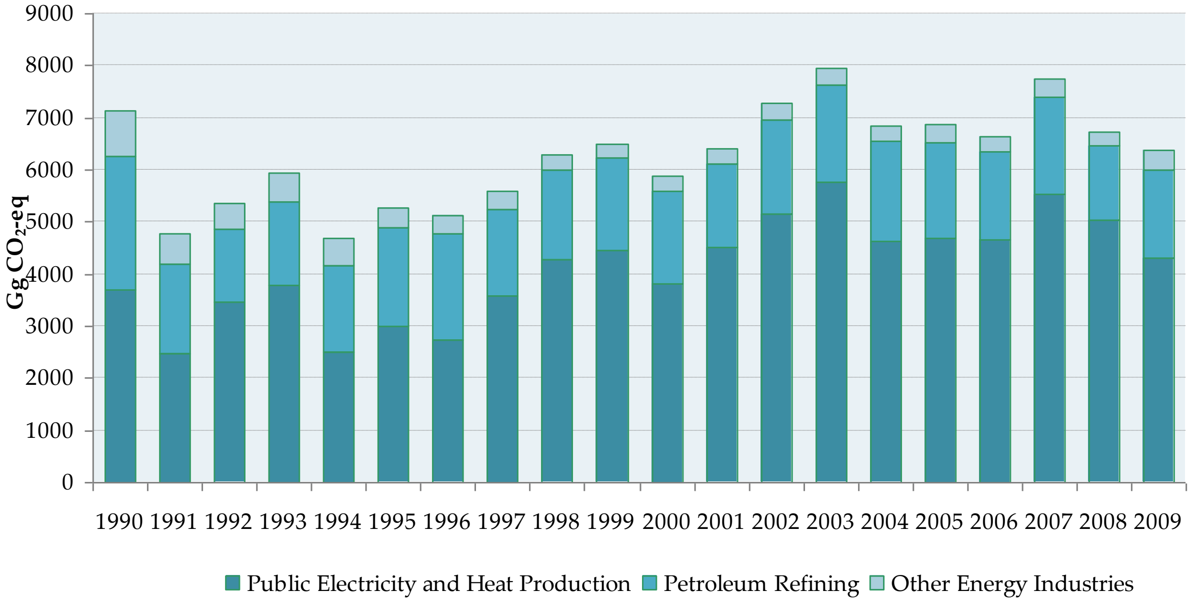

Figure 3.2-1: CO_2-eq emissions from Energy Industries

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 3,769 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, 2,088 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 2009 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 2009, the import of electricity was about 41 percent of total electricity consumption in Croatia. Electricity supply for the period from 1990 to 2009 is presented in Figure 3.2-2.

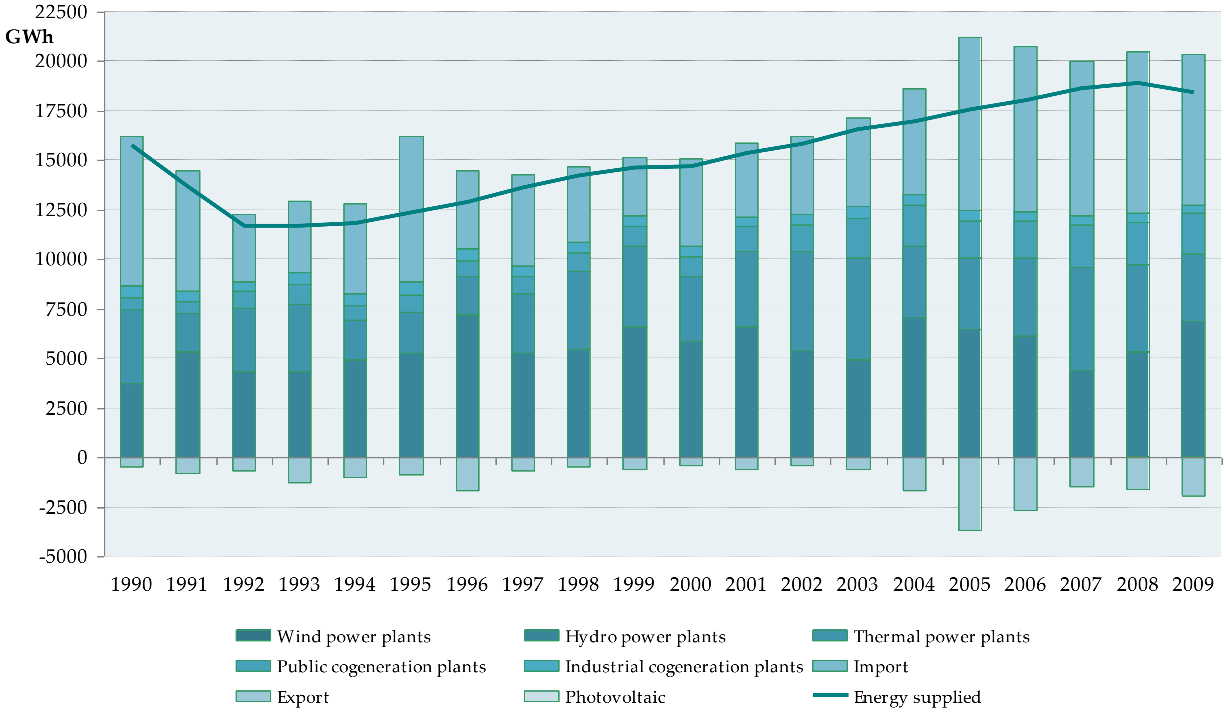

Figure 3.2-2: Electricity supply for the period from 1990 to 2009

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 2009.

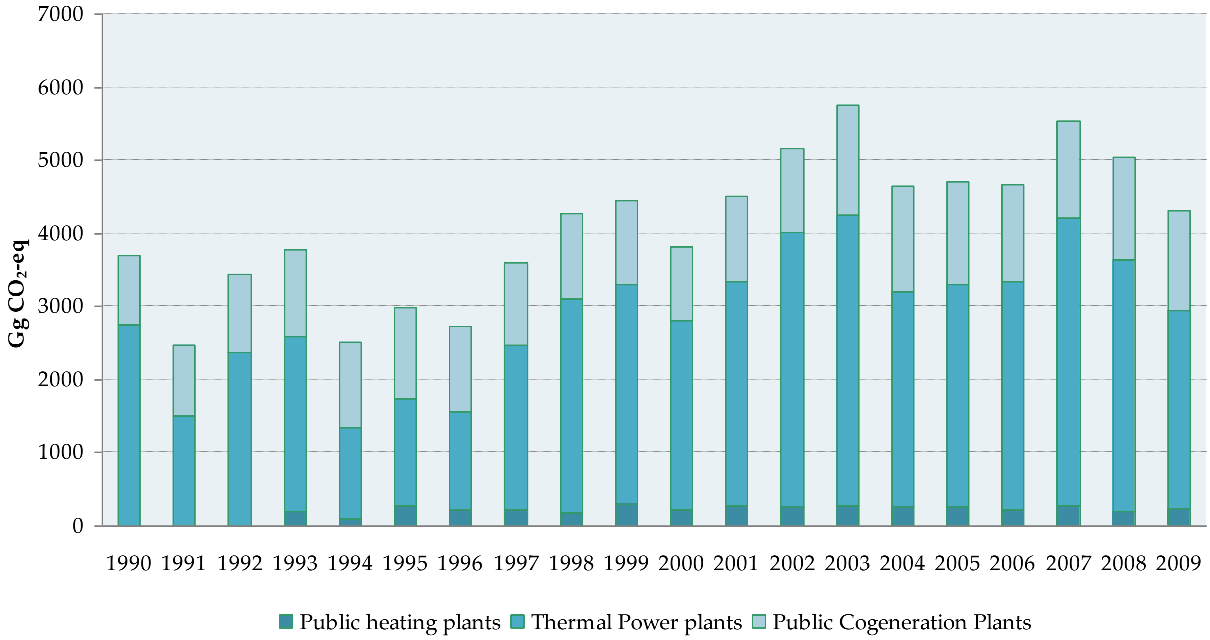

Figure 3.2-3: CO_2-eq emissions from Public Electricity and Heat Production subsector's

Production of electricity has increasing trend trough the years, from 8 TWh (1990) to 13 TWh (2009) 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 2009 is presented in Figure 3.2-4. In 2009, the total electricity production was 3.5 percent higher than in the former year. Decrease in total energy consumption is mostly due to favourable hydrological conditions which leaded to increase in electricity production from hydro power by 21.8 percent (Table 3.2-5).

Table 3.2-5: Differences between electricity production in 2008 and 2009

ENERGY BALANCE	Electricity, GWh		Difference 2009-2008	Difference %
	2008	2009		
Production	12,325.6	12,777.1	451.5	3.53
Hydro power plants	5,325.9	6,814.4	1,488.5	21.84
Wind power plants	39.9	54.2	14.3	26.38
Photovoltaic	0.1	0.1	0	0.00
Thermal power plants	4,414.3	3,422.2	-992.1	-28.99
Public cogeneration plants	2,085.7	2,085.3	-0.4	-0.02
Industrial cogeneration plants	459.7	400.9	-58.8	-14.67
Import	8,163.8	7,580.7	-583.1	-7.69
Export	1,586.9	1,898.6	311.7	16.42
TOTAL CONSUMPTION	**18,902.5**	**18,459.2**	**-443.3**	**-2.40**

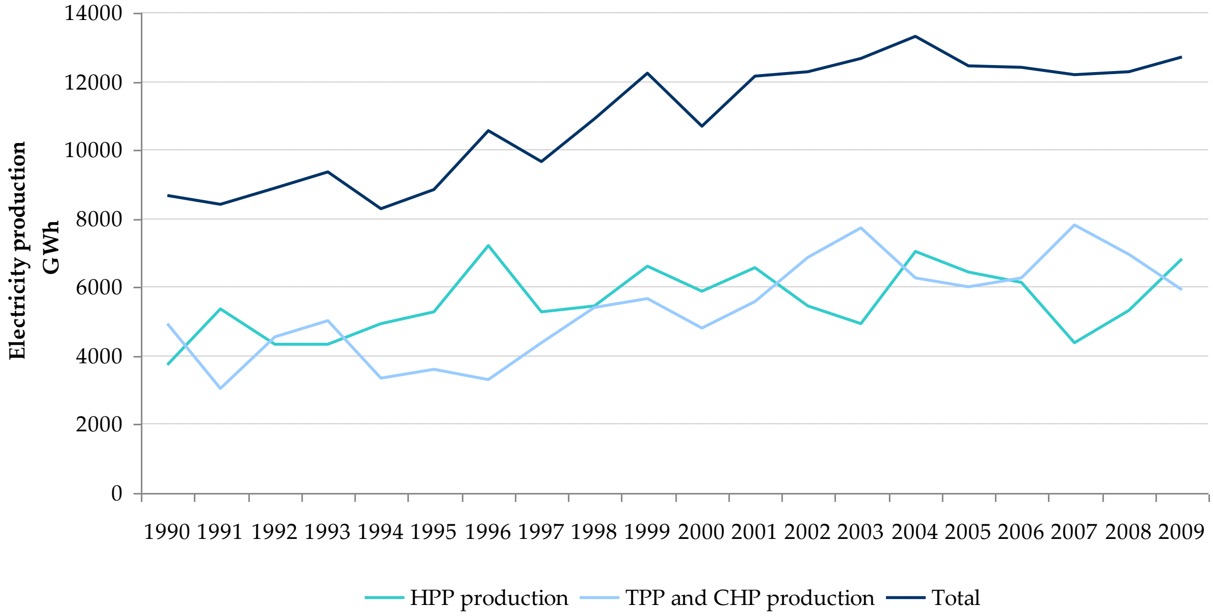

Figure 3.2-4: Domestic production of electricity by sources for the period from 1990 to 2009

Electricity and heat production, fuel consumption and GHG emissions for the years 1990, 1995 and 2000-2009 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.

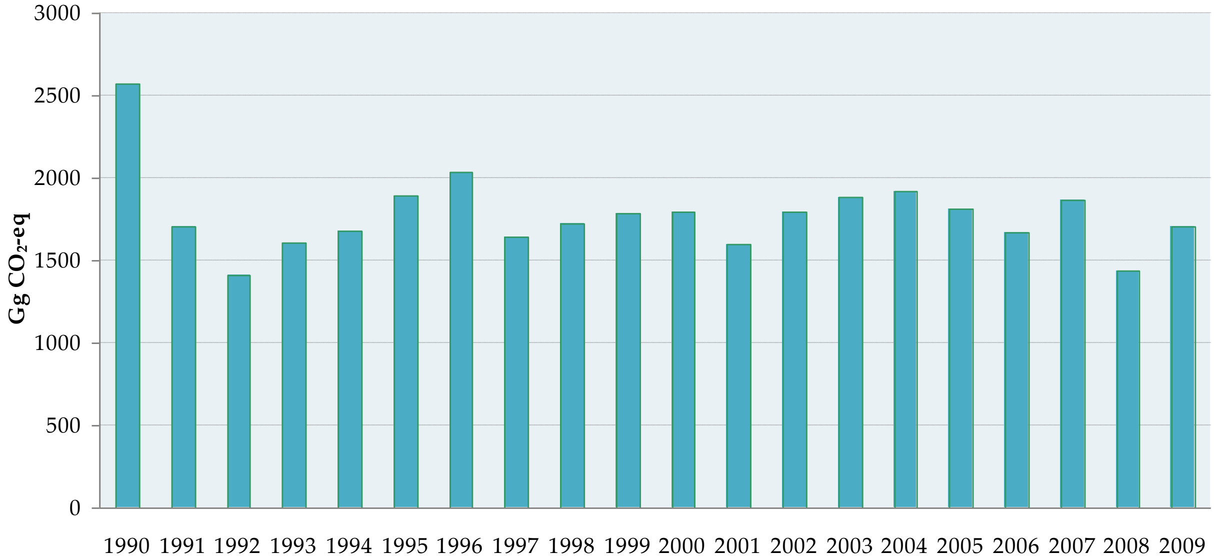

Figure 3.2-5: CO_2-eq emissions from Petroleum Refining subsector for the period from 1990 to 2009

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 2009 are presented in Figure 3.2-6.

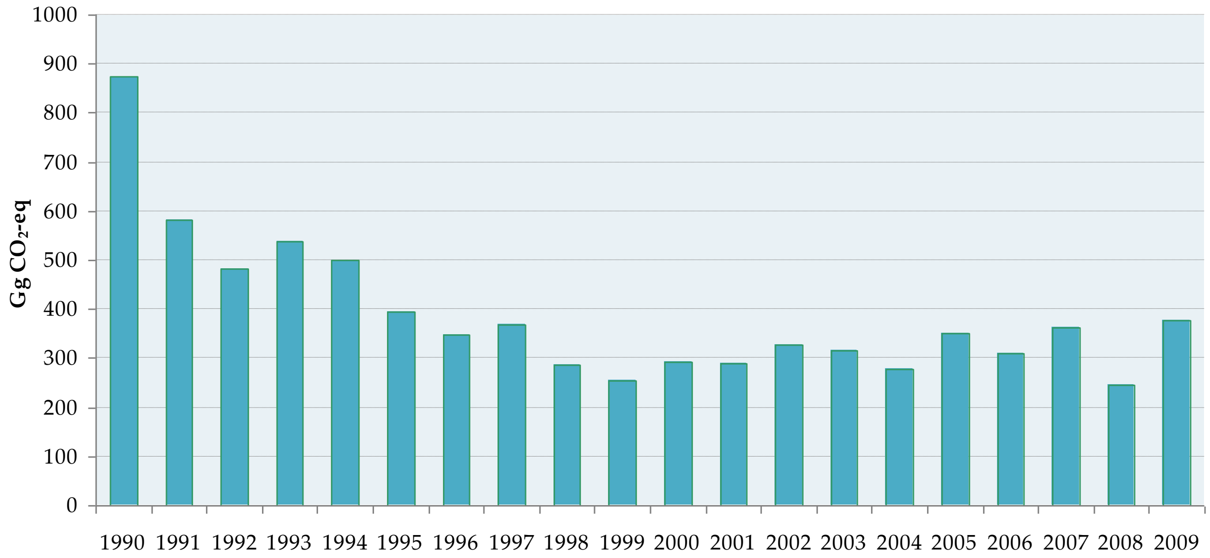

Figure 3.2-6: CO_2-eq emissions from Manufacturing of Solid Fuels and Other Energy Industries for the period from 1990 to 2009

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

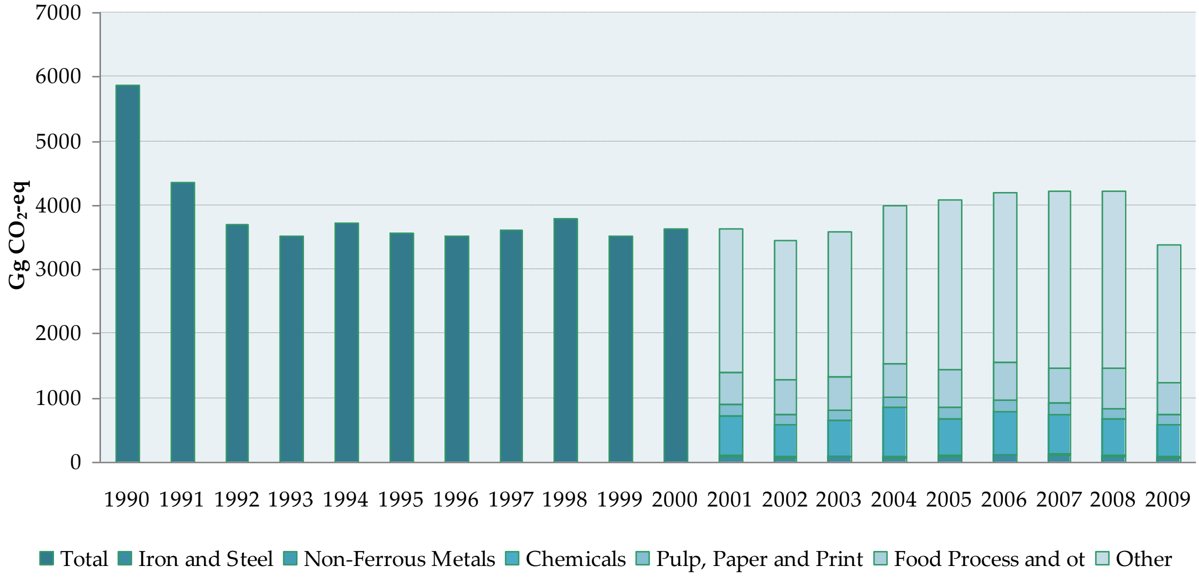

Figure 3.2-7: CO_2-eq emissions from Manufacturing Industries and Construction

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 2001-2009 (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
Civil Aviation	156.1	79.4	55.4	67.2	73.9	76.7	89.0	78.1
Road Transport	3,630.6	3,147.5	4,276.0	5,373.2	5,670.0	6,094.2	5,919.9	5,842.5
Railways	138.7	106.8	85.8	95.9	101.6	102.5	101.6	89.6
National Navigation	133.5	98.7	86.1	100.0	104.1	108.2	131.3	145.9
Total Transport	**4,059.0**	**3,432.4**	**4,503.3**	**5,636.3**	**5,949.5**	**6,381.5**	**6,241.8**	**6,156.1**

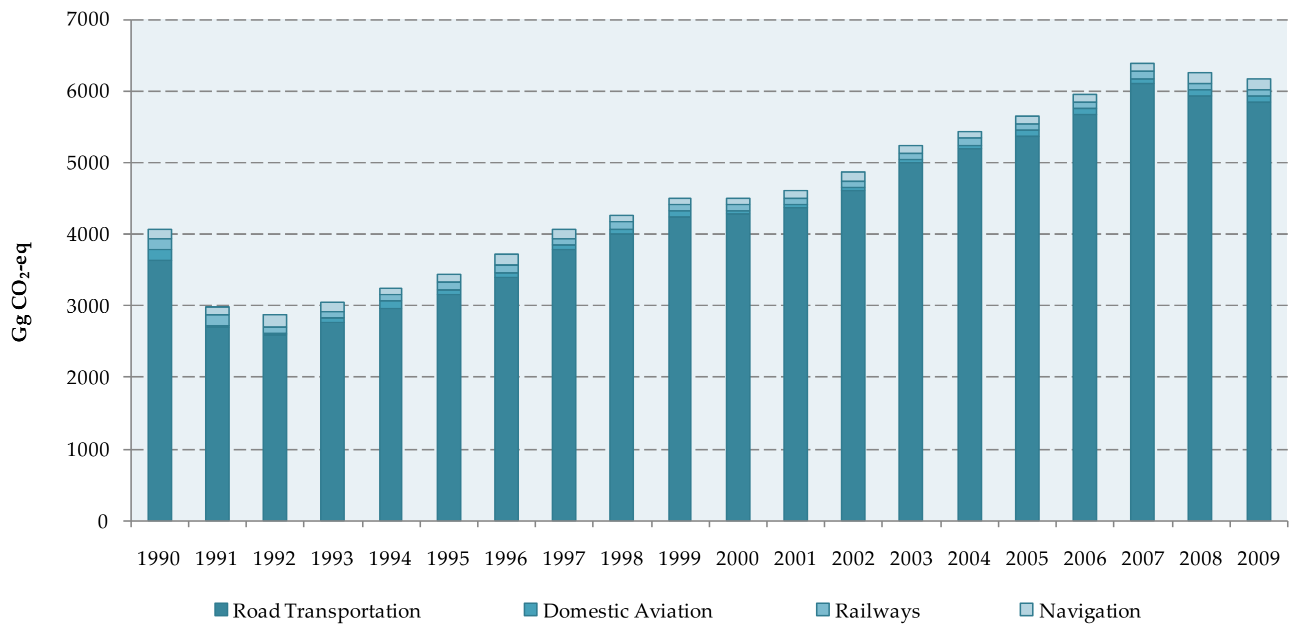

Figure 3.2-8: The CO_2-eq emissions from Transport

The contribution from Transport sector to the total CO_2-eq emissions from Energy sector in 2009 was 28%.

CO_2-eq emissions from the transport sector in 2009 amounted to 6,156.07 Gg, which is 1.37% less than in 2008 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 2009 and contributed to the CO_2-eq emissions from the transport sector with 94.91%. In 2009, the sector Civil aviation (domestic) was contributed to the CO_2-eq emissions from the transport sector with 1.27%, Railways with 1.46% and Navigation with 2.34% (Figure 2.3-8).

In comparison with 1990, CO_2-eq emissions from the transport sector were increased by 51.67% 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 2009 was amounted to 78.11 Gg, which is 12.25% less than in 2008 as a result of decrease of fuel jet kerosene consumption. In comparison with 1990, CO_2-eq emission was by 49.96% 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
Total jet kerosene (10^3 t)	160.0	85.0	72.0	93.0	96.3	99.6	112.7	96.9
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
Passangers carried – international (10^3)		346.0	712.0	1,633.0	1,698.0	1,796.0	1,775.0	1,561.0
Passangers carried – domastic (10^3)		333.0	360.0	466.0	450.0	492.0	554.0	492.0
Passangers kilometers- total (10^6)		444.0	763.0	1,989.0	1,959.0	2,055.0	1,945.0	1,636.0
Passangers kilometers-inter. (10^6)		317.0	656.0	1,842.0	1,813.0	1,896.0	1,768.0	1,483.0
Passangers kilometers-dom. (10^6)		127.0	107.0	147.0	146.0	159.0	177.0	153.0
Passangers domestic/km		381.4	297.2	315.5	324.4	323.2	319.5	311.0
Passangers international/km		916.2	921.3	1,128.0	1,067.7	1,055.7	996.1	950.0
Passangers international+domastic		1,297.6	1,218.1	1,443.4	1,392.2	1,378.9	1,315.6	1,261.0
share domestic	0.311	0.294	0.244	0.219	0.233	0.234	0.243	0.247
Jet kerosene in domestic aviation	**49.68**	**24.98**	**17.56**	**20.32**	**22.44**	**23.34**	**27.37**	**23.90**
Jet kerosene in international aviation	**110.32**	**60.02**	**54.44**	**72.68**	**73.86**	**76.26**	**85.33**	**73.00**

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 1991-2007 (Figure 3.2-9).

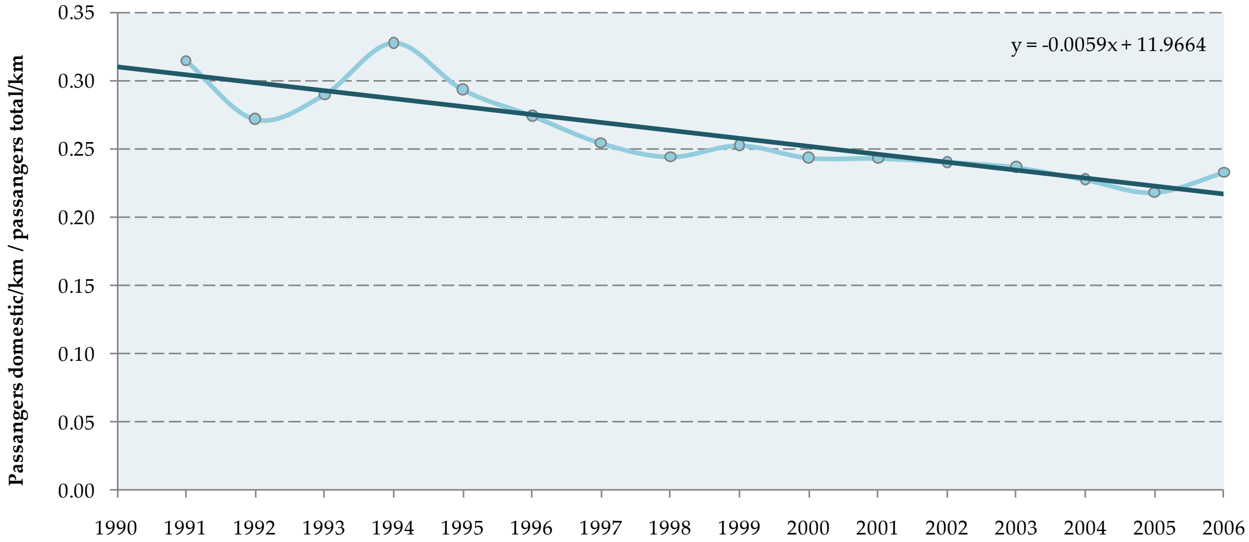

Figure 3.2-9: The average km traveled per passenger on domestic/international routes for the period 1991-2006

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 7.1 software package (Tier 2/3 method) was used for CO_2, CH_4 and N_2O emission calculation for the period from 1990 to 2009, 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 for year 1990, 1995, 2000, and 2005 – 2009 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.

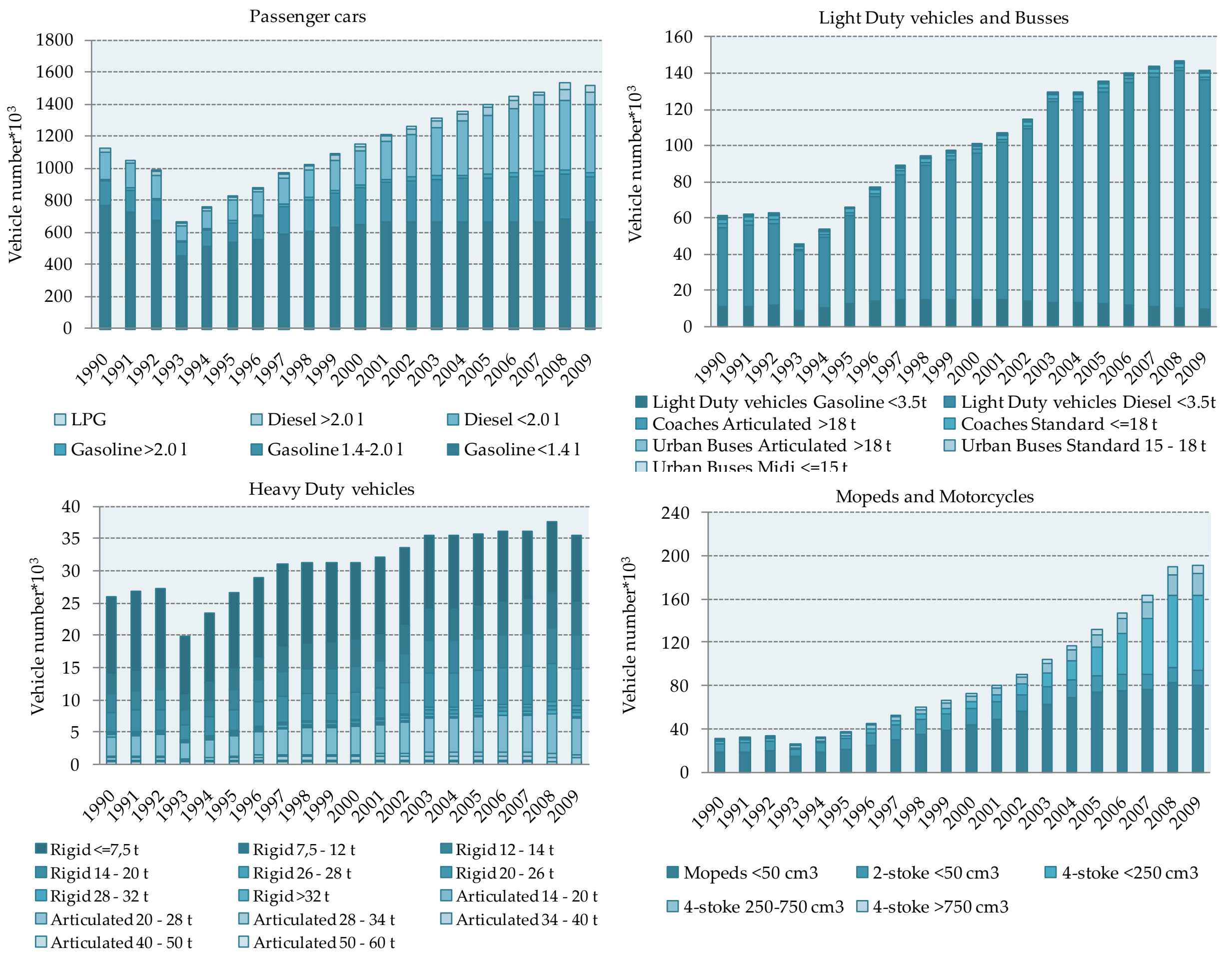

Figure 3.2-10: Number of vehicles in sub-classes in the period from 1990 to 2009

Comparing the total number of vehicles in 2009 with the number of vehicles in 1990 it can be notice the increase by 52.3% (Table A2-10 Annex 2). The increase was largely the result of increase in the number of passenger cars by 35.4%, constituting 80.5% of the total number of road vehicles in 2009. Other classes of vehicles were also increased in this period: the number of Light Duty vehicles increased by 2.5 times, Heavy Duty vehicles by 2.4 times, motorcycles and mopedsby 6.3 times. In the period 1990 - 2009 only the number of buses was increased by 22.5%.

The number of passenger cars was increased from 1990 to 2009 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 (88.6%). At the same time the number of gasoline cars with engine size <1.4 l decreased by 13.6%.

The total number of duty vehicles in the period from 1990 to 2009 was increased by 2.0 times as a result of increasing the number of diesel light duty vehicles with engine size <3.5 t (72.0% 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 2009 due to increase in the number of mopeds engine size <50 cm^3 (+41.9%) and motorcycle engine size <250 cm^3 (+36.3%).

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.

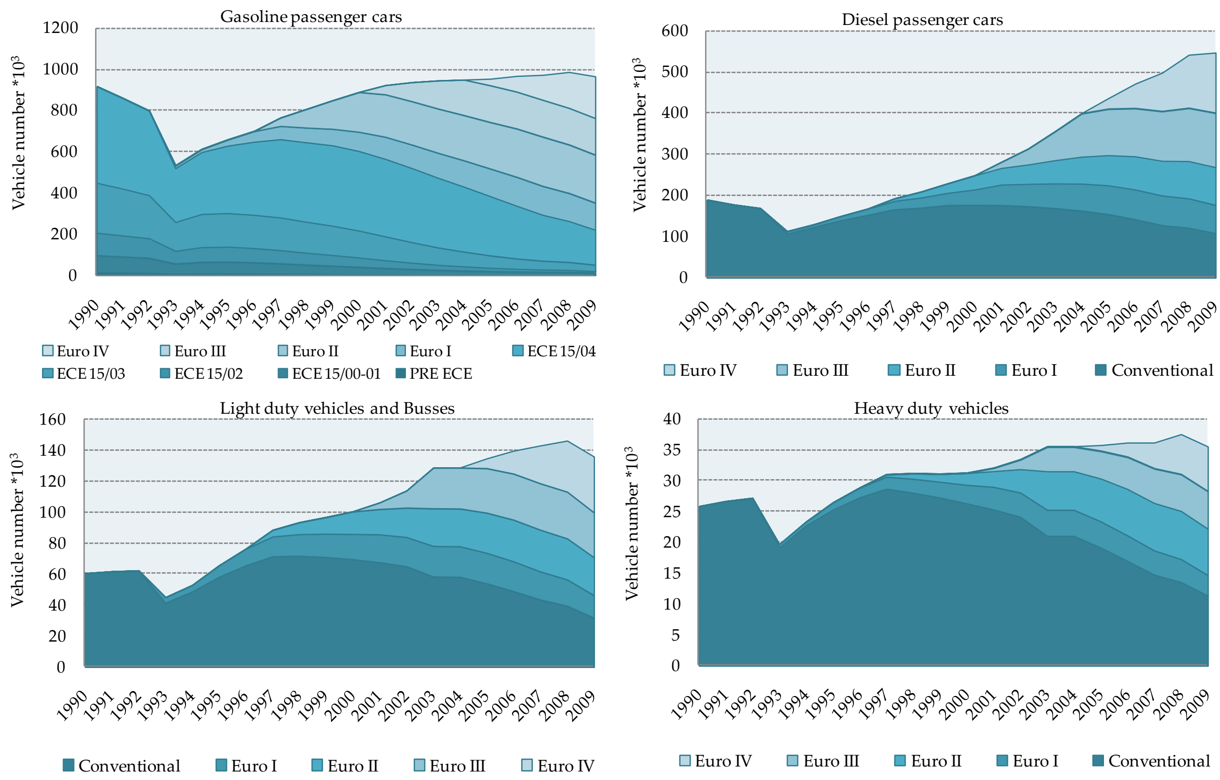

Figure 3.2-11: Layer distribution of vehicle numbers per vehicle type for the period from 1990 to 2009

The GHG emissions for the period from1990 to 2009 were calculated using COPERT 4 ver 7.1 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 - 2009 are shown in Table A2-11 Annex 2.

The CO_2-eq from the sub-sectors Road transport in 2009 amounted to 5,842.5 Gg, which is 1.3% less than in 2008 as a result of decrease in fuel consumption. In comparison with 1990, CO_2-eq was increased by 60.9% 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 11.0%.

Trends of CO_2-eq emissions for fossil fuel type consumed in road transport for the period from 1990 to 2009 are shown in Figure 3.2-12.

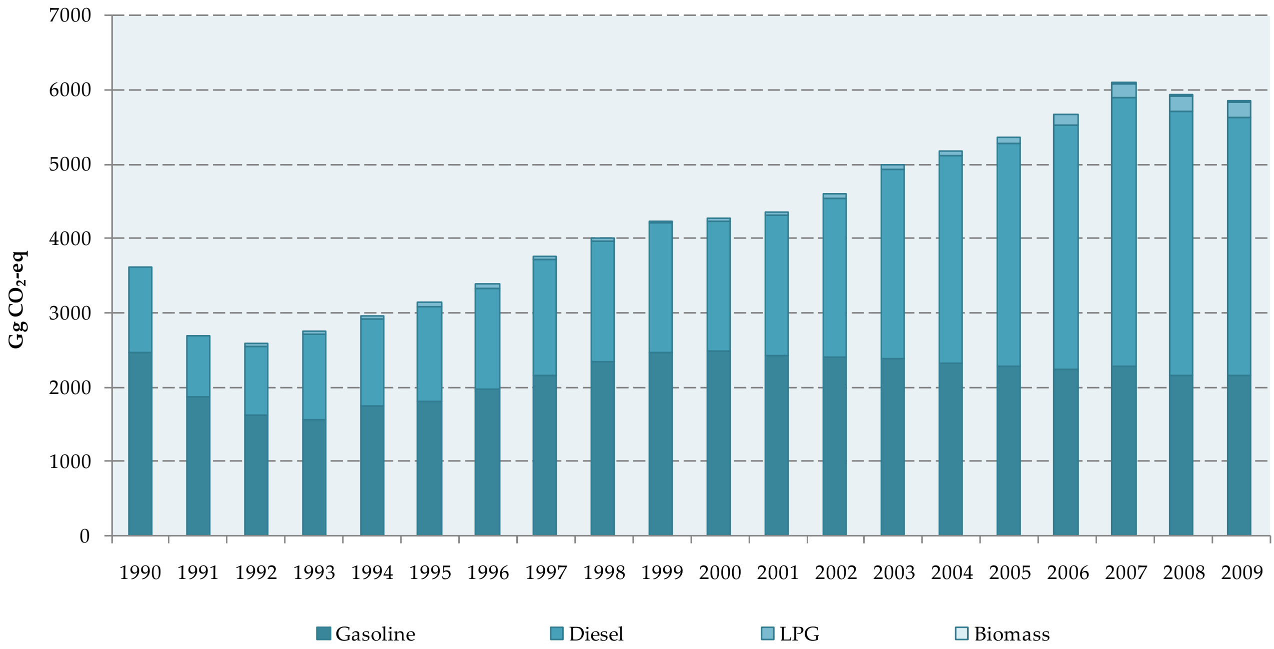

Figure 3.2-12: The CO_2-eq emission from Road transport sub-sector by fossil fuel type for the period from 1990 to 2009

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 - 2009 are shown in the Table A2-14 of the Annex 2.

The CO_2-eq from the sub-sectors Railways in 2009 was amounted to 89.61 Gg, which is 11.76% less than in 2008 as a result of decrease in fuel consumption. 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 - 2009 are shown in the Table A2-13 of the Annex 2.

The CO_2-eq from the sub-sectors Navigation in 2009 was amounted to 145.87 Gg, that is for 11.06% higher than in 2008 as a result of increase in fuel consumption. In comparison with 1990, CO_2-eq was increased by 9.26% as a result of increase in navigation traffic and consequently increases 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
Commerc./Institutional	775	652	638	786	723	611	626	627
Residential	2,176	1,688	2,008	2,481	2,286	2,060	2,116	2,166
Agric./Forestry/Fishing	843	583	861	712	732	725	787	738
Total	**3,794**	**2,923**	**3,507**	**3,979**	**3,741**	**3,396**	**3,529**	**3,531**

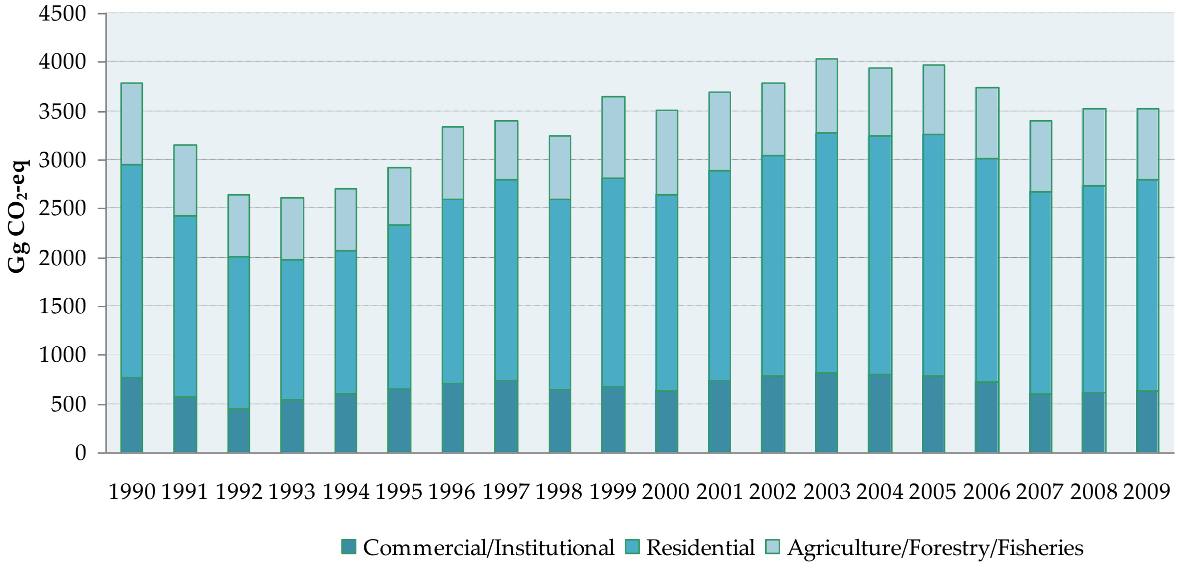

Figure 3.2-13: The CO_2-eq emissions from Small Stationary Energy Sources

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 2009 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 2009 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).

NOx emissions

The NOx emission encompasses nitrogen monoxide and nitrogen dioxide emissions. The emissions are expressed as equivalents of NO_2. NOx 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, NOx takes part in ground ozone formation.

The emission of NOx from Energy sector (Fuel Combustion Activities) in 2009 was 68.4 Gg which is 7 percent lower than the year before and 20.6 percent lower compared to 1990. The NOx emissions from Energy sector contribute with 97.6 percent to national total NOx emission. The structure of NOx emission in Energy sector has not changed significantly in the period from 1990 to 2009 (Figure 3.2-14). The main source of NOx emission is transport (44.8 percent of total emission). Small stationary energy sources accounted for 19 percent to national total NOx emission and emission from industry sectors accounted for 18 percent to the national total.

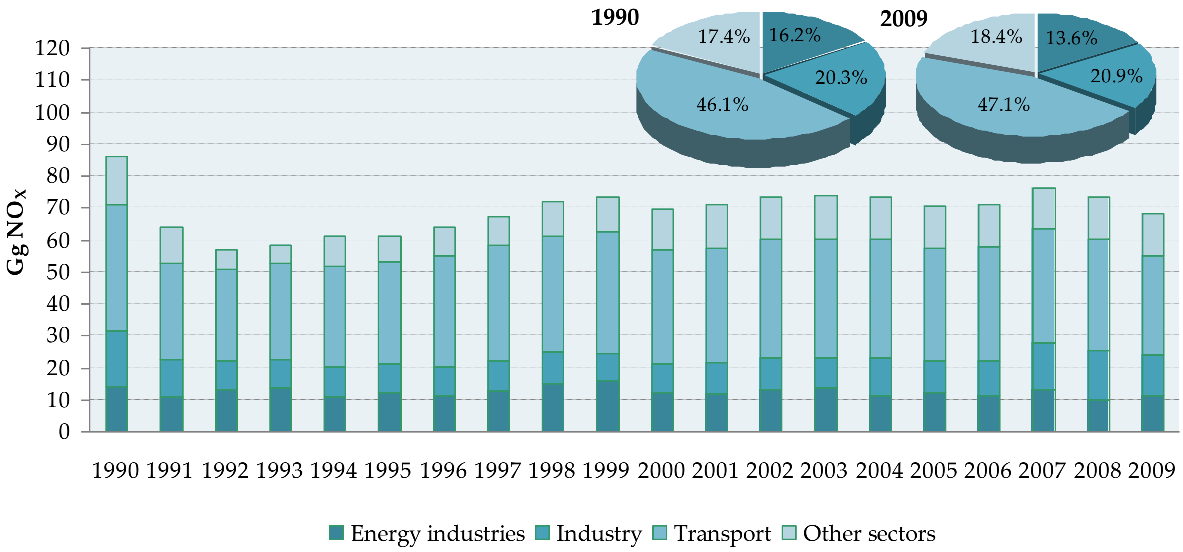

Figure 3.2-14: NOx emissions from Energy sector in the period 1990-2009

CO emissions

In 2009, the emission of CO from Fuel Combustion Activities was 234.4 Gg which is 1.8 percent lower than in the year before and 51.7 percent lower compared to 1990, the year with maximum emission (484.8 Gg) of CO in the observed period. The CO emissions from Energy sector in 2009 contribute with 81.7 percent to national total CO emission. 31 percent of CO emission in Energy sector in 2009 was the result of incomplete fossil fuel combustion in Road transport sector and 53.8 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).

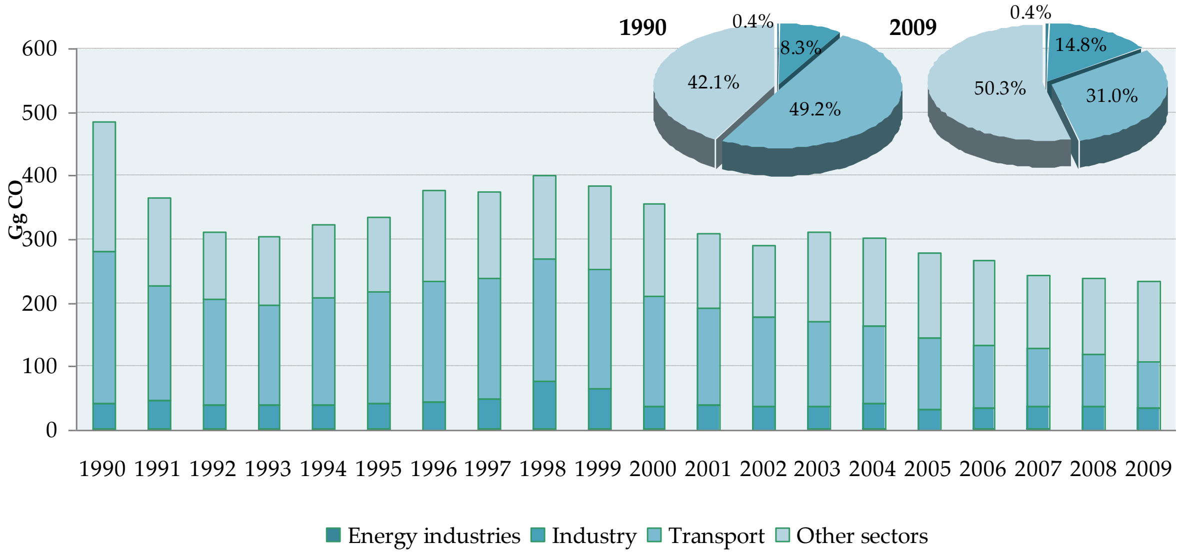

Figure 3.2-15: CO emissions from Energy sector in the period 1990-2009

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 23.6 Gg in 2009 which was 7.7 percent lower than the year before and 55.2 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 2009 (Figure 3.2-16). The main source of NMVOC emission is transport sources sector (57.4 percent of total emission of Energy sector). Emission of NMVOC from stationary combustion sectors accounted with 14.3 percent to the national total, mainly from the Commercial and Residential sector (11.4 percent).

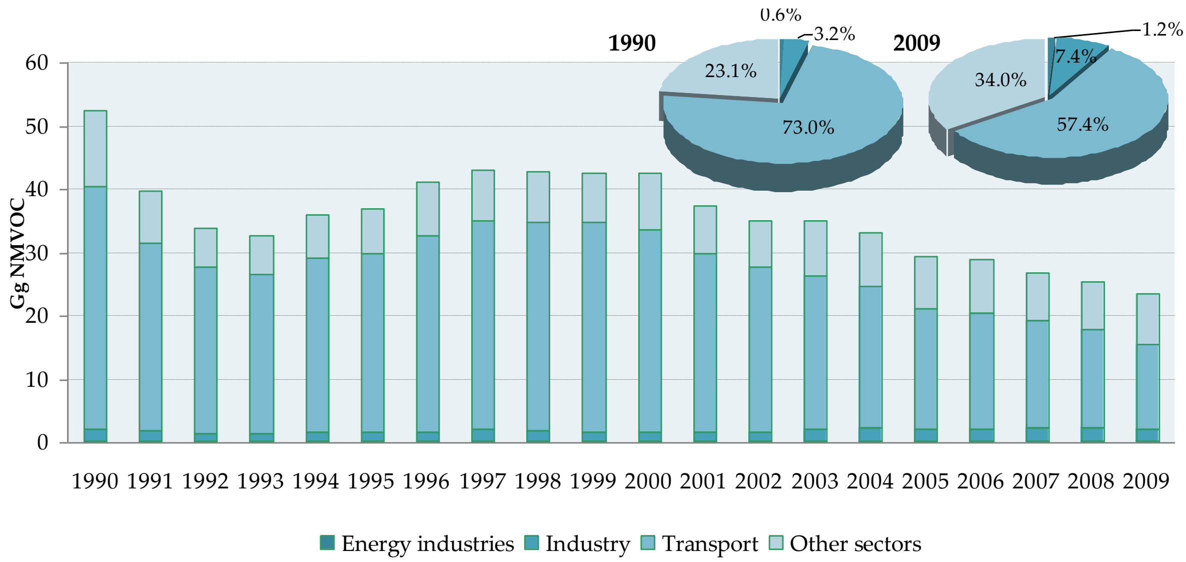

Figure 3.2-16: NMVOC emissions from Energy sector in the period 1990-2009

SO_2 emissions

In accordance with the calculated results, the level of SO_2 emission from Fuel Combustion Activities in 2009 reached 61.8 Gg which is 92.7% of total national SO_2 emission. The trend shows that emissions of SO_2 have increased by 19.1 percent compared to the emission in 2008 and decreased by 61.9 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 2009, the decrease of SO_2 emissions was achieved in almost all sectors and the greatest decrease of SO_2 emission was in Manufacturing Industries and Construction sector (-74.3%). Emission trend for SO_2 in the period of 1990 to 2009 as well as the share of the particular sectors in total emission of SO_2 in Energy sector 1990 and 2009 is presented in Figure 3.2-17.

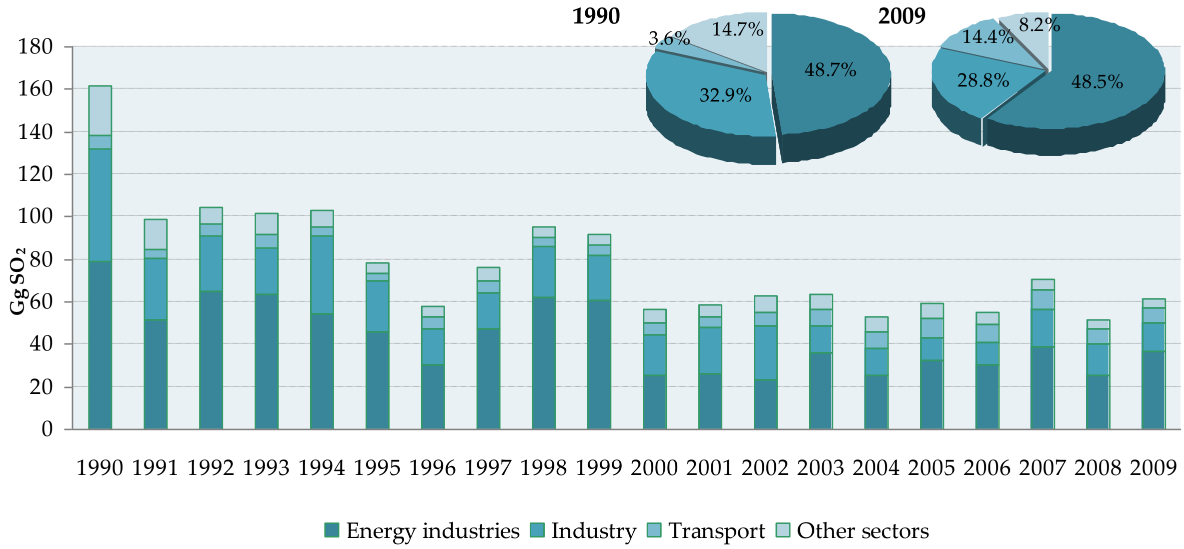

Figure 3.2-17: SO_2 emissions from Energy sector in the period 1990-2009

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
NO_x Emission	86.25	61.16	69.65	70.60	70.91	76.18	73.56	68.44
Energy Industries	13.96	12.24	12.11	12.04	11.15	13.41	10.03	11.16
Manuf. Ind. & Cons.	17.49	8.92	9.15	9.91	11.04	14.51	15.36	12.61
Transport	39.77	31.87	35.55	35.50	35.47	35.41	34.66	31.38
Other Sectors	15.03	8.13	12.85	13.15	13.24	12.86	13.51	13.29
CO Emission	484.83	334.80	357.29	278.78	267.52	243.70	238.70	234.37
Energy Industries	1.70	1.22	1.23	0.93	1.35	1.90	1.14	0.96
Manuf. Ind. & Cons.	40.44	41.20	36.43	32.93	33.48	34.94	36.51	34.71
Transport	238.74	175.68	173.24	111.95	99.22	91.29	80.99	72.55
Other Sectors	203.95	116.68	146.39	132.96	133.47	115.58	120.06	126.15
NMVOC Emission	52.55	36.88	42.65	29.44	28.91	26.77	25.50	23.58
Energy Industries	0.33	0.26	0.29	0.29	0.29	0.34	0.28	0.33
Manuf. Ind. & Cons.	1.70	1.36	1.43	1.76	1.86	2.01	2.14	1.75
Transport	38.38	28.35	31.92	19.10	18.39	17.02	15.37	13.50
Other Sectors	12.14	6.91	9.01	8.29	8.37	7.41	7.72	8.01
SO_2 Emission	161.97	78.42	56.81	59.03	55.12	70.29	51.83	61.76
Energy Industries	78.91	45.69	25.39	32.76	30.22	38.69	25.13	36.73
Manuf. Ind. & Cons.	53.32	24.54	18.94	10.34	10.64	17.53	14.95	13.73
Transport	5.87	3.54	5.98	9.15	8.45	9.22	7.49	6.79
Other Sectors	23.88	4.66	6.51	6.78	5.82	4.85	4.27	4.51

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 2009 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 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 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 2008 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

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

In this sector one recalculation was performed:

- CO_2 emission from Petrochemical Production (ammonia production)
  - 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).

Table 3.2-13 gives an overview of the differences in emissions before and after recalculation in Manufacturing Industry and Construction sector. Impact of recalculation in Manufacturing Industry and Construction sector on total emissions (excluding LULUCF) are shown in the Table 3.2-14.

Table 3.2-13: Differences in emissions before and after recalculation in Manufacturing Industries and Construction sector

Manufacturing Industries and Construction	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, %	7.26	11.89	19.21	16.96	16.52	20.92	18.02	19.81	14.72	18.58
CH_4, %	7.48	11.51	18.02	15.58	16.57	20.61	17.85	17.97	14.48	19.50
N_2O, %	1.24	2.00	3.34	2.94	3.22	3.85	3.36	3.46	2.77	3.74

Manufacturing Industries and Construction	2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2, %	17.55	14.02	13.37	15.03	11.95	11.55	10.61	11.75	11.40
CH_4, %	18.56	15.75	14.83	15.44	11.63	12.75	11.75	12.35	12.81
N_2O, %	3.51	2.91	2.70	2.78	2.09	2.27	2.03	2.24	2.37

Table 3.2-14: Impact of recalculation on total emissions (excluding LULUCF)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, %	1.26	1.86	2.57	2.21	2.36	2.67	2.28	2.39	1.93	2.09
CH_4, %	0.002	0.004	0.005	0.004	0.004	0.005	0.004	0.004	0.004	0.004
N_2O, %	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

	2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2, %	2.08	1.63	1.43	1.56	1.42	1.40	1.31	1.37	1.39
CH_4, %	0.004	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.003
N_2O, %	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

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

GHG emissions of this sector have been recalculated for the sequence 1990-2008. The reason of recalculation is the usage of new version of COPERT 4 for calculating the pollutant emissions from the road traffic, COPERT 4 ver.7.1. 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. Changes that are included within the scope of version 7.1 COPERT 4 are listed in the literature 1.

Within this report, a more detailed distribution of heavy duty vehicle and buses were introduced (see Table 3.2-10).

It was noted that in 2006 and 2007 were lacked data on millages for passenger car sub-categories Gasoline 1.4 to 2.0 l, PC Euro 4 - 98/69/EC Stage2005 which is corrected in this report. The above implies that for this vehicle class, GHG emissions were not been calculated.

Given the above, recalculation resulted with changes in GHG emissions (%), as shown in Table 3.2-15.

Table 3.2-15: Differences in GHG emissions (%) from road traffic due to the recalculation conducted in relation to previously reported CRF and NIR-2010

Transport	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, %	-0,03	-0,17	-0,05	0,14	0,77	-0,06	-0,01	-0,01	-0,03	0,01
CH_4, %	-22,68	-22,74	-22,33	-23,27	-22,51	-23,15	-23,34	-23,06	-22,55	-22,38
N_2O, %	-23.60	-30.12	-27.50	-26.93	-26.10	-27.49	-26.24	-25.77	-25.00	-25.11

Transport	2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2, %	-0,03	-0,06	-0,02	0,04	-0,03	-0,05	-0,09	0,02	-0,03
CH_4, %	-21,98	-22,63	-22,70	-22,28	-22,34	-22,22	-23,26	-22,93	-21,98
N_2O, %	-24.24	-27.09	-24.97	-26.09	-26.26	-28.35	-61.04	-26.96	-24.24

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:

<u>Short-term goals (< 1 years)</u>

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

<u>Long-term goals (> 1 years)</u>

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.

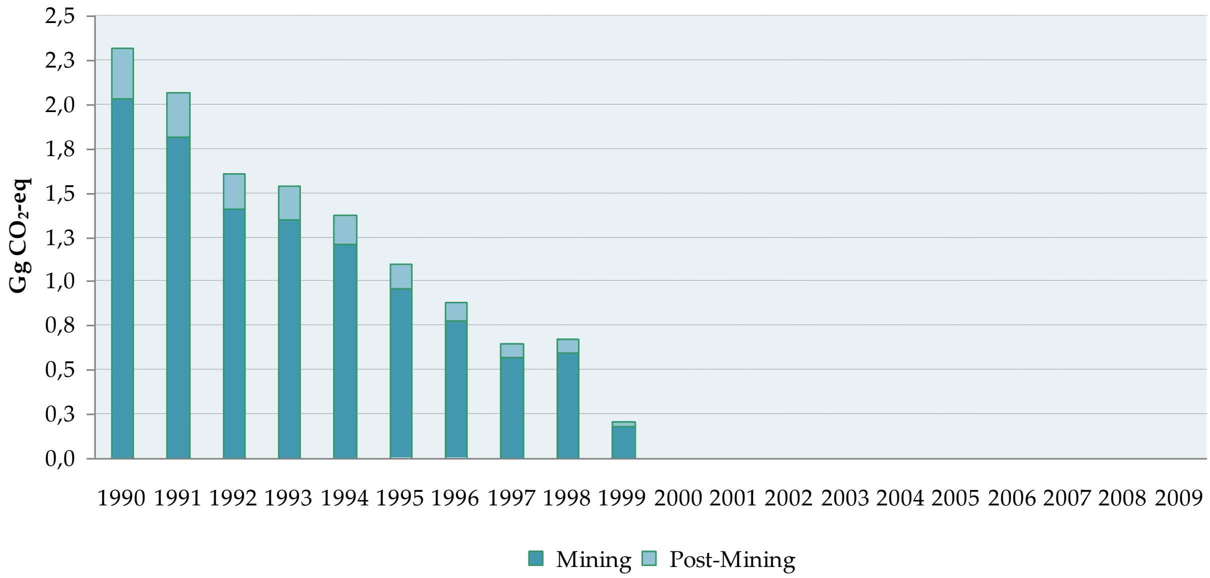

Figure 3.3-1: The fugitive emissions of methane from coal mines

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.

<u>Fugitive emission of methane</u>

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.

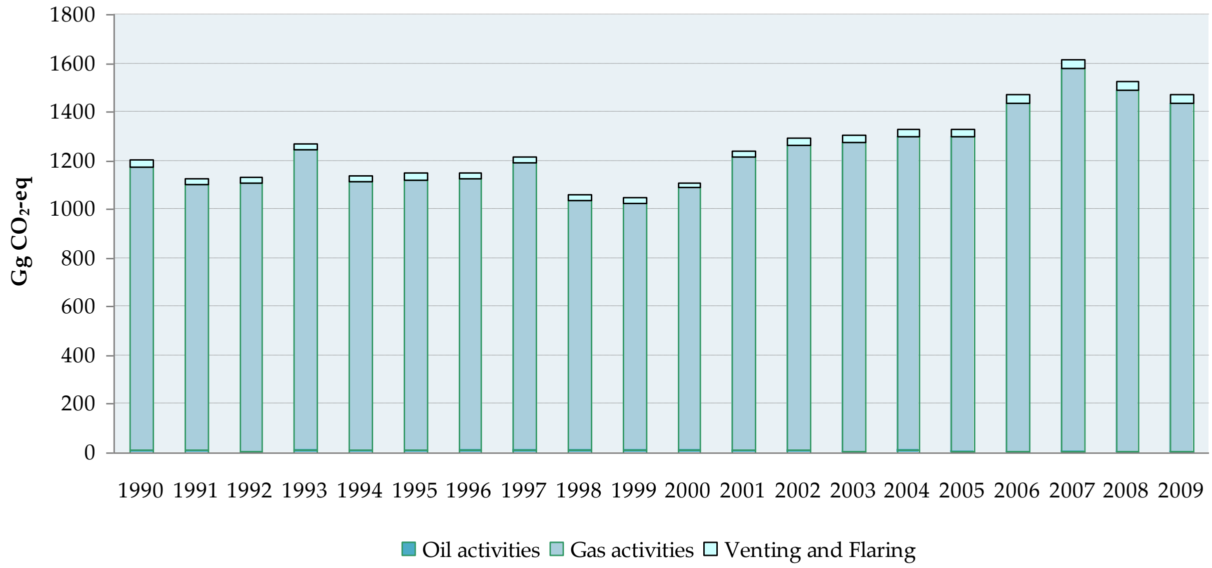

Figure 3.3-2: The fugitive emissions of methane from oil and gas activities

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 2009 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
CO emission	50.04	34.50	54.07	54.41	44.43	53.47	41.61	51.91
NO_x emission	0.26	0.18	0.28	0.28	0.23	0.27	0.21	0.27
NMVOC emission	8.50	6.73	9.06	8.45	8.34	8.24	7.47	7.95
SO_2 emission	1.80	1.24	3.11	3.10	2.54	3.17	2.83	3.27

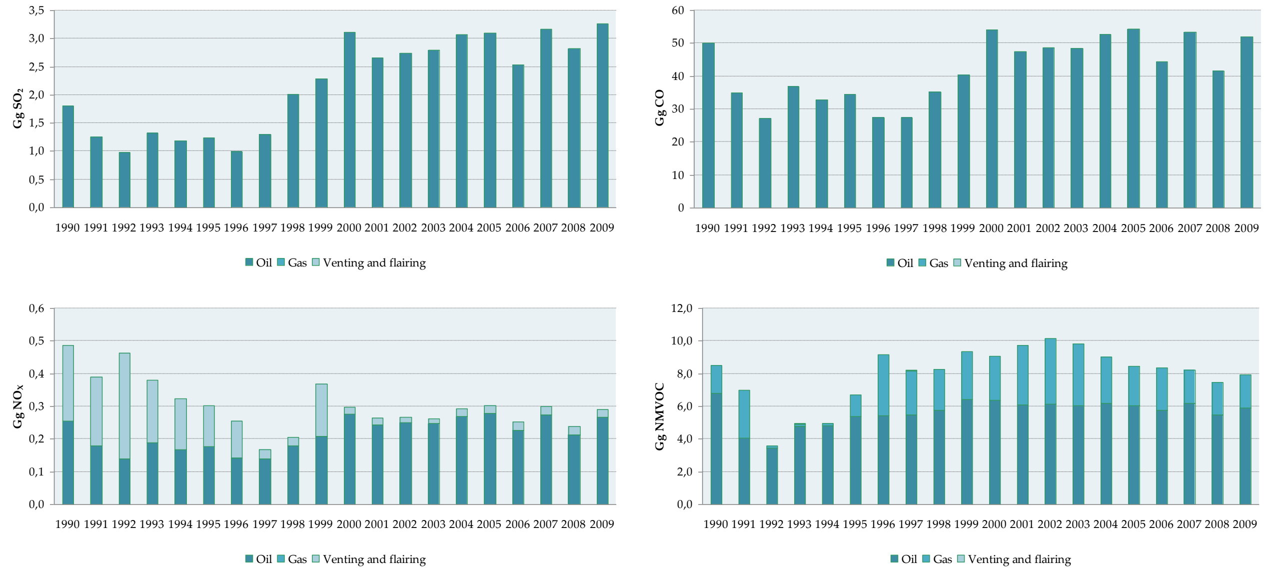

Figure 3.3-3: The fugitive emissions of CO, NO_x, NMVOC and SO_2

<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
Central Gas Station MOLVE	416	697	633	691	663	665	576	516

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)
    - Necessary recalculation was due to typing errors. Recalculation was performed for 2008.

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

Fugitive Emission from Oil, Natural Gas and Other Sources	Previous submission	Last submission	Difference	Difference	Impact of recalculation on total emissions (excluding LULUCF)
	Gg			%	
CO_2	666.00	575.82	-90.18	-13.54	**-0.29**

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)

4.1. OVERVIEW 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 source of N_2O emissions. Emissions of CH_4 are appeared 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 are, in most cases, extracted from Annual Industrial Reports, published by Central Bureau of Statistics, Department of Manufacturing and Mining. These reports cover industrial activities according to prescribed national classification of activities and comprise data on production and consumption of raw materials on annual basis. In cases when such data were insufficient or some production-specific data were required to calculate emissions, individual manufacturers were contacted and surveys were carried out.

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 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 has been dropped by 20 percent average, regarding 2008. In 2009, cement production was decreased by 22 percent, lime production by 36 percent, ammonia production by 16 percent and iron and steel production by 67 percent, regarding 2008.

The total annual emissions of GHGs, expressed in Gg CO_2-eq, from Industrial Processes in the period 1990-2009 are presented in the Figure 4.1-1.

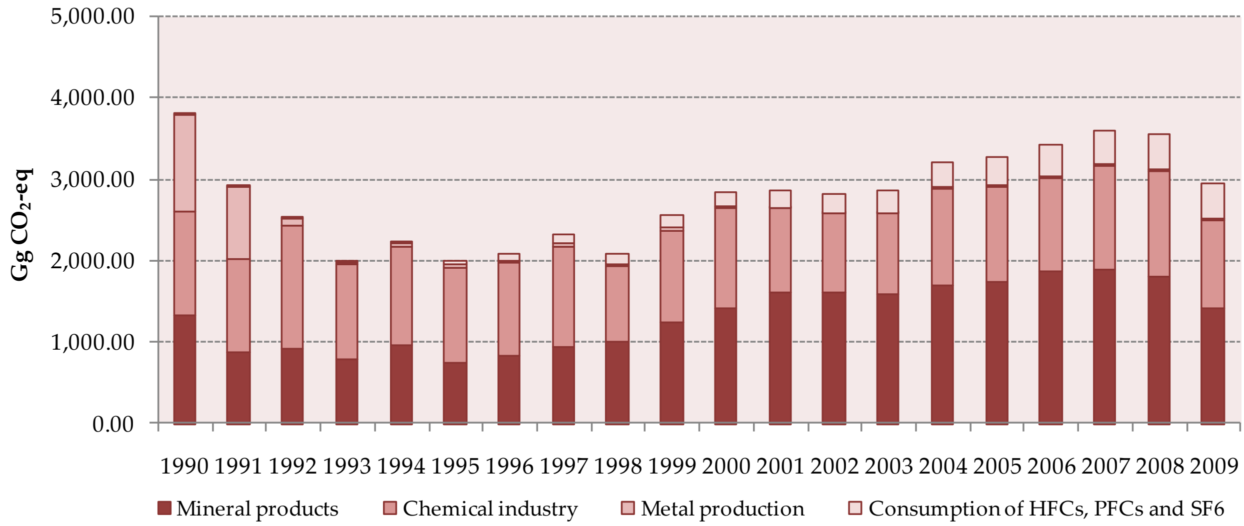

Figure 4.1-1: Emissions of GHGs from Industrial Processes (1990-2009)

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 2009[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		
CO_2 Emissions from Ferroalloys Production	CO_2			T1e, T2e	T1i
CO_2 Emissions from Aluminium Production	CO_2			T1e	T1i
N_2O Emissions from Nitric Acid Production	N_2O	L1e, L2e	L1i, L2i	T1e, T2e	T1i, 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		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 - 2009)

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

[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 - 2009)

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
1998	116,397	0	82,451	14	-22,552	8,827

Table 4.2-2: Import/export quantities of clinker (1990 - 2009), cont.

Year	Clinker import / tonnes		Clinker export / tonnes		Change in clinker stocks* / tonnes	
	Portland	Aluminate	Portland	Aluminate	Portland	Aluminate
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
1990	0	0	0	0	9,484	-113

* 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 1990-2009 are presented in the Figure 4.2-1.

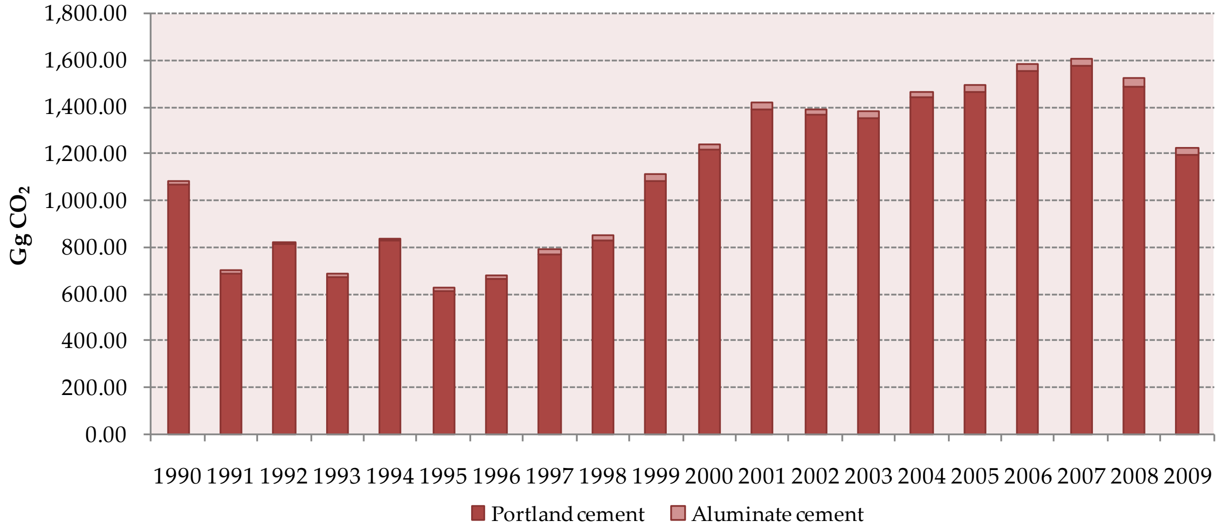

Figure 4.2-1: Emissions of CO_2 from Cement Production (1990-2009)

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, which influenced decreasing of cement production by 22 percent, emissions were decreased by 20 percent, regarding 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 (1990-2009)

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

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 2009* 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 1990-2009 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

There are no source-specific recalculations in this report.

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.

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 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.

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

Table 4.2-4: Lime production and emission factors (1990-2009)

Year	Quicklime		Dolomitic lime	
	Production (tonnes)	EF (t CO_2/t lime)	Production (tonnes)	EF (t CO_2/t lime)
1990	211,801	0.728	7,474	0.869
1991	155,258	0.732	0	-
1992	106,393	0.720	0	-
1993	116,893	0.723	0	-
1994	117,178	0.725	0	-
1995	113,452	0.735	0	-
1996	109,185	0.722	38,070	0.862
1997	100,863	0.720	55,171	0.850
1998	105,261	0.733	53,367	0.874
1999	90,794	0.738	52,704	0.870
2000	105,374	0.731	68,572	0.887
2001	118,161	0.741	84,838	0.887
2002	129,134	0.746	94,378	0.892
2003	124,617	0.749	96,191	0.879
2004	181,306	0.747	56,689	0.895
2005	173,710	0.757	76,351	0.875
2006	199,784	0.750	105,653	0.895
2007	198,790	0.759	115,315	0.899
2008	190,344	0.752	120,680	0.900
2009	116,642	0.717	87,789	0.861

The resulting emissions of CO_2 from Lime Production in the period 1990-2009 are presented in the Figure 4.2-2.

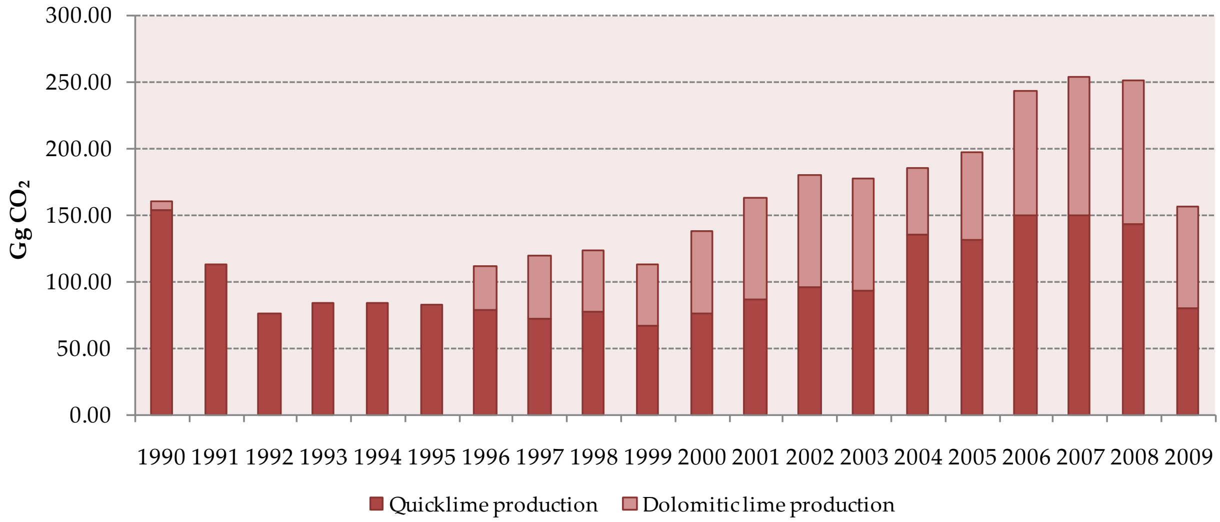

Figure 4.2-2: Emissions of CO_2 from Lime Production (1990-2009)

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 36 percent, emissions were decreased by 38 percent, regarding 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 2009* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of CO from Lime Production in the period 1990-2009 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.

Lime 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 lime 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 quicklime and dolomitic lime were compared with IPCC default emission factors. Difference between these two data sets is caused by difference in CaO/CaO*MgO content in lime.

4.2.2.5. Source specific recalculations

There are no source-specific recalculations in this report.

4.2.2.6. Source–specific planned improvements

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

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).

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, assuming 100 percent purity of raw material (*Revised 1996 IPCC Guidelines*).

The activity data for limestone use in the pig iron production for the 1990 and 1991 were collected by survey of iron manufacturer.

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. Data for the period from 2000-2009 include limestone use in desulphurization process in Thermal Power Plant (TPP) Plomin 2[6] (see Table 4.2-5).

[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.

Table 4.2-5: Limestone and dolomite use (1990-2009)

Year	Limestone use (tonnes)	Dolomite use (tonnes)
1990	60,609	52,031
1991	30,500	40,452
1992	9,946	21,505
1993	9,588	20,134
1994	13,701	32,504
1995	14,080	23,461
1996	12,935	25,063
1997	10,745	14,762
1998	12,957	17,565
1999	11,782	16,205
2000	18,585	16,695
2001	22,233	18,596
2002	26,226	20,022
2003	30,870	23,975
2004	32,871	24,088
2005	32,759	25,269
2006	30,275	22,350
2007	27,138	20,018
2008	31,759	20,018
2009	30,320	35,707

The resulting emissions of CO_2 from Limestone and Dolomite Use in the period 1990-2009 are presented in the Figure 4.2-3.

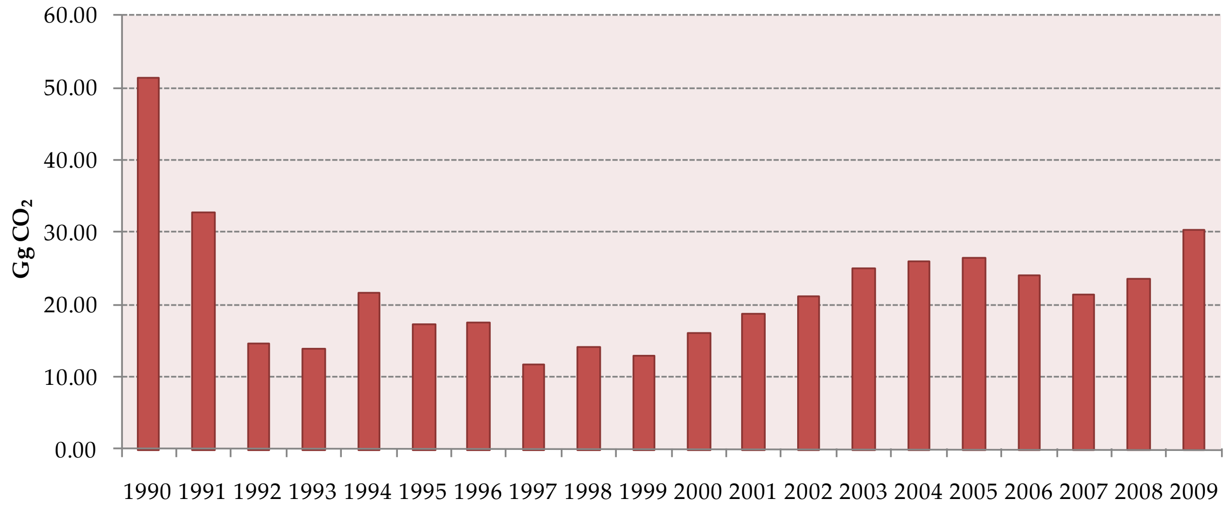

Figure 4.2-3: Emissions of CO_2 from Limestone and Dolomite Use (1990-2009)

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 1997-2009. 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 2009 are more detailed regarding data for the period 1997-2008 and therefore discrepancy has occurred concerning the whole time-series. So far, detailed data for the period 1997-2008 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

There are no source-specific recalculations in this report.

4.2.3.6. Source–specific planned improvements

Detailed activity data have been collected from individual plants only for the year 2009. Therefore, gathering of data for entire time-series 1997-2008 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 a white crystalline solid that is commercially used as a raw material in a large number of industrial processes including glass and ceramic manufacture, soap and detergents, pulp and paper production and water treatment.

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 1990-2009. 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).

Table 4.2-6: Soda ash use (1990-2009)

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	34,139
2002	32,910

Table 4.2-6: Soda ash use (1990-2009), cont.

Year	Soda ash use (tonnes)
2003	39,119
2004	43,217
2005	46,272
2006	41,690
2007	37,735
2008	37,555
2009	41,810

The resulting emissions of CO_2 from Soda Ash Use in the period 1990-2009 are presented in the Figure 4.2-4.

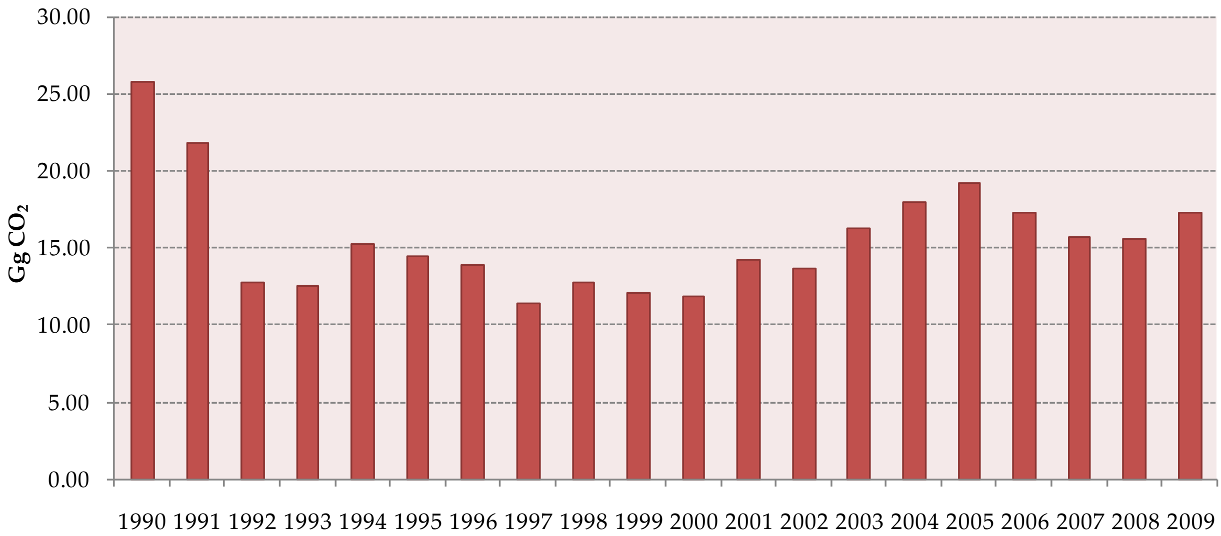

Figure 4.2-4: Emissions of CO_2 from Soda Ash Use (1990-2009)

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 1997-2009. 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. Data for 2009 are more detailed regarding data for the period 1997-2008 and therefore discrepancy has occurred concerning the whole time-series. So far, detailed data for the period 1997-2008 has not been collected from all 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.

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 1997-2008 because data from one soap and detergent manufacturer have been added.

4.2.4.6. Source–specific planned improvements

Gathering of data for entire time series 1997-2008 by all manufacturers should be performed to avoid potential inconsistency.

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 2009* 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 1990-2009 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

4.3.1.1. Source 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).

4.3.1.2. Methodological 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. Natural gas used as fuel (in previous report included in the sector Industrial Processes) has been relocated to the sector Energy.

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).

Table 4.3-1: Consumption and composition of natural gas in Ammonia Production (1990-2009)

Year	Natural gas consumption (m^3)	Carbon content of gas (kg C/m^3)
	Feedstock	
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

Table 4.3-1: Consumption and composition of natural gas in Ammonia Production (1990-2009), cont.

Year	Natural gas consumption (m^3)	Carbon content of gas ($kg C/m^3$)
	Feedstock	
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	0.5081

The resulting emissions of CO_2 from Ammonia Production in the period 1990-2009 are presented in the Figure 4.3-1.

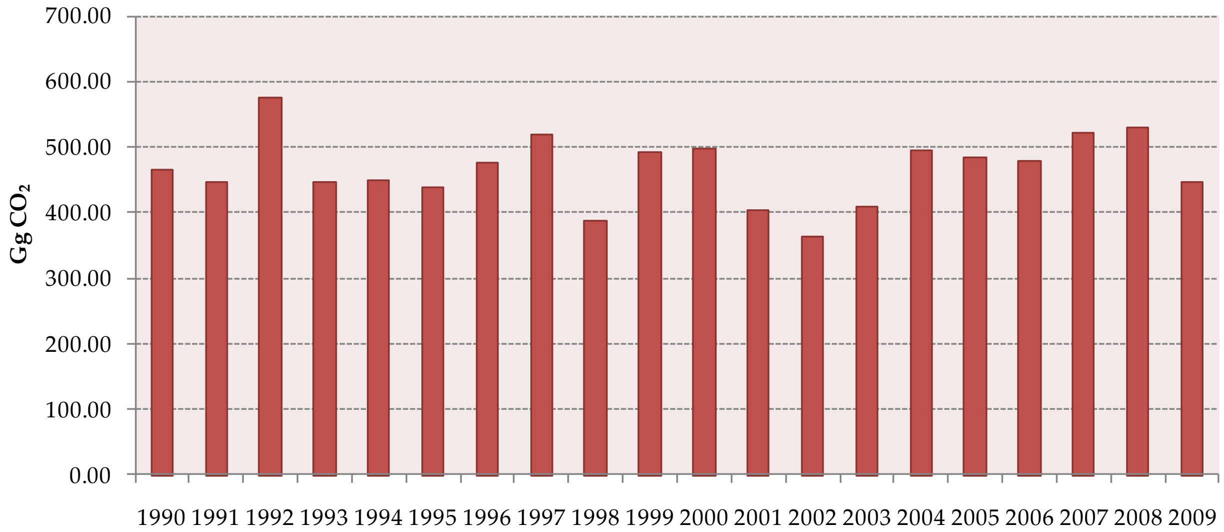

Figure 4.3-1: Emissions of CO_2 from Ammonia Production (1990-2009)

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.

4.3.1.5. Source–specific recalculations

According to ERT recommendation, natural gas used as fuel (in previous report included in the sector Industrial Processes) has been relocated to the sector Energy. Recalculation was made for the entire period (1990-2008).

4.3.1.6. Source–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 (1990-2009)

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

The resulting emissions of N_2O from Nitric Acid Production in the period 1990-2009 are presented in the Figure 4.3-2.

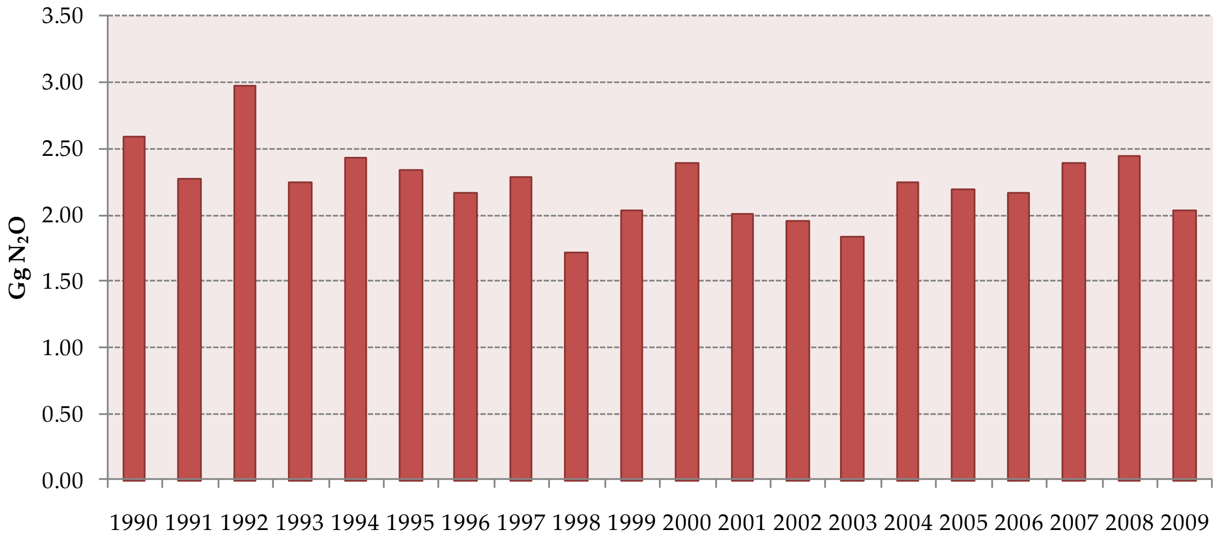

Figure 4.3-2: Emissions of N_2O from Nitric Acid Production (1990-2009)

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 1990-2009 are reported in Table 4.3-5.

Table 4.3-4: Production of Other chemicals (1990-2009)

Year	Carbon black (tonnes)	Ethylene (tonnes)	Dichloro-ethylene (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

Table 4.3-5: Emissions of CH_4 from Production of Other Chemicals (1990-2009)

Year	Emissions of CH_4 from production of other chemicals (Gg)				
	Carbon black	Ethylene	Dichloro-ethylene	Styrene	Coke
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

Table 4.3-5: Emissions of CH_4 from Production of Other Chemicals (1990-2009), cont.

Year	Emissions of CH_4 from production of other chemicals (Gg)				
	Carbon black	Ethylene	Dichloro-ethylene	Styrene	Coke
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

The emissions of indirect GHGs from Production of Other Chemicals for the period 1990-2009 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.

4.3.3.4. 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.

4.3.3.5. Source–specific recalculations

There are no source–specific recalculations in this report.

4.3.3.6. Source–specific planned improvements

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

4.4. METAL PRODUCTION (CRF 2.C.)

4.4.7. 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[7].

The resulting emission of CO_2 from Pig Iron Production in 1990 was amounted 335000 tonnes. In 1991 about 111000 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 2005-2009 CO_2 emissions (which are just underway of verifying because Croatia is not in EU ETS yet) have been taken for the inventory. The same

[7] 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.

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 (1990-2009)

Year	Scrap iron (tonnes)	Steel scrap (tonnes)	EAF carbon electrodes (tonnes)	EAF charge carbon (tonnes)	Petroleum coke (tonnes)
1990	2500	173588	1180	121	0
1991	13221	119396	982	106	600
1992	17866	96221	927	88	327
1993	23557	60799	627	63	253
1994	14892	56777	550	122	68
1995	10559	41661	346	27	0
1996	12858	38966	312	12	191
1997	18233	61114	468	7	369
1998	31968	84281	698	100	246
1999	11743	72647	557	78	127
2000	7845	70363	462	67	58
2001	7003	55100	375	60	118
2002	5324	29121	213	292	115
2003	15934	29777	223	240	215
2004	20409	76594	417	737	274
2005	7818	77641	286	745	99
2006	5510	87978	331	886	177
2007	4523	85054	351	967	97
2008	31421	130815	713	1418	399
2009	25531	26293	333	4	376

Table 4.4-2: Consumption of other carbon donors (input materials) and reducing fuels in EAFs (1990-2009)

Year	Lime (tonnes)	Other carbon donors* (tonnes)	Natural gas (m³)	Diesel oil (tonnes)	Liquefied petroleum gases (tonnes)
1990	2970	603	8470000	1624	0
1991	2095	262	5310000	960	0
1992	1484	256	1331000	756	0
1993	2737	286	1547000	379	0
1994	1530	629	1242000	444	0
1995	848	235	687000	398	0
1996	1322	496	908000	252	0
1997	1729	695	1119000	429	0
1998	2606	1103	2032000	617	0
1999	1468	518	1976000	495	0
2000	861	530	1146000	509	0
2001	1047	449	1264000	334	0
2002	670	280	570000	0	438
2003	1226	500	1505000	0	371
2004	1641	564	1818000	0	1221
2005	555	289	1036000	0	1392
2006	592	315	1446000	0	1642
2007	386	180	1033000	0	1661
2008	2559	366	2311000	0	2041
2009	2327	317	2839000	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[8] (Table 4.4-3) and reducing fuels[9] (Table 4.4-4) have been used.

Table 4.4-3: EF for carbon donors (input materials) in EAFs (1990-2009)

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 (1990-2009)

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

[8] 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

[9] 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 (1990-2009)

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

The resulting emissions of CO_2 from Steel Production in the period 1990-2009 are presented in the Figure 4.4-1.

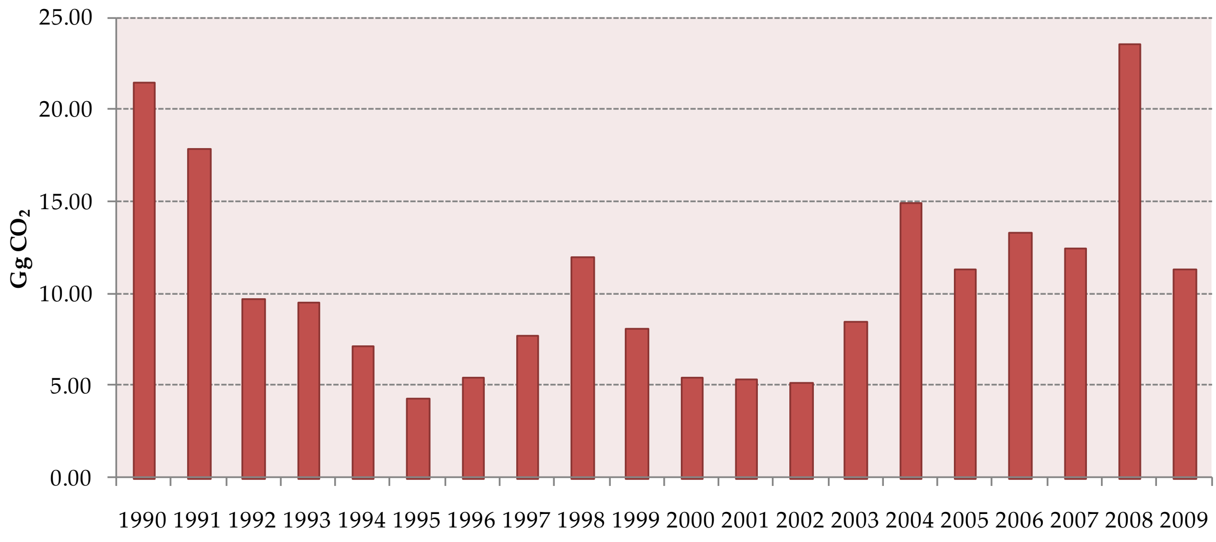

Figure 4.4-1: Emissions of CO_2 from Steel Production (1990-2009)

CO_2 emissions fluctuated over the period. It is mainly a result of discontinuous operation which requires increasing consumption of input materials. A drop in emission in 2009 is due to halt of steel production in one installation.

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

In this report 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 2005-2009 CO_2 emissions (which are just underway of verifying because Croatia is not in EU ETS yet) have been taken for the inventory. The same methodology has been used for the entire time series. Recalculation was made for the entire period (1990-2008).

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 (1990-2009)

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 1990-2009 are presented in the Figure 4.4-2.

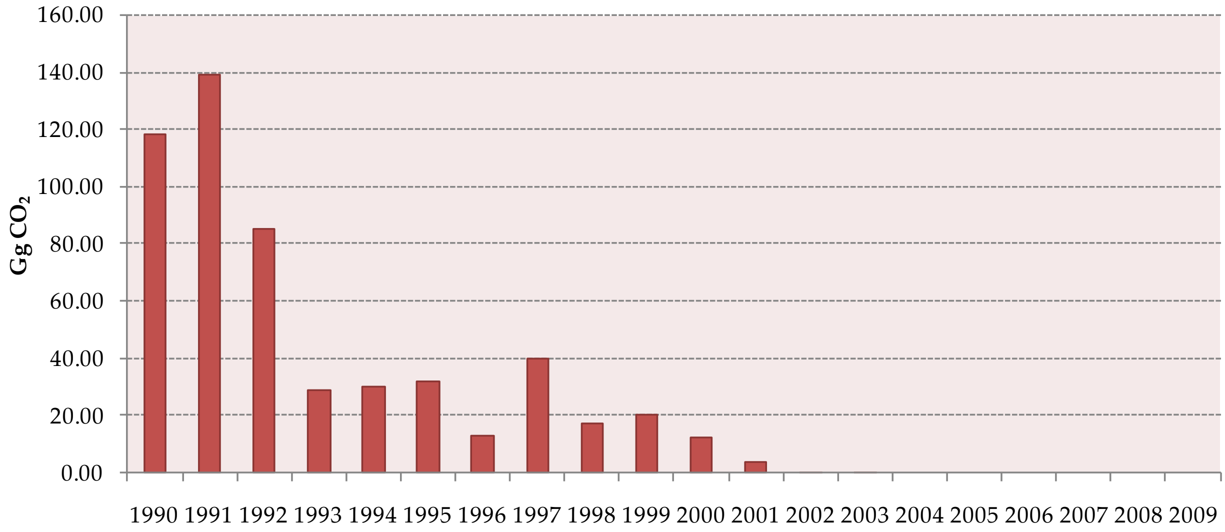

Figure 4.4-2: Emissions of CO_2 from Ferroalloys Production (1990-2009)

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[10] .

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

[10] 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.

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. 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 2009* Submission to the Convention on Long-range Transboundary Air Pollution'.
The resulting emissions of indirect GHGs from Pulp and Paper in the period 1990-2009 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 2009* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of NMVOC from Food and Drink in the period 1990-2009 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 Protection, Physical Planning and Construction (MEPPPC) 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 MEPPPC. 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 1990-2009 are presented in the Figure 4.6-1.

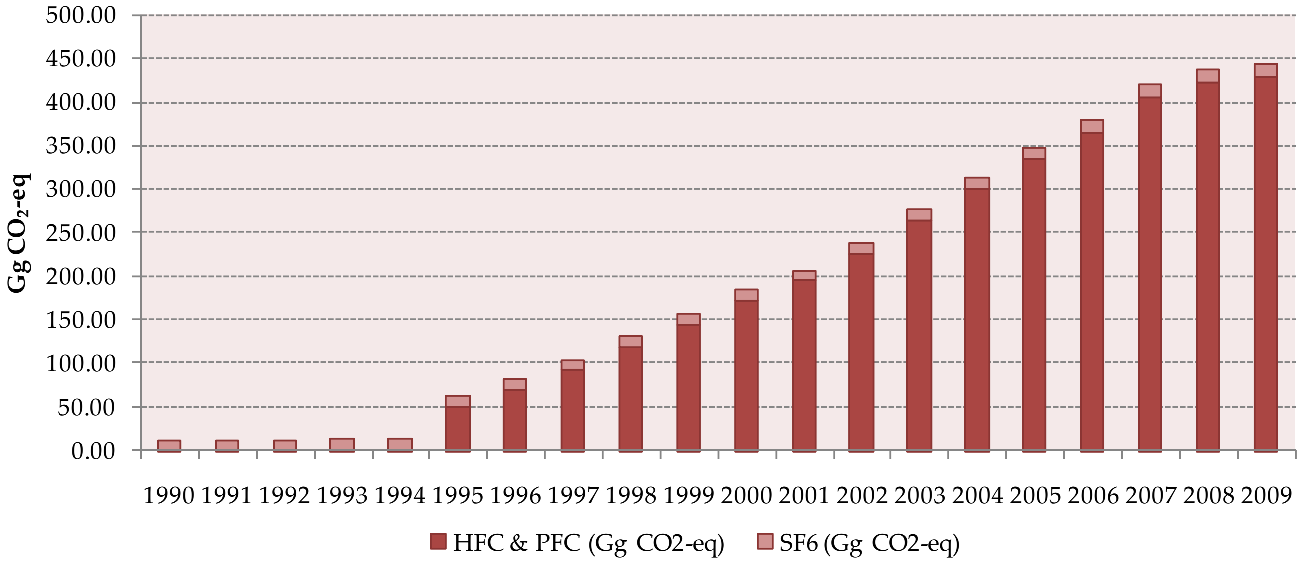

Figure 4.6-1: Emissions of HFCs and SF_6 (Gg CO_2-eq) from Consumption of Halocarbons and SF_6 (1990-2009)

Detailed description on actual and potential emissions calculation are presented in sub sectors' chapters. Actual emissions of HFC-32, HFC-125, HFC-134a and HFC-143a and potential emission of PFC-218 used in Refrigeration and Air Conditioning Equipment, actual emissions of HFC-227ea and HFC-125 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 are presented in the Figure 4.6-1.

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-32, HFC-125, HFC-134a and HFC-143a) and PFC (PFC-218), which are used as substitutes for cooling gases in refrigerating and air-conditioning systems that deplete the ozone layer. Refrigerants used are R-134a, R-404A, R-407C, R-410A, R-507A. 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 1995-2009. Potential emission of PFC-218 used in Refrigeration and Air Conditioning Equipment has been calculated for 2009, when this gas started to use.

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 1995-2009 have been compiled by MEPPPC.
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 PFC, which were used for calculation of potential emissions, has been compiled by MEPPPC. Potential emissions of HFCs from Refrigeration and Air Conditioning Equipment were calculated (Tier 1a method, *Revised 1996 IPCC Guidelines*) for the period 1996-2009. In the same way, potential emission of PFC-218 was calculated for 2009.
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 1995-2009 are reported in Table 4.6-1.

Table 4.6-1: Emissions of HFCs (Gg CO_2-eq) (1990 – 2009)

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 – 2009), cont.

Source/Gas	2003	2004	2005	2006	2007	2008	2009
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
Commercial Refrigeration							
HFC-125	7.13	8.18	8.80	9.33	10.38	10.56	10.65
HFC-134a	0.65	0.74	0.80	0.85	0.94	0.96	0.97
HFC-143a	8.42	9.67	10.40	11.02	12.27	12.48	12.58
Transport Refrigeration							
HFC-134a	80.93	93.93	105.30	113.75	124.80	133.25	134.88
Industrial Refrigeration							
HFC-125	2.60	3.08	3.68	3.92	4.08	4.20	4.48
HFC-134a	1.91	2.25	2.66	2.83	2.83	2.91	3.00
HFC-32	2.53	2.99	3.58	3.81	3.97	4.09	4.36
Stationary Air-Conditioning							
HFC-125	2.80	3.23	3.60	3.94	4.20	4.31	4.34
HFC-134a	2.18	2.39	2.55	2.73	2.86	2.99	2.99
HFC-32	2.72	3.13	3.50	3.83	4.09	4.20	4.22
Mobile Air-Conditioning							
HFC-134a	54.90	61.50	68.40	80.85	89.25	97.20	97.50

Actual and potential emissions of HFCs used in Refrigeration and Air Conditioning Equipment in the period 1990-2009 are 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 – 2009)

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	35.82	14.35	6.32	23.71	**49.08**	**60.57**
1996	0.75	3.32	9.99	34.41	46.62	19.86	10.67	31.62	**68.03**	**89.21**
1997	1.21	3.47	13.47	38.81	63.03	24.60	13.04	37.54	**90.75**	**104.42**
1998	1.59	4.27	19.12	48.47	78.03	26.83	19.36	42.42	**118.1**	**121.99**
1999	2.05	4.12	21.86	51.46	98.07	28.91	20.55	53.35	**142.53**	**137.85**
2000	2.58	5.22	26.19	60.06	118.08	33.70	23.71	59.28	**170.56**	**158.26**
2001	2.98	4.24	28.74	57.09	136.67	40.25	24.90	61.26	**193.29**	**162.84**
2002	3.18	5.54	32.60	63.92	159.53	44.20	29.64	63.23	**224.95**	**176.90**
2003	3.41	7.27	35.08	80.25	183.17	51.84	32.01	77.06	**253.67**	**216.42**
2004	3.98	8.37	40.57	91.54	209.60	60.68	36.75	88.92	**290.9**	**249.51**
2005	4.60	6.97	45.02	119.50	234.21	105.51	39.52	142.27	**323.35**	**374.25**
2006	4.97	8.22	48.12	127.57	261.84	97.92	41.89	146.22	**356.82**	**379.92**
2007	5.24	10.61	52.26	146.69	287.30	100.31	46.63	160.06	**391.43**	**417.67**
2008	5.39	14.83	53.40	180.38	308.90	131.82	47.42	183.77	**415.11**	**510.80**
2009	5.58	13.23	54.50	181.69	311.51	133.42	47.82	197.11	**419.41**	**525.45**

There is inconsequent 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 MEPPPC. 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.

Data for potential emission calculation for PFC-218 in 2009 (0.216 Gg CO_2-eq) is available so far. Actual emission of PFC-218 is not calculated. Potential emission of PFC-218 is added to the total actual emission of HFCs for 2009.

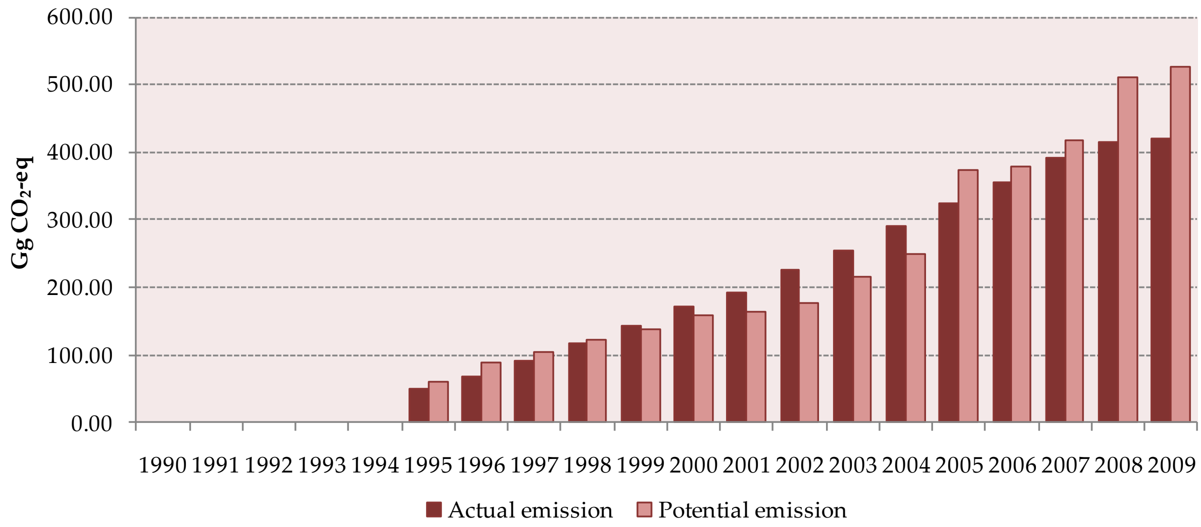

Figure 4.6-2: Actual and potential emission of HFCs in Refrigeration and Air Conditioning Equipment (Gg CO_2-eq) (1990-2009)

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 MEPPPC. Accordingly, actual and potential emissions from Refrigeration and Air Conditioning Equipment for the period 1995-2008 have been recalculated.

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 MEPPPC. 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. These data need to be additionally investigated.

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 MEPPPC 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

Emissions are released by consumption of HFC-227ea and HFC-125 in Fire Extinguishers, 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.

4.6.2.2. Methodological issues

Actual emissions of HFC-227ea used in Fire Extinguishers have been calculated for the period 1995-2009. Actual emissions of HFC-125 used in Fire Extinguishers and HFC-134a used in Aerosols/Metered Dose Inhalers have been calculated for the period 2003-2009, when these gases started to use.
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-152a used in Foam Blowing are not available for the period 2006-2009. Data have been compiled by MEPPPC. 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 2006-2009. Insufficient data on HFC-152a used in Foam Blowig for 2007 and 2008 are assessed according to data for 2006. Data on HFC-227ea used in Fire Extinguishers are not available for the period 1995-2005, insufficient data for 2007 and 2008 have been assessed by interpolation method. Data on HFC-125 used in Fire Extinguishers for 2006 are available so far. Potential emissions from Aerosols/Metered Dose Inhalers have been calculated for the period 2003-2009. There was no use of HFCs in Metered Dose Inhalers before that period. The data on consumption of HFC-152-a (which is used in Foam Blowing), HFC-125, HFC-227ea and HFC-236fa (which are used in Fire Extinguishers) and HFC-134a (which is used in Aerosols/Metered Dose Inhalers) have been compiled by MEPPPC. It has been determined that HFCs have not been used as solvents in the period 1995-2009.

Actual emissions of HFCs used in Fire Extinguishers and Aerosols/Metered Dose Inhalers in the period 1995-2009 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 – 2009)

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	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
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 – 2009), cont.

Source/Gas	2003	2004	2005	2006	2007	2008	2009
2.F.2 Foam Blowing							
Hard Foam	NO	NO	NO	NE	NE	NE	NE
Soft Foam	NO	NO	NO	NO	NO	NO	NO
2.F.3 Fire Extinguishers							
HFC-227ea	0.06	0.06	0.07	0.15	0.32	0.39	0.48
HFC-125	0.01	0.01	0.01	0.01	0.01	0.01	0.02
2.F.4 Aerosols/Metered Dose Inhalers							
HFC-134a	7.05	6.84	7.74	5.85	9.73	5.51	6.07

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 – 2009)

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 – 2009), cont.

Source/Gas	2003	2004	2005	2006	2007	2008	2009
2.F.2 Foam Blowing							
Hard Foam	NO	NO	NO	0.0001	0.0001	0.0001	6.4095
2.F.3 Fire Extinguishers							
HFC-227ea	0.06	0.06	0.07	0.15	0.32	0.39	0.48
HFC-125	NO	NE	NE	3.55	NE	NE	NE
HFC-236fa	NO	NO	NO	6.30	12.60	18.90	NO
2.F.4 Aerosols/Metered Dose Inhalers							
HFC-134a	9.17	8.89	10.06	7.61	12.65	7.16	7.89

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

Potential emissions of SF_6 used in GIS application and high voltage circuit-breakers have been calculated only for the period 2006-2009, because data for potential emission calculation for the previous period are not available. Data on the amount of consumed gas for the period 2006-2009 have been compiled by MEPPPC.

Actual emissions of SF_6 expressed in Gg CO_2-eq for the period 1990-2009 are presented in the Table 4.6-5.

Table 4.6-5: Emissions of SF_6 (Gg CO_2-eq) (1990 – 2009)

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	13.95
2009	14.11

4.6.2.3. 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.

4.6.2.4. 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.

4.6.2.5. Source–specific recalculations

In this report new data for actual emission calculation have been compiled by MEPPPC. Actual emissions of HFC-227ea from Fire Extinguishers have been calculated for the period 2003-2009. Actual emissions of HFC-125 from Fire Extinguishers and HFC-134a from Aerosols/Metered Dose Inhalers have been calculated for the period 2003-2009.
A mistake was made in the calculation of potential emissions from Foam Blowing for the period 2006-2008. Also, for 2008, data was updated. Accordingly, recalculations of potential emissions from Foam Blowing for the period 2006-2008 have been made.
A mistake in data entry, made in the previous report for the year 2008 regarding potential emissions from Fire Extinguishers, has been corrected. Additional data have been included for Aerosols/Metered Dose Inhalers for the period 2003-2008. Consequently, potential emissions have been recalculated for the period 2003-2008.

4.6.2.6. 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 SF_6 were calculated with data compiled by MEPPPC. Actual emissions were calculated by using data on annual stocks of HFCs and SF_6 in operating systems. Decommissioning and disposal have not been occurred so far because all of equipment is still functioning and in use. These data need to be additionally investigated.

Actual emissions from Foam Blowing were not calculated in this report, due to the lack of required data. This is planned to be corrected in the future report.

Potential emissions from Foam Blowing, Fire Extinguishers and Aerosols/Metered Dose Inhalers were not calculated for the period 1995-2005, due to the lack of required data. There are insufficient data for the period

2006-2009, while data compiled by MEPPPC have high uncertainty. Accordingly, potential emission trend need 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 1990-2009 are presented in Table 4.8-1.

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2009)

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	28.51	4.69
	1991		702.56		702.56	24.04	4.09
	1992		826.23		826.23	32.47	5.29
	1993		687.13		687.13	34.34	4.40
	1994		841.87		841.87	37.84	5.81
	1995		628.67		628.67	31.25	4.06
	1996		684.69		684.69	32.84	4.80
	1997		792.26		792.26	34.17	5.19
	1998		852.93		852.93	40.77	5.56
	1999		1,115.06		1,115.06	43.50	6.82
	2000		1,243.59		1,243.59	43.57	7.80
	2001		1,423.55		1,423.55	49.65	8.34
	2002		1,392.12		1,392.12	49.30	7.72
	2003		1,383.62		1,383.62	48.17	7.12
	2004		1,470.38		1,470.38	45.59	7.66
	2005		1,499.86		1,499.86	45.85	7.68
	2006		1,588.04		1,588.04	46.42	7.99
	2007		1,611.88		1,611.88	44.73	7.66
	2008		1,526.87		1,526.87	42.78	7.71
	2009		1,224.17		1,224.17	41.33	4.24
Lime production	1990	CO_2	160.63	1	160.63	4.22	0.69
	1991		113.60		113.60	3.89	0.66
	1992		76.58		76.58	3.01	0.49
	1993		84.48		84.48	4.22	0.54
	1994		84.92		84.92	3.82	0.59
	1995		83.42		83.42	4.15	0.54
	1996		111.65		111.65	5.36	0.78
	1997		119.51		119.51	5.16	0.78
	1998		123.79		123.79	5.92	0.81
	1999		112.82		112.82	4.40	0.69
	2000		137.85		137.85	4.83	0.86
	2001		162.84		162.84	5.68	0.95
	2002		180.56		180.56	6.39	1.00
	2003		177.83		177.83	6.19	0.92
	2004		186.09		186.09	5.77	0.97
	2005		198.36		198.36	6.06	1.02
	2006		244.47		244.47	7.15	1.23
	2007		254.46		254.46	7.06	1.21
	2008		251.36		251.36	7.04	1.27
	2009		156.33		156.33	5.28	0,54

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2009), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Limestone and dolomite use	1990	CO_2	51.49	1	51.49	1.35	0.22
	1991		32.72		32.72	1.12	0.19
	1992		14.63		14.63	0.58	0.09
	1993		13.82		13.82	0.69	0.09
	1994		21.53		21.53	0.97	0.15
	1995		17.39		17.39	0.86	0.11
	1996		17.65		17.65	0.85	0.12
	1997		11.77		11.77	0.51	0.08
	1998		14.08		14.08	0.67	0.09
	1999		12.91		12.91	0.50	0.08
	2000		16.14		16.14	0.57	0.10
	2001		18.65		18.65	0.65	0.11
	2002		21.09		21.09	0.75	0.12
	2003		25.02		25.02	0.87	0.13
	2004		25.95		25.95	0.80	0.14
	2005		26.47		26.47	0.81	0.14
	2006		23.98		23.98	0.70	0.12
	2007		21.49		21.49	0.60	0.10
	2008		23.52		23.52	0.66	0.12
	2009		30.35		30.35	1.03	0.11
Soda ash production and use	1990	CO_2	25.74	1	25.74	0.68	0.11
	1991		21.75		21.75	0.74	0.13
	1992		12.76		12.76	0.50	0.08
	1993		12.54		12.54	0.63	0.08
	1994		15.21		15.21	0.68	0.10
	1995		14.39		14.39	0.72	0.09
	1996		13.86		13.86	0.66	0.10
	1997		11.33		11.33	0.49	0.07
	1998		12.71		12.71	0.61	0.08
	1999		12.08		12.08	0.47	0.07
	2000		11.78		11.78	0.41	0.07
	2001		14.17		14.17	0.49	0.08
	2002		13.66		13.66	0.48	0.08
	2003		16.23		16.23	0.57	0.08
	2004		17.94		17.94	0.56	0.09
	2005		19.20		19.20	0.59	0.10
	2006		17.30		17.30	0.51	0.09
	2007		15.66		15.66	0.43	0.07
	2008		15.59		15.59	0.44	0.08
	2009		17.20		17.20	0.58	0.06
Ammonia production	1990	CO_2	466.01	1	466.01	12.24	2.01
	1991		447.00		447.00	15.30	2.60
	1992		575.22		575.22	22.61	3.68
	1993		446.83		446.83	22.33	2.86
	1994		450.03		450.03	20.23	3.10
	1995		438.77		438.77	21.81	2.83
	1996		476.59		476.59	22.86	3.34
	1997		517.83		517.83	22.34	3.39

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2009), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Ammonia production	1998		388.43		388.43	18.57	2.53
	1999		492.14		492.14	19.20	3.01
	2000		497.96		497.96	17.45	3.12
	2001		403.70		403.70	14.08	2.37
	2002		363.78		363.78	12.88	2.02
	2003		409.38		409.38	14.25	2.11
	2004		495.43		495.43	15.36	2.58
	2005		484.65		484.65	14.82	2.48
	2006		477.34		477.34	13.95	2.40
	2007		521.51		521.51	14.47	2.48
	2008		530.39		530.39	14.86	2.68
	2009		445.19		445.19	15.03	1.54
Nitric acid production	1990	N_2O	2.59	310	803.89	21.11	3.47
	1991		2.28		706.05	24.16	4.11
	1992		2.98		923.19	36.29	5.91
	1993		2.24		695.91	34.78	4.46
	1994		2.43		752.57	33.83	5.19
	1995		2.33		723.70	35.97	4.67
	1996		2.17		673.86	32.32	4.73
	1997		2.28		708.21	30.55	4.64
	1998		1.72		533.19	25.49	3.48
	1999		2.03		629.16	24.54	3.85
	2000		2.39		740.39	25.94	4.65
	2001		2.01		622.72	21.72	3.65
	2002		1.95		604.48	21.41	3.35
	2003		1.84		569.79	19.84	2.93
	2004		2.24		695.34	21.56	3.62
	2005		2.19		678.84	20.75	3.48
	2006		2.17		671.21	19. 62	3.38
	2007		2.39		741.40	20.57	3.52
	2008		2.44		756.66	21.20	3.82
	2009		2.04		632.25	21.35	2.19
Production of other chemicals	1990	CH_4	0.75	21	15.80	0.41	0.07
	1991		0.55		11.49	0.39	0.07
	1992		0.46		9.74	0.38	0.06
	1993		0.50		10.48	0.52	0.07
	1994		0.48		10.06	0.45	0.07
	1995		0.40		8.41	0.43	0.05
	1996		0.38		7.94	0.38	0.06
	1997		0.34		7.15	0.31	0.05
	1998		0.32		6.65	0.33	0.04
	1999		0.27		5.73	0.22	0.04
	2000		0.29		6.04	0.21	0.04
	2001		0.31		6.41	0.22	0.04
	2002		0.26		5.39	0.19	0.03
	2003		0.28		5.83	0.20	0.03
	2004		0.27		5.73	0.18	0.03
	2005		0.25		5.33	0.16	0.03

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2009), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Production of other chemicals	2006		0.34		7.09	0.21	0.04
	2007		0.31		6.43	0.18	0.03
	2008		0.23		4.81	0.13	0.02
	2009		0.08		1.73	0.06	0.01
Steel production	1990	CO_2	21.45	1	21.45	0.56	0.093
	1991		17.86		17.86	0.61	0.104
	1992		9.65		9.65	0.38	0.062
	1993		9.46		9.46	0.47	0.061
	1994		7.06		7.06	0.32	0.049
	1995		4.24		4.24	0.21	0.027
	1996		5.36		5.36	0.26	0.038
	1997		7.64		7.64	0.33	0.050
	1998		11.96		11.96	0.57	0.078
	1999		8.06		8.06	0.31	0.049
	2000		5.43		5.43	0.19	0.034
	2001		5.27		5.27	0.18	0.031
	2002		5.14		5.14	0.18	0.029
	2003		8.47		8.47	0.29	0.044
	2004		14.89		14.89	0.46	0.078
	2005		11.24		11.24	0.34	0.058
	2006		13.25		13.25	0.39	0.067
	2007		12.42		12.42	0.34	0.059
	2008		23.51		23.51	0.66	0.119
	2009		11.30		11.30	0.38	0.039
Ferroalloys production	1990	CO_2	118.84	1	118.84	3.12	0.513
	1991		139.26		139.26	4.77	0.811
	1992		85.34		85.34	3.35	0.546
	1993		29.29		29.29	1.46	0.188
	1994		30.11		30.11	1.35	0.208
	1995		31.88		31.88	1.58	0.206
	1996		12.92		12.92	0.62	0.091
	1997		36.79		36.79	1.71	0.260
	1998		16.01		16.01	0.83	0.113
	1999		18.77		18.77	0.79	0.124
	2000		11.24		11.24	0.43	0.076
	2001		3.70		3.70	0.14	0.023
	2002		0.01		0.01	0.00	0.000
	2003		0.04		0.04	0.00	0.000
	2004-2009		-		-	-	-
Aluminium production	1990	CO_2	111.37	1	111.37	2.92	0.48
	1991		76.40		76.40	2.61	0.44
	1992-2009		-		-	-	-
	1990	CF_4	0.13	6500	820.44	19.54	3.54
	1991		0.09		562.79	19.26	3.28
	1992 - 2009		-		-	-	-

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2009), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Aluminium production	1990	C_2F_6	0.013	9200	116.12	3.05	0.50
	1991		0.009		79.66	2.73	0.46
	1992 - 2009		-		-	-	-
Consumption	1990	HFC PFC SF_6	[2]	[2]	10.95	0.29	0.05
	1991				10.83	0.37	0.06
	1992				10.92	0.43	0.07
	1993				11.04	0.55	0.07
	1994				11.16	0.50	0.08
	1995				60.85	3.02	0.39
	1996				80.28	3.85	0.56
	1997				102.85	4.44	0.67
	1998				130.78	6.25	0.85
	1999				155.22	6.06	0.95
	2000				182.86	6.41	1.15
	2001				205.72	7.18	1.21
	2002				237.72	8.42	1.32
	2003				274.90	9.61	1.42
	2004				313.16	9.71	1.63
	2005				347.30	10.62	1.78
	2006				378.52	11.06	1.90
	2007				418.71	11.62	1.99
	2008				436.45	12.23	2.20
	2009				442.85	14.96	1.52

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

[3] HFC-32 (GWP=650); HFC-125 (GWP=2800); HFC-134a (GWP=1300); HFC-143a (GWP=3800); HFC-152a (GWP=130); HFC-227ea (GWP=2900); HFC-236fa (GWP=6,300); PFC-218 (GWP=7000); SF6 (GWP=23900)

- 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 2009* 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 1990-2009 are reported in table 4.8-3.

Table 4.8-3: Emissions of indirect GHGs from Industrial Processes (1990-2009)

Year	SO_2 (Gg)	NO_x (Gg)	CO (Gg)	NMVOC (Gg)
1990	2.57	2.76	41.71	25.20
1991	1.75	2.42	26.30	21.65
1992	1.54	2.82	14.87	14.10
1993	1.42	2.32	18.35	12.69
1994	1.82	2.48	22.94	10.06
1995	1.63	2.62	28.35	10.47
1996	1.58	2.53	27.98	11.59

Table 4.8-3: Emissions of indirect GHGs from Industrial Processes (1990-2009), cont.

Year	SO_2 (Gg)	NO_x (Gg)	CO (Gg)	NMVOC (Gg)
1997	1.65	2.64	25.67	9.75
1998	1.48	2.24	25.76	9.64
1999	1.87	2.44	22.48	9.21
2000	2.05	2.78	32.10	7.95
2001	2.04	2.09	26.26	7.35
2002	2.17	2.17	29.17	7.92
2003	1.86	2.41	30.96	7.63
2004	2.07	2.77	20.35	7.15
2005	2.07	8.83	19.79	9.20
2006	1.90	9.49	41.81	8.69
2007	2.06	10.05	37.99	6.76
2008	2.41	9.21	12.77	6.19
2009	1.77	6.96	2.33	5.73

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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 2009* 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 2.1-1: Activity data for NMVOC emissions from Solvent and Other Product Use (1990-2009)

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	1990-2009
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	14,983	16,393	17,318	20,097	19,716	15,186	500
Degreasing, dry cleaning and electronics																					
Metal degreasing *	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	0.85
Dry cleaning *	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	0.25
Chemical products manufacturing or processing																					
Polyurethane process.– solid foam	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	15
Polyurethane process.– soft foam	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	25
Polyester processing	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	40
Polystyrene foam process.	104,602	67,934	70,969	44,259	84,546	99,243	44,791	23,094	77,811	34,202	7,368	1,036	661	8,387	10,064	9,396	8,045	7,866	9,341	6,815	15
Polyvinylchloride processing	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	40
Rubber processing	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	15
Pharmaceutical products manufac.*	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	0.014
Paints manufacturing	4,672	3,605	1,343	985	1,416	1,367	1,420	1,430	1,071	797	916	822	863	789	673	630	684	438	6	0	15
Inks 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	33,849	30
Glues manufacturing	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	20
Other use of solvents and related activities																					
Printing industry	4,672	3,605	1,343	985	1,416	1,367	1,420	1,430	1,071	797	916	822	863	789	673	630	684	910	928	612	100
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	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	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.

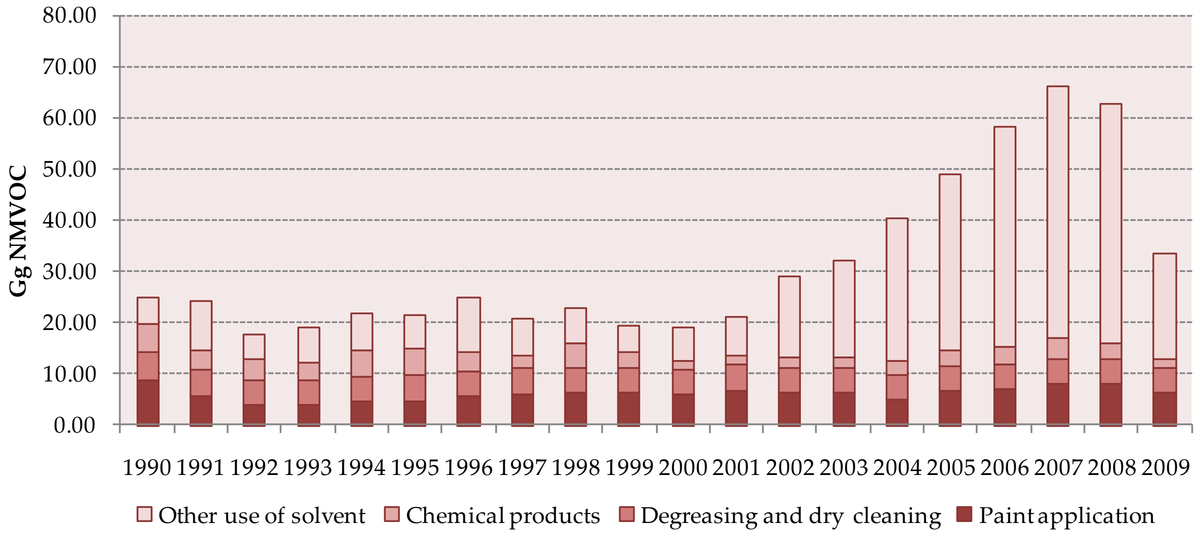

Figure 5.1-1: Emissions of NMVOC from Solvent and Other Product Use (1990-2009)

CO_2 emissions

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.

N_2O emissions

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 only producer and distributor of N_2O in Croatia (Messer Croatia Gas Ltd.).

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 1990-2009 are presented in the Figure 5.1-2.

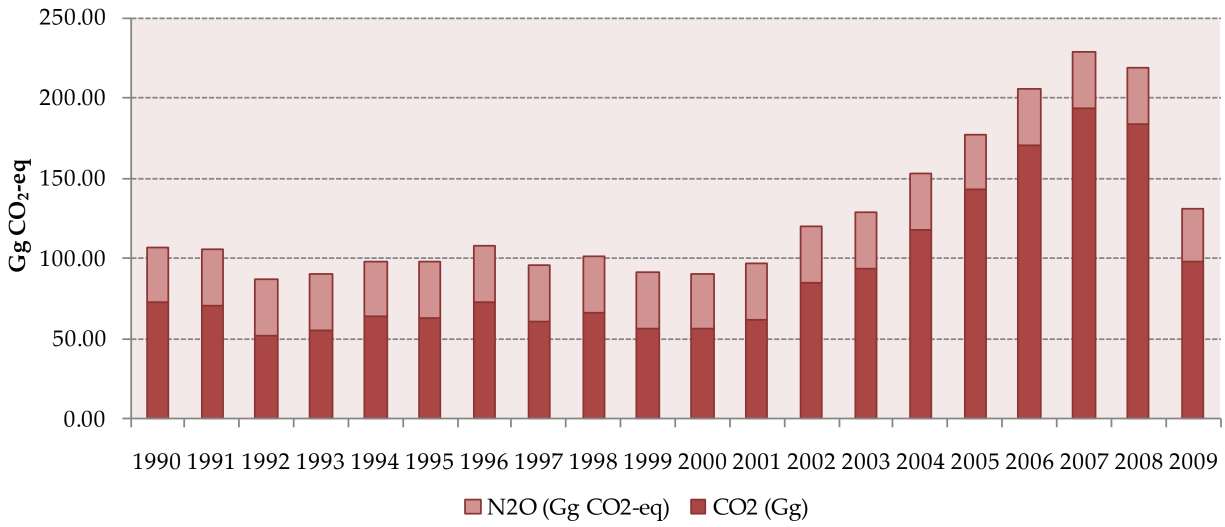

Figure 5.1-2: Emissions of CO_2 and N_2O from Solvent and Other Product Use (1990-2009)

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.

Solvent and Other Product Use is key source category. Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories.

5.1.5. SOURCE–SPECIFIC RECALCULATIONS

Activity data for NMVOC emission calculation for the whole period 1990-2008 has been updated according to 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'. Therefore, CO_2 emissions have been recalculated for the period 1990-2008 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

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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 2009 caused by agricultural activities was 3,314.47 Gg CO_2-eq, which represents about 11.5 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.

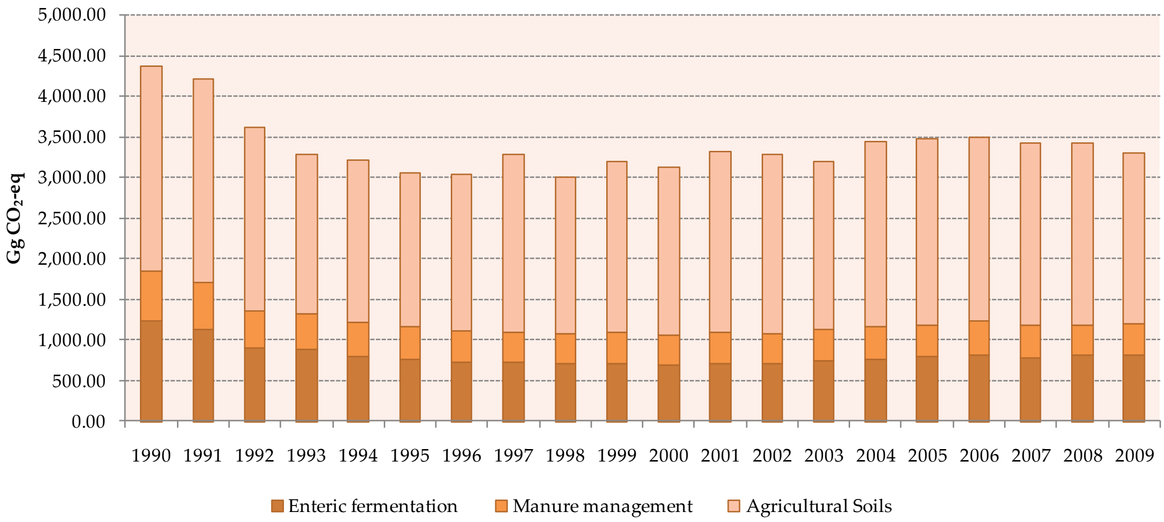

Figure 6.1-1: Agriculture emission trend

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 1990-2009.

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	9.38
1991	54.23	10.69	64.92	1.15	8.08	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	6.41	7.24
1995	36.53	7.52	44.05	0.78	6.13	6.91
1996	34.82	7.41	42.24	0.73	6.24	6.98
1997	34.63	7.28	41.91	0.72	7.05	7.77
1998	34.14	7.17	41.31	0.70	6.22	6.92
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	7.91
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	7.39	8.12
2006	39.09	8.57	47.65	0.75	7.31	8.06
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	38.77	8.21	46.97	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	2,526.07	2,907.91	**4,378.46**
1991	1,138.74	224.57	1,363.31	354.98	2,505.62	2,860.60	**4,223.91**
1992	904.73	169.82	1,074.54	282.53	2,268.13	2,550.65	**3,625.20**
1993	881.07	174.68	1,055.75	276.21	1,965.34	2,241.55	**3,297.30**
1994	796.64	175.38	972.03	257.44	1,988.08	2,245.52	**3,217.54**
1995	767.22	157.86	925.08	242.06	1,900.05	2,142.11	**3,067.19**
1996	731.26	155.68	886.94	227.64	1,935.58	2,163.23	**3,050.16**
1997	727.27	152.86	880.13	223.74	2,184.96	2,408.70	**3,288.82**
1998	716.89	150.52	867.41	217.94	1,926.70	2,144.64	**3,012.05**
1999	713.41	166.81	880.22	222.82	2,107.45	2,330.28	**3,210.50**
2000	701.73	154.90	856.63	216.08	2,062.44	2,278.52	**3,135.15**
2001	719.27	155.74	875.01	218.31	2,232.55	2,450.86	**3,325.87**
2002	709.67	158.11	867.78	212.85	2,213.51	2,426.36	**3,294.14**
2003	742.09	165.69	907.78	222.78	2,073.40	2,296.18	**3,203.96**
2004	771.66	178.66	950.32	227.73	2,268.29	2,496.02	**3,446.34**
2005	805.76	155.58	961.34	224.03	2,292.28	2,516.31	**3,477.65**
2006	820.84	179.87	1,000.70	231.79	2,265.74	2,497.54	**3,498.24**
2007	791.66	166.44	958.09	222.15	2,258.92	2,481.08	**3,439.17**
2008	820.08	159.47	979.56	209.80	2,238.06	2,447.86	**3,427.42**
2009	814.10	172.36	986.46	212.24	2,115.77	2,328.01	**3,314.47**

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 54% of total CH_4 emission from Enteric fermentation in 2009, followed by non dairy cattle representing about 27%. Jointly, cattle are responsible for around 81% 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 1990-2009. 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).

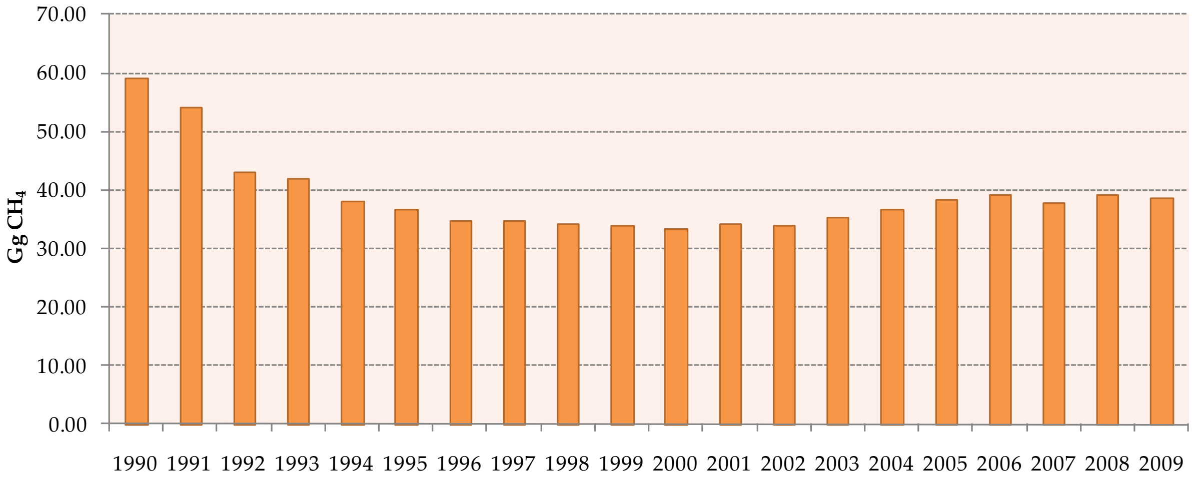

Figure 6.2-1: CH_4 emission from Enteric fermentation

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 (see Table 6.2-1).

Table 6.2-1: Sources of activity data regarding animal population

Animal category	CBS	FAO	Croatian Livestock Centre
Cattle	1990-2009		
Sheep	1990-2009		
Goats	1990-1991; 1999; 2000-2009	1992-1998	
Horses	1990-2009		
Mules/assess	1990-1991	1992-2008	2009
Swine	1990-2009		
Poultry	1990-2009		

The number of livestock is reported in Table 6.2-2.

Table 6.2-2: Livestock population in the period from 1990 – 2009

Year	Animal number / 1000 heads							
	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Mules/asses	Swine	Poultry
1990	460	370	751	172	39	17	1,573	17,102
1991	422	335	753	133	36	13	1,621	16,512
1992	369	221	539	114	26	13	1,182	13,142
1993	333	256	525	105	22	12	1,262	12,697
1994	328	191	444	108	21	7	1,347	12,503
1995	308	185	453	107	21	4	1,175	12,024
1996	283	178	427	105	21	4	1,197	10,993
1997	279	172	453	100	19	4	1,176	10,945
1998	270	173	427	84	16	4	1,166	9,959
1999	268	170	488	78	13	4	1,362	10,871
2000	262	164	529	79	11	4	1,234	11,256
2001	254	184	539	93	10	4	1,234	11,747
2002	247	170	580	97	9	4	1,286	11,665
2003	252	192	587	86	9	4	1,347	11,778
2004	226	240	722	126	10	4	1,489	11,185
2005	235	236	796	134	9	4	1,205	10,641
2006	233	250	680	103	10	4	1,488	10,088
2007	225	242	646	92	14	4	1,348	10,053
2008	213	241	643	84	16	4	1,104	10,015
2009	212	235	619	76	17	2	1,250	10,787

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 1990-2009. The population of other animal categories fluctuates through the period concerned but the explanation for the latter requires more detailed information which will be obtained from further research and provided in the next NIR.

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 1990-2009 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
Milk yield (kg/day)	6.54	7.08	7.44	7.67	7.90	9.08	9.94	10.04	10.34	10.60

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.

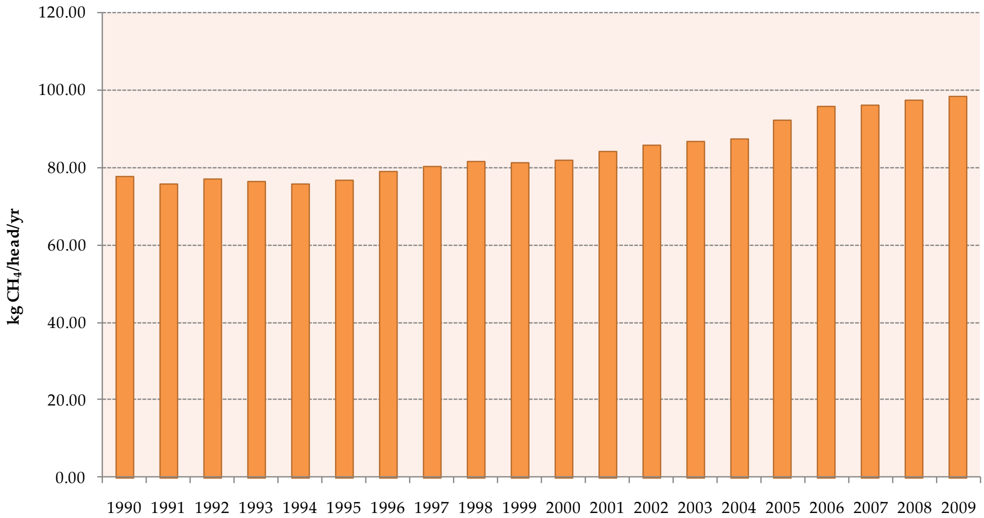

Figure 6.2-2: Enteric fermentation emission factors used for dairy cattle

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 (2008-2009). 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)	2008-2009 (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

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 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 period 1990-1993, for 1999, 2006 and 2008 due to:

1.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.

2.usage of EFs for developed countries

The recalculation refers only to 2008 for animal categories sheep and swine.
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.

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 2009 is presented in Figure 6.3-1. The emission trend depends on the animal population trend.

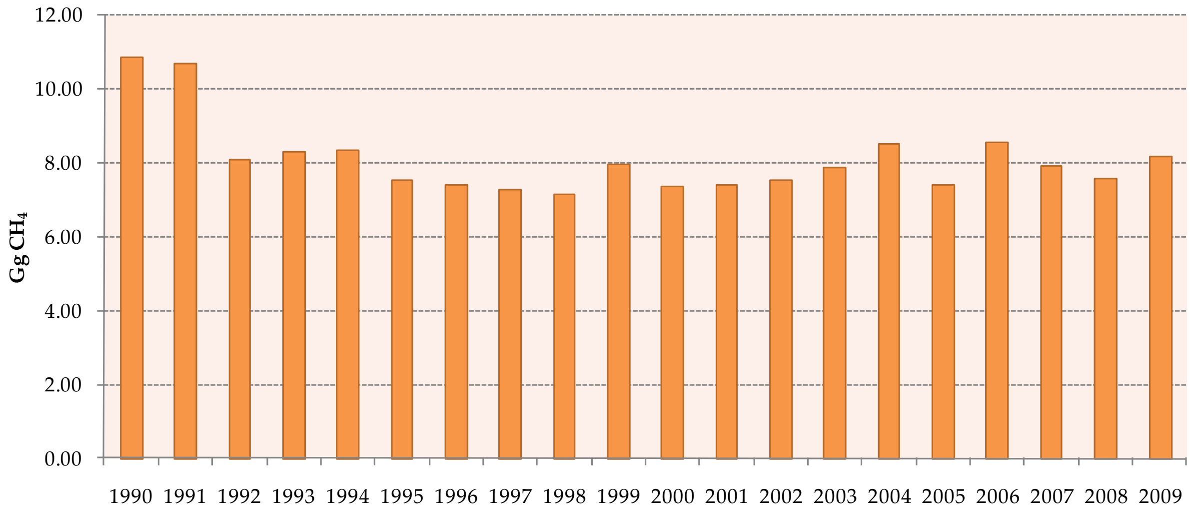

Figure 6.3-1: CH_4 emission from Manure management

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 in 2008 and 2009, 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)	2008-2009 (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 period 1990-1993, for 1999, 2006 and 2008 due to:

1. changes of activity data regarding animal population in the period from 1990-1993, for 1999 and 2006 (see explanation for Enteric fermentation)
2. more detailed activity data regarding animal population of goats (1992, 1994-1998) and mules/asses (1992-1994)
3. usage of EFs for developed countries for 2008

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. 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 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 4-5) 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.

4. mistakes regarding implied emission factors for horses, mules/asses and poultry

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.

Mistakenly, in the previous submission, regarding dairy cattle and its nitrogen excretion in solid storage and dry lot, 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 %.

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 2009 are presented in Figure 6.4-1. The emission trend depends on the animal population trend.

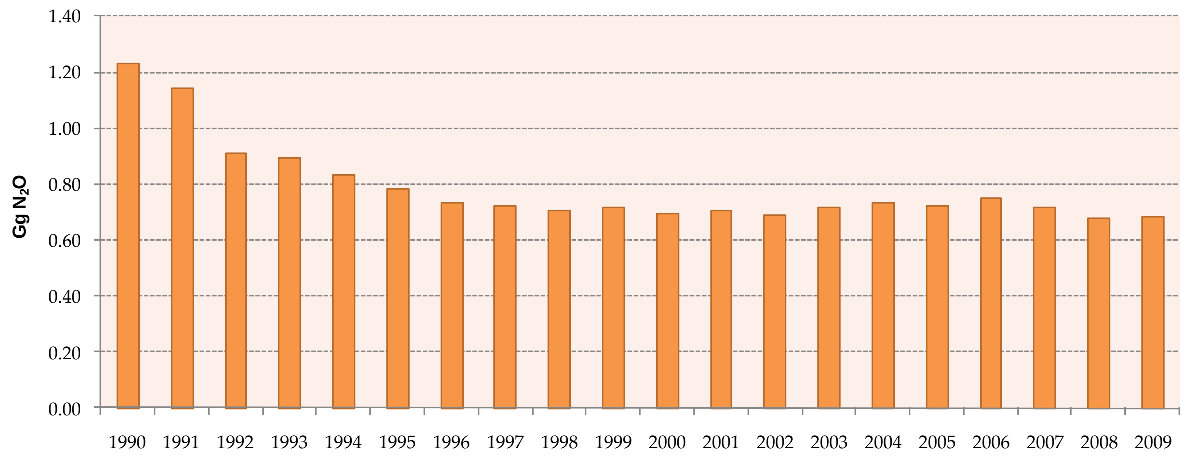

Figure 6.4-1: N_2O Emissions from Manure management

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 period from 1990-1993, for 1999, 2006 due to new and updated data on animal number.

In CRF table 4.B(b), a mistake was noticed regarding goats because notation key NO was used for its nitrogen excretion instead of 25 kgN/head/yr. The latter was corrected but it did not influence the N_2O emission; thus no recalculations were necessary in this regard.

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 2009 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.

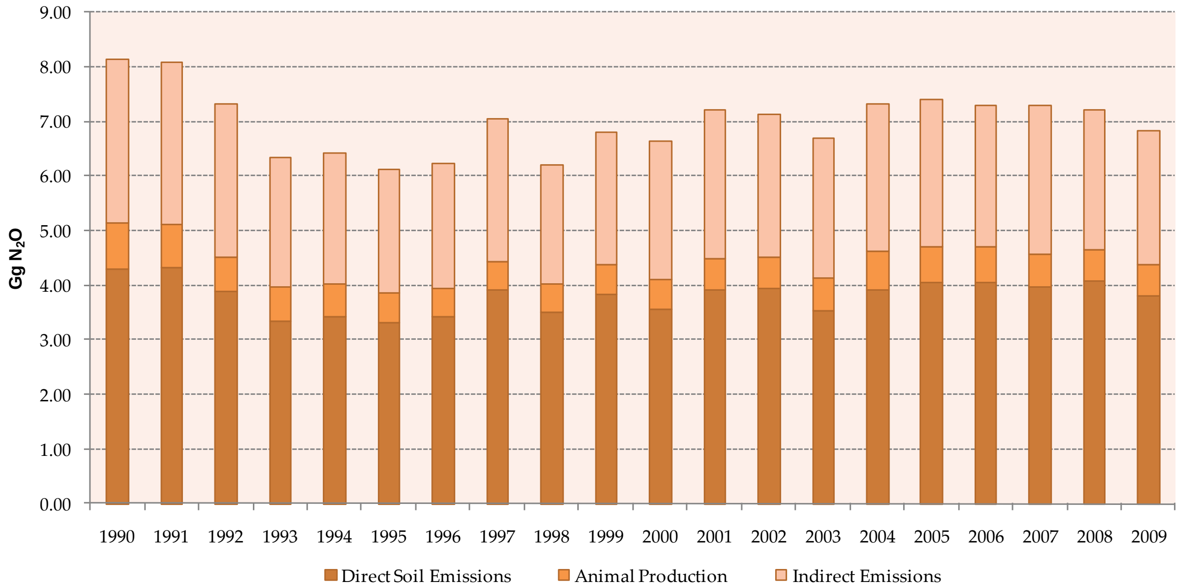

Figure 6.5-1: Total N_2O emissions from Agricultural soils

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 and soil nitrogen mineralization due to cultivation of histosols. 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

Direct emission from agricultural soils is calculated by the following equation:
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)

Direct Emissions of N_2O from Agricultural soils for the period from 1990 to 2009 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.

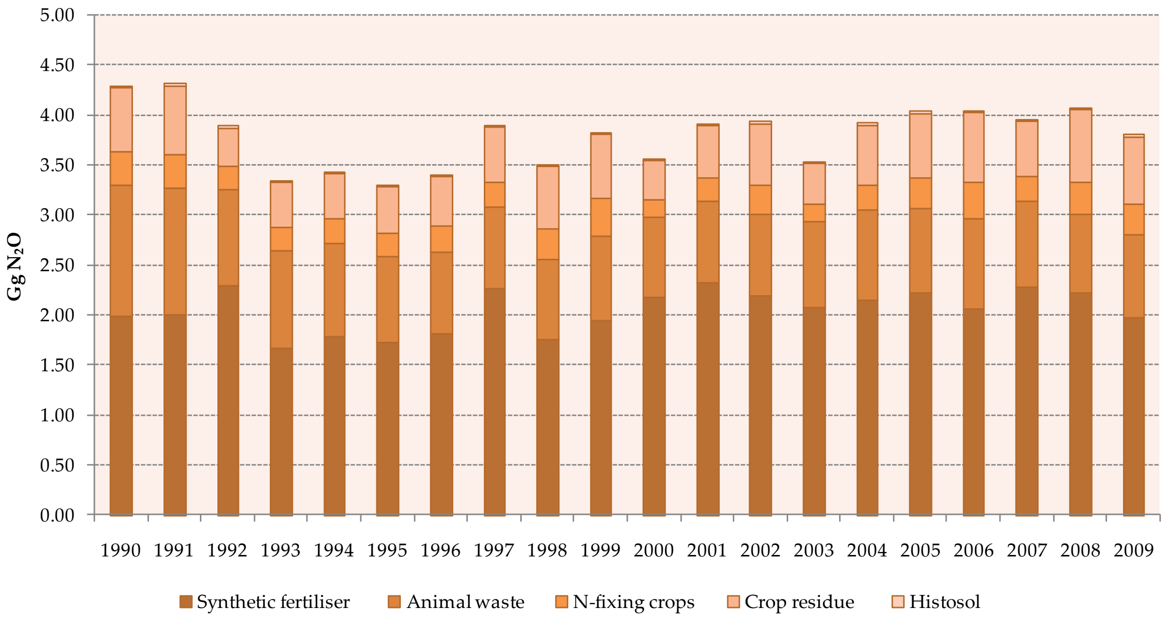

Figure 6.5-2: Direct N_2O emissions from Agricultural soils

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.*

Nitrous oxide from mineral fertilisers

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 1992-2009. 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 2000-2009. 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 1990-2009 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.

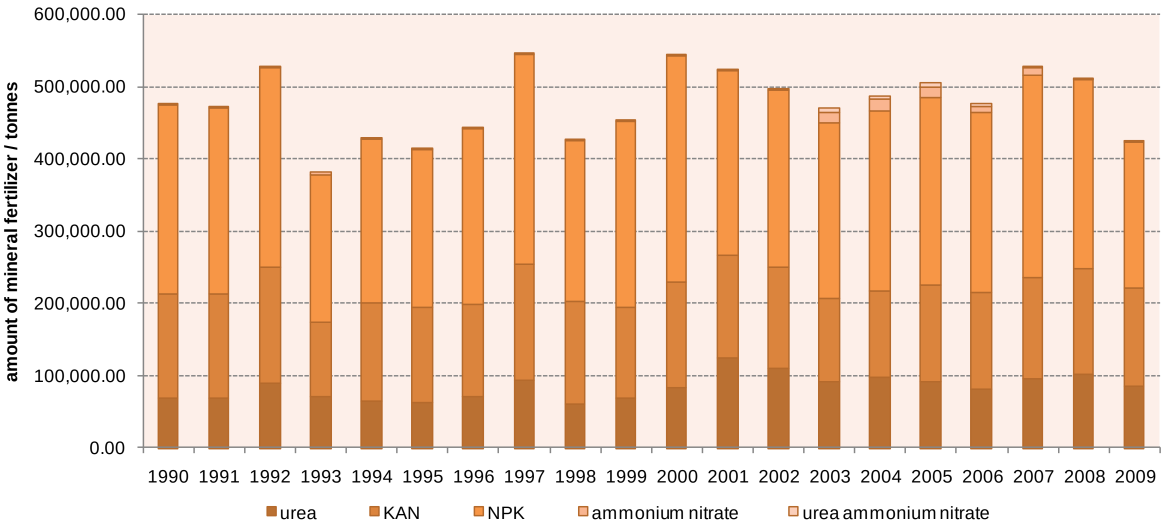

Figure 6.5-3: Mineral fertilizers applied to soil in the period from 1990-2009

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 while the 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 in 2008 was high up to the last quartal 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 1990-2009

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	34,225	2,730	1,390	111,971
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

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	0.24269
1996	0.245532
1997	0.248143
1998	0.243599
1999	0.248162
2000	0.252881
2001	0.253461
2002	0.262077
2003	0.255733
2004	0.273931
2005	0.283887
2006	0.26481
2007	0.262293
2008	0.262149
2009	0.257696

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	1990-2009		
Beans, dry	1990-2009		
Cow peas, dry	2008-2009	1992-2007	1990-1991
Lentils		1992-2009	1990-1991
Peas, dry	2008-2009	1992-2007	1990-1991
Vetches		1992-2009	1990-1991
Clover	1990-2009		
Alfaalfa	1990-2009		

**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 – 2009

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	400	123
1997	39,469	20,527	400	135
1998	77,458	21,003	400	135
1999	115,853	22,291	400	135
2000	65,299	2,657	400	135
2001	91,841	4,421	400	130
2002	129,470	5,163	400	130
2003	82,591	4,967	400	130
2004	97,923	4,459	400	130
2005	119,602	6,041	400	130
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

Table 6.5-4: Production of N-fixing crops in the period from 1990 – 2009 (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	2,400	165,973	188,462
1997	577	2,400	157,559	179,669
1998	746	2,400	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	2,300	131,103	107,815
2003	1,335	2,300	51,890	72,056
2004	1,100	2,300	124,813	103,555
2005	893	2,300	125,460	147,272
2006	715	2,400	121,411	162,694
2007	670	2,300	111,675	137,291
2008	870	2,300	176,089	196,244
2009	955	2,000	147,763	174,274

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	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	1990-2009	
Maize	1990-2009	
Potatoes	1990-2009	
Sugar beets	1990-2009	
Tobacco	1990-2009	
Sunflowers	1990-2009	
Rape seed	1990-2009	
Tomatoes	1990-2009	
Barley	1990-2009	
Oats	1990-1991; 2000-2009	1992-1999

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 – 2009

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

Table 6.5-7: Production of non N-fixing crops in the period from 1990 – 2009 (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

Table 6.5-7: Production of non N-fixing crops in the period from 1990 – 2009 (cont.)

Year	Production of non N-fixing crops / tonnes				
	Sunflowers	Rape seed	Tomatoes	Barley	Oats
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

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

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 1990-2009.
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).

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 were made for each part of the N_2O direct soil emission. The latter is explained below and summarized in Table 6.5-9.

<u>Direct soil emissions</u>

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.

Recalculations of N_2O emission from animal manure[11] 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

[11] 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.

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.

Table 6.5-9: Summary of recalculations of direct N2O emissions from agricultural soils

Recalculations of N_2O emissions from	Due to	For the year/period
Mineral fertilizers	correction of the N-fraction emitted as NH_3 and NO_x (only for urea ammonium nitrate)	2003-2008
Animal manure	change in animal number	1990-1993; 1999; 2006
Biological fixation Crop residue	new and updated activity data (lentils)	2008
	new and updated activity data (beans, dry)	2000-2008
Histosols	new and updated activity data	1990-2008

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:

$$N_2O_{ANIMALS} = N_2O_{(AWMS)} = \Sigma_{(T)}\ [N_{(T)}\ x\ Nex_{(T)}\ x\ AWMS_{(T)}\ x\ EF_{3(AWMS)}]$$

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 2009 are shown in the Figure 6.5-4. The emission trend follows the animal population trend.

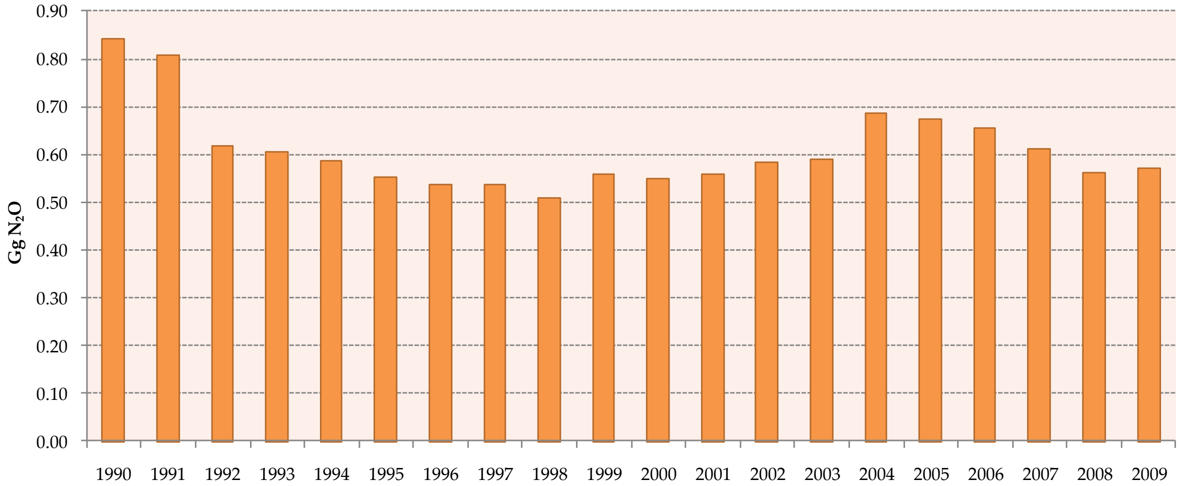

Figure 6.5-4: Direct N_2O emissions from animal production

6.5.2.2. 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.

6.5.2.3. Source specific recalculations

Due to changes in animal number (goats 1992, 1994-1999; mules/asses 1992-1994, horses 2006) 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 2009 is shown in Figure 6.5-5. The emission trend is influenced by the mineral fertilizer consumption and animal population altogether.

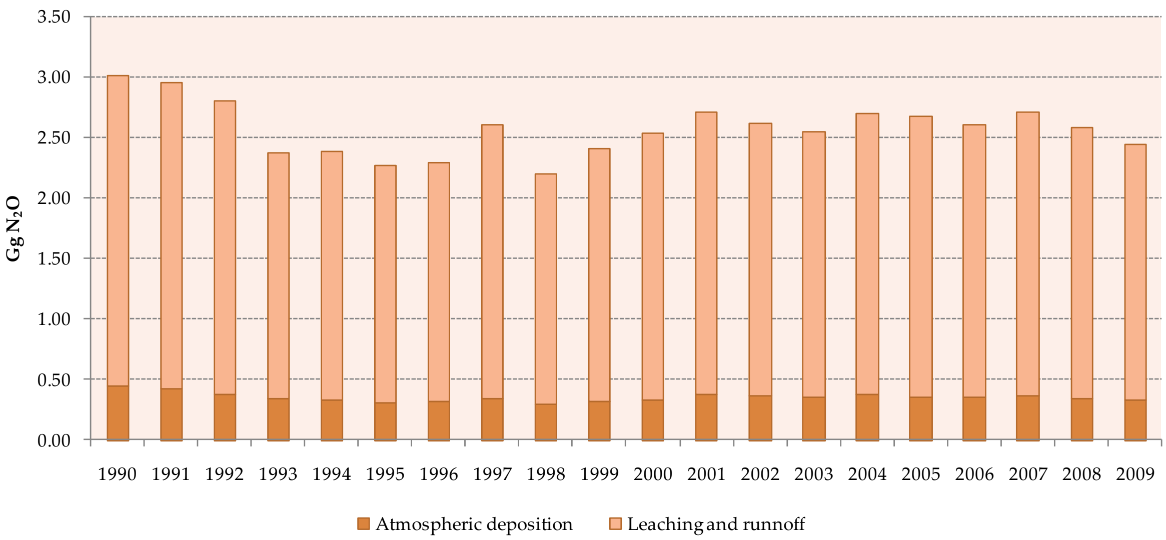

Figure 6.5-5: Indirect N_2O emissions from Agriculture

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.

Emissions from mineral fertilizers

Indirect emissions of nitrous oxide from mineral fertilizers depend to a large extent on the fraction of N that volatilises during 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 correction of N-fraction emitted as NH_3 or NO_x and the 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 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
- 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 2009[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 Tier 1 T2e - Trend excluding LULUCF Tier 2
T1i - Trend including LULUCF Tier 1 T2i - Trend including LULUCF Tier 2

[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:

- investigation with the purpose of detailed explanation of the activity data trends (livestock population, crop production)
- 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 proposed by the IPCC Good Practice Guidance for LULUCF (GPG 2003), the top-level categories for greenhouse gas (GHG) reporting are:

- Forest land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other land

Croatia reports its emissions/removals for Forest land and Settlements (Table 7.1-1). The comparison of the UNFCCC land use categories and the reported land use transitions with the national frame is illustrated in Figure 7.1-1.

Table 7.1-1: Reported LULUCF categories

LAND USE CATEGORY	SUBCATEGORIES	
Forest land	*Forest land remaining forest land*	
	Land converted to forest land	*Other land converted to forest land*
Settlements	*Land converted to settlements*	*Forest land converted to Settlements*

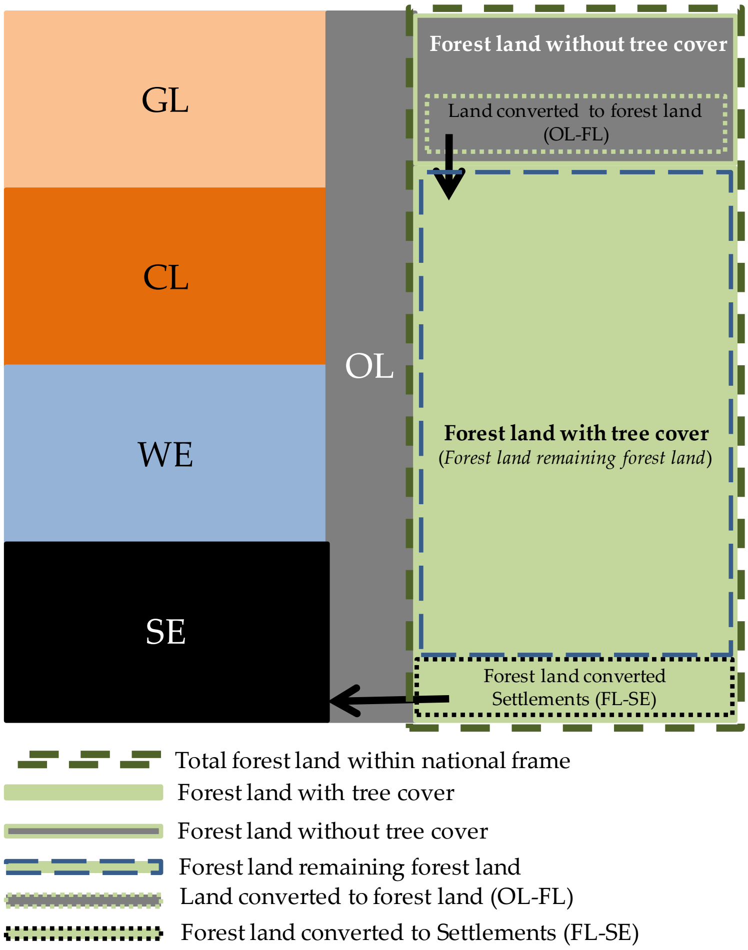


Figure 7.1-1: Comparison of land use categories and reported land use transitions with the national frame

Based on the information presented above, it is clear that, in Croatia, land use changes from and to forest land are recorded (see detail description of forest land within national frames in Chapter 7.2.2.1.). In regard to land use change records, the best status has the category Forest land (although certain assumptions are made) due to long-lasting comprehensive national system for data collection and analyses. However, in general, for other land use categories, data and information on land use changes are unavailable. However, Croatia plans to improve this part of the inventory and report land use transition matrices in the future.

Table 7.1-2 and Figure 7.1-2 show emission/removal trend for *Forest land remaining forest land (FF), Land converted to Forest land (OL-LF)* and for *Land converted to Settlements (SE).* These categories and activities altogether result in removals for LULUCF sector (referred to as the total emission/removal). Relatively smaller CO_2 removal in the period from 1991-1996 is primarily due to different circumstances at that time related to war conditions and

also the lack of some data for certain forest ownerships[13] (other state and private), which was bridged over by assuming that the status of these parameters in 1990 is the same as in 1996. Afterwards, the sector began to revitalize and the data are more complete and more reliable.
In 2009, the share of total national removal in total national emission is about 30%. Moreover, data analysis indicates low significance of land conversion to forest land in the total removal (on average 1%). Conversion of forest land to settlements results in CO_2 emission which makes about 0.3% of total national emission in 2009.

Detailed explanations are provided in the following chapters.

Table 7.1-2: Emissions/removals from LULUCF

Year	Emissions/removals from LULUCF / Gg CO_2			
	Forest land remaining forest land, FF	Land converted to forest land (OL-FL)	Land converted to Settlements (FL-SE)	Total removal
1990	-7,059.35	-11.03	136.79	**-6,933.59**
1991	-6,912.56	-16.62	95.42	**-6,833.76**
1992	-6,836.07	-28.13	32.69	**-6,831.51**
1993	-6,878.17	-39.95	83.51	**-6,834.61**
1994	-6,907.76	-55.88	91.72	**-6,871.92**
1995	-6,826.25	-66.60	30.09	**-6,862.77**
1996	-6,424.86	-73.14	26.19	**-6,471.81**
1997	-6,630.89	-83.31	29.84	**-6,684.36**
1998	-6,803.30	-91.28	34.37	**-6,860.21**
1999	-6,974.25	-100.50	45.97	**-7,028.78**
2000	-7,172.25	-106.24	60.53	**-7,217.96**
2001	-7,348.40	-108.07	68.33	**-7,388.14**
2002	-7,506.17	-115.15	64.52	**-7,556.80**
2003	-7,683.48	-122.94	56.48	**-7,749.95**
2004	-7,925.88	-125.44	116.79	**-7,934.53**
2005	-8,053.08	-130.14	83.21	**-8,100.01**
2006	-8,153.53	-133.70	71.79	**-8,215.44**
2007	-8,423.06	-137.13	54.44	**-8,505.76**
2008	-8,593.94	-140.47	91.29	**-8,643.12**
2009	-8,641.96	-144.61	74.52	**-8,712.06**
Average	-7,387.76	-91.52	67.42	-7,411.85

[13] In the document, although there are two types of forest ownerships in Croatia (state, private) and actually three management institution types (Croatian Forests Ltd., other legal bodies, private persons), for simplicity, the latter will be referred to as three ownership types.

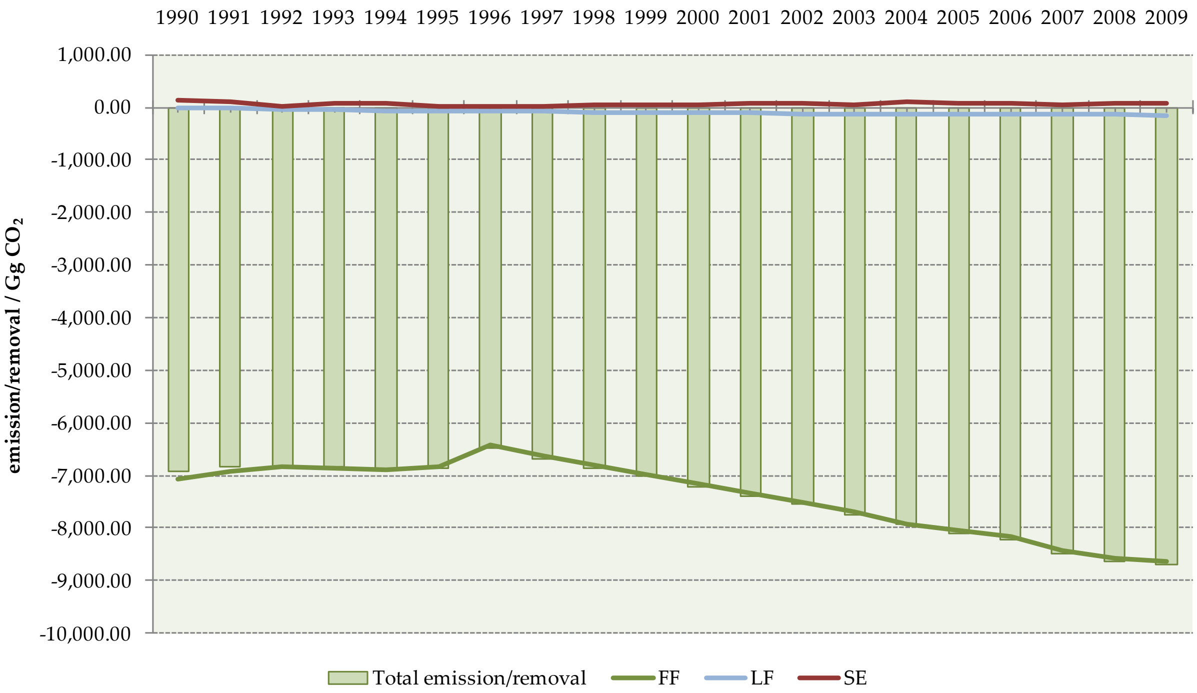


Figure 7.1-2: Emission/removal trend for LULUCF

7.2. FOREST LAND

7.2.1. DESCRIPTION

Under this land category, CO_2 emissions/removals from living biomass[14] from *Forest land remaining forest land* and from *Land converted to forest land* have been reported. All data necessary for emission/removal calculation for other carbon pools are not available.[15] Non-CO_2 emissions due to wildfires are also reported but only for *Forest land remaining forest land* because, currently, area burnt can not be differentiated to *Forest land remaining forest land* and *Land converted to forest land.*

Forest land subcategories are fully in line with the KP reporting activities; thus, *Forest land remaining forest land* refers to *Forest Management* and *Land converted to forest land* refers to *Afforestation.* In this way, coherence and congruity between the two forest-related reporting is maintained.

CO_2 removal from *Forest land remaining forest land* in 2009 is -8,642 Gg CO_2 and from *Land converted to forest land* is -145 Gg CO_2-eq. Therefore, the share of removal from land conversion in total Forest land removal is only about 1.65%. Annual emission/removal from Forest land subcategories and their share in the total Forest land removal is presented in Table 7.2-1.

Table 7.2-1: Emissions/removals from Forest land subcategories and their share in Forest land removal

	Gg CO_2-eq			%	
	Forest land remaining forest land, FF	Land converted to forest land, LF	Forest land removal	The share of FF in Forest land removal	The share of LF in Forest land removal
1990	-7,059.35	-11.03	-7,070.38	99.84	0.16
1991	-6,912.56	-16.62	-6,929.17	99.76	0.24
1992	-6,836.07	-28.13	-6,864.20	99.59	0.41
1993	-6,878.17	-39.95	-6,918.12	99.42	0.58
1994	-6,907.76	-55.88	-6,963.64	99.20	0.80
1995	-6,826.25	-66.60	-6,892.85	99.03	0.97
1996	-6,424.86	-73.14	-6,498.01	98.87	1.13
1997	-6,630.89	-83.31	-6,714.20	98.76	1.24
1998	-6,803.30	-91.28	-6,894.58	98.68	1.32
1999	-6,974.25	-100.50	-7,074.75	98.58	1.42
2000	-7,172.25	-106.24	-7,278.49	98.54	1.46

[14] Below ground biomass is combined with the above ground and thus the notation key IE is used for below ground biomass.

[15] However, within the Kyoto protocol reporting frame, information is provided which shows that these pools do not represent emission sources (see KP Chapter 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 carbon pools*).

2001	-7,348.40	-108.07	-7,456.46	98.55	1.45
2002	-7,506.17	-115.15	-7,621.32	98.49	1.51
2003	-7,683.48	-122.94	-7,806.42	98.43	1.57
2004	-7,925.88	-125.44	-8,051.32	98.44	1.56
2005	-8,053.08	-130.14	-8,183.22	98.41	1.59
2006	-8,153.53	-133.70	-8,287.23	98.39	1.61
2007	-8,423.06	-137.13	-8,560.19	98.40	1.60
2008	-8,593.94	-140.47	-8,734.41	98.39	1.61
2009	-8,641.96	-144.61	-8,786.58	98.35	1.65
Average	-7,387.76	-91.52	-7,479.28	98.81	1.19

In order to provide the basis for certain explanations and to increase the transparency, detailed description of the forestry sector and forest land in Croatia is presented in the following subchapter.

7.2.2.1. Description of the forestry sector in Croatia

<u>Forest land</u>

Forest land in the Republic of Croatia is a good of general interest and under special protection of the state. The Forest Act (OG 140/05, 82/06, 129/08, 80/10, 124/10) 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 the year 2006 provided in the Forest Management Area Plan for the period from 2006-2015 (FMAP 2006-2015).

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. Forest land without tree cover

- Productive forest land without tree cover (e.g. clearings)
- 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, land without tree cover is categorized as forest land. The latter indicates for example that afforestation does not necessarily mean land conversion for Croatia in the administrative national frame.

The share of each category/subcategory that constitutes forest land in Croatia in total forest land area is shown in Figure 7.2-1.

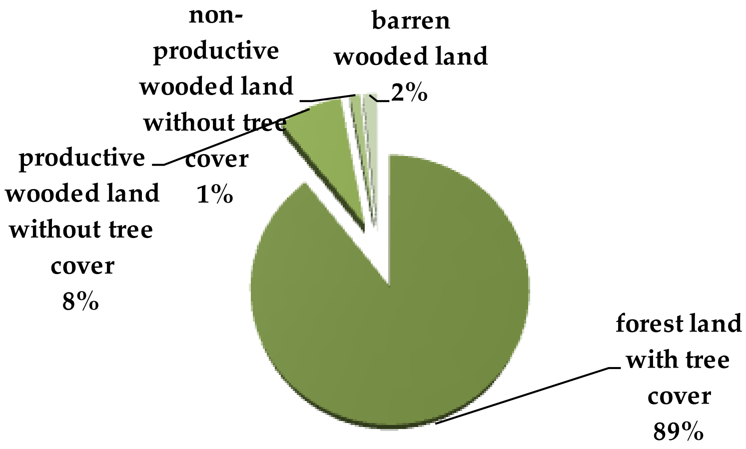


Figure 7.2-1: Share of each category/subcategory in total forest land area, year 2006

Based on forest stands, forest land with tree cover is divided as follows:

- high forests
- plantations
- forest cultures
- coppice
- maquia
- scrub
- garigue
- shrub

Their share in forest land with tree cover is shown in Figure 7.2-2.

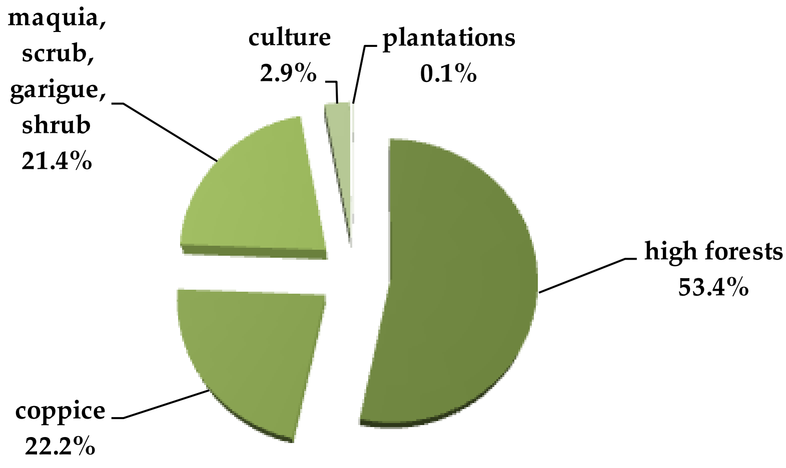


Figure 7.2-2: The share of each forest stand in forest land with tree cover, year 2006

According to the *Forest Act* (OG 140/05, 82/06, 129/08, 80/10, 124/10), forests are classified in three (3) categories:

- management forests (which made about 90% of total forest area in 2006)
- protection forests (which made about 6% of total forest area in 2006)
- forests with special purpose (which made about 4% of total forest area in 2006)

Based on 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 (Figure 7.2-3).

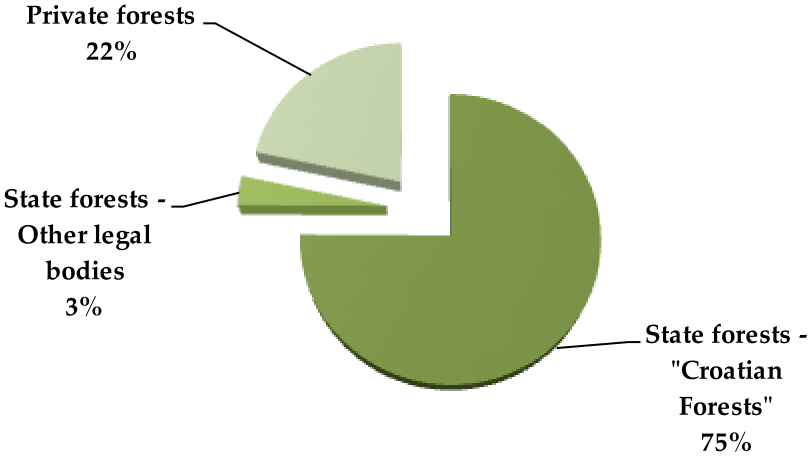


Figure 7.2-3: The ownership structure of forest area in Croatia, year 2006

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 does not match real conditions – private forests are 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 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 satellite images (scale 1: 1,000,000), 3. by using CORINE data.

Data on growing stock are presented based on ownership structure and by species (Figures 7.2-4 and 7.2-5). The current FMAP 2006-2015 determines total growing stock of about 398 mil. m^3 in 2006 determined 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).

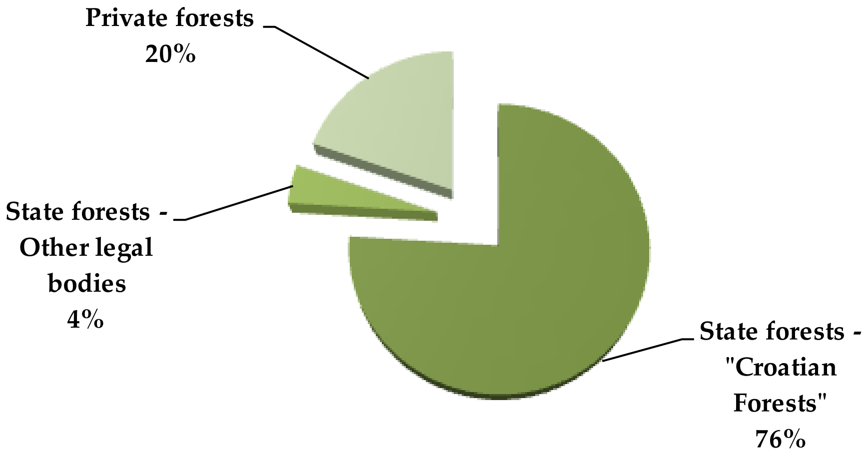


Figure 7.2-4: The share of growing stock in state and private forests, year 2006

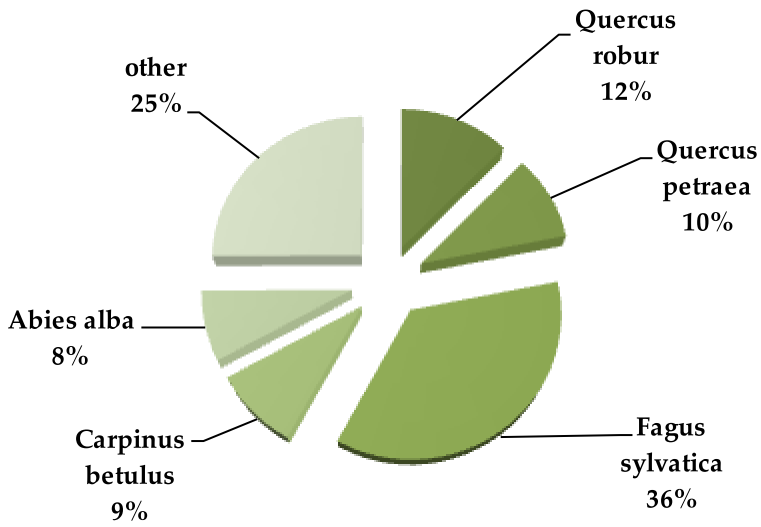


Figure 7.2-5: Share of main species in total growing stock, year 2006

Diameters at breast height are measured at sample plots taking, from the total sub-compartment area:

- At least 2% in even-aged stands of the second age class regarding high forests, 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) and in uneven-aged forests

For example, planned work normative for state forests managed by „Croatian Forests" for the year 2010 is as follows:

- Extracting the sub-compartment at 143,000 ha

- Measurements of breast diameters at 69,000 sample plots of the 5% sample trees
- Measurements of breast diameters at 25,000 sample plots of the 2% sample trees
- Measurements of breast diameters of all trees at 6,000 ha
- Measurements of 123,000 tree heights
- Taking 43,000 bores

When FMAPs are prepared, increment is estimated based on local tables of increment percentage which are made by using the bore-spill method (Article 23, *Regulation on Forest Management*, OG 111/06, 141/08). The increment cores are taken at breast height (1.30 m) with Pressler's borer. The two basic methods to calculate increment percentage are either based on increment in diameter or on transfer period for the uneven-aged forests. The share of increment in state and private forests is presented in Figure 7.2-6.

Figure 7.2-6: The share of increment in state and private forests, year 2006

<u>Forest management</u>

Croatia has a long tradition of forest management with a comprehensive, vertically structured, national system for monitoring, data collection and reporting on the condition and activities in forestry sector.

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.

According to the *Act* (Article 7), forest management includes cultivation, protection and usage of forest and forest land and also building and maintenance of forest infrastructure, in accordance with the all-European criteria for sustainable forest management which are as follows:

- Maintenance and adequate improvement of forest ecosystems and their contribution to the global carbon cycle
- Maintenance of forest ecosystems' health and vitality
- Maintenance and promotion of productive functions of the forest
- Maintenance, protection and adequate improvement of biological diversity in forest ecosystem
- Maintenance and adequate improvement of protective functions in forest management (especially of soil and water)
- Maintenance of other socio-economic functions and conditions.

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. 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 is approved by the Ministry of Regional Development, Forestry and Water 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. FMAPs, among other, appoint 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, total forest land in Croatia constitutes one forest management area which is established in order to ensure unique and sustainable management of the forest land. Therefore, according to national criteria, both forest land with and without tree cover is sustainably managed regardless of their ownership, purpose, forest stand etc.

Based on 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 maquia, scrub, garigue and shrub). The management is based on stands which means that the stand or the subcompartment are the lowest management units. Uneven-aged forests make about 17 % of forest land with tree cover (excluding maquia, scrub, garigue and shrub). In these forests, tree management is performed which means that the lowest management unit is the tree or a group of trees.

State forests are managed either by "Croatian Forests Ltd." or by other legal bodies. For private forests, Forest Advisory Service (FAS) was established in 2006 (began working in 2007). Its function is to assist private owners in management and improvement of private forests' condition. This service has recently been merged with the "Croatian Forests Ltd".
Furthermore, detailed information on the system within state forests managed by "Croatian Forests" is provided. 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.

The system is divided in 16 organizational and territorial units – forest districts (Figure 7.2-7). This division was established in 1996.

Districts consist of forest units and today Croatian area is divided into 170 forest units. The forest unit is the basic organizational unit for performing all expert and technical activities in forest management and they are directly supervised by the District. Forest management in forest units is based upon forest management plans for individual management units approved by the Ministry of Regional Development, Forestry and Water Management. An example of one district divided into 11 forest units is presented in Figure 7.2-8.

Each forest unit manages a certain number of management units. The division of forest management area on management units is performed to facilitate the implementation of forest management plans. The area of a management unit is usually between 1,000 and 3,000 ha. The area of management units is determined by the Forest Management Area Plan and, usually, they are not changed (now there is about 653 management units). The number of management units governed by a certain forest unit is variable. Figure 7.2-9 shows forest unit "Cerna" divided into three management units.

Management unit is divided into compartments and sub-compartments. Compartment is considered as the permanent, basic unit regarding the management forest division. They are established in order o facilitate the management, inspection and field orientation. The compartment area, except for first age class, shrub, scrubs, maquia, garigue and barren wooded land, in general can not be larger than 60 ha. Figure 7.2-10 shows the division of the management unit "Krivsko ostrvo" on 33 compartments.

Compartments are divided into smaller areas (sub-compartments), and a sub-compartment is the smallest variable, basic area regarding the management division of forests which is specially managed as a stand. Stands are included in sub-compartments depending on their stand origin, stand form, development stage, tree specie, age, management goal, mixture ratio and tree coverage. The smallest area of a sub-compartment is 1 ha except in private forests and separated forest area when it can be even smaller, and the largest sub-compartment area is determined by the compartment size. However, the sampling is performed within the sub-compartment on a 0.05 ha grid. Figure 7.2-11 shows that compartment 7 of the management unit "Krivsko ostrvo" is divided into 3 sub-compartments.

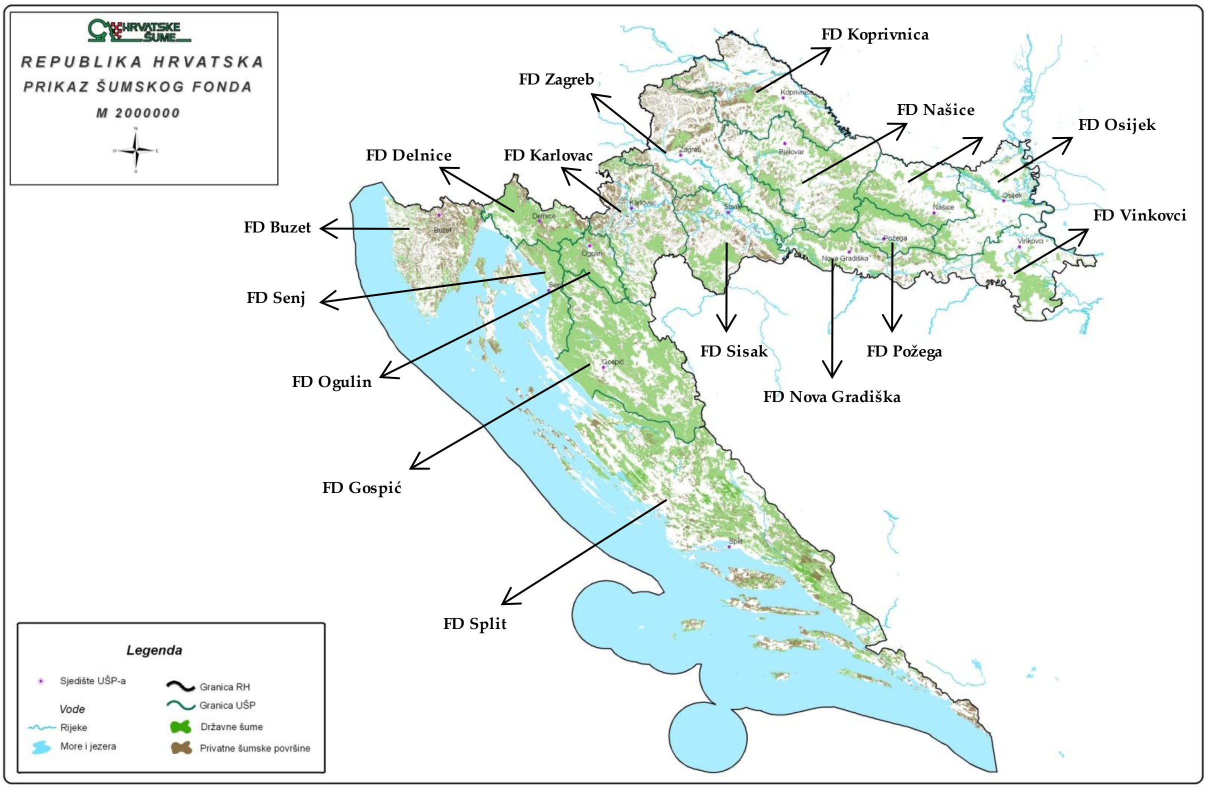
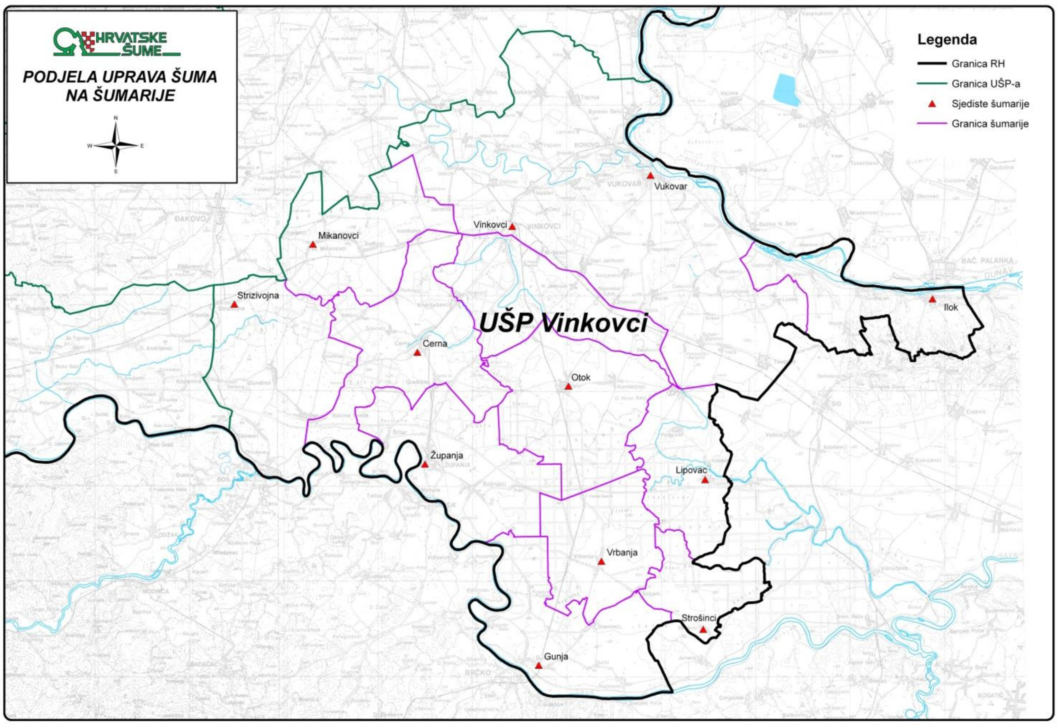


Figure 7.2-7: Spatial division of the Republic of Croatia on forest districts



UŠP refers to FD

Figure 7.2-8: Division of forest district “Vinkovci” on related forest units (example)

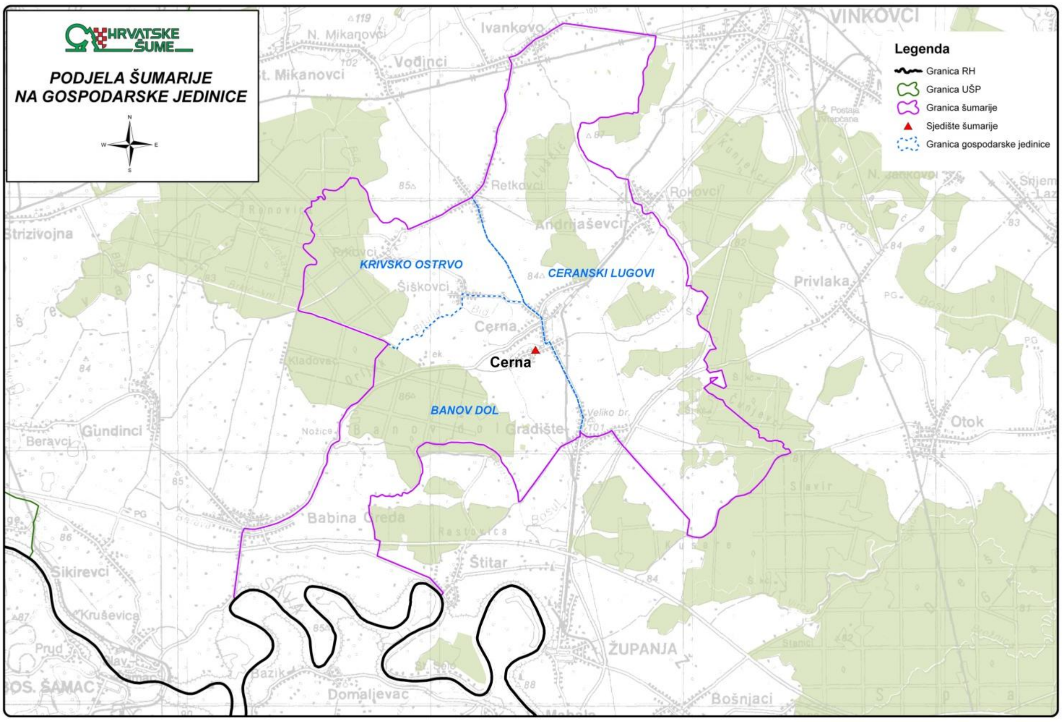


Figure 7.2-9: Area of a forest unit “Cerna” with the spatial division on related management units (example)

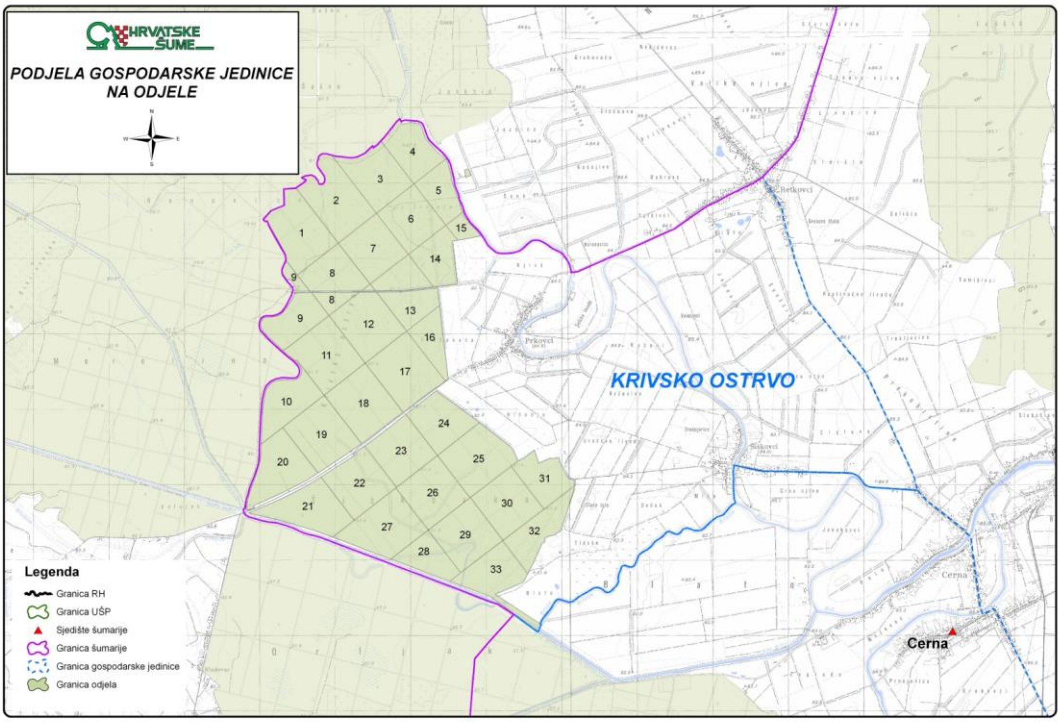


Figure 7.2-10: Area of a management unit "Krivsko ostrvo" divided into compartments (example)

Figure 7.2-11: Compartment area divided into sub-compartments (example)

Short scheme of the system's structure is presented in Figure 7.2-12.

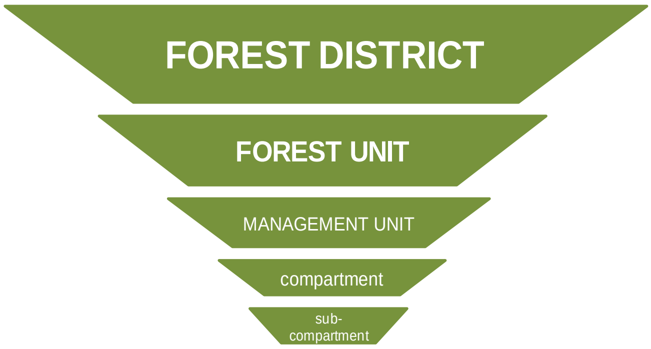


Figure 7.2-12: The scheme of the national system's structure

Therefore, it should be emphasized again that the basic unit for forest management in Croatia is the sub-compartment for which, based on field measurements on a 0.05 ha grid and the analysis of the related results, data on area, land category, growing stock and increment on diameter class (above 10 cm in diameter at 130 cm above ground, classes by 5 cm), age, ecological and management type, crown cover, height above sea level, the level of fire vulnerability, tree species and related number of trees etc. are determined. Furthermore, for each sub-compartment, a felling and silvicultural treatment rule is prepared which is recorded each year.

7.2.3. INFORMATION ON APPROACHES USED FOR REPRESENTING LAND AREAS AND ON LAND-USE DATABASES USED FOR THE INVENTORY PREPARATION

Representation of Forest land 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[16]:

- 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 *Forest land remaining forest land* and *Land converted to forest land are* through the entire period divided on three types of ownership but the data are not available for each ownership in each year.

Therefore, the applied approach for representation of 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.

[16] 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".

Regarding other land use categories, at this point, they are not reported due to lack of adequate data. For the same reason, land use matrices could not be assembled and also due to differences between the information/data within the current administrative system and the real status of these lands in the field. The latter generates certain inconsistencies which are evident even in the activity matrices for the KP.

7.2.4. LAND-USE DEFINITIONS AND THE CLASSIFICATION SYSTEMS USED AND THEIR CORRESPONDENCE TO THE LULUCF CATEGORIES

Definitions applied within this inventory regarding 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. Therefore, *Forest land remaining forest land* is represented in KP reporting within Article 3.4 (Forest Management) and *Land converted to forest land* within 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*).

Therefore, Forest land is composed of *Forest land remaining forest land* and *Land converted to forest land. Forest land remaining forest land* is forest land with tree cover (national frame) but with forest defined as 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, 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 in biomass for the related forest stands is not performed; thus, these areas are excluded form the reporting.
Therefore, *Forest land remaining forest land* is forest land covered with high forests, plantations, cultures and coppice.

As for *Land converted to forest land*, in national frames, it refers to the transition of forest land without tree cover to forest land with tree cover. Since this type of national classification is specific and comprehensive, it was concluded that the best option for now is to address forest land without tree cover as *Other land* within the UNFCCC reporting frame and thus to report this type of transition as *Other land converted to Forest land*.

Figure 7.2-13 shows the relationship between national and UNFCCC frame regarding forest land. For detailed explanation of the national frame, see Chapter 7.2.2.1.

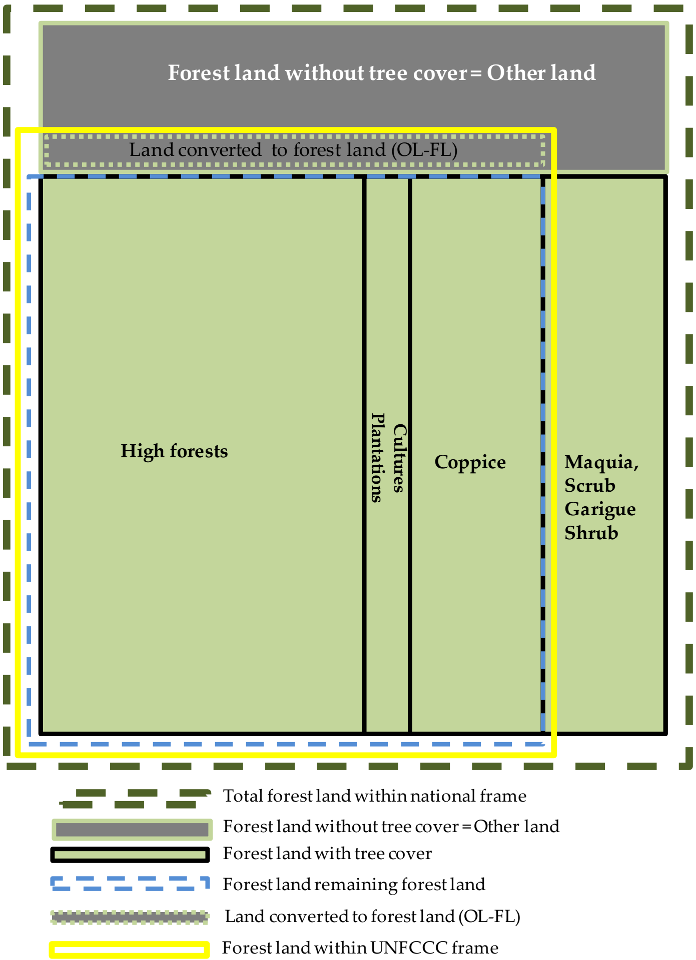


Figure 7.2-13: Relationship between forest land within national and the UNFCCC frame

7.2.4. METHODOLOGICAL ISSUES

7.2.4.1. Forest land remaining forest land

Emissions and removals regarding *Forest land remaining forest land* were calculated based on more detailed data which enabled the estimation of carbon stock changes in biomass for the land subcategory *Forest land remaining forest land* to be based on a different approach than the one described in Addendum to NIR 2010.

The dataset encompasses the entire period from 1990-2009 and the main data source are Forest Management Area Plans (FMAPs). Data are divided based on ownership and forest type upon which the related emission/removal calculation was performed using primarily Tier 1. The calculation refers only to living biomass as a carbon pool since data required for other pools (dead wood, litter, soil) are not available. 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 *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 which are presented further on (Table 7.2-2 and Figures 7.2-14 to 7.2-17). 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 state forests managed by "Croatian Forests". Methodological issues are explained in detail below.

Table 7.2-2: Activity data on forest area, increment and fellings for all forest regardless of the ownership

	kha	mil. m^3	
Year	FOREST AREA	INCREMENT	FELLINGS
1990	1,793	8.865	4.674
1991	1,785	7.734	3.573
1992	1,776	7.588	3.472
1993	1,766	7.499	3.346
1994	1,757	7.726	3.567
1995	1,748	7.510	3.395
1996	1,739	7.450	3.635
1997	1,752	7.978	4.056
1998	1,765	8.142	4.112
1999	1,778	8.208	4.066
2000	1,792	8.539	4.281
2001	1,806	8.710	4.342
2002	1,819	8.810	4.340
2003	1,832	9.161	4.592
2004	1,846	9.483	4.768
2005	1,859	9.565	4.773
2006	1,873	9.829	4.977
2007	1,873	10.280	5.275
2008	1,874	10.314	5.533
2009	1,875	10.224	5.404

Forest area

The data on forest area are in line with the relevant definitions and therefore exclude afforested area. Figure 7.2-14 shows forest area by ownership for the period from 1990-2009. The observed changes in forest area are a result of several different influences which can not be explained only by reported land use transitions but more with the differences between the administrative system and the real status in the field.

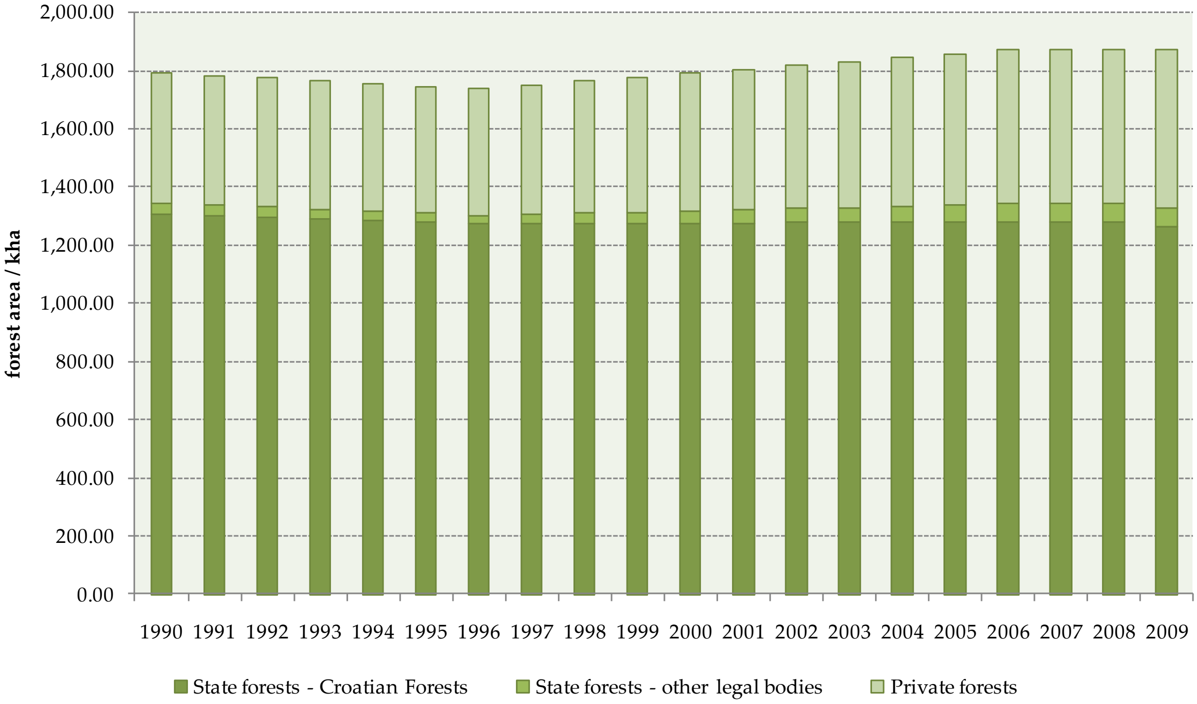


Figure 7.2-14: Forest area by ownership

Increment

The methodological approach, in regards to the annual increment[17], differs between 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 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.

The increment in state forests managed by other legal bodies was directly taken from the FMAP 2006-2015 while, for the years in between, interpolation was applied. 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 is the same as the one in 1996. For the period after 2006 (2007-2009), the increment is determined based on the FMAP data according to which the percentage of growing stock increment in other state forests is 2.4% (growing stock is available). Regarding the broadleaved/coniferous distribution, most accurate data is known for 2006 and the related ratio was assumed the same for the entire period concerned from 1990-2009.

[17] Generally speaking, volume is measured, calculated and presented as the volume of heavy wood (includes branches thicker than 7 cm) for all tree above taxation level which is 10 cm in diameter at breast height (130 cm).

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 (2007-2009), the increment is determined based on the FMAP data according to which the percentage of growing stock increment in private forests is 2.7%. Since the data on growing stock are not available, it was assumed that the mentioned increase refers also to the increment itself. Regarding the broadleaved/coniferous distribution, most accurate data is also known for 2006 and the related ratio was assumed the same for the entire period concerned from 1990-2009.

The increment by ownership is shown in Figure 7.2-15. Lower increment is noticed in the war period when forest management practices were not in their usual frames which indicates the importance of 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 1 (and Tier 2 for state forests managed by "Croatian Forests") and related equation 3.2.5 from GPG 2003.

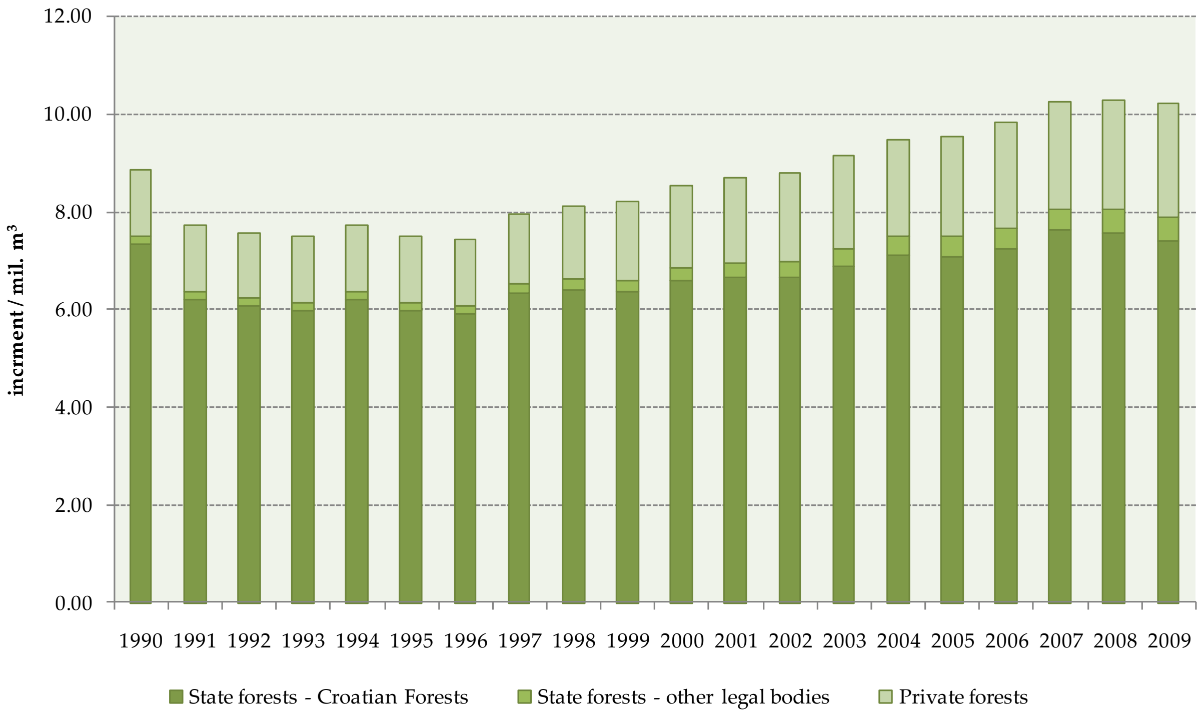


Figure 7.2-15: Increment by ownership

Carbon losses include losses due to fellings and natural disturbances.

Data on fellings used refer to gross volume felled (overbark), excluding volume cut in deforestation, which is further disaggregated as broadleaved and coniferous in all state and private forests. The volume already includes fuelwood and the volume cut after natural disturbances. As for fuelwood gathering, according to forest experts' opinion, the latter is negligible and the data are not available. Fellings are presented in Figure 7.2-16. Due to war conditions, fellings significantly decreased in the period from 1991-1995. Afterwards, the sector began to revitalize and fellings started to increase. In 2009, fellings made about 53% of the increment. Fraction of biomass left to decay (f_{BL}) is set to 0 based on the assumption that total biomass, associated with the volume of extracted roundwood, is considered as an immediate emission. Finally, carbon loss due to fellings is calculated using Tier 1 and equation 3.2.7 from GPG 2003.

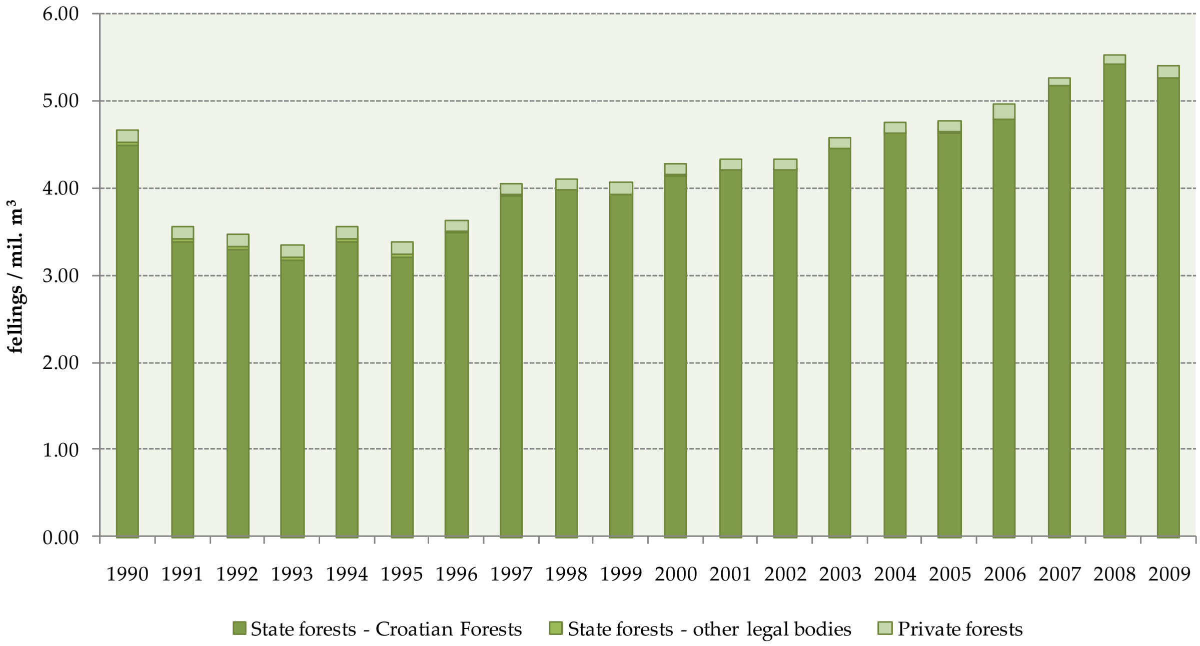


Figure 7.2-16: Fellings by ownership

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	

Since the methodology for state forests managed by "Croatian Forests" differs from other ownerships, detailed overview of the approach is shown below:

ΔC_{FFLB}	=	$\Delta CFFG_{CFj} - \Delta CFFL_{CFj}$
$\Delta CFFG_{CF}$	=	$\Sigma_j ((V_{t2CFj}-V_{t1CFj})+H_{t1CFj})*Dj*BEF1j*(1+Rj)*CF$

Where

j	=	Type of forest, j=1,2 (broadleaved, coniferous)
V_{t1CFj}	=	mercantable growing stock in state forests managed by "Croatian Forests" at time t_1, by forest types (j=1,2), m^3
V_{t2CFj}	=	mercantable growing stock in states forests managed by "Croatian Forests" at time t_2, by forest types (j=1,2), m^3
H_{t1CFj}	=	gross volume felled in state forests managed by "Croatian Forests" 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, $(tonnes\ d.m)^{-1}$
$\Delta CFFL_{CF}$	=	$L_{fellings}+L_{fuelwood}+L_{other\ losses}$
$L_{fellings}$	=	$\Sigma_j H_{t1CFj}*D_j*BEF2_j*CF$
H_{t1CFj}	=	gross volume felled in state forests managed by "Croatian Forests" 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

Non-CO_2 greenhouse gas emissions (CH_4, CO, N_2O and NO_x) released in wildfires are estimated according to Tier 1, equation 3.2.19, GPG 2003 using input data on:

- A = area burned, ha
- B = mass of available fuel, kg d.m.ha^{-1}
- C = combustion efficiency, dimensionless
- D = emission factor, g (kg d.m.)$^{-1}$

Activity data relates to area burnt which is presented in Table 7.2-4. Since the data for 1990 and 1991 are 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. It should be emphasized that area burnt on *Forest land remaining forest land* and area burnt on *Land converted to forest land* can not be differentiated for now. Therefore, non-CO_2 emissions in general are reported only under the subcategory *Forest land remaining forest land.* Products of B and C are estimated using GPG 2003, Table 3.A.1.13.

Table 7.2-4: Area burnt

Year	Area burnt / ha
1990*	4,234
1991*	4,234
1992	964.00
1993	8,196.00
1994	3,723.00
1995	633.00
1996	2,550.00
1997	4,025.66
1998	7,551.30
1999	472.16
2000	17,174.21
2001	3,513.87
2002	1,769.00
2003	8,271.00
2004	355.00
2005	381.00
2006	507.00
2007	1,698.00
2008	1,299.00
2009	646.00

*Average 1996-2006.

Table 7.2-5 provides information on annual change in carbon stock in living biomass in *Forest land remaining forest land*. CO_2 removals for the period from 1990-2009 are presented in Figure 7.2-17.

Table 7.2-5: 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	3,754.79	1,829.52	1,925.28
1991	3,286.08	1,400.83	1,885.24
1992	3,223.66	1,359.28	1,864.38
1993	3,181.42	1,305.55	1,875.86
1994	3,278.15	1,394.22	1,883.93
1995	3,192.37	1,330.66	1,861.71
1996	3,173.53	1,421.30	1,752.23
1997	3,400.85	1,592.43	1,808.42
1998	3,468.75	1,613.30	1,855.45
1999	3,503.96	1,601.90	1,902.07
2000	3,641.87	1,685.80	1,956.07
2001	3,710.17	1,706.06	2,004.11
2002	3,746.50	1,699.36	2,047.14
2003	3,892.52	1,797.03	2,095.49
2004	4,018.92	1,857.32	2,161.60
2005	4,060.21	1,863.91	2,196.29
2006	4,155.06	1,931.37	2,223.69
2007	4,350.32	2,053.12	2,297.20
2008	4,479.03	2,135.23	2,343.80
2009	4,442.92	2,086.02	2,356.90
Average	3,698.05	1,683.21	2,014.84

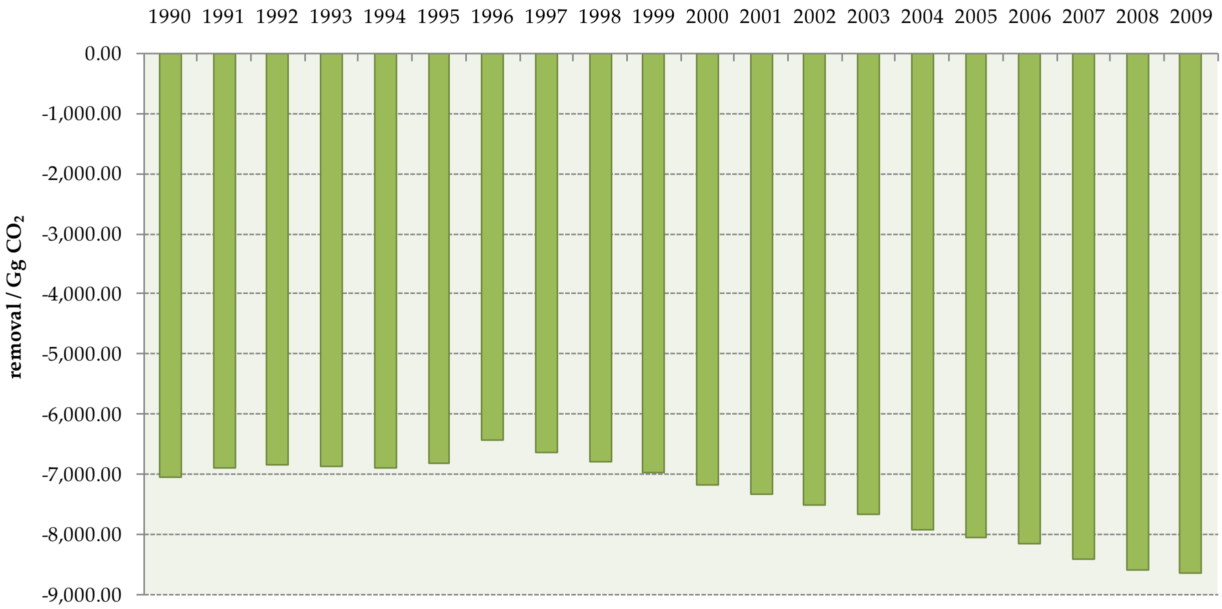


Figure 7.2-17: CO_2 removal in living biomass in FF

During the war (1991-1995), when 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 increases 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 approximately 32% and the fellings about 37%.

7.2.4.2. Land Converted to Forest Land

Emission/removals from land conversion activities have been calculated using Tier 1 method for living biomass only for the entire period from 1990-2009.

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.

The basic input data is the area afforested which refers only to the area managed by "Croatian Forests" and private forests but not for the entire period concerned. Detailed data on afforestation activities in other state is not available. The attained data on annually afforested area is shown in Table 7.2-6. Figure 7.2-18 shows total afforested area in the period from 1990-2009.

Table 7.2-6: Land converted to forest land each year

Year	Afforested area / ha
1990	1,373.99
1991	695.40
1992	1,433.50
1993	1,472.32
1994	1,983.91
1995	1,334.84
1996	814.97
1997	1,265.55
1998	992.76
1999	1,148.30
2000	715.09
2001	227.30
2002	882.30
2003	969.94
2004	311.23
2005	584.85
2006	443.88
2007	427.48
2008	415.08
2009	516.64

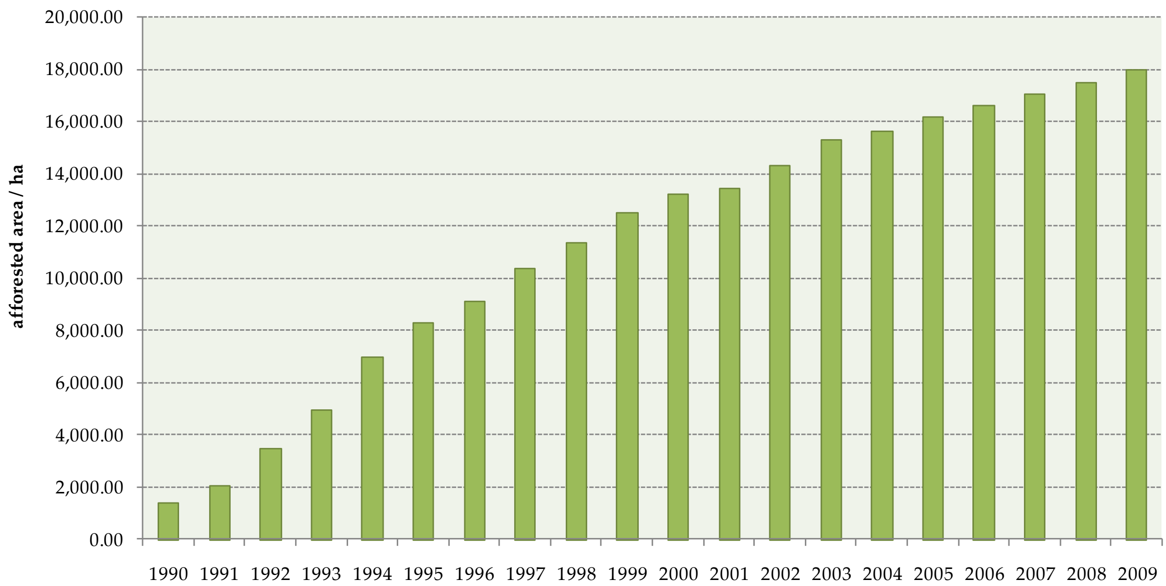


Figure 7.2-18: Land converted to forest land

Annual increase in carbon stock due to biomass increment in afforested area is estimated according to equation 3.2.23 (GPG 2003).

The largest part of forest area in Croatia is managed on a sustainable manner and little is intensively managed. Extensive forest management as such, does not exist in Croatia. According to forest experts' judgement, 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 area of land converted to sustainably managed forest.

Furthermore, following the aforementioned, since the data on increment was not available (the increment on these areas is not measured within the national forest management system), default data on average annual increment in aboveground biomass in natural regeneration by broad category were used that refer to temperate coniferous forests, age class ≤ 20 years. The latter was chosen based on the forest experts' judgement that afforestation was mainly performed with coniferous species.

As for the root-to-shoot ratio, default data were also used, related to conifer forest/plantation with the aboveground biomass < 50 t/ha, due to lack of national data. The latter was chosen based on the forest experts' judgement that biomass in coniferous forest, moreover in young stands (< 20 years), is very small and that R connected to aboveground biomass < 50 t/ha is the most appropriate value to be used.

Brief summary of abovementioned is as follows:

- Iv = average annual net increment in aboveground biomass in natural regeneration by broad category, t/ha (GPG 2003, Table 3A.1.5., temperate coniferous forest, age class ≤ 20 years)
- R = root to shoot ratio, dimensionless (GPG 2003, Table 3A.1.8, conifer forest/plantation with aboveground biomass < 50 t/ha)
- CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d. m.)$^{-1}$

There is no decrease in biomass carbon stock since fellings are not performed on afforested area.
As for wildfires, area caught by fire can not 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 *Forest land remaining forest land* as are non-CO_2 emissions. Therefore, CO_2 and non-CO_2 emissions for *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).

Table 7.2-7 provides information on annual change in carbon stock in living biomass for *Land converted to forest land*. The conversion of land to forest land results in CO_2 removal shown in Figure 7.2-19. The increase of removal follows the increased trend of afforested area.

Table 7.2-7: Annual change in carbon stock in living biomass for Land converted to forest land

	Gg C		
Year	Annual increase in carbon stocks	Annual decrease in carbon stocks due to carbon loss	Annual change in carbon stock in living biomass
1990	3.01	0	3.01
1991	4.53	0	4.53
1992	7.67	0	7.67
1993	10.90	0	10.90
1994	15.24	0	15.24
1995	18.16	0	18.16
1996	19.95	0	19.95
1997	22.72	0	22.72
1998	24.89	0	24.89
1999	27.41	0	27.41
2000	28.98	0	28.98
2001	29.47	0	29.47
2002	31.41	0	31.41
2003	33.53	0	33.53
2004	34.21	0	34.21
2005	35.49	0	35.49
2006	36.46	0	36.46
2007	37.40	0	37.40
2008	38.31	0	38.31
2009	39.44	0	39.44
Average	24.96	0	24.96

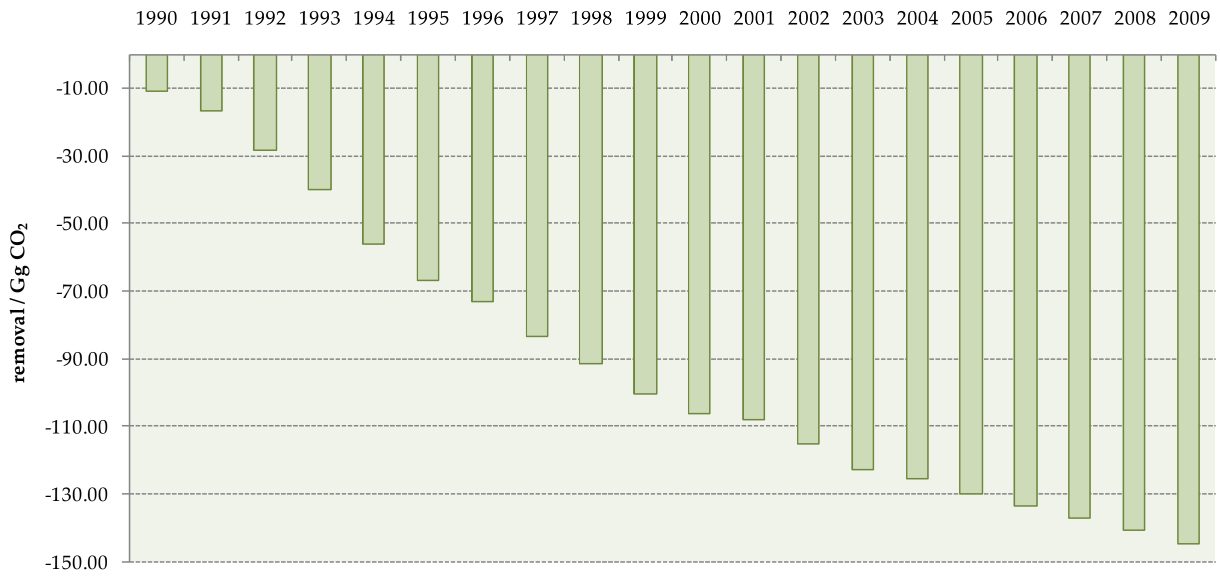


Figure 7.2-19: Trend of CO_2 sink in living biomass in LF

7.2.5. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

For *Forest land remaining forest land*, 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 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 expert judgement, for *Land converted to forest land*, 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 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.

7.2.6. SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of inventory submission, which overlapped with the preparation of the reference level 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 prepares the inventory. Institution that leads the technical work has MEPPPC approval for doing 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. After a final draft of this chapter was prepared, an audit was carried out.

Moreover, in March 2010 and February 2011, TAIEX workshops were held in Croatia regarding GHG emissions and the Kyoto Protocol (2010) and also specifically greenhouse gases inventory in the forestry sector (2011). During these expert missions, reporting experiences of other countries were presented and relevant national institutions participated in the discussion and analyses of the methodological approaches, activity data and ways to improve the Croatian inventory in the future. Both missions were highly fruitful and important for all institutions involved in the inventory preparation process.

Regarding Forest land (and LULUCF in general), two land subcategories represent key sources as presented in Table 7.2-8.

Table 7.2-8: *Key categories regarding Forest land (and LULUCF) based on the level and trend assessment in 2009*

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
Land converted to forest land	CO_2				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

Since Addendum to NIR 2010, certain recalculations were performed in regards to *Forest land remaining forest land* which is explained further on.

With this NIR 2011, the estimation of carbon stock changes in biomass for the land subcategory *Forest land remaining forest land* is based on a different approach than the one described in Addendum to NIR 2010 which resulted in a decreased CO_2 removal, on average by 22% (Table 7.2-8). This was possible due to 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. As for private forests, the assumption that the increment per area in state forests equals the increment per area in private forests is no longer used. It is considered that a more reliable approach is to take the related data directly from the FMAP 2006-2015. Overall, the methodology presented in this document, although including certain assumptions, results in more reliable emission/removal estimation which better reflects the condition of forests in Croatia.

Table 7.2-9: Changes in FF removal between NIR 2010 and NIR 2011

Year	Removal / Gg CO_2		%
	Addendum to NIR 2010	NIR 2011	Difference
1990	-8,427.86	-7,059.35	-16.24
1991	-7,688.94	-6,912.56	-10.10
1992	-7,530.45	-6,836.07	-9.22
1993	-7,507.92	-6,878.17	-8.39
1994	-7,668.79	-6,907.76	-9.92
1995	-7,489.74	-6,826.25	-8.86
1996	-9,233.38	-6,424.86	-30.42
1997	-9,595.62	-6,630.89	-30.90
1998	-9,699.27	-6,803.30	-29.86
1999	-9,778.08	-6,974.25	-28.67
2000	-10,005.85	-7,172.25	-28.32
2001	-10,109.81	-7,348.40	-27.31
2002	-10,144.51	-7,506.17	-26.01
2003	-10,368.41	-7,683.48	-25.90
2004	-10,614.00	-7,925.88	-25.33
2005	-10,658.42	-8,053.08	-24.44
2006	-10,687.81	-8,153.53	-23.71
2007	-11,081.08	-8,423.06	-23.99
2008	-11,075.13	-8,593.94	-22.40

No recalculations were performed for *Land converted to forest land.*

7.2.8. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Short term goals are as follows:

- Further investigation of the gross volume felled and the necessity to make corrections to exclude "waste"
- Attaining more detailed data on land converted to forest land in order to accomplish the same level of detail for the entire period and to improve the related emission/removal calculation
- Attaining required data on forest fires separately for *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

Long-term goals:

- Compilation of land-use matrices
- Further stratification (e.g. on specie level) in order to improve the overall calculation and to be able to apply more country-specific BEFs and other, currently default, parameters

- Development of research strategies in order to attain the dataset required for emission/removal calculation for maquia and scrub since this vegetation is also within the Kyoto forest definition
- Including other carbon pools (dead wood, litter, soil) in emission/removal calculation
- Improvement of data quality regarding private forests

Croatian National Forest Inventory (CRONFI) is still under the consideration among the forestry society and not available and published. During the preparation and consideration of the CRONFI, it was found out that the data from the forest management plans are more accurate and reflect actual situation on the ground because they are based on measurements and that the CRONFI cannot provide so many levels of data accuracy. Also due to consistency requirements, it should be taken into consideration that CRONFI has been produced for the first time, while forest management in Croatia is based on the forest management plans for 250 years. In that respect, Ministry of Regional Development, Forestry and Water Management and the Ministry of Environmental Protection, Physical Planning and Construction agreed that preparation of the annual GHG Inventory in respect of LULUCF sector should be based on forest management plans. Once CRONFI becomes official and published, it could be only used to fill the gaps in reporting.

7.3. SETTLEMENTS

7.3.2. DESCRIPTION

Under this land category, CO_2 emissions/removals from living biomass from only *Land converted to settlements* have been reported. The land converted to settlements refers only to forest land converted to settlements. All data necessary for emission/removal calculation for dead wood, litter and soil are not available.[18]
This subcategory is fully in line with the KP reporting; there represented under the Article 3.3 as *Deforestation*. In this way, coherence and congruity between the two related reporting, as for Forest land, is also maintained.

The conversion to settlements results in CO_2 emission which in 2009 amounted 75 Gg CO_2 which is less than 0.3% of total annual emission. Annual emissions along with their shares in the total annual national emission (excluding LULUCF) are presented in Table 7.3-1. On average, CO_2 emission from this type of land conversion makes only about 0.25% of total national emission.

Table 7.3-1: CO_2 emission from Land converted to settlements

Year	Emission / Gg CO_2	Share in total
1990	136.79	0.44
1991	95.42	0.39
1992	32.69	0.14
1993	83.51	0.36
1994	91.72	0.41
1995	30.09	0.13
1996	26.19	0.11
1997	29.84	0.12
1998	34.37	0.14
1999	45.97	0.18
2000	60.53	0.23
2001	68.33	0.25
2002	64.52	0.23
2003	56.48	0.19
2004	116.79	0.39
2005	83.21	0.27
2006	71.79	0.23
2007	54.44	0.17
2008	91.29	0.29
2009	74.52	0.26
Average	**67.42**	**0.25**

[18] However, within the Kyoto protocol reporting frame, it is proven that these do not represent emission sources (see KP Chapter 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 carbon pools).*

7.3.3. INFORMATION ON APPROACHES USED FOR REPRESENTING LAND AREAS AND ON LAND-USE DATABASES USED FOR THE INVENTORY PREPARATION

Land converted to Settlements refers only to the conversion of forest land to settlements. Representation of these lands is connected to HS-database and therefore to FMAPs. They are divided in two levels: ownership and forest type.

7.3.3. LAND-USE DEFINITIONS AND THE CLASSIFICATION SYSTEMS USED AND THEIR CORRESPONDENCE TO THE LULUCF CATEGORIES

Definitions applied within this inventory regarding Settlements 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. Since *Land converted to Settlements* refers to forest land converted to settlements, the applied definition is the one that defines deforestation. Therefore, *Land converted to Settlements* is represented in KP reporting within Article 3.3 (ARD) as *Deforestatio*n (see KP Chapters 11.1.1. *Definition of forest and any other criteria* and 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*).

7.3.4.METHODOLOGICAL ISSUES

7.3.4.1. Settlements remaining settlements

Croatia does not report on this land use subcategory due to data unavailability.

7.3.4.2. Land converted to Settlements

Croatia reports CO_2 emission from living biomass only from *Land converted to Settlements.* The calculation was based on the conservative assumption and forest experts' judgement that deforestation activities were done primarily for constructing infrastructure.

Emission from forest land converted to settlements has been calculated by using Tier 1 method for the entire period from 1990-2009. Attained data regarding deforestation activities (deforested area and volume felled) refers to the area managed by "Croatian Forests" (see Table 7.3-2 and Figure 7.3-1). Detailed data on deforestation activities on other state and private lands are not available.

Table 7.3-2: Forest land converted to Settlements

Year	Area converted / ha	Volume felled / m³
1990	451.00	97,844
1991	115.00	68,252
1992	131.00	23,380
1993	1,567.00	59,733
1994	1,187.00	65,608
1995	312.00	21,520
1996	90.90	18,734
1997	205.17	21,344
1998	171.25	24,585
1999	281.71	32,883
2000	308.57	43,298
2001	256.50	48,875
2002	419.84	46,154
2003	242.74	40,397
2004	597.67	81,913
2005	191.75	55,133
2006	313.53	51,352
2007	163.79	39,408
2008	406.60	66,896
2009	288.39	55,971

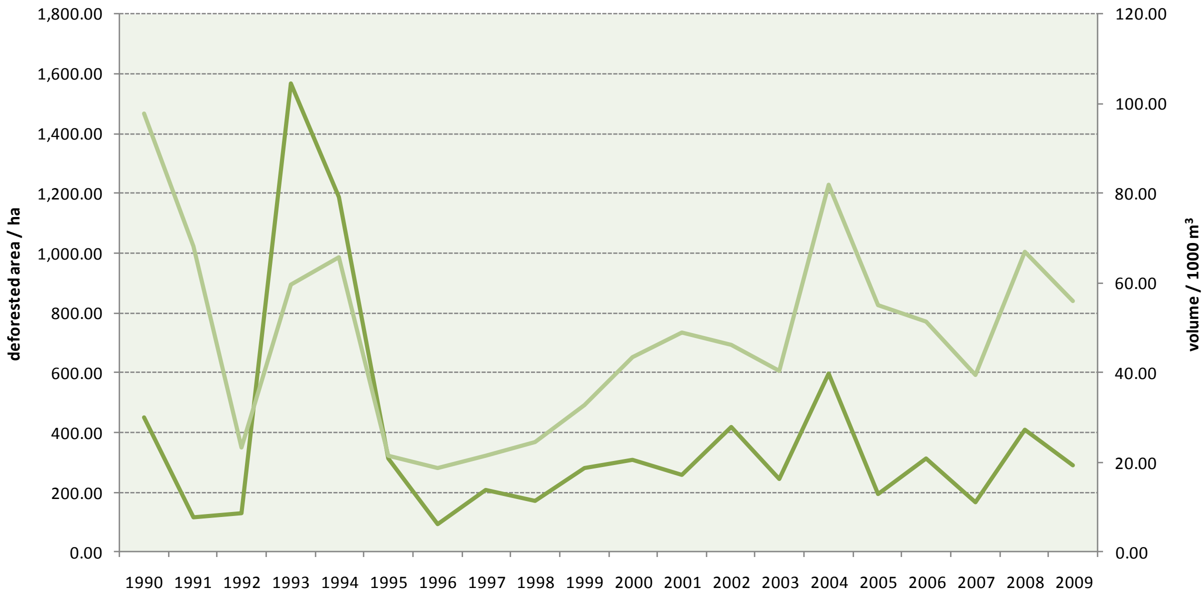


Figure 7.3-1: Deforested area and related volume felled

The main equation used for the calculation is 3.6.1. By applying the Tier 1 methodology, all living biomass is assumed to be lost in the same year as the conversion takes place; thus, C_{after} is equal to zero. The C_{before} is calculated based on volume felled using equation 3.2.7 from GPG 2003. For the period from 1990-2003, detailed data disaggregated to coniferous and broadleaved are not available; thus it is the forest experts's judgement that 80% of deforested forests refer to broadleaved forests. From 2004 onwards, there are detailed data in this regard which are then used in the calculation. The latter is as follows:

Period/year	Forest	Share of broadleaved and coniferous forest in total growing stock deforested / %
1990 - 2003	broadleaved	80
	coniferous	20
2004	broadleaved	85
	coniferous	15
2005	broadleaved	100
	coniferous	0
2006	broadleaved	80
	coniferous	20
2007	broadleaved	77
	coniferous	23
2008	broadleaved	74
	coniferous	26
2009	broadleaved	68
	coniferous	32

Relevant default factors used are the same as presented in Table 7.2-3.
Fires are not used to clear the vegetation; thus, emissions from fires are not calculated.

The conversion of forest land to settlements results in CO_2 emission for the entire period from 1990-2009 which is shown in Figure 7.3-2. The emission trend follows the trend of activity data related to volume felled; thus the highest emission can be noticed in 1990, 1991, 1993, 1994, 2004 and 2008. In 2004, for example, a highway was being constructed which required certain forest areas to be cleared.

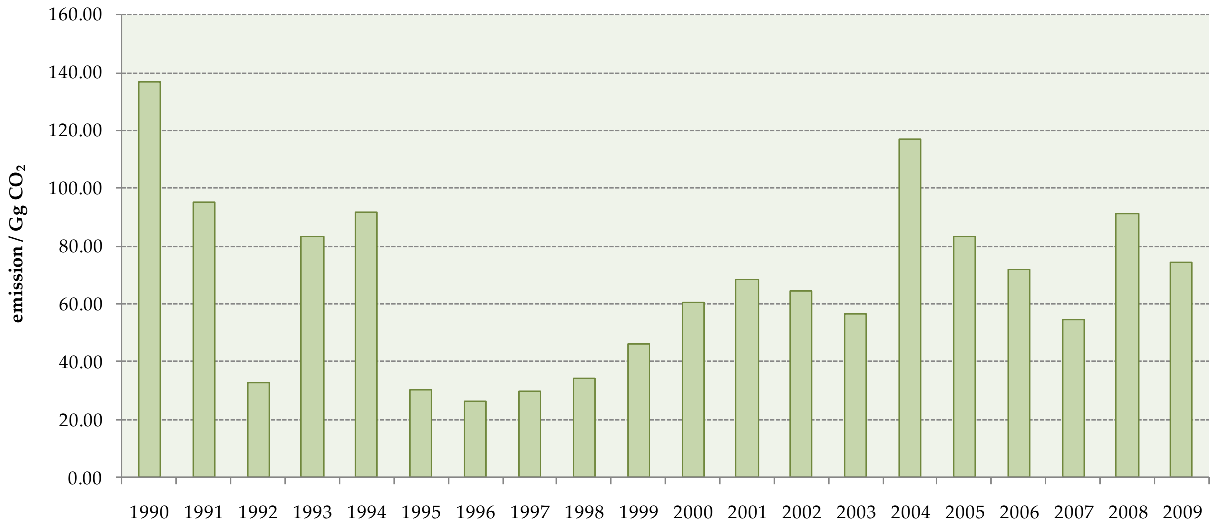


Figure 7.3-2: CO_2 emission as a result of deforestation

All other information is provided in relevant chapters for Forest land.

7.3.5.UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Uncertainty estimates are based on expert judgement. Uncertainty of activity data for CO_2 emission/removal calculation is estimated at 40%. Uncertainty of the carbon fraction dry matter is estimated at 2%.

Emissions/removals from 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.

7.3.6.SOURCE-SPECIFIC QA/QC AND VERIFICATION

QA/QC procedures and verification is the same as described in subchapter 7.2.6.
As for key category analyses, *land converted to settlements* does represent a key category.

7.3.7.SOURCE-SPECIFIC RECALCULATIONS

After the explanation related to noticed mistakes regarding Addendum to NIR 2010, which was delivered to the ERT in December 2010, recalculations were performed for the entire period from 1990-2009 due to change in the methodology. Previously, equation 3.2.5 from GPG 2003 was used instead of 3.2.7.

7.3.8.SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no short term goals recognized at this point. All activities require additional time (more than 1 year). Therefore, the main mid term goal is to attain required data on deforestation for state forests managed by other legal bodies and private forests.

7.4. REFERENCES

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Response of Croatia to *Potential Problems and Further Questions from the ERT formulated in the course of the 2010 review of the greenhouse gas inventories of Croatia submitted in 2010*

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[19], Strategy[20] and Plan[21]. 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

[19] Waste Act (OG 178/04, 111/06, 60/08, 87/09)

[20] Waste Management Strategy of the Republic of Croatia (OG 130/05)

[21] Waste Management Plan of the Republic of Croatia for 2007 - 2015 (OG 85/07)

of data (e.g. sludge) are not available in required form, which caused that CH_4 emissions are not estimated for the entire time series.

The total annual emissions of GHGs, expressed in Gg CO_2-eq, from waste management in the period 1990-2009 are presented in the Figure 8.1-1.

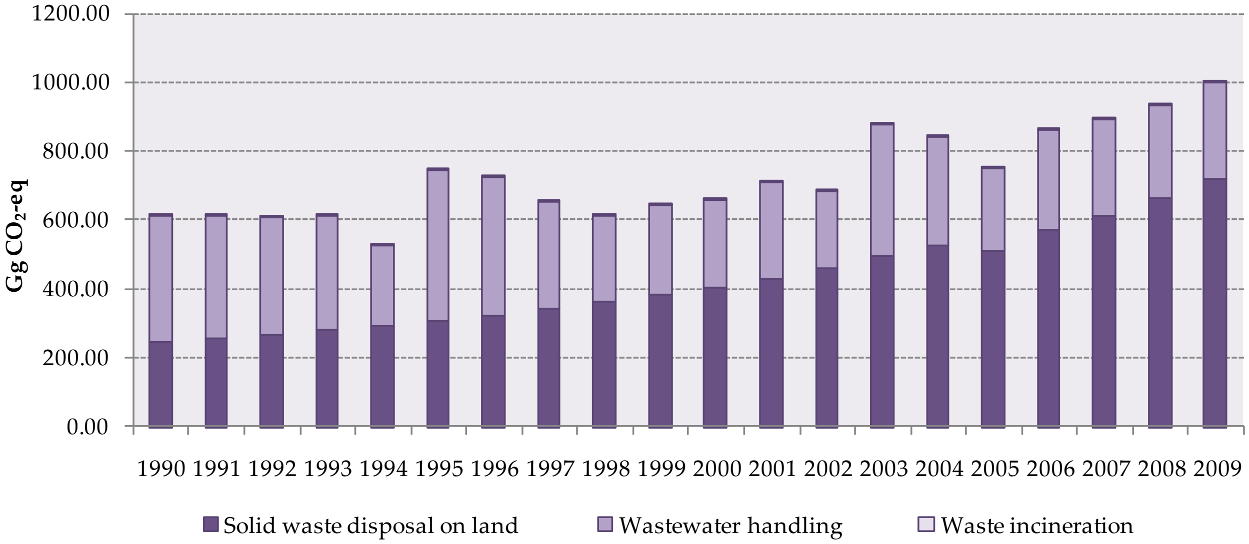

Figure 8.1-1: Emissions of GHGs from Waste (1990-2009)

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 2009[22]

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			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 Tier 1 T2e - Trend excluding LULUCF Tier 2
T1i - Trend including LULUCF Tier 1 T2i - Trend including LULUCF Tier 2

[22] 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	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 2005-2009. 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[23] 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.

[23] 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 (≥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 Protection, Physical Planning and Construction. 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 2006-2009 were obtained from *Cadastre of Waste - Municipal Solid Waste,* as a part of Environmental Pollution Register/Waste[24].

Information on CH_4 that is recovered and burned in a flare or energy recovery device in the period 2005-2009 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 and 2.15 Gg CH_4 in 2009).

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 1990-2009 and related MCF are reported in the Table 8.2-2.

[24] 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 (1990-2009)

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	529	107	0.898

* 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[25]. CH_4 that is recovered and burned in a flare or energy recovery device in the period 2005-2009 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 1990-2009 are presented in the Figure 8.2-1.

[25] Council Directive 1999/31/EC

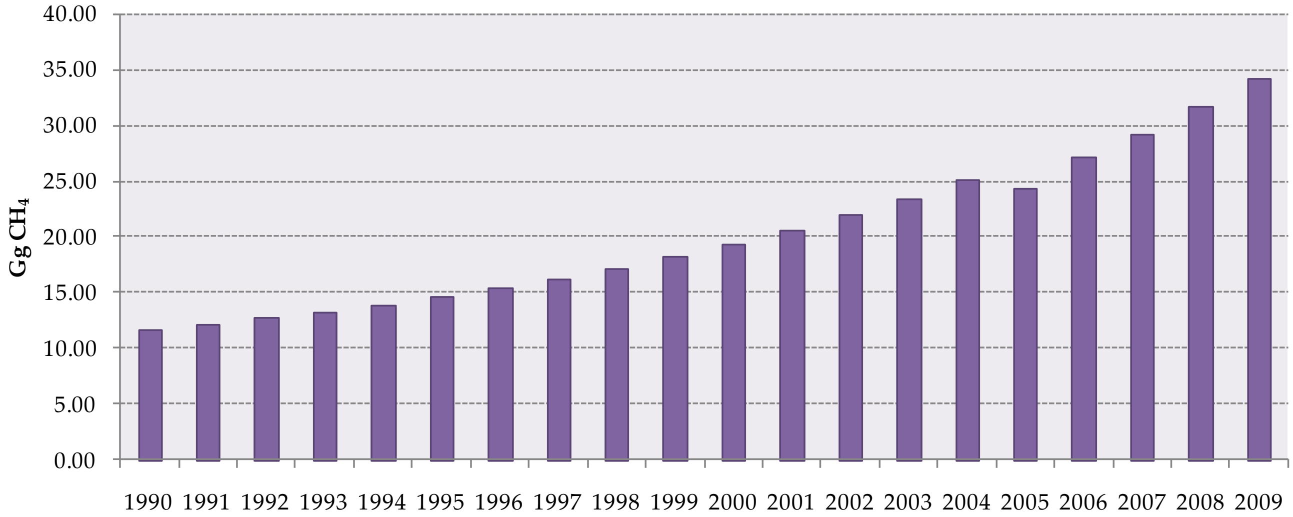

Figure 8.2-1: Emissions of CH_4 from Solid Waste Disposal on Land (1990-2009)

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 NIR 2010 historical data on the total amount of generated and disposed municipal solid waste has been provided back to the year 1970. In this report, according to the ERT recommendation proposed in line with *IPCC Good Practice Guidance*, data for 3-5 year half-lives for the waste deposited at the SWDS is included in order to achieve accurate emission estimate. Historical data has been estimated back to 1955 because Croatia uses IPCC default value k = 0.05. Thereupon, CH_4 emissions have been recalculated for the period 1990-2008.

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 2006-2009, 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 1990-2009.

CH_4 emissions from sludge are not estimated for the entire time series because data are not available in required form. Investigation will be performed with a view to include all relevant institutions and companies owing for gathering of data on sludge.

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 2003-2009. Insufficient data have been assessed by interpolation method.
Data for CH_4 emission calculation for the period 1990-2009 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 (1990-2009)

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 (1990-2009), 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

* data for population with individual system of drainage

The resulting annual emissions of CH_4 from Domestic and Commercial Wastewater in the period 1990-2009 are presented in the Figure 8.3-1.

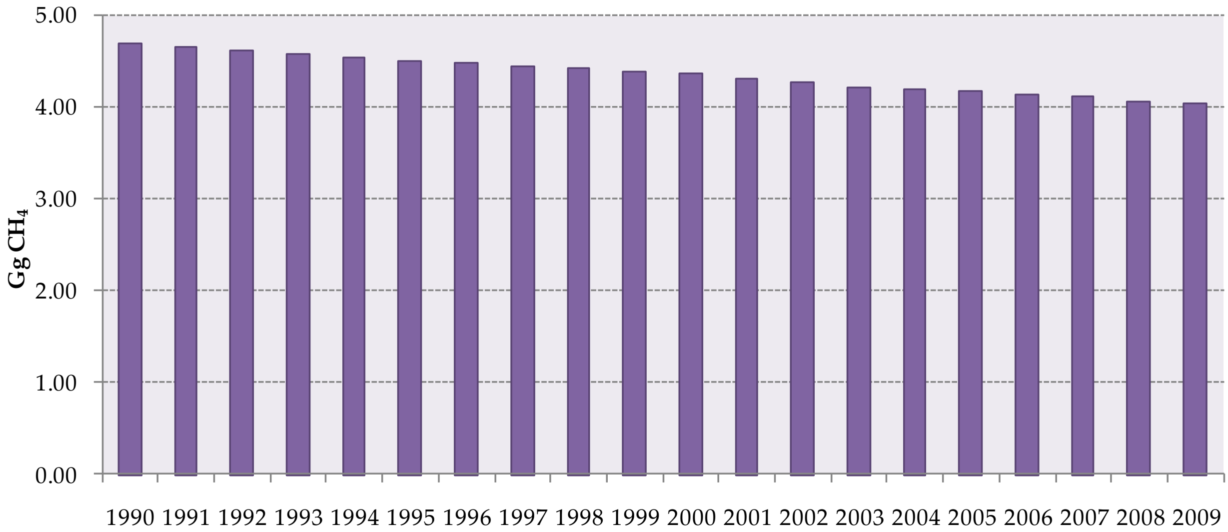

Figure 8.3-1: Emissions of CH_4 from Domestic and Commercial Wastewater (1990-2009)

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 1990-2009 are presented in the Table 8.3.2.

Table 8.3-2: Data for CH_4 emission calculation from Industrial Wastewater (1990-2009)

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
2008	2,570	63	1,574	1,007	2,693.10
2009	2,553	70	1,766	1,332	3,038.22

The resulting annual emissions of CH_4 from Industrial Wastewater in the period 1990-2009 are presented in the Figure 8.3-2.

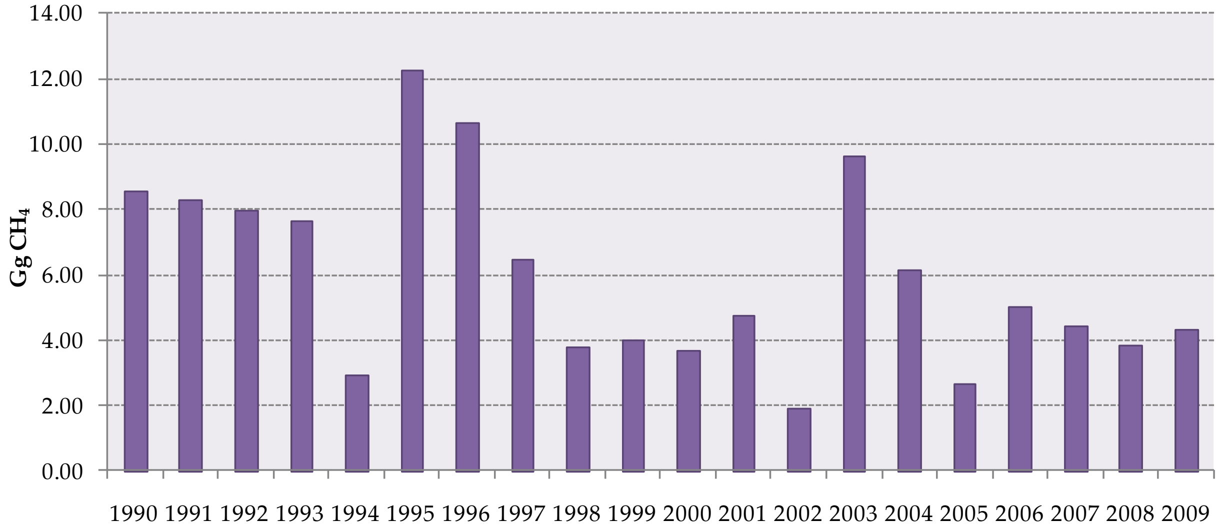

Figure 8.3-2: Emissions of CH_4 from Industrial Wastewater (1990-2009)

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 1990-2009 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 2008 and 2009.

Data for N_2O emission calculation from Human Sewage for the period 1990-2009 are presented in the Table 8.3.3.

Table 8.3-3: Data for N_2O emission calculation from Human Sewage (1990-2009)

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

The resulting annual emissions of N_2O from Human Sewage in the period 1990-2009 are presented in the Figure 8.3-3.

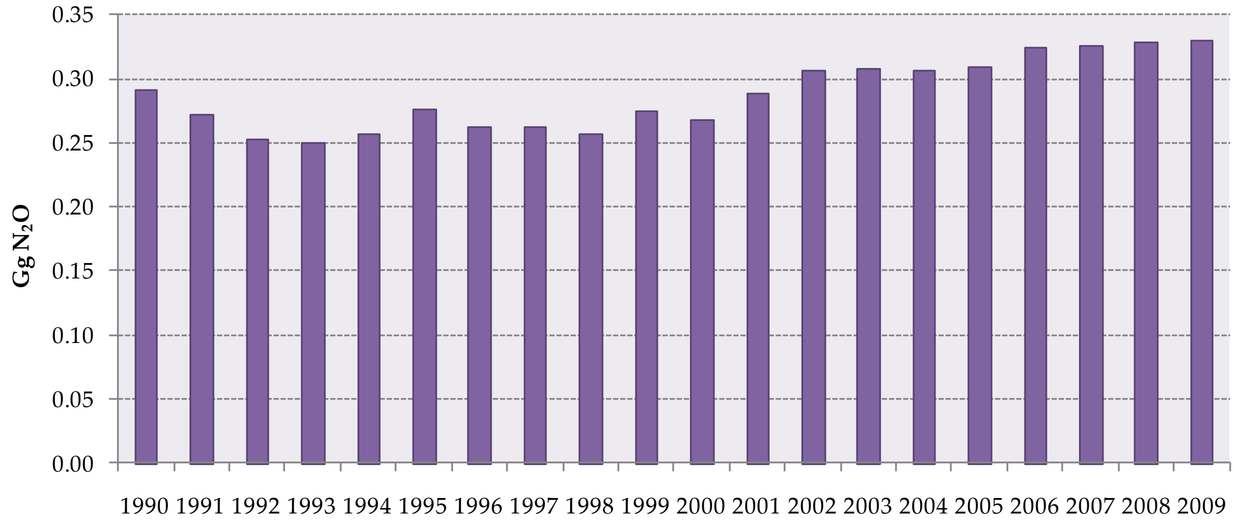

Figure 8.3-3: Emissions of N_2O from Human Sewage (1990-2009)

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

<u>Human Sewage</u>

New data for PIV were provided by FAOSTAT database for the period 1992-2007. Data on 2006 and 2007 have been used as the pattern for recalculation of data for 2008. Thereupon, CH_4 emissions have been recalculated for the period 1990-2008.

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, data for CH_4 emissions from sludge 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 1990-2009. 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 and 2009.

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 2004-2009 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. More detailed data on incineration of hazardous waste and plastics only for 2007 and 2008 have been provided by Croatian Environment Agency that collects data from emission point sources in the Environmental Pollution Register (ROO). Data on incineration of hazardous waste and plastics for 2009 have not been collected yet. Data have been assessed according to data for 2008. After collection of mentioned data, recalculation will be performed. Data for CO_2 emission calculation for the period 1990-2009 are presented in the Table 8.3.4.

Table 8.3-4: Incinerated waste (1990-2009)

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

Table 8.3-4: Incinerated waste (1990-2009), cont.

Year	Incinerated waste (tonnes)
1997	49.47
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

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, hospital waste was incinerated with energy recovery.

The resulting annual emissions of CO_2 from Waste Incineration in the period 1990-2009 are presented in the Figure 8.3-4.

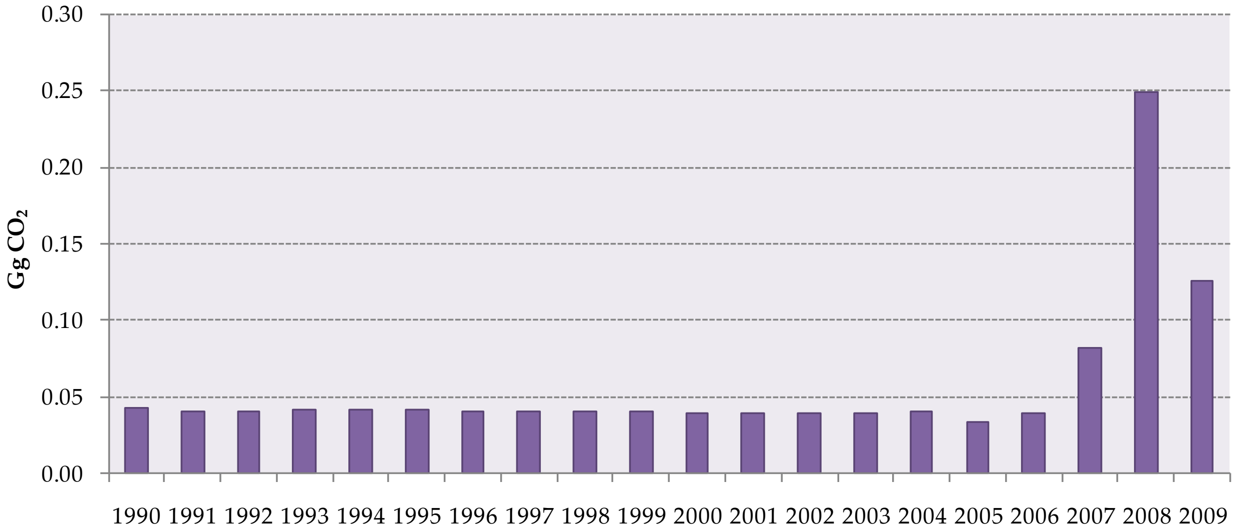

Figure 8.3-4: Emissions of CO_2 from Waste Incineration (1990-2009)

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 1990-2008 are presented in Table 8.5-1.

Table 8.5-1: Emissions from Waste (1990-2008)

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	1.37
	1997		16.20		340.30	52.25	1.37
	1998		17.13		359.75	58.83	1.44
	1999		18.18		381.84	59.37	1.46
	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	1.86
	2007		29.14		611.87	68.57	1.90
	2008		31.61		663.71	71.23	2.14
	2009		34.20		718.14	72.07	2.49
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	0.30
	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	8.51	0.29

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
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	0.55
	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	9.12	0.31
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	0.35
	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	0.33
	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	10.28	0.35

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

[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).

10.1. EXPLANATIONS 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
    - Manufacturing Industries and Construction and Road Transport, Fugitive Emissions from oil, natural gas and Other Sources
    - Feedstock and non-energy use
    - Reference Approach
- Industrial Processes
    - Soda Ash Production and Use, Ammonia Production, Iron and Steel Production, 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, Wastewater Handling (Human sewage)

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

Industrial processes

Mineral products (2.A.); Soda Ash Production and Use (2.A.4.)

Recalculations were made for the period 1997-2008 because data from one soap and detergent manufacturer have been added.

Chemical Industry (2.B.); Ammonia Production (2.B.1.)

According to ERT recommendation, natural gas used as fuel (in previous report included in the sector Industrial Processes) has been relocated to the sector Energy. Recalculation was made for the entire period (1990-2008).

Consumption of Halocarbons and SF_6 (2.F.); Refrigeration and Air Conditioning Equipment (2.F.1.)

New data have been compiled by MEPPPC. Accordingly, actual and potential emissions from Refrigeration and Air Conditioning Equipment for the period 1995-2008 have been recalculated.

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)

In this report new data for actual emission calculation have been compiled by MEPPPC. Actual emissions of HFC-227ea from Fire Extinguishers have been calculated for the period 2003-2009. Actual emissions of HFC-125 from Fire Extinguishers and HFC-134a from Aerosols/Metered Dose Inhalers have been calculated for the period 2003-2009.

A mistake was made in the calculation of potential emissions from Foam Blowing for the period 2006-2008. Also, for 2008, data was updated. Accordingly, recalculations of potential emissions from Foam Blowing for the period 2006-2008 have been made.

A mistake in data entry, made in the previous report for the year 2008 regarding potential emissions from Fire Extinguishers, has been corrected. Additional data have been included for Aerosols/Metered Dose Inhalers for the period 2003-2008. Consequently, potential emissions have been recalculated for the period 2003-2008.

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 1990-2008 has been updated according to 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'. Therefore, CO_2 emissions have been recalculated for the period 1990-2008 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[26] 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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[26] 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.)

In NIR 2010 historical data on the total amount of generated and disposed municipal solid waste has been provided back to the year 1970. In this report, according to the ERT recommendation proposed in line with *IPCC Good Practice Guidance*, data for 3-5 year half-lives for the waste deposited at the SWDS is included in order to achieve accurate emission estimate. Historical data has been estimated back to 1955 because Croatia uses IPCC default value k = 0.05. Thereupon, CH_4 emissions have been recalculated for the period 1990-2008.

Wastewater Handling (6.B.); Human Sewage

New data for PIV were provided by FAOSTAT database for the period 1992-2007. Data on 2006 and 2007 have been used as the pattern for recalculation of data for 2008. Thereupon, CH_4 emissions have been recalculated for the period 1990-2008.

10.1.1.2. Consistency with good practice guidance

Energy

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

- CO_2 emission from Petrochemical Production (ammonia production)
  - 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).

Feedstock and non-energy use (1.A.d)

- 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., as recommended by ERT (2010). Recalculation was performed for the whole period (from 1990 to 2009).

Reference Approach

- Gas works gas as a secondary fuel is excluded from the production column of the Reference Approach. This recalculation was carried out as recommended by ERT (2010), for the whole period from 1990 to 2009.

10.1.1.3.New methods

Energy

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

GHG emissions of this sector have been recalculated for the sequence 1990-2008. The reason of recalculation is the usage of new version of COPERT 4 for calculating the pollutant emissions from the road traffic, COPERT 4 ver.7.1. 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. Changes that are included within the scope of version 7.1 COPERT 4 are listed in the literature 1.

Industrial Processes

Metal Production (2.C.); Iron and Steel Production (2.C.1.)

In this report 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 2005-2009 CO_2 emissions (which are just underway of verifying because Croatia is not in EU ETS yet) have been taken for the inventory. The same methodology has been used for the entire time series. Recalculation was made for the entire period (1990-2008).

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

Fugitive Emissions from Oil, Natural Gas and Other Sources (1.B.2.b.ii)

CO_2 emission from natural gas scrubbing was recalculated only for the year 2008 due to a typing error. Previously used amount was 666.00 Gg instead of 575.82 Gg.

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

It was noted that in 2006 and 2007 were lacked data on millages for passenger car sub-categories Gasoline 1.4 to 2.0 l, PC Euro 4 - 98/69/EC Stage2005 which is corrected in this report. The above implies that for this vehicle class GHG emissions were not been calculated.

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 2010) and current submission (NIR 2011), on the level of the different greenhouse gases.

Table 10.2-1: Differences between NIR 2010 and NIR 2011, for 1990-2008 due to recalculations

Source		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 (Gg) Incl. LULUCF	NIR 2010	22160	16469	15638	16610	15591	16463	16995	17926	18787	19203
	NIR 2011	22534	16908	16216	17109	16121	17056	17510	18499	19247	19729
	Difference %	*1.7*	*2.7*	*3.7*	*3.0*	*3.4*	*3.6*	*3.0*	*3.2*	*2.5*	*2.7*
CO_2 (Gg) Excl. LULUCF	NIR 2010	4198	3396	3149	2495	2735	2574	2599	2893	2455	2962
	NIR 2011	3809	2922	2544	2001	2225	2012	2085	2319	2092	2564
	Difference %	*-9.3*	*-14.0*	*-19.2*	*-19.8*	*-18.7*	*-21.9*	*-19.8*	*-19.9*	*-14.8*	*-13.4*
CH_4 (CO_2-eq Gg)	NIR 2010	131	129	111	116	124	124	133	121	126	117
	NIR 2011	107	105	86	90	98	98	107	95	101	91
	Difference %	*-18.4*	*-18.2*	*-22.5*	*-22.6*	*-21.0*	*-21.2*	*-19.0*	*-21.2*	*-20.2*	*-22.3*
N_2O (CO_2-eq Gg)	NIR 2010	4361	4217	3630	3294	3213	3063	3046	3285	3008	3207
	NIR 2011	4378	4224	3625	3297	3218	3067	3050	3289	3012	3210
	Difference %	*0.4*	*0.2*	*-0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
HFCs (CO_2-eq Gg)	NIR 2010	590	590	589	594	509	727	705	636	597	630
	NIR 2011	612	610	608	612	526	744	721	651	612	643
	Difference %	NO	NO	NO	NO	NO	*2.3*	*2.2*	*2.4*	*2.4*	*2.1*
PFCs (CO_2-eq Gg)	NIR 2010	-8293	-7598	-7457	-7504	-7690	-7475	-9217	-9582	-9693	-9837
	NIR 2011	-6934	-6834	-6832	-6835	-6872	-6863	-6472	-6684	-6860	-7029
	Difference %	*-16.4*	*-10.1*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*
SF_6 (CO_2-eq Gg)	NIR 2010	0	0	0	0	0	0	0	0	0	0
	NIR 2011	0	0	0	0	0	0	0	0	0	0
	Difference %	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Total (Gg CO_2-eq) Incl. LULUCF	NIR 2010	23148	17202	15660	15606	14482	15476	14260	15279	15281	16281
	NIR 2011	24506	17935	16248	16275	15315	16113	17002	18168	18203	19208
	Difference %	*5.9*	*4.3*	*3.8*	*4.3*	*5.8*	*4.1*	*19.2*	*18.9*	*19.1*	*18.0*
Total (Gg CO_2-eq) Excl.LULUCF	NIR 2010	31441	24800	23117	23110	22172	22951	23478	24861	24973	26118
	NIR 2011	31440	24769	23080	23109	22187	22976	23474	24853	25063	26237
	Difference %	*0.0*	*-0.1*	*-0.2*	*0.0*	*0.1*	*0.1*	*0.0*	*0.0*	*0.4*	*0.5*

Table 10.2-1: Differences between NIR 2010 and NIR 2011 for 1990-2008 due to recalculations, cont.

Source		2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2 (Gg) Incl. LULUCF	NIR 2010	18766	19850	20953	22365	21867	22226	22378	23628	22473
	NIR 2011	19281	20251	21334	22810	22248	22599	22675	24044	22813
	Difference %	***2.7***	***2.0***	***1.8***	***2.0***	***1.7***	***1.7***	***1.3***	***1.8***	***1.5***
CO_2 (Gg) Excl. LULUCF	NIR 2010	3229	3157	3044	3231	3518	3690	3872	4080	4129
	NIR 2011	2854	2867	2824	2872	3225	3271	3421	3604	3570
	Difference %	***-11.6***	***-9.2***	***-7.2***	***-11.1***	***-8.3***	***-11.3***	***-11.6***	***-11.7***	***-13.5***
CH_4 (CO_2-eq Gg)	NIR 2010	115	122	145	154	178	203	231	255	253
	NIR 2011	90	96	120	128	153	177	205	228	219
	Difference %	***-21.6***	***-20.8***	***-17.5***	***-16.5***	***-14.3***	***-12.8***	***-11.2***	***-10.4***	***-13.5***
N_2O (CO_2-eq Gg)	NIR 2010	3133	3322	3290	3178	3443	3473	3497	3443	3359
	NIR 2011	3135	3326	3294	3204	3446	3478	3498	3439	3427
	Difference %	***0.1***	***0.1***	***0.1***	***0.8***	***0.1***	***0.1***	***0.0***	***-0.1***	***2.0***
HFCs (CO_2-eq Gg)	NIR 2010	643	696	671	865	826	800	855	887	930
	NIR 2011	656	710	683	877	839	748	863	892	932
	Difference %	***2.0***	***2.0***	***1.9***	***1.5***	***1.5***	***-6.4***	***0.9***	***0.6***	***0.3***
PFCs (CO_2-eq Gg)	NIR 2010	-10080	-10189	-10232	-10460	-10708	-10753	-10785	-11171	-11167
	NIR 2011	-7218	-7388	-7557	-7750	-7935	-8100	-8215	-8506	-8643
	Difference %	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***
SF_6 (CO_2-eq Gg)	NIR 2010	0	0	0	0	0	0	0	0	0
	NIR 2011	0	0	0	0	0	0	0	0	0
	Difference %	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***
Total (Gg CO_2-eq) Incl. LULUCF	NIR 2010	15806	16957	17871	19332	19126	19640	20049	21123	19977
	NIR 2011	18799	19862	20698	22142	21976	22173	22447	23702	22318
	Difference %	***18.9***	***17.1***	***15.8***	***14.5***	***14.9***	***12.9***	***12.0***	***12.2***	***11.7***
Total (Gg CO_2-eq) Excl.LULUCF	NIR 2010	25886	27147	28103	29792	29833	30392	30833	32294	31143
	NIR 2011	26016	27250	28255	29891	29910	30273	30662	32208	30961
	Difference %	***0.5***	***0.4***	***0.5***	***0.3***	***0.3***	***-0.4***	***-0.6***	***-0.3***	***-0.6***

The change in the 1990-2008 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 4.06 percent including LULUCF and 7.24 percent excluding LULUCF comparing NIR 2010 and NIR 2011. 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 2010 and NIR 2011 for the emission trends 1990-2008

Gas	Trend (absolute)		
CO_2-eq (Gg)	NIR 2010	NIR 2011	*Difference*
CO_2 emissions including net CO_2 from LULUCF	-2294.01	-1173.02	*1120.98*
CO_2 emissions excluding net CO_2 from LULUCF	579.53	536.50	*-43.03*
CH_4	-65.45	-14.59	*50.86*
N_2O	-464.63	-490.72	*-26.09*
HFCs	0.00	0.00	*0.00*
PFCs	0.00	0.00	*0.00*
SF6	0.00	3.00	*3.00*
Total (including LULUCF)	**-3170.96**	**-2188.47**	***982.49***
Total (excluding LULUCF)	**-297.41**	**-478.94**	***-181.53***

Table 10.2-2: Differences between NIR 2010 and NIR 2011 for the emission trends 1990-2008, cont.

Gas	Trend (percent)		
CO_2-eq (Gg)	NIR 2010	NIR 2011	*Difference*
CO_2 emissions including net CO_2 from LULUCF	-15.48	-19.27	*-3.78*
CO_2 emissions excluding net CO_2 from LULUCF	2.51	-5.78	*-8.29*
CH_4	-1.90	0.05	*1.95*
N_2O	-11.77	-18.71	*-6.94*
HFCs	100.00	100.00	*0.00*
PFCs	-100.00	-99.98	*0.02*
SF_6	27.37	28.82	*1.44*
Total (including LULUCF)	**-13.70**	**-17.76**	***-4.06***
Total (excluding LULUCF)	**-0.95**	**-8.19**	***-7.24***

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 period 1995-2001, in 2004 for period 1990-2002, in 2005 for period 1990-2003, in 2006 for period 1990-2004, in 2007 for period 1990-2005, in 2008 for period 1990-2006, in 2008 Resubmission of Croatia's 2008 Inventory Submission, in 2009 for period 1990-2007, in 2010 for the period from 1990-2008 and this latest submission in April 2011.

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[27]. 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.

[27] 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. MEPPPC 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

11.1. GENERAL INFORMATION

Since the enforcement of the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia (OG 1/07) in 2007, which *inter alia* established National system as required by Decision 19/CMP.1, the Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC), 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 the beginning of 2010, MEPPPC commissioned a preparation of *Action plan for implementation of Article 3, paragraphs 3 and 4 of the Kyoto Protocol* which facilitated 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. Along with the collection of data used for emission/removal calculation, the main result of the Plan is the plan of activities that would facilitate and improve the quality of KP reporting in the future.

The UNFCCC and the KP reporting are completely harmonized (see Table 11.1-1); thus, the same data division was used in emission/removal calculation but due to more specific KP requirements, within the KP database it is presented in more spatial detail than within the CRF database. Therefore, all stated for the UNFCCC is valid also for the KP (definitions, methodology, etc.). The emission/removal estimation regarding Forest Management is based on a different approach than the one described in Addendum to NIR 2010 due to more detailed data attained. The latter resulted in more reliable calculation which better reflects the condition of forests in Croatia.

Table 11.1-1: The relationship between KP activities and the reported UNFCCC land categories

UNFCCC			KP	
Land use category	**Subcategories**		**Article**	**Activities**
Forest Land	*Forest land remaining Forest land*		3.4	Forest management
	Land converted to Forest land	*Other land converted to Forest land*	3.3	Afforestation
Settlements	*Land converted to Settlements*	*Forest land converted to Settlements*		Deforestation

As for CRONFI and its usage in the preparation of the GHG inventory, as stated before, having in mind the basics for forest management in Croatia, data accuracy attained through ground measurements, consistency requirements etc., the Ministry of Regional Development, Forestry and Water Management and the Ministry of Environmental Protection, Physical Planning and Construction agreed that preparation of the annual GHG Inventory in respect of LULUCF sector should be based on forest management plans. Once it becomes official and published, it could be only used to fill the gaps in reporting.

11.1.1. DEFINITION OF FOREST AND ANY OTHER CRITERIA

Definition of forest:

Forest is 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, these areas are excluded and forest is consisted of the following (see also subchapters 7.2-3 and 7.2.2.1.):

- high forests
- forest cultures
- plantations
- coppice

11.1.2. ELECTED 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 2009, 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 1990–2009 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 forest land without tree cover 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.

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 constitute 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 in accordance 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 3.1-2). Therefore, the area under forest management for the KP reporting refers to the area of high forests, cultures, plantations and coppice, excluding at this moment maquia and scrub due to unavailability of the complete dataset. The latter is illustrated in Figure 11.1-1.

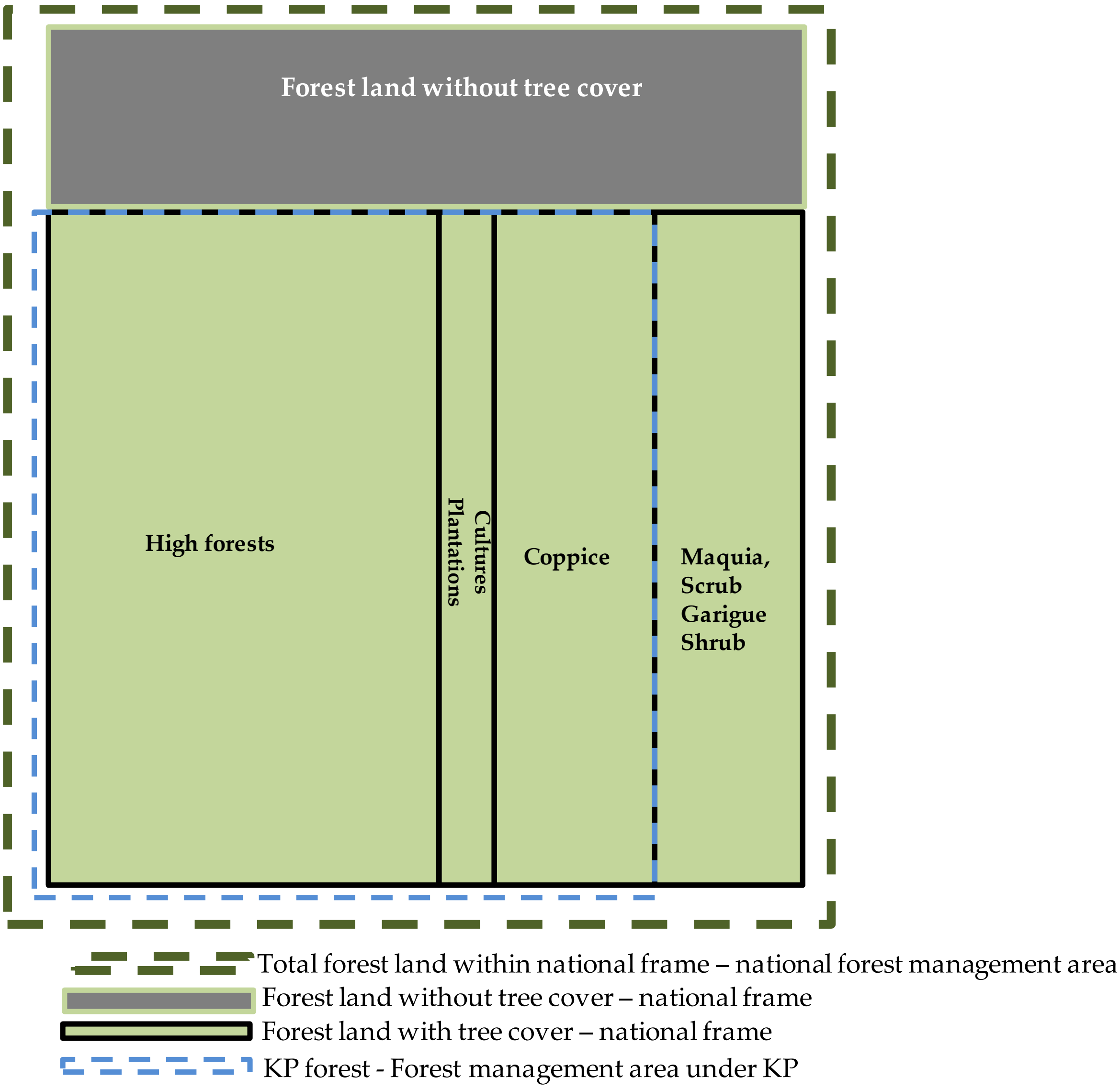

Figure 11.1-1: Forest management area under KP and within the national frame

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 *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 2008 and 2009 (Tables 11.2-1 and 11.2-2). Certain corrections have been made in comparison to matrices presented in Addendum to NIR 2010 related to FM (and consequently Other) in order to present only FM in accordance with the KP and not the forest management considered in the national frame. However, certain inconsistencies are noticed which are generated by the same reasons as those recorded for land-use matrices within the UNFCCC reporting (see Chapter 7.1.). The latter requires further comprehensive research in order to completely and accurately compile the related matrices.

Table 11.2-1: *Activity matrix for 2008, kha*

		Article 3.3 activities		Article 3.4 activities				Other	TOTAL (beginning of 2008)
		A/R	D	FM	CM	GM	RV		
Article 3.3 activities	A/R	17.08	0.00						**17.08**
	D		0.00						**0.00**
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	6,874.07	**6,874.48**
TOTAL (end of 2008)		**17.49**	**0.41**	**1,874.13**	**0.00**	**0.00**	**0.00**	**6,874.07**	**8,766.10**

Table 11.2-2: *Activity matrix for 2009, kha*

		Article 3.3 activities		Article 3.4 activities				Other	TOTAL (beginning of 2009)
		A/R	D	FM	CM	GM	RV		
Article 3.3 activities	A/R	17.49	0.00						**17.49**
	D		0.00						**0.00**
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	6,872.94	**6,873.45**
TOTAL (end of 2009)		**18.01**	**0.29**	**1,874.86**	**0.00**	**0.00**	**0.00**	**6,872.94**	**8,766.10**

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 ownership (state and private forests). The annex to FMAP 2006-2015 is composed of certain thematic maps, map on forest ownership being one of them. The map is prepared by connecting digital spatial data with HS-Fond database, scale 1:100,000. Therefore, ownership is spatially located. Figure 7.2-7 in Chapter 7.2.2.1 shows spatial division of forest area managed by Croatian Forests (16 forest districts).

11.3. ACTIVITY-SPECIFIC INFORMATION

Data used in the calculations are attained from FMAPs. The data were divided based on 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 *State forests (CF)*, state forests managed by other legal bodies as *State forests (Other)* and private forests as *Private forests*.

Table 11.3-1: Activity data division for 2008 and 2009

	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

11.3.1. METHODS FOR CARBON STOCK CHANGE AND GHG EMISSION AND REMOVAL ESTIMATES

11.3.1.1. Description of the methodologies and the underlying assumptions used

1) ARD activities

Emissions and removals from ARD activities have been calculated using Tier 1 method (GPG 2003) and Level 1 and Level 2 activity data disaggregation. However, related data regarding other state forests are not available. The spatially more explicit calculation at the sublevel I also could not be performed for any ownership since all required data were not available at this point. The activity data obtained refer only to living biomass and are as follows:

- For afforestation – afforested area
- For deforestation – deforested area and related volume felled

Regarding afforestation, only units of land not harvested since the beginning of the commitment period and related emission/removals have been reported.
Description of the methodologies and the underlying assumptions used are presented in Chapter 7.2.4. *Methodological issues* and 7.3.4.2. *Land converted to settlements*.

2) FM activities

Emissions and removals from FM were calculated based on GPG 2003 and related equations were used covering only living biomass as a carbon pool. It should be emphasized that the calculation for 2008 and 2009 was performed at Level 1, sublevel I and Level 2 which is spatially more explicit; thus, representing an improvement in the KP reporting. The UNFCCC and the KP reporting have been harmonized but due to respected spatial disaggregation, there is only one difference between these two reporting frames which can also be noticed when CRF and KP tables are compared. The latter refers to reported area under forest management for state forests (CF) which, within KP tables, includes afforested area because it could not be disaggregated to sublevel I for the entire period from 1990. However, it is important to emphasize that the emission/removal estimation itself does not actually depend on forest area because the entire calculation relies on volume. Taking this in consideration, there are no differences in CO_2 emission/removals.

The entire calculation and the description of the methodological approach are presented in Chapter 7.2.4. *Methodological issues*. Certain specifities in regards to sublevel I are explained below.

For forest districts Osijek and Našice, reliable data for 2009 could not be obtained due to certain ownership changes (still undergoing asset return to private owners). Thus, it was assumed that the data, regarding increment calculation, obtained for 2008 are also valid for 2009.

As for forest district Split, growing stock is decreasing through the entire period which is related to the decrease in forest area. Therefore, the methodological approach for the calculation of the increment results in negative value. Considering the aforementioned, there are no carbon gains in this forest district. As for carbon losses, along with the losses due to fellings, the decrease of growing stock volume is also referred to as carbon loss (added to losses). Thus, emission/removal calculation for FD Split results in CO_2 emission.

CO_2 removal in 2008 and 2009, divided by ownership, are presented in Table 11.3-2. In general, the removal increased from 2008 to 2009 due to an increased increment and decreased fellings. In regards to specific ownerships, a slight decrease of removal is noticed for state forests (CF) due to lower increment although fellings decreased too. As for other state and private forests, respected removal increased due to increased increment.

Table 11.3-2: CO_2 removal in state and private forests in 2008 and 2009

Year	CO_2 removal / Gg CO_2			
	State forests (CF)	State forests (Other)	Private forests	TOTAL
2008	-4,473.88	-687.41	-3,432.65	-8,593.94
2009	-4,443.84	-721.00	-3,477.12	-8,641.96

CO_2 removal in 2008 and 2009 for each forest district of state forests managed by "Croatian Forests" is shown in Figure 11.3-1. According to the results, emission/removal has not changed significantly. However, the decrease in removals has been observed in most forest districts due to primarily the decrease of increment.

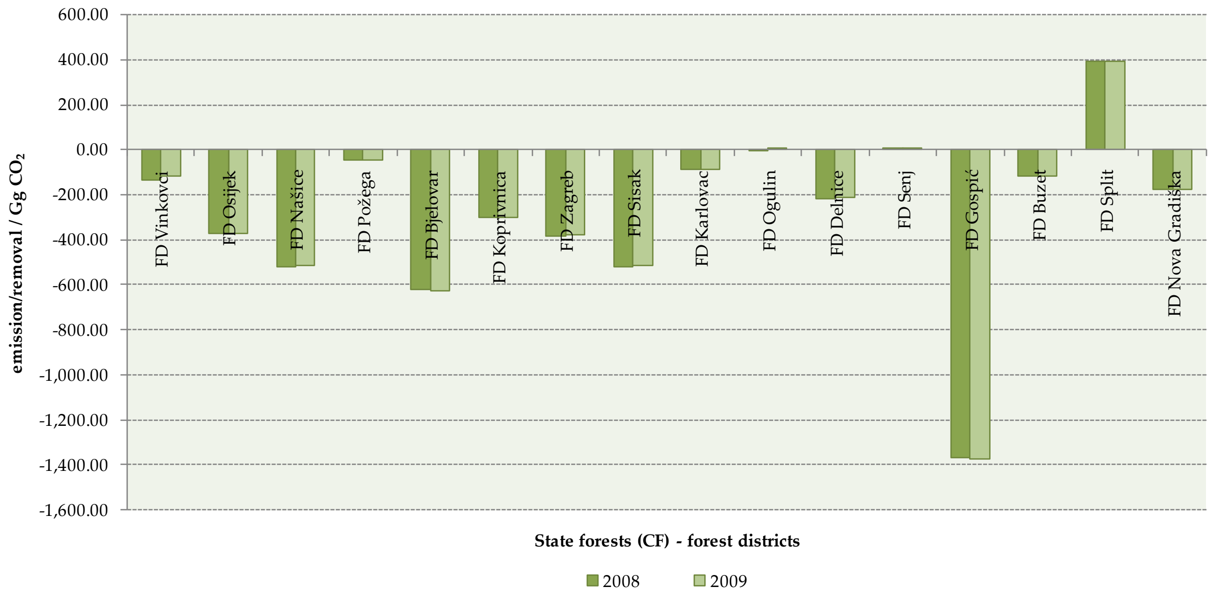

Figure 11.3-1: CO_2 removal for each forest district of state forests managed by "Croatian Forests"

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, 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 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, so emissions are reported as not occurring.

Table 5(KP-II)2. N_2O emissions from drainage of soils

According to available information, 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 has been supposed as not occurring in Croatia, as total deforested area was assumed in 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.

Omitting carbon pools

Croatia reports above-ground and below-ground biomass for Article 3.3 and 3.4 activities. As for other carbon pools, based on 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 related carbon pools (dead wood, litter and soil), it is considered that conversion of Other land to Forest land can not generate carbon stock changes in terms of losses, especially in the long-term. Moreover, since these afforested areas are actually, in national frames, within the forest land without tree cover which is one of the componenets of the total national forest management area, reviewing the legislation and management practices, it can be concluded that these pools do not represent emission sources.
As stated within the description of the national frame, forest land encompasses forest land with tree cover and without tree cover. Afforestation is performed on forest land without tree cover. Therefore, it contributes to dead wood and litter pools (increases carbon stocks). As for the soil, taking into account that cultivation methods prior to afforestation are very important in regards to carbon storage and that these lands are forest lands without tree cover (thus not cultivated and managed for example like croplands which could generate higher carbon stocks), the carbon stock in the soil on these lands is considered rather small. Thus, examining all aforementioned, soil carbon stock is considered not to decrease which implies that this pool is not an emission source.

In regard to deforestation, considering the significance of this activity in Croatia, the final land use (settlements) and the overall emission/removal context, carbon stock changes in dead wood, litter and soil can be assumed as practicably negligible.

FM activities

a) Dead wood

According to FRA 2005, carbon stock in this pool for forest land has increased form 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.

In Figure 11.3-2, data on wood removal from FRA reports have been used (for 1990 FRA 2005 and for 2000 and 2005 FRA 2010) and compared to NIR data on fellings already presented in Chapter 7.2.4.1. The results show that not all wood is removed from the forest and that certain percentage (about 10-15% considering 2000 and 2005) is left in the forest; thus contributing to other carbon pools. Moreover, within KP Forest management, total gross fellings are reported. Considering the latter, there are no underestimations in regard to dead wood or litter.

Also, it should be mentioned that 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).

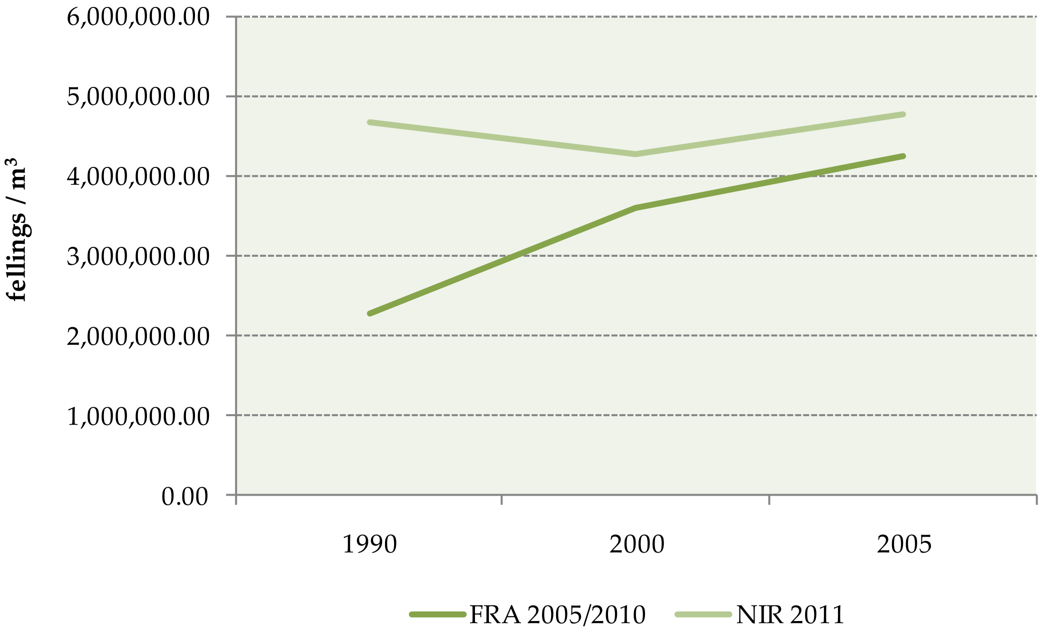

Figure 11.3-2: Comparison of wood removal and fellings

b) litter

The legal framework mentioned above (Forest Act, Article 32, OG 140/05, 82/06, 129/08, 80/10, 124/10) also prohibits the removal of peat, litter and humus from the forest. 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. Taking the latter into account and the "transfers" between the pools (dead wood not decreasing), it can be concluded that litter as a carbon pool is not an emission source.

c) soil

In order to analyze the change of carbon stock in forest soil, preliminary analysis was performed based on existing data. These are supplemented data of the first scientific soil inventarization in Croatia documented in the Croatian soil database (Martinović, Vranković et. al., 1997, 1998, 1999). This analysis encompassed 20 economically (management) and ecologically main types of forest ecosystems (defined by Horvat's vegetation and soil type) in order to provide the general status of organic carbon in soil humus-accumulative horizon (layer) and its possible dynamics in the form that is allowed by the procedure of periodic characterization and fond of available data. The periodic characterization of organic carbon status included data on soil humus-accumulative horizon in two time periods:

- Period I - 1970-1980
- Period II – 1980-1990

The condition of humization is an important indicator of the soil's "production power", its stability. Thus, for establishing relative relationships between humization conditions, a term humization index (Ih) is introduced (J. Martinović, 2000):

$$Ih = \text{share of C in soils x soil's depth}$$

Higher index values mean ecologically more advantageous soil humization condition.

Average humization index for the first period concerned is 0.765, while for the second period, the calculation resulted with 0.729 (Figure 11.3-3). The small difference in humization indices between period I and II can not be interpreted as a carbon stock change in the soil, because the data deviation is too large. As conclusion, this analysis shows that there is no, statistically significant, change of carbon stock in soil that would result in CO_2 emissions.

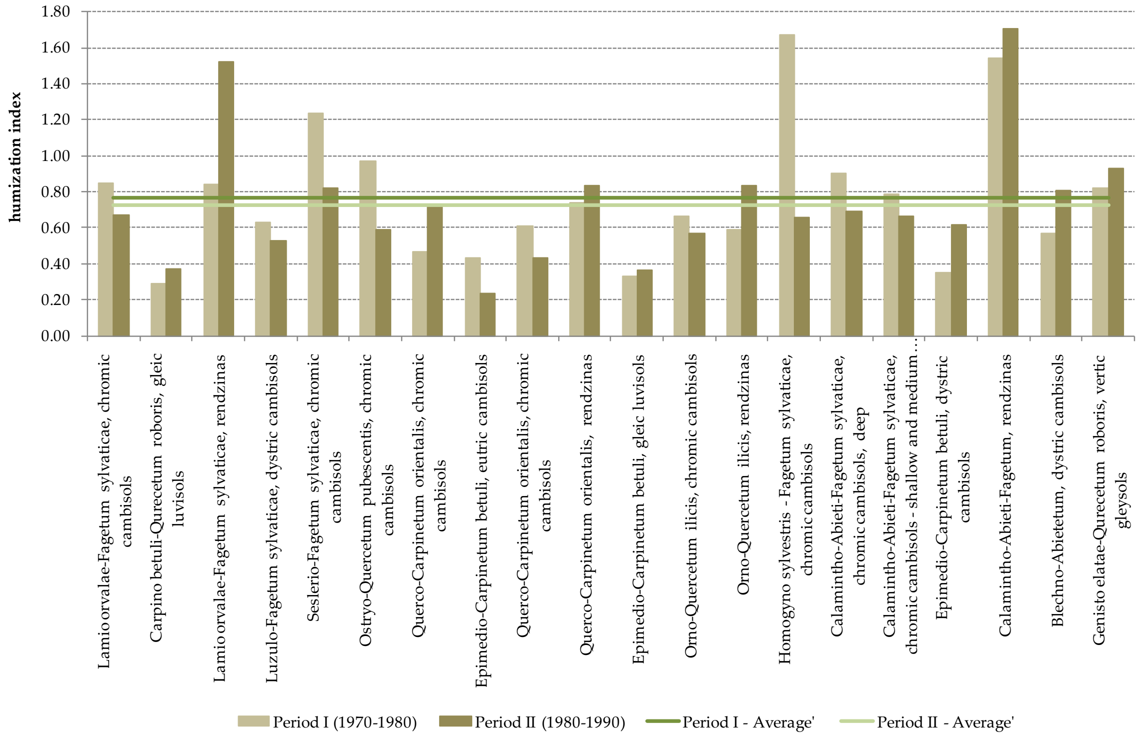

Figure 11.3-3: Humization index for 20 main forest ecosystems

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 do not give 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 *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)

Recalculations were performed for all KP activities (afforestation, deforestation and forest management) for 2008 due to following reasons:

- Afforestation – correction of units in the KP database (Gg C instead of Gg CO_2)
- Deforestation – equation 3.2.7 is used instead of 3.2.5 (usage of units is also corrected)
- Forest Management – new spatial disaggregation and more detailed activity data which enabled the usage of more reliable methodological approach (see subchapter 7.2.4.1.)

11.3.1.5. Uncertainty estimates

LULUCF sector calculation has many input parameters that lead to uncertainty, in respect to accuracy and precision. If data are not available from field, or national data bases, 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 improvements explained in Chapter *Methodological issues* (regarding Forest land), it could be concluded that uncertainty of the estimated has decreased.

Some of assumptions and parameters, implemented for calculation, certainly lead to bias of final results. In Table 11.3-3 given is list of elements which should to 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 the 10 cm in radius) are not included in calculation of gains and losses, but they belongs to KP definition of forests	+
FM area change during time due to inclusion/exclusion of small areas in FM category. GPG suggests that calculation of increment in this situation could lead to overestimation, if carbon stock change is used as method of calculation. Usually, new areas included in FM category have relatively smaller biomass stock, or belongs to class bellow 10 cm in radius which is not accounted. Therefore it is decided not to make correction in this regard, since no spatial data are available, just an aggregate figures of change. This element relates to state forest (CF) estimation.	±
BEF1 and BEF2 factors should be corrected to better present national situation	+

+ means that element, if corrected, will create higher carbon sink

In total, if all above pluses and minuses are summing up, 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 7.2.5. and 7.3.5.

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 and 2009, Croatia reports afforestation, deforestation and forest management activities.

11.4. ARTICLE 3.3

In 2008 and 2009, afforestation activities resulted in net removal 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

Activity	*Emissions/removals / Gg CO_2*	
	2008	2009
Afforestation	-140.47	91.29
Deforestation	-145.61	74.52
Total	**-49.18**	**-70.10**

Therefore, in each year, mentioned activities altogether result in net removal. The share of total ARD removal in total national removal (ARD+FM) is below 1%.

11.4.1. INFORMATION THAT DEMONSTRATES THAT ACTIVITIES UNDER ARTICLE 3.3 BEGAN ON OR AFTER 1 JANUARY 1990 AND BEFORE 31 DECEMBER 2012 AND ARE DIRECT HUMAN-INDUCED

All data regarding 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 the year 1990.

As stated earlier, *afforestation in national circumstances is the activity within the biological forest renewal and it refers to afforestation of unstocked forest land and establishing plantations of fast growing species*. This activity mentioned is connected to forest management plans; 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 the 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 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. Below more detail information is provided.

While comparing and interpreting definitions within the IPCC framework and within national legislation, it was concluded that deforestation in national circumstances refers 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 is regulated by *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).

11.4.3. INFORMATION ON THE SIZE AND GEOGRAPHICAL LOCATION OF FOREST AREAS THAT HAVE LOST FOREST COVER BUT WHICH ARE NOT YET CLASSIFIED AS DEFORESTED

Generally, forest cover can be lost through harvesting or forest disturbance which represent 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 are not classified as deforested.

11.5. ARTICLE 3.4

11.5.1. INFORMATION THAT DEMONSTRATES THAT ACTIVITIES UNDER ARTICLE 3.4 HAVE OCCURRED SINCE 1 JANUARY 1990 AND ARE HUMAN-INDUCED

Croatia has a very long tradition in 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 managed, then it is demonstrated that forest management as an activity under Article 3.4 of the KP is human induced.

11.5.2. INFORMATION RELATING TO 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 RELATING TO FOREST MANAGEMENT

As stated before, forest management area within the national frame is managed based on the FMAP and is even wider than forest management area under the KP because it includes for example afforested area and also forest land that is covered with vegetation but which does not reach the selected thresholds for the KP definition of forest (see Figure 11.1-1).

Forest management resulted in net removal in 2008 and 2009. Carbon stock changes in living biomass resulted with removal of -8,594 Gg CO_2-eq and -8,642 Gg CO_2 respectively (see Table 11.5-1).

Table 11.5-1: Emissions/removals of Article 3.4 activity

Activity	Emissions/removals / Gg CO_2	
	2008	2009
Forest Management	-8,593.94	-8,641.96

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 RELATING 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 2010 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 2010.
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications.	No CDM notifications occurred in 2010.
15/CMP.1 annex I.E paragraph 15: List of non-replacements.	No non-replacements occurred in 2010.
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2010.
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). Before accession to EU and before joining to EU ETS Croatian national registry is in "reconciliation mode only", meaning the registry is effectively connected to the ITL, but no transactions are allowed. In this stage HR registry do not have open any accounts exept National accounts and those account are without units because of pending issue on the calculation of the assigned amount of Croatia in accordance with Article 3, paragraphs 7 and 8, of the Kyoto Protocol. For detail information please check document FCCC/KP/CMP/2010/2 "Appeal by Croatia against a final decision of the enforcement branch of the Compliance Committee". 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.
15/CMP.1 annex I.E paragraph 18 CPR Calculation	Total emissions without LULUCF(CRF, Summary2) = 28.865.485,43 t CO_2eq CPR = 5 x 28.865.485,43 t CO_2eq = 144.327.427,15 t CO_2eq

13. INFORMATION ON CHANGES IN NATIONAL SYSTEM

National system is unchanged compared to the description given in last inventory submission in May 2010.

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	More information about Article 6 projects related to the paragraph 46 of the annex to decision 13/CMP.1
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.The external assessor reiterates the recommendation of the previous ERT in that the Party specifically address the recommendation contained in Paragraph 88 of the report FCCC/ARR/2009/HRV and report on any changes in its national registry in accordance with section I G of the annex to decision 15/CMP.1. According the recommondations listed in FCCC/ARR/2010/HRV, 145 (a), in this submission HR gives clear statement whether a change has occured or not in the reporting period. 2.The ERT reiterates the recommendation of the SIAR that Croatia provide through its national registry the public information referred to in paragraphs 45 to 48 of the annex to decision 13/CMP.1, and report, in its next annual submission, on any changes to that public information According the recommondations listed in FCCC/ARR/2010/HRV, 145 (b), HR updated web site with public information referred to in paragraphs 45 to 48 of the annex to decision 13/CMP.1 for more details please check www.azo.hr/ghgregistry 3.The external assessor reiterates the recommendation of the previous ERT in that Croatia specifically address the recommendation contained in Paragraph 85 of the report FCCC/ARR/2009/HRV by providing more complete and detailed information on the NTP procedure and a detailed plan for the disaster recovery plan. It is recommended that the Party submits these complementary documents or demonstrates how the information has been made available, as part of the SIAR process, by the next annual submission. According the recommondations listed in FCCC/ARR/2010/HRV, 145 (c), for details for the disaster recovery plan HR submited confidential document „Backup and disaster recovery plan". Regarding detailed information on the NTP procedure, the Croatian Registry uses Network Time Protocol to continuously update server time based on two time servers: zg1.ntp.carnet.hr and zg2.ntp.carnet.hr. The time is automatically synchronized every 15 minutes.

Annual Submission Item	HR report
The previous Annual Review recommendations	System is also set up to check time discrepancy between Registry servers and time servers every half an hour and synchronized to the local Registry time. Croatian Registry also checks time discrepancy between Registry servers and ITL server via provide Time service.

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 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	
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 2009 in CRF tables is the Excel file HRV-2011-2009-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)-2009), (Table A1.2-11: Key categories analysis – Level Assessment - Tier 2 (Excluding LULUCF)-2009), (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)-2009).

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	3559.022	0.113	53%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.088	61%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	0.042	66%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.040	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	839.186	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	95%
CH4 Emissions from Manure Management	CH4	228.623	0.007	95%
Fuel Combustion - Stationary Sources	CH4	168.641	0.005	96%
CO2 Emissions from Lime Production	CO2	160.629	0.005	96%
Mobile Combustion: Aircraft	CO2	154.724	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	72.192	0.002	99%
Fuel Combustion - Stationary Sources	N2O	62.365	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	0.002	99%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.002	99%
Mobile Combustion - Road Vehicles	N2O	38.634	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	0.001	100%
Mobile Combustion - Road Vehicles	CH4	32.964	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%
Combustion - Agriculture/Forestry/Fishing	N2O	2.038	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.000	100%
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		**31439.935**		

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	0.220	22%
Forest land remaining forest land	CO2	7059.349	0.183	40%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	0.115	52%
Mobile Combustion - Road Vehicles	CO2	3559.022	0.092	61%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.072	68%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	0.034	72%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.032	75%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	0.031	78%
CO2 Emissions from Cement Production	CO2	1085.790	0.028	81%
PFC Emissions from Aluminium production	PFC	936.564	0.024	83%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	0.024	86%
Combustion - Agriculture/Forestry/Fishing	CO2	839.186	0.022	88%
Nitric Acid Production	N2O	803.886	0.021	90%
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	94%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	0.007	95%
Solid Waste Disposal Sites	CH4	242.623	0.006	95%
CH4 Emissions from Manure Management	CH4	228.623	0.006	96%
Fuel Combustion - Stationary Sources	CH4	168.641	0.004	96%
CO2 Emissions from Lime Production	CO2	160.629	0.004	97%
Mobile Combustion: Domestic Aviation	CO2	154.724	0.004	97%
Mobile Combustion: Railways	CO2	138.142	0.004	97%
Land converted to Settlements	CO2	136.789	0.004	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	72.192	0.002	99%
Fuel Combustion - Stationary Sources	N2O	62.365	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	0.001	99%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.001	99%
Mobile Combustion - Road Vehicles	N2O	38.634	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	0.001	100%
Mobile Combustion - Road Vehicles	CH4	32.964	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%
Land converted to Forest land	CO2	11.033	0.000	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%
Forest land remaining forest land	CH4	0.012	0.000	100%
Forest land remaining forest land	N2O	0.003	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	100%
TOTAL		**38647.120**		

Table A1.2-3: Key categories analysis – Level Assessment - Tier 1(Excluding LULUCF)-2009

Tier 1 Analysis - Level Assessment – Excluding LULUCF					
IPCC Source Categories	Direct GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Current Year (2009) Estimate (Gg eq-CO_2)	Level Assessment	Cumulative Total (%)
Mobile Combustion - Road Vehicles	CO2	3559.022	5764.895	0.200	20%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	5481.204	0.190	39%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	4994.524	0.173	56%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	1969.357	0.068	63%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	1472.583	0.051	68%
CO2 Emissions from Cement Production	CO2	1085.790	1224.170	0.042	72%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	1179.855	0.041	77%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	814.101	0.028	79%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	758.526	0.026	82%
Combustion - Agriculture/Forestry/Fishing	CO2	839.186	734.771	0.025	85%
Solid Waste Disposal Sites	CH4	242.623	718.143	0.025	87%
Nitric Acid Production	N2O	803.886	632.400	0.022	89%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	516.438	0.018	91%
CO2 Emissions from Ammonia Production	CO2	466.009	445.187	0.015	93%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.954	443.066	0.015	94%
N2O Emissions from Manure Management	N2O	381.844	212.238	0.007	95%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	177.390	0.006	95%
Emissions from Waste Water Handling	CH4	278.732	175.747	0.006	96%
CH4 Emissions from Manure Management	CH4	228.623	172.363	0.006	97%
CO2 Emissions from Lime Production	CO2	160.629	156.330	0.005	97%
Mobile Combustion: Water-borne Navigation	CO2	132.980	145.292	0.005	98%
Emissions from Waste Water Handling	N2O	90.235	102.427	0.004	98%
Total Solvent and Other Product Use	CO2	72.192	97.542	0.003	98%
Fuel Combustion - Stationary Sources	CH4	168.641	91.763	0.003	99%
Mobile Combustion: Railways	CO2	138.142	89.255	0.003	99%
Mobile Combustion: Domestic Aviation	CO2	154.724	77.418	0.003	99%
Mobile Combustion - Road Vehicles	N2O	38.634	62.831	0.002	99%
Fuel Combustion - Stationary Sources	N2O	62.365	42.052	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	33.589	0.001	100%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	30.370	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	17.203	0.001	100%
Mobile Combustion - Road Vehicles	CH4	32.964	14.767	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	11.304	0.000	100%
Combustion - Agriculture/Forestry/Fishing	N2O	2.038	1.797	0.000	100%
Production of Chemicals	CH4	15.798	1.733	0.000	100%
Combustion - Agriculture/Forestry/Fishing	CH4	1.299	1.106	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.679	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.368	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.226	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.208	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.128	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.127	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.011	0.000	100%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.000	0.000	100%
Aluminium Production	CO2	111.372	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	0.000	100%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.000	0.000	100%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.000	100%
TOTAL		**31439.935**	**28865.485**		

Table A1.2-4: Key categories analysis – Level Assessment - Tier 1 (Including LULUCF)-2009

Tier 1 Analysis - Level Assessment – Including LULUCF				
IPCC Source Categories	Direct GHG	Last Year (2009) Estimate (Gg eq-CO2)	Level Assessment	Cumulative Total (%)
Forest land remaining forest land	CO2	8641.961	0.229	23%
Mobile Combustion - Road Vehicles	CO2	5764.895	0.153	38%
CO2 Emissions from Stationary Combustion - Oil	CO2	5481.204	0.145	53%
CO2 Emissions from Stationary Combustion - Gas	CO2	4994.524	0.132	66%
CO2 Emissions from Stationary Combustion - Coal	CO2	1969.357	0.052	71%
Fugitive Emissions from Oil and Gas Operations	CH4	1472.583	0.039	75%
CO2 Emissions from Cement Production	CO2	1224.170	0.032	78%
Direct N2O Emissions from Agricultural Soils	N2O	1179.855	0.031	81%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	814.101	0.022	84%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	758.526	0.020	86%
Combustion - Agriculture/Forestry/Fishing	CO2	734.771	0.019	88%
Solid Waste Disposal Sites	CH4	718.143	0.019	89%
Nitric Acid Production	N2O	632.400	0.017	91%
CO2 Emissions from Natural Gas Scrubbing*	CO2	516.438	0.014	93%
CO2 Emissions from Ammonia Production	CO2	445.187	0.012	94%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	443.066	0.012	95%
N2O Emissions from Manure Management	N2O	212.238	0.006	95%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	177.390	0.005	96%
Emissions from Waste Water Handling	CH4	175.747	0.005	96%
CH4 Emissions from Manure Management	CH4	172.363	0.005	97%
CO2 Emissions from Lime Production	CO2	156.330	0.004	97%
Mobile Combustion: Water-borne Navigation	CO2	145.292	0.004	98%
Land converted to Forest land	CO2	144.615	0.004	98%
Emissions from Waste Water Handling	N2O	102.427	0.003	98%
Total Solvent and Other Product Use	CO2	97.542	0.003	99%
Fuel Combustion - Stationary Sources	CH4	91.763	0.002	99%
Mobile Combustion: Railways	CO2	89.255	0.002	99%
Mobile Combustion: Domestic Aviation	CO2	77.418	0.002	99%
Land converted to Settlements	CO2	74.515	0.002	99%
Mobile Combustion - Road Vehicles	N2O	62.831	0.002	100%
Fuel Combustion - Stationary Sources	N2O	42.052	0.001	100%
Total Solvent and Other Product Use	N2O	33.589	0.001	100%
CO2 Emissions from Limestone and Dolomite Use	CO2	30.370	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	17.203	0.000	100%
Mobile Combustion - Road Vehicles	CH4	14.767	0.000	100%
CO2 Emissions from Iron and Steel Production	CO2	11.304	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	1.797	0.000	100%
Production of Other Chemicals	CH4	1.733	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.106	0.000	100%
Mobile Combustion: Aircraft	N2O	0.679	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.368	0.000	100%
Mobile Combustion: Railways	N2O	0.226	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.208	0.000	100%
Mobile Combustion: Railways	CH4	0.128	0.000	100%
Emissions from Waste Incineration	CO2	0.127	0.000	100%
Mobile Combustion: Aircraft	CH4	0.011	0.000	100%
Forest land remaining forest land	CH4	0.002	0.000	100%
Forest land remaining forest land	N2O	0.000	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		**37726.579**		

Table A1.2-5: Key categories analysis – Trend Assessment - Tier 1 (Excluding LULUCF)-2009

Tier 1 Analysis - Trend Assessment – Excluding LULUCF						
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2009) Estimate (Gg eq-CO_2)	Trend Assess	% Contrib. on to trend	Cumulative Total of Column F
Mobile Combustion - Road Vehicles	CO2	3559.022	5764.895	0.094	0.241	24%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	5481.204	0.088	0.224	46%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	4994.524	0.034	0.087	55%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.032	0.083	63%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	1969.357	0.022	0.056	69%
Solid Waste Disposal Sites	CH4	242.623	718.143	0.019	0.048	74%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.954	443.066	0.016	0.042	78%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.180	1472.583	0.014	0.036	82%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	814.101	0.012	0.031	85%
CO2 Emissions from Cement Production	CO2	1085.790	1224.170	0.009	0.022	87%
N2O Emissions from Manure Management	N2O	381.844	212.238	0.005	0.013	88%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	516.438	0.005	0.013	89%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.000	0.004	0.011	91%
Nitric Acid Production	N2O	803.886	632.400	0.004	0.010	92%
Aluminium Production	CO2	111.372	0.000	0.004	0.010	93%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.066	758.526	0.004	0.010	94%
Emissions from Waste Water Handling	CH4	278.732	175.747	0.003	0.008	94%
Mobile Combustion: Domestic Aviation	CO2	154.724	77.418	0.002	0.006	95%
Fuel Combustion - Stationary Sources	CH4	168.641	91.763	0.002	0.006	96%
N2O Emissions from Pasture, Range and Paddock	N2O	261.130	177.390	0.002	0.006	96%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.000	0.002	0.004	97%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	1179.855	0.002	0.004	97%
Mobile Combustion: Railways	CO2	138.142	89.255	0.001	0.004	97%
CH4 Emissions from Manure Management	CH4	228.623	172.363	0.001	0.004	98%
Combustion - Agriculture/Forestry/Fishing	CO2	839.186	734.771	0.001	0.003	98%
Total Solvent and Other Product Use	CO2	72.192	97.542	0.001	0.003	98%
Mobile Combustion - Road Vehicles	N2O	38.634	62.831	0.001	0.003	99%
Mobile Combustion: Water-borne Navigation	CO2	132.980	145.292	0.001	0.002	99%
Emissions from Waste Water Handling	N2O	90.235	102.427	0.001	0.002	99%
CO2 Emissions from Ammonia Production	CO2	466.009	445.187	0.001	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	30.370	0.001	0.002	99%
Mobile Combustion - Road Vehicles	CH4	32.964	14.767	0.001	0.001	99%
Fuel Combustion - Stationary Sources	N2O	62.365	42.052	0.001	0.001	100%
Production of Chemicals	CH4	15.798	1.733	0.000	0.001	100%
CO2 Emissions from Lime Production	CO2	160.629	156.330	0.000	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	11.304	0.000	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	17.203	0.000	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	33.589	0.000	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.679	0.000	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.226	0.000	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.127	0.000	0.000	100%
Combustion - Agriculture/Forestry/Fishing	CH4	1.299	1.106	0.000	0.000	100%
Combustion - Agriculture/Forestry/Fishing	N2O	2.038	1.797	0.000	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.128	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.368	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.208	0.000	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.011	0.000	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	0.000	0.000	100%
TOTAL		**31439.935**	**29865.485**			

Table A1.2-6: Key categories analysis – Trend Assessment - Tier 1 (Including LULUCF)-2009

Tier 1 Analysis - Trend Assessment – Including LULUCF						
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2009) 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	5481.2038	0.0764	0.2202	22%
Mobile Combustion - Road Vehicles	CO2	3559.0224	5764.8954	0.0622	0.1793	40%
Forest land remaining forest land	CO2	7059.3485	8641.9612	0.0475	0.1370	54%
PFC Emissions from Aluminium production	PFC	936.5643	0.0000	0.0248	0.0716	61%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.4471	1969.3566	0.0202	0.0583	67%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.5394	4994.5237	0.0174	0.0503	72%
Solid Waste Disposal Sites	CH4	242.6230	718.1430	0.0131	0.0377	75%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.9542	443.0663	0.0117	0.0338	79%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.9196	814.1015	0.0108	0.0312	82%
Fugitive Emissions from Oil and Gas Operations	CH4	1201.1796	1472.5827	0.0081	0.0235	84%
CO2 Emissions from Cement Production	CO2	1085.7898	1224.1700	0.0045	0.0129	86%
N2O Emissions from Manure Management	N2O	381.8439	212.2377	0.0044	0.0126	87%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.0663	758.5264	0.0042	0.0120	88%
Nitric Acid Production	N2O	803.8859	632.4000	0.0041	0.0119	89%
Land converted to Forest land	CO2	11.0331	144.6149	0.0036	0.0105	90%
Direct N2O Emissions from Agricultural Soils	N2O	1330.8725	1179.8555	0.0032	0.0093	91%
CO2 Emissions from Ferroalloys Production	CO2	118.8360	0.0000	0.0031	0.0091	92%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.9492	516.4379	0.0030	0.0086	93%
Aluminium Production	CO2	111.3720	0.0000	0.0030	0.0085	94%
Emissions from Waste Water Handling	CH4	278.7322	175.7466	0.0026	0.0075	95%
Combustion - Agriculture/Forestry/Fishing	CO2	839.1862	734.7711	0.0023	0.0066	95%
N2O Emissions from Pasture, Range and Paddock	N2O	261.1304	177.3901	0.0021	0.0061	96%
Mobile Combustion: Domestic Aviation	CO2	154.7239	77.4178	0.0020	0.0058	96%
Fuel Combustion - Stationary Sources	CH4	168.6406	91.7631	0.0020	0.0057	97%
Land converted to Settlements	CO2	136.7885	74.5155	0.0016	0.0046	97%
CH4 Emissions from Manure Management	CH4	228.6231	172.3634	0.0014	0.0040	98%
Fugitive Emissions from Coal Mining and Handling	CH4	48.7570	0.0000	0.0013	0.0037	98%
Mobile Combustion: Railways	CO2	138.1421	89.2550	0.0012	0.0036	99%
Total Solvent and Other Product Use	CO2	72.1921	97.5424	0.0007	0.0021	99%
Mobile Combustion - Road Vehicles	N2O	38.6342	62.8305	0.0007	0.0020	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.4867	30.3700	0.0005	0.0016	99%
Fuel Combustion - Stationary Sources	N2O	62.3653	42.0523	0.0005	0.0015	99%
Mobile Combustion - Road Vehicles	CH4	32.9642	14.7669	0.0005	0.0014	99%
Mobile Combustion: Water-borne Navigation	CO2	132.9800	145.2920	0.0004	0.0012	100%
Emissions from Waste Water Handling	N2O	90.2352	102.4269	0.0004	0.0011	100%
Production of Other Chemicals	CH4	15.7981	1.7332	0.0004	0.0011	100%
CO2 Emissions from Ammonia Production	CO2	466.0087	445.1873	0.0003	0.0008	100%
CO2 Emissions from Iron and Steel Production	CO2	21.4468	11.3042	0.0003	0.0008	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.7400	17.2032	0.0002	0.0006	100%
Mobile Combustion: Aircraft	N2O	1.3552	0.6789	0.0000	0.0001	100%
CO2 Emissions from Lime Production	CO2	160.6288	156.3300	0.0000	0.0000	100%
Total Solvent and Other Product Use	N2O	34.7200	33.5885	0.0000	0.0000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.0385	1.7968	0.0000	0.0000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.2987	1.1058	0.0000	0.0000	100%
Mobile Combustion: Railways	N2O	0.3917	0.2264	0.0000	0.0000	100%
Emissions from Waste Incineration	CO2	0.0432	0.1267	0.0000	0.0000	100%
Mobile Combustion: Railways	CH4	0.2136	0.1278	0.0000	0.0000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.3367	0.3684	0.0000	0.0000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.1901	0.2080	0.0000	0.0000	100%
Mobile Combustion: Aircraft	CH4	0.0230	0.0115	0.0000	0.0000	100%
Forest land remaining forest land	CH4	0.0125	0.0019	0.0000	0.0000	100%
Forest land remaining forest land	N2O	0.0029	0.0004	0.0000	0.0000	100%
Other non-specified NEU	CO2	0.0000	0.0000	0.0000	0.0000	100%
TOTAL		**38647.120**	**37726.579**			

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	0.412	41%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	0.218	63%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	0.076	71%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	0.029	73%
PFC Emissions from Aluminium production	PFC	936.564	0.029	76%
Nitric Acid Production	N2O	803.886	0.028	79%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.021	81%
N2O Emissions from Manure Management	N2O	381.844	0.015	83%
Solid Waste Disposal Sites	CH4	242.623	0.015	84%
Fuel Combustion - Stationary Sources	N2O	62.365	0.014	86%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	0.014	87%
Emissions from Waste Water Handling	CH4	278.732	0.014	88%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.014	90%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.013	91%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	0.011	92%
Mobile Combustion - Road Vehicles	CO2	3559.022	0.010	93%
Fuel Combustion - Stationary Sources	CH4	168.641	0.010	94%
Mobile Combustion - Road Vehicles	N2O	38.634	0.009	95%
CO2 Emissions from Cement Production	CO2	1085.790	0.005	96%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	0.005	96%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.004	97%
Aluminium Production	CO2	111.372	0.004	97%
CH4 Emissions from Manure Management	CH4	228.623	0.004	97%
Emissions from Waste Water Handling	N2O	90.235	0.003	98%
CO2 Emissions from Ammonia Production	CO2	466.009	0.003	98%
Total Solvent and Other Product Use	CO2	72.192	0.003	98%
Combustion - Agriculture/Forestry/Fishing	CO2	839.186	0.003	99%
Total Solvent and Other Product Use	N2O	34.720	0.003	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	0.002	99%
Mobile Combustion - Road Vehicles	CH4	32.964	0.002	99%
Mobile Combustion: Domestic Aviation	CO2	154.724	0.001	99%
Mobile Combustion: Railways	CO2	138.142	0.001	99%
Mobile Combustion: Water-borne Navigation	CO2	132.980	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%
CO2 Emissions from Lime Production	CO2	160.629	0.001	100%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.954	0.000	100%
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%
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%
Other non-specified NEU	CO2	0.000	0.000	100%
TOTAL		**31439.935**		

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	0.353	35%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	934.066	0.186	54%
Forest land remaining forest land	CO2	7059.349	0.138	68%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	0.065	74%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	0.025	77%
PFC Emissions from Aluminium production	PFC	936.564	0.025	79%
Nitric Acid Production	N2O	803.886	0.024	82%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.920	0.018	83%
N2O Emissions from Manure Management	N2O	381.844	0.013	85%
Solid Waste Disposal Sites	CH4	242.623	0.013	86%
Fuel Combustion - Stationary Sources	N2O	62.365	0.012	87%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	0.012	88%
Emissions from Waste Water Handling	CH4	278.732	0.012	90%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.012	91%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	0.011	92%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	261.130	0.010	93%
Mobile Combustion - Road Vehicles	CO2	3559.022	0.009	94%
Fuel Combustion - Stationary Sources	CH4	168.641	0.008	95%
Mobile Combustion - Road Vehicles	N2O	38.634	0.008	95%
Land converted to Settlements	CO2	136.789	0.005	96%
CO2 Emissions from Cement Production	CO2	1085.790	0.005	96%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	0.004	97%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.004	97%
Aluminium Production	CO2	111.372	0.003	97%
CH4 Emissions from Manure Management	CH4	228.623	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%
Total Solvent and Other Product Use	CO2	72.192	0.003	98%
Combustion - Agriculture/Forestry/Fishing	CO2	839.186	0.003	99%
Total Solvent and Other Product Use	N2O	34.720	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	0.002	99%
Mobile Combustion - Road Vehicles	CH4	32.964	0.001	99%
Mobile Combustion: Domestic Aviation	CO2	154.724	0.001	99%
Mobile Combustion: Railways	CO2	138.142	0.001	99%
Mobile Combustion: Water-borne Navigation	CO2	132.980	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%
CO2 Emissions from Lime Production	CO2	160.629	0.001	100%
Land converted to Forest land	CO2	11.033	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 Other 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%
TOTAL		**38647.120**		

Table A1.2-9: Key categories analysis – Level Assessment - Tier 2 (Excluding LULUCF)-2009

Tier 2 Analysis - Level Assessment – Excluding LULUCF				
IPCC Source Categories	**Direct GHG**	Last Year (2009) Estimate (Gg eq-CO_2	**Level Assessment Tier 2**	**Cumulative Total (%)**
Fugitive Emissions from Oil and Gas Operations	CH4	1472.583	0.505	51%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	758.526	0.177	68%
Direct N2O Emissions from Agricultural Soils	N2O	1179.855	0.067	75%
Solid Waste Disposal Sites	CH4	718.143	0.045	79%
Nitric Acid Production	N2O	632.400	0.022	82%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	443.066	0.020	84%
CO2 Emissions from Stationary Combustion - Oil	CO2	5481.204	0.019	85%
Mobile Combustion - Road Vehicles	CO2	5764.895	0.017	87%
CO2 Emissions from Stationary Combustion - Gas	CO2	4994.524	0.016	89%
Mobile Combustion - Road Vehicles	N2O	62.831	0.014	90%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	814.101	0.014	92%
Fuel Combustion - Stationary Sources	N2O	42.052	0.010	92%
Emissions from Waste Water Handling	CH4	175.747	0.009	93%
N2O Emissions from Manure Management	N2O	212.238	0.009	94%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	177.390	0.008	95%
CO2 Emissions from Natural Gas Scrubbing*	CO2	516.438	0.006	96%
CO2 Emissions from Cement Production	CO2	1224.170	0.006	96%
Total Solvent and Other Product Use	CO2	97.542	0.006	97%
Fuel Combustion - Stationary Sources	CH4	91.763	0.005	97%
CO2 Emissions from Stationary Combustion - Coal	CO2	1969.357	0.005	98%
Emissions from Waste Water Handling	N2O	102.427	0.004	98%
CO2 Emissions from Ammonia Production	CO2	445.187	0.003	99%
CH4 Emissions from Manure Management	CH4	172.363	0.003	99%
Total Solvent and Other Product Use	N2O	33.589	0.003	99%
Combustion - Agriculture/Forestry/Fishing	CO2	734.771	0.003	99%
Mobile Combustion: Water-borne Navigation	CO2	145.292	0.001	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	30.370	0.001	100%
Mobile Combustion: Railways	CO2	89.255	0.001	100%
Mobile Combustion - Road Vehicles	CH4	14.767	0.001	100%
Mobile Combustion: Domestic Aviation	CO2	77.418	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	17.203	0.001	100%
CO2 Emissions from Lime Production	CO2	156.330	0.001	100%
Combustion - Agriculture/Forestry/Fishing	N2O	1.797	0.000	100%
CO2 Emissions from Iron and Steel Production	CO2	11.304	0.000	100%
Mobile Combustion: Aircraft	N2O	0.679	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.368	0.000	100%
Mobile Combustion: Railways	N2O	0.226	0.000	100%
Combustion - Agriculture/Forestry/Fishing	CH4	1.106	0.000	100%
Production of Chemicals	CH4	1.733	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.208	0.000	100%
Emissions from Waste Incineration	CO2	0.127	0.000	100%
Mobile Combustion: Railways	CH4	0.128	0.000	100%
Mobile Combustion: Aircraft	CH4	0.011	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		**28865.485**		

Table A1.2-10: Key categories analysis – Level Assessment - Tier 2 (Including LULUCF)-2009

Tier 2 Analysis - Level Assessment – Including LULUCF				
IPCC Source Categories	Direct GHG	Last Year (2009) Estimate (Gg eq-CO_2	Level Assessment Tier 2	Cumulative Total (%)
Fugitive Emissions from Oil and Gas Operations	CH4	1472.583	0.428	43%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	758.526	0.150	58%
Forest land remaining forest land	CO2	8641.961	0.143	72%
Direct N2O Emissions from Agricultural Soils	N2O	1179.855	0.057	78%
Solid Waste Disposal Sites	CH4	718.143	0.038	82%
Nitric Acid Production	N2O	632.400	0.018	83%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	443.066	0.017	85%
CO2 Emissions from Stationary Combustion - Oil	CO2	5481.204	0.016	87%
Mobile Combustion - Road Vehicles	CO2	5764.895	0.014	88%
CO2 Emissions from Stationary Combustion - Gas	CO2	4994.524	0.013	89%
Mobile Combustion - Road Vehicles	N2O	62.831	0.012	91%
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	814.101	0.011	92%
Fuel Combustion - Stationary Sources	N2O	42.052	0.008	93%
Emissions from Waste Water Handling	CH4	175.747	0.007	93%
N2O Emissions from Manure Management	N2O	212.238	0.007	94%
Land converted to Forest land	CO2	144.615	0.007	95%
N2O Emissions from Pasture, Range and Paddock Manure	N2O	177.390	0.007	95%
CO2 Emissions from Natural Gas Scrubbing*	CO2	516.438	0.005	96%
CO2 Emissions from Cement Production	CO2	1224.170	0.005	97%
Total Solvent and Other Product Use	CO2	97.542	0.005	97%
Fuel Combustion - Stationary Sources	CH4	91.763	0.004	97%
CO2 Emissions from Stationary Combustion - Coal	CO2	1969.357	0.004	98%
Emissions from Waste Water Handling	N2O	102.427	0.003	98%
Land converted to Settlements	CO2	74.515	0.003	98%
CO2 Emissions from Ammonia Production	CO2	445.187	0.003	99%
CH4 Emissions from Manure Management	CH4	172.363	0.002	99%
Total Solvent and Other Product Use	N2O	33.589	0.002	99%
Combustion - Agriculture/Forestry/Fishing	CO2	734.771	0.002	99%
Mobile Combustion: Water-borne Navigation	CO2	145.292	0.001	100%
CO2 Emissions from Limestone and Dolomite Use	CO2	30.370	0.001	100%
Mobile Combustion: Railways	CO2	89.255	0.001	100%
Mobile Combustion - Road Vehicles	CH4	14.767	0.001	100%
Mobile Combustion: Domestic Aviation	CO2	77.418	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	17.203	0.001	100%
CO2 Emissions from Lime Production	CO2	156.330	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	1.797	0.000	100%
CO2 Emissions from Iron and Steel Production	CO2	11.304	0.000	100%
Mobile Combustion: Aircraft	N2O	0.679	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.368	0.000	100%
Mobile Combustion: Railways	N2O	0.226	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.106	0.000	100%
Production of Other Chemicals	CH4	1.733	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.208	0.000	100%
Emissions from Waste Incineration	CO2	0.127	0.000	100%
Mobile Combustion: Railways	CH4	0.128	0.000	100%
Mobile Combustion: Aircraft	CH4	0.011	0.000	100%
Forest land remaining forest land	CH4	0.002	0.000	100%
Forest land remaining forest land	N2O	0.000	0.000	100%
CO2 Emissions from Ferroalloys Production	CO2	0.000	0.000	100%
Aluminium Production	CO2	0.000	0.000	100%
TOTAL		**37726.579**		

Table A1.2-11: Key categories analysis – Trend Assessment - Tier 2 (Excluding LULUCF)-2009

Tier 2 Analysis - Trend Assessment – Excluding LULUCF						
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2009) 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	1472.583	4.186267	0.404	40%
Solid Waste Disposal Sites	CH4	242.623	718.143	1.021954	0.099	50%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.881428	0.085	59%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.066	758.526	0.76233	0.074	66%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.954	443.066	0.638052	0.062	72%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.000	0.422362	0.041	76%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	5481.204	0.26263	0.025	79%
Mobile Combustion - Road Vehicles	CO2	3559.022	5764.895	0.24135	0.023	81%
Mobile Combustion - Road Vehicles	N2O	38.634	62.831	0.20654	0.020	83%
N2O Emissions from Manure Management	N2O	381.844	212.238	0.185364	0.018	85%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.920	814.101	0.178852	0.017	87%
Emissions from Waste Water Handling	CH4	278.732	175.747	0.132676	0.013	88%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.000	0.127308	0.012	89%
Nitric Acid Production	N2O	803.886	632.400	0.120203	0.012	90%
Fuel Combustion - Stationary Sources	CH4	168.641	91.763	0.119582	0.012	92%
Aluminium Production	CO2	111.372	0.000	0.116327	0.011	93%
Fuel Combustion - Stationary Sources	N2O	62.365	42.052	0.114792	0.011	94%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	4994.524	0.09404	0.009	95%
N2O Emissions from Pasture, Range and Paddock	N2O	261.130	177.390	0.089327	0.009	96%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	1179.855	0.078756	0.008	96%
Total Solvent and Other Product Use	CO2	72.192	97.542	0.062697	0.006	97%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	516.438	0.053005	0.005	98%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	1969.357	0.048879	0.005	98%
CO2 Emissions from Cement Production	CO2	1085.790	1224.170	0.036386	0.004	98%
Mobile Combustion - Road Vehicles	CH4	32.964	14.767	0.023574	0.002	99%
Emissions from Waste Water Handling	N2O	90.235	102.427	0.023364	0.002	99%
CH4 Emissions from Manure Management	CH4	228.623	172.363	0.020587	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	30.370	0.01972	0.002	99%
Mobile Combustion: Domestic Aviation	CO2	154.724	77.418	0.017246	0.002	99%
Production of Chemicals	CH4	15.798	1.733	0.011097	0.001	99%
Mobile Combustion: Railways	CO2	138.142	89.255	0.010026	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	11.304	0.009786	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	17.203	0.007502	0.001	100%
Mobile Combustion: Water-borne Navigation	CO2	132.980	145.292	0.00619	0.001	100%
Total Solvent and Other Product Use	N2O	34.720	33.589	0.004567	0.000	100%
Mobile Combustion: Aircraft	N2O	1.355	0.679	0.004267	0.000	100%
Combustion - Agriculture/Forestry/Fishing	CO2	839.186	734.771	0.00426	0.000	100%
CO2 Emissions from Ammonia Production	CO2	466.009	445.187	0.003815	0.000	100%
CO2 Emissions from Lime Production	CO2	160.629	156.330	0.001016	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.226	0.001005	0.000	100%
Combustion - Agriculture/Forestry/Fishing	N2O	2.038	1.797	0.000564	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.368	0.000448	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.127	0.000192	0.000	100%
Combustion - Agriculture/Forestry/Fishing	CH4	1.299	1.106	0.000132	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.128	0.000104	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.208	5.09E-05	0.000	100%
Mobile Combustion: Aircraft	CH4	0.023	0.011	1.46E-05	0.000	100%
Other non-specified NEU	CO2	0.000	0.000	0	0.000	100%
TOTAL		**31439.935**	**29865.385**			

Table A1.2-12: Key categories analysis – Trend Assessment - Tier 2 (Including LULUCF)-2009

Tier 2 Analysis - Trend Assessment – Including LULUCF						
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2009) 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	1472.583	2.444	0.286	29%
Indirect N2O Emissions from Nitrogen Used in	N2O	934.066	758.526	0.849	0.099	39%
Forest land remaining forest land	CO2	7059.349	8641.961	0.814	0.095	48%
Solid Waste Disposal Sites	CH4	242.623	718.143	0.714	0.084	56%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.674	0.079	64%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	10.954	443.066	0.458	0.054	70%
Fugitive Emissions from Coal Mining and Handling	CH4	48.757	0.000	0.323	0.038	73%
CO2 Emissions from Stationary Combustion - Oil	CO2	8497.044	5481.204	0.229	0.027	76%
Land converted to Forest land	CO2	11.033	144.615	0.182	0.021	78%
Direct N2O Emissions from Agricultural Soils	N2O	1330.872	1179.855	0.161	0.019	80%
Mobile Combustion - Road Vehicles	CO2	3559.022	5764.895	0.159	0.019	82%
CH4 Emissions from Enteric Fermentation in Domestic	CH4	1241.920	814.101	0.157	0.018	84%
N2O Emissions from Manure Management	N2O	381.844	212.238	0.155	0.018	86%
Mobile Combustion - Road Vehicles	N2O	38.634	62.831	0.136	0.016	87%
Nitric Acid Production	N2O	803.886	632.400	0.125	0.015	89%
Emissions from Waste Water Handling	CH4	278.732	175.747	0.115	0.013	90%
Fuel Combustion - Stationary Sources	N2O	62.365	42.052	0.102	0.012	91%
Fuel Combustion - Stationary Sources	CH4	168.641	91.763	0.099	0.012	92%
CO2 Emissions from Ferroalloys Production	CO2	118.836	0.000	0.097	0.011	94%
Aluminium Production	CO2	111.372	0.000	0.089	0.010	95%
N2O Emissions from Pasture, Range and Paddock	N2O	261.130	177.390	0.080	0.009	96%
Land converted to Settlements	CO2	136.789	74.515	0.064	0.008	96%
CO2 Emissions from Stationary Combustion - Gas	CO2	4458.539	4994.524	0.048	0.006	97%
CO2 Emissions from Stationary Combustion - Coal	CO2	2780.447	1969.357	0.045	0.005	97%
Total Solvent and Other Product Use	CO2	72.192	97.542	0.039	0.005	98%
CO2 Emissions from Natural Gas Scrubbing*	CO2	415.949	516.438	0.031	0.004	98%
CH4 Emissions from Manure Management	CH4	228.623	172.363	0.020	0.002	98%
Mobile Combustion - Road Vehicles	CH4	32.964	14.767	0.019	0.002	99%
CO2 Emissions from Cement Production	CO2	1085.790	1224.170	0.019	0.002	99%
CO2 Emissions from Limestone and Dolomite Use	CO2	51.487	30.370	0.017	0.002	99%
Mobile Combustion: Domestic Aviation	CO2	154.724	77.418	0.014	0.002	99%
Emissions from Waste Water Handling	N2O	90.235	102.427	0.012	0.001	99%
Mobile Combustion: Railways	CO2	138.142	89.255	0.009	0.001	100%
Production of Other Chemicals	CH4	15.798	1.733	0.009	0.001	100%
CO2 Emissions from Iron and Steel Production	CO2	21.447	11.304	0.008	0.001	100%
Combustion - Agriculture/Forestry/Fishing	CO2	839.186	734.771	0.007	0.001	100%
CO2 Emissions from Soda Ash Production and Use	CO2	25.740	17.203	0.007	0.001	100%
Mobile Combustion: Aircraft	N2O	1.355	0.679	0.003	0.000	100%
Mobile Combustion: Water-borne Navigation	CO2	132.980	145.292	0.003	0.000	100%
CO2 Emissions from Ammonia Production	CO2	466.009	445.187	0.002	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N2O	2.038	1.797	0.001	0.000	100%
Mobile Combustion: Railways	N2O	0.392	0.226	0.001	0.000	100%
Total Solvent and Other Product Use	N2O	34.720	33.589	0.001	0.000	100%
Mobile Combustion: Water-borne Navigation	N2O	0.337	0.368	0.000	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH4	1.299	1.106	0.000	0.000	100%
Emissions from Waste Incineration	CO2	0.043	0.127	0.000	0.000	100%
Mobile Combustion: Railways	CH4	0.214	0.128	0.000	0.000	100%
CO2 Emissions from Lime Production	CO2	160.629	156.330	0.000	0.000	100%
Mobile Combustion: Water-borne Navigation	CH4	0.190	0.208	0.000	0.000	100%
Forest land remaining forest land	CH4	0.012	0.002	0.000	0.000	100%
TOTAL		**38647.120**	**37726.579**			

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
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

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)-2009

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,L2,T2
CO_2 Emissions from Stationary Combustion: Gas	CO_2	Yes	L1,T1,L2
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	T1
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
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,T1,L2,T2
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	Yes	L1,T1,L2,T2
PFC Emissions from Aluminium production	PFC	Yes	T1
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

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,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	T1,T2
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

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	
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)-2009

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,L2,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	No	
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	T2
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	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
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,T1,T2
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	L1,T1,T2
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L1,L2,T1,T2
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	No	

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	Yes	T1,T2
Land converted to Settlements	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	T1,T2
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	
		2008	2009	2008	2009
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	Yes	No	Yes*	No
CO_2 Emissions from Ammonia Production	CO_2	Yes	Yes	Yes	No
N_2O Emissions from Nitric Acid Production	N_2O	Yes	Yes	No	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	Yes**	No	Yes	No
N_2O Emissions from Manure Management	N_2O	No	Yes	Yes	Yes
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Yes	No	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	No	Yes*
Land converted to Settlements	CO_2	No	No	No	No
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	No	Yes	Yes

*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	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	

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			
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 2009

Table 7.A3							
Tier 1 and Tier 2 Analysis - Source Analysis Summary (Croatian Inventory, 2009)							
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	T1i	
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	L1e,L2e	T1e,T2e	L1i,L2i	T1i,T2i	
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	L1e,L2e	T1e	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		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		T1e			
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		L1i		
Emissions from Iron and Steel Production	CO_2	No					
Emissions from Ferroalloys Production	CO_2	Yes		T1e,T2e		T1i	
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,T2e	L1i,L2i	T1i,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		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	L1i	T1i,T2i	

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				
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	Yes				T1i,T2i	
Land converted to Settlements	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		T1e,T2e		T1i,T2i	
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	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Hard coal (1000 t)	253.7	96.2	569.9	915.0	835.9	895.8	925.0	640.3
NCV for hard coal (MJ/kg)	25.1	25.7	26.2	24.2	24.6	24.5	24.5	24.4
Fuel oil (1000 t)	570.4	325.4	283.4	284.0	311.4	423.9	331.6	304.8
NCV for fuel oil (MJ/kg)	40.4	40.8	40.5	40.3	40.4	40.2	40.2	40.2
Extra light oil (1000 t)	0.7	2.6	7.5	3.0	1.0	1.4	1.2	1.6
NCV for ex. light oil (MJ/kg)	42.3	42.0	42.0	42.3	42.3	42.3	42.3	42.1
Natural gas (1000000 m^3)	194.6	114.5	155.7	48.2	128.4	296.8	166.4	157.9
NCV for nat. gas (MJ/m^3)	33.4	33.4	33.4	33.4	33.4	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	19641	31930	35336	37478	48938	41585	33216
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	1464	2577	3030	3113	3896	3435	2686
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	19.4	22.9	26.1	27.5	42.2	31.4	28.4
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	8.4	28.0	39.1	37.2	41.2	40.8	29.2

Table A2-2: The GHG emissions from Public Cogeneration Plants

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Fuel oil (1000 t)	117.7	336.2	108.6	162.0	156.1	93.8	124.9	173.5
NCV for fuel oil (MJ/kg)	40.5	40.5	40.7	40.7	38.4	40.2	40.2	40.2
Extra light oil (1000 t)	0.0	1.0	0.9	0.0	0.0	0.0	0.2	0.1
NCV for extra light oil (MJ/kg)	0.0	21.3	21.4	21.4	0.0	0.0	21.4	21.4
Natural gas (1000000 m^3)	312.7	103.3	357.7	479.0	458.8	550.6	541.9	446.0
NCV for natural gas (MJ/m^3)	33.3	33.4	33.4	33.4	33.6	33.3	33.3	33.3

Table A2-2: The GHG emissions from Public Cogeneration Plants

	1990	1995	2000	2005	2006	2007	2008	2009
Total fuel consumption (TJ)	15196	17170	16399	22567	21411	22124	23091	21854
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	1240	1005	1397	1322	1313	1393	1365
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	24.9	34.4	88.6	85.2	91.8	90.3	85.2
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	4.5	2.5	3.6	3.4	3.0	3.3	3.6

Table A2-3: The GHG emissions from Public Heating Plants

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Fuel oil (1000 t)	0.0	38.8	37.0	39.0	33.4	36.9	20.8	21.6
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	27.4	-3.0	8.2	5.4	4.4	5.5	4.2
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	36.0	58.8	59.4	51.8	79.0	58.8	86.2
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	1.5	0.0					
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9			
Gas works gas (1000000 m^3)	0.0	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
Landfill Gas (1000000 m^3)						3.9	2.2	3.3
NCV for landfill gas (MJ/m^3)						17.0	17.0	17.0
Total fuel cunsumption (TJ)	0.0	4026.8	3359.8	3969.7	3384.2	4467.0	3109.7	4034.9
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	62.4	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
CO_2 Emission (Gg)	0.0	278.2	216.2	260.0	220.3	282.9	195.0	246.4
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	1995	2000	2005	2006	2007	2008	2009
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
CH_4 Emission (Mg)	0.0	10.1	6.1	7.8	6.5	7.8	5.3	6.1
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
N_2O Emission (Mg)	0.0	1.8	1.0	1.4	1.1	1.3	0.8	0.9

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, 1995, 2000, 2005 and last three years, on aggregated level. The GHG emissions on plant level, for the year 2009, are given in the Table A2-5.

Table A2-4: The GHG emissions from TPPs and PCPs (Tier 2), year 2009

	TE Plomin	TE Rijeka	TE Sisak	TE-TO Zagreb	EL-TO Zagreb	TE-TO Osijek	KTE Jertovec
Fuel consumption							
Hard coal (1000 t)	640.3						
NCV for hard coal (MJ/kg)	24.4						
Fuel oil (1000 t)		248.5	56.26	93.814	37.908	41.772	
NCV for fuel oil (MJ/kg)		40.2	40.1	40.2	40.2	40.4	
Extra light oil (1000 t)	1.405	0.2363		0.137			
NCV for ELLU (MJ/kg)	42.0	42.1		42.9			
Natural gas (1000000 m^3)			128.0	298.9	131.9	15.207	29.907
NCV for nat. gas (MJ/m^3)			33.3	33.3	33.3	33.3	33.3
Total fuel consumption (TJ)	15691.4	10001.8	6525.4	13740.8	5920.4	2193.0	997.1

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)	1453.6	766.0	411.1	845.4	362.1	157.4	55.7
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	5.7	5.0	0.5	6.0
CH_4 emission (Mg)	11.0	9.0	2.5	59.8	23.5	1.8	6.0
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)	25.0	3.0	1.1	2.1	0.9	0.6	0.1

Table A2-5: The GHG emissions from Petroleum Refining

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Fuel oil (1000 t)	227.2	199.5	193.4	254.0	249.9	288.0	194.2	252.7
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)	0.0	0.0	0.0	9.5	9.7	10.9	0.0	0.0
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
Petroleum coke (1000 t)	0.0	0.0	0.0	70.7	61.9	67.8	57.9	71.9
NCV for petroleum coke (MJ/kg)	33.6	29.3	31.0	31.0	31.0	31.0	31.0	31.0
Refinery gas (1000 t)	58.4	27.7	40.7	241.1	210.4	217.4	154.5	200.2
NCV for refinery gas (MJ/kg)	48.6	48.6	48.6	48.6	48.6	48.6	48.6	48.6
Natural gas (1000000 m^3)	7.3	7.1	0.2	1.2	0.4	18.9	86.7	30.4
NCV for natural gas (MJ/m^3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Total fuel consumption (TJ)	12216	9605	9756	24596	22650	25389	20052	23142
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 – LPG (t/TJ)	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
EF CO_2 – petroleum coke (t/TJ)	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8
EF CO_2 – refinery gas (t/TJ)	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1
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)	900.6	716.5	726.3	1804.4	1665.1	1861.7	1437.3	1.700.5
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 – LPG (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
EF CH_4 – petroleum coke (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
EF CH_4 – refinery gas (kg/TJ)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Table A2-5: The GHG emissions from Petroleum Refining (cont.)

	1990	1995	2000	2005	2006	2007	2008	2009
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	28.3	29.3	73.7	67.9	74.9	54.3	67.4
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	5.6	5.9	14.7	13.6	14.9	10.6	13.4

Table A2-6: The GHG emissions from Manufacturing of Solid Fuels and Other Energy Industries

	1990	1995	2000	2005	2006	2007	2008	2009
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	1.2	7.5	5.5	2.5			
NCV for ex.light oil (MJ/kg)	42.7	42.7	42.7	42.7	42.7			
Natural gas (1000000 m^3)	392.0	205.8	140.5	175.5	158.4	190.4	129.3	199.3
NCV for nat. gas (MJ/m^3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Total fuel consumpt. (TJ)	15869.3	7048.5	5144.2	6201.9	5492.4	6473.6	4396.2	6776.2
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	394.3	293.1	350.3	308.4	361.4	245.4	378.2
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	7.2	5.8	6.7	5.7	6.5	4.4	6.8
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	0.7	0.6	0.6	0.4	0.7

Table A2-7: The GHG emissions from Manufacturing Industries and Construction – liquid fuels

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Gasoline (1000 t)	0.2	8.5	7.6	6.9	7.3	7.6	7.9	7.0
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	0.1						
NCV for petroleum (MJ/kg)	44.0	44.0						
Gas/diesel oil (1000 t)	246.5	101.5	130.8	161.6	164.8	177.4	194.3	145.4
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	269.7	302.2	198.6	206.8	141.8	124.3	90.7
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	17.6	21.0	22.8	29.4	28.2	30.4	20.1
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
NCV for petroleum coke (MJ/kg)	29.3			31.0	31.0	31.0	31.0	31.0
Total fuel consumpt. (TJ)	28498	16383	19056	21602	23719	21151	21012	15462
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	1225.9	1424.6	1738.5	1926.4	1718.2	1697.2	1249.3
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	0.033	0.038	0.043	0.047	0.042	0.042	0.031
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	0.010	0.011	0.013	0.014	0.013	0.013	0.009

Table A2-8: The GHG emissions from Manufacturing Industries and Construction – solid fuels

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Anthracite (1000 t)	107.2	5.0		0.3	0.1	0.3	0.0	0.3
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	41.9	53.2	169.3	151.0	185.1	195.7	158.1
NCV for hard coal (MJ/kg)	25.1	28.1	26.2	25.1	24.9	24.9	24.9	24.6
Brown Coal (1000 t)	261.2	95.8	28.2	56.9	61.3	53.2	47.1	36.9
NCV for brown coal (MJ/kg)	16.7	17.8	17.8	18.5	17.7	17.7	18.0	18.0
Lignite (1000 t)	73.2	56.3	14.4	0.2	0.2	0.4	0.0	0.0
NCV for lignite (MJ/kg)	10.9	12.0	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	31.4	37.7	22.6	20.6	27.9	24.9	25.4
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	4626	3171	5976	5448	6374	6451	5307
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	448.4	310.5	564.4	514.7	603.3	608.9	502.9
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	0.046	0.032	0.060	0.054	0.064	0.065	0.053
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	0.002	0.008	0.008	0.009	0.009	0.007

Table A2-9: The GHG emissions from Manufacturing Industries and Construction –gaseous fuels

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Natural gas (1000000 m3)	1056.9	978.1	984.3	931.4	912.4	985.1	990.7	852.4
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	9.8	7.9	3.6	3.0	2.5	1.5	0.3
NCV for gas work gas (MJ/kg)	15.8	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	33409	33590	31744	31112	33562	33714	28988
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	1866.5	1881.6	1778.2	1740.3	1883.1	1891,5	1626.4
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	0.167	0.168	0.159	0.156	0.168	0.169	0.145
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	0.003

Table A2-10: The number of road motor vehicles (´000) for year 1990, 1995, 2000, and 2005 – 2009 in Croatia

	1990	1995	2000	2005	2006	2007	2008	2009
Mopeds, (´000)	18.0	20.7	44.2	73.9	75.7	76.6	82.5	80.3
Motorcycles, (´000)	12.5	16.6	28.3	58.8	72.2	87.0	107.7	111.3
Passenger Cars, (´000)	1,120.0	817.2	1,145.0	1,394.6	1,443.2	1,474.7	1,532.3	1,516.1
Buses, (´000)	6.5	4.5	4.7	4.9	4.9	5.0	5.1	5.0
Light and Heavy Duty Vehicles, (´000)	80.0	87.7	127.3	165.8	171.2	174.5	178.9	171.6
Total, (´000)	1,237.0	946.7	1,349.6	1,698.0	1,767.2	1,817.9	1,906.4	1,884.3

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, 1995, 2000. and 2005 - 2009

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption and NCV								
Gasoline (1000 t)	759.3	557.9	764.1	693.6	694.4	708.3	678.4	675.6
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	406.2	557.9	955.3	1,048.2	1,152.6	1,116.0	1,094.1
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	13.7	9.8	22.1	36.9	51.3	68.7	69.5
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
Total fuel consumption (TJ)	49,489.9	42,864.9	58,361.4	72,767.7	77,460.2	83216.7	81,137.4	80,112.1
Emissions								
CO_2 emission (Gg)	3,559.0	3,091.8	4,195.9	5,246.8	5,591.1	6,011.5	5,842.0	5,764.9
CH_4 emission (Gg)	1.6	1.2	1.4	0.9	0.9	0.8	0.8	0.7
N_2O emission (Gg)	0.1	0.1	0.2	0.3	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, 1995, 2000 and 2005 - 2009

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption and NCV								
Gasoline (1000 t)	0.0	0.3	0.1	1.1	1.1	1.1	1.0	1.0
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	25.0	17.6	20.3	22.4	23.3	27.4	23.9
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	1,112	776	943	1,036	1,075	1,248	1,095
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	78.7	55.0	66.6	73.2	76.0	88.2	77.4
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	0.6	0.4	0.5	0.5	0.5	0.6	0.5
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	2.2	1.6	1.9	2.1	2.2	2.5	2.2

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, 1995, 2000 and 2005 – 2009

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption and NCV								
Gasoline (1000 t)	0.1	0.6	0.3	NO	NO	NO	NO	NO
NCV for gasoline (MJ/kg)	44.6	44.6	44.6	-	-	-	-	-
Diesel (1000 t)	38.7	23.2	25.7	31.8	33.1	34.4	40.3	46.0
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)	2.1	6.2	1.4	NO	NO	NO	1.5	0.4
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2	-	-	-	40.2	40.2
Light heating oil (1000 t)	1.6	1.5	NO	NO	NO	NO	NO	NO
NCV for light heating oil (MJ/kg)	42.7	42.7	-	-	-	-	-	-
Total fuel cunsumption (TJ)	1,810.1	1,330.9	1,167.3	1,358.2	1,413.7	1,469.2	1,781.5	1,980.7
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	98.3	85.7	99.6	103.7	107.7	130.8	145.3
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
CH_4 Emission (Mg)	9.1	6.7	5.8	6.8	7.1	7.3	8.9	9.9
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	0.8	0.7	0.8	0.8	0.9	1.1	1.2

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, 1995, 2000 and 2005 - 2009

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption and NCV								
Gasoline (1000 t)	0.1	NO	0.1	NO	NO	NO	NO	NO
NCV for gasoline (MJ/kg)	44.6	-	44.6	-	-	-	-	-
Diesel (1000 t)	36.1	30.7	27.2	30.5	32.3	32.6	32.3	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	1.5	NO	NO	NO	NO	NO	NO
NCV for fuel oil (MJ/kg)	40.2	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, 1995, 2000 and 2005 – 2009 (cont.)

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption and NCV								
Light heating oil (1000 t)	1.1	1.7	NO	NO	NO	NO	NO	NO
NCV for light heating oil (MJ/kg)	42.7	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	0.1	NO	NO	NO	NO	NO	NO
NCV for petroleum (MJ/m3)	-	44.0	-	-	-	-	-	-
Total fuel cunsumption (TJ)	1,820.0	1,448.5	1,166.2	1,302.7	1,379.5	1,392.4	1,379.5	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	106.4	85.5	95.5	101.2	102.1	101.2	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	7.2	5.8	6.5	6.9	7.0	6.9	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	0.9	0.7	0.8	0.8	0.8	0.8	0.7

Table A2-15: The GHG emissions from Commercial/Institutional

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Petroleum (1000 t)	3.8	0.2						
NCV for jet kerosene (MJ/kg)	43.9							
Light heating oil (1000 t)	92.0	106.3	120.5	131.6	112.5	91.6	87.2	78.3
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	2.5	3.9	6.6	4.5	3.6	3.2	8.4
NCV for fuel oil (MJ/kg)	40.2		40.2	40.2	40.2	40.2	40.2	40.2
LPG (1000 t)	4.3	13.8	13.9	20.1	21.1	9.4	10.4	11.9
NCV for LPG (MJ/kg)	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
Anthracite (1000 t)								
NCV for anthracite (MJ/kg)								
Brown coal (1000 t)	24.5	12.7	9.5	0.2	4.5	2.4	1.7	3.8
NCV for brown coal (MJ/kg)	16.74	17.30	17.80	18.50	17.73	19.03	18.0	18.0
Lignite (1000 t)	40.0	1.6	1.2	0.6	0.2	0.1	0.1	0.4
NCV for lignite (MJ/kg)	10.9	10.1	12.0	12.1	12.3	11.7	11.8	11.7
Briquettes (1000 t)	2.9							
NCV for briquettes (MJ/kg)	16.7							
Gas work gas (1000000 m3)	4.9	1.4	1.5	3.4	3.3	2.9	2.4	3.1
NCV for gas work gas (MJ/m3)	15.8	15.9	19.5	21.5	30.4	27.8	19.6	18.7
Natural gas (1000000 m3)	82.0	132.6	98.2	151.2	147.0	144.2	160.4	162.5
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)		0.3						
NCV for gasoline (MJ/kg)		44.6						
Petroleum coke (1000 t)	1.5							
NCV for petroleum coke (MJ/kg)	29.31							
Solid Biomass-Wood (TJ)						90.0	80.3	125.60
Bio gass (TJ)							170.9	116.7
Total fuel cunsumption (TJ)	10819	9969	9507	12054	11157	9617	10125	10139
Emissions								
EF CO_2 - petroleum (t/TJ)	73.3	73.3	73.3	73.3	73.3	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	1995	2000	2005	2006	2007	2008	2009
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	649.3	635.2	782.8	719.5	617.0	641.0	643.9
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	77.0	78.2	94.5	86.1	97.4	95.5	108.8
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	3.9	4.2	4.6	4.2	3.6	3.5	3.7

Table A2-16: The GHG emissions from Residential sector

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Petroleum (1000 t)		7.9	1.6	1	0.9	1.2	1.1	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	198.6	231.5	252.8	218.5	177.7	151.0	147.3
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	6.5	8.1	15.4	10.6	8.6	4.5	10.8
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	57.3	51.9	60.9	63.5	61.8	74.0	77.8
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	11.1	12.0	14	7.5	4	3.8	2.2
NCV for brown coal (MJ/kg)	16.7	17.3	17.8	18.5	17.7	19.0	18.0	18.0
Lignite (1000 t)	207.3	10.8	15.0	11.7	10.6	5	8.1	5.7
NCV for lignite (MJ/kg)	10.9	10.1	12.0	12.1	12.3	11.7	11.8	11.7
Briquettes (1000 t)	6.1							
NCV for briquettes (MJ/kg)	16.7							
Gas work gas (1000000 m^3)	24.4	11.8	9.9	10.24	9.0	7.7	6.4	6.8
NCV for gas work gas (MJ/m^3)	15.8	15.9	19.5	21.5	30.4	27.8	19.6	18.7
Natural gas (1000000 m^3)	230.0	381.3	496.6	687.8	651.7	622.5	682.7	699.5
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	11070	13410	12510	12600	10620	11055	11720
Total fuel consumption (TJ)	47477	36301	43598	50831	48069	43019	44705	46149
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	2785.3	3337.3	3718.8	3534.7	3113.2	3212.2	3328.3
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	1.0	5.0	5.0

Table A2-16: The GHG emissions from Residential sector (cont.)

	1990	1995	2000	2005	2006	2007	2008	2009
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	3594.9	4353.6	4134.4	4099.0	3442.2	3584.0	3771.6
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	53.1	63.5	61.6	60.7	51.3	52.9	55.7

Table A2-17: The GHG emissions from Agriculture/Forestry/Fishing

	1990	1995	2000	2005	2006	2007	2008	2009
Fuel consumption								
Gasoline (1000 t)	4.0	7.8	12.1	8.1	11.2	8.4	8.9	8.5
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	0.1						
NCV for other kerosene (MJ/kg)	44.4	44.4						
Extra light oil (1000 t)	232.6	159.1	237.6	197.4	203.5	204.5	216.7	207.3
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	7147	10687	8792	9191	9109	9869	9233
Fuel oil (1000 t)	12.3	6.2	13.4	4.7	4.5	4.5	4.6	4.6
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	3.2	2.6	2.7	2.8	2.7	2.8	2.8
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	15.5	14.5	23.2	18.9	17.9	20.8	19.6
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	926.2	1153.5	1104.3	954.7	916.1	1023.4	982.6
Total fuel consumption (TJ)	11668	8074	11841	9896	10146	10025	10892	10215
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	522.4	781.1	643.0	671.6	666.1	721.8	675.2
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	1995	2000	2005	2006	2007	2008	2009
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
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	57.9	76.4	66.4	57.9	55.7	61.8	59.6
Total CO_2 emission (Gg)	839.2	580.3	857.5	709.4	729.5	721.9	783.6	734.8
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	35.7	53.4	44.0	46.0	45.5	49.3	46.2
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	1.0	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	6.6	9.1	7.1	6.3	6.1	6.7	6.5
Total CH_4 emission (Mg)	61.8	42.4	62.5	51.1	52.3	51.7	56.0	52.7
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	4.3	6.4	5.3	5.5	5.5	5.9	5.5
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 - 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	0.3	0.4	0.3	0.3	0.2	0.3	0.3
Total N_2O emission (Mg)	6.6	4.6	6.9	5.5	5.8	5.7	6.2	5.8

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, 2009

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, 2009 (cont.)

Source and Sink Categories			Activity data Fuel Quantity PJ	Emission Estimates CH_4 /(Gg)	Emission Factor $kgCH_4$/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 2009					
1B 2a	Oil				
		Production	33.07	0.09	2650
		Transport	172.45	0.13	745
		Refining	204.66	0.03	135
		Storage	204.66	0.15	745
1B 2b	Natural Gas				
		Prod./Process./Trans./Distrib.	93.50	42.82 [1)]	458000
		Other Leakage(non-residential)	78.37	21.90 [2)]	279500
		Other Leakage (residential)	23.78	3.32 [3)]	139500
1B 2c	Venting and Flaring				
		Gas	93.50	1.68	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***

Table A3-2: Net calorific values for different fossil fuels from 1990 to 2009

			Net calorific values 1990- 2009 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 2009

ENERGY BALANCE 2009 *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					776,2	2704,8
Import	0,3	712,7	42,9	6,1	4048,2	1044,2
Export						804,9
Import-processing						
Export-processing						
Stock change		85,7			-20,2	15,3
Bunkers						
Energy supplied	**0,3**	**798,4**	**42,9**	**6,1**	**4804,2**	**2959,4**
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		640,3				143,7
public cogeneration plants						472,2
public heating plants						74,2
industrial cogeneration plants			36,8			298,5
– in rafineries						12,2
– in gas production						59,7
Industrial heating plants						69,6
Petroleum refineries					4695,0	
NGL-plant					109,2	9,9
Coke plant						
Gas works						3,7
Total transformation sector		**640,3**	**36,8**		**4804,2**	**1071,8**
Energy sector own use						
Oil and gas extraction						128,9
Coal production						
Electric energy supply industry						
hydro power plants						
thermal power plants						
public cogeneration plants						
industrial cogeneration plants						
Industrial heating plants						
Petroleum refineries						18,2
NGL-plant						10,7
Gas works						
Total energy sector own use						**157,8**
Losses						**51,6**
Final energy demand	**0,3**	**158,1**	**6,1**	**6,1**		**1678,2**
Non energy use						**419,6**
Energy sector						
Petrochemical industry						419,6
Other industry						
Construction						
Transport						
Agriculture						
Energy consumption	**0,3**	**158,1**	**6,1**	**6,1**		**1258,6**
Industry	**0,3**	**158,1**	**0,1**			**375,6**
Iron and steel	0,3	0,5				29,1
Non-ferrous metals						1,2
Non-metallic minerals						50,5
Chemical						77,9
Construction materials		157,6	0,1			98,1
Pulp and paper						6,5
Food production						70,2
Not elsewhere specified						42,1
Transport						**1,4**
Rail						
Road						1,4
Air						
– international						
– domestic						
Sea and River						
Public transport						
Not elsewhere specified						
Other sectors			**6,0**	**6,1**		**881,6**
Households			2,2	5,7		699,5
Services			3,8	0,4		162,5
Agriculture						19,6
Construction						

Table A3-3: National energy balance for 2009 (continue)

ENERGY BALANCE 2009 *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	65769,2	1579,2	523,1	201,3	132,2	14307,3	6,3	3754,4
Import		3,5					6,2	142,5
Export		266,0					3,5	1330,9
Import-processing								
Export-processing								
Stock change								
Bunkers								
Energy supplied	**65769,2**	**1316,7**	**523,1**	**201,3**	**132,2**	**14307,3**	**9,0**	**2566,0**
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								
NGL-plant								
Coke plant								
Gas works								
Total production								
Transformation sector								
hydro power plants	65769,2							
– small HPP	960,3							
Wind power plants			523,1					
Solar power plants				1,0				
Geothermal power plants								
thermal power plants						3272,0		
public cogeneration plants								
public heating plants								
industrial cogeneration plants						11035,3		111,6
– in rafineries								
– in gas production								
Industrial heating plants								1628,3
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total transformation sector	**65769,2**		**523,1**	**1,0**		**14307,3**		**1739,9**
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		**1316,7**		**200,3**	**132,2**		**9,0**	**826,1**
Non energy use								
Energy sector								
Petrochemical industry								
Other industry								
Construction								
Transport								
Agriculture								
Energy consumption		**1316,7**		**200,3**	**132,2**		**9,0**	**826,1**
Industry		**44,3**						**432,0**
Iron and steel		2,4						
Non-ferrous metals		0,7						
Non-metallic minerals		0,1						
Chemical		0,2						
Construction materials		0,2						432,0
Pulp and paper								
Food production		0,4						
Not elsewhere specified		40,3						
Transport							**9,0**	
Rail								
Road							9,0	
Air								
– international								
– domestic								
Sea and River								
Public transport								
Not elsewhere specified								
Other sectors		**1272,4**		**200,3**	**132,2**			**394,1**
Households		1260,0		200,3				380,1
Services		12,4			132,2			14,0
Agriculture								
Construction								

Table A3-3: National energy balance for 2009 (continue)

ENERGY BALANCE 2009 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		354,6	1028,4	178,3	0,1	93,6	1220,2	268,4	65,2	1000,7
Import	23,6	16,5	220,1	1,0	0,8		520,3	64,6	60,6	14,3
Export	0,2	185,6	582,2	136,7		0,8	245,3	56,7	64,3	271,7
Import-processing										
Export-processing										
Stock change	2,0	-1,8	25,0	-41,6		4,1	18,2	1,9	-0,9	69,2
Bunkers							1,4			5,6
Energy supplied	**25,4**	**183,7**	**691,3**	**1,0**	**0,9**	**96,9**	**1512,0**	**278,2**	**60,6**	**806,9**
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		295,4	1028,4	178,3	0,1	93,6	1220,2	268,4	65,2	1000,7
NGL-plant		59,2								
Coke plant										
Gas works										
Total production		**354,6**	**1028,4**	**178,3**	**0,1**	**93,6**	**1220,2**	**268,4**	**65,2**	**1000,7**
Transformation sector										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants								1,6		304,8
public cogeneration plants								0,1	45,2	128,3
public heating plants								4,3		21,6
industrial cogeneration plants										222,9
– in rafineries										205,1
– in gas production										
Industrial heating plants		1,5						0,8		27,8
Petroleum refineries										
NGL-plant										
Coke plant										
Gas works		1,6								
Total transformation sector		**3,1**						**6,8**	**45,2**	**705,4**
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										47,6
NGL-plant										
Gas works										
Total energy sector own use										**47,6**
Losses										
Final energy demand	**25,4**	**180,6**	**691,3**	**1,0**	**0,9**	**96,9**	**1512,0**	**271,4**	**15,4**	**53,9**
Non energy use										
Energy sector										
Petrochemical industry										
Other industry										
Construction										
Transport										
Agriculture										
Energy consumption	**25,4**	**180,6**	**691,3**	**1,0**	**0,9**	**96,9**	**1512,0**	**271,4**	**15,4**	**53,9**
Industry	**25,4**	**16,2**	**0,1**				**19,6**	**20,5**	**15,4**	**29,7**
Iron and steel	1,0	2,1						1,2	0,2	0,1
Non-ferrous metals		2,7						0,2	2,3	
Non-metallic minerals		0,5						0,1	2,0	
Chemical								0,3		7,3
Construction materials	18,2	5,4	0,1				19,6	4,1	5,3	7,3
Pulp and paper		0,1						0,1		1,8
Food production	5,9	1,1						8,2	2,4	12,7
Not elsewhere specified	0,3	4,3						6,3	3,2	0,5
Transport		**69,5**	**675,7**	**1,0**		**96,9**	**1186,3**			**0,4**
Rail							28,5			
Road		69,5	675,7				1085,0			
Air				1,0		96,9				
– international						42,5				
– domestic				1,0		54,4				
Sea and River							46,0			0,4
Public transport							26,8			
Not elsewhere specified										
Other sectors		**94,9**	**15,5**		**0,9**		**306,1**	**250,9**		**23,8**
Households		77,8			0,9			147,3		10,8
Services		11,9						78,3		8,4
Agriculture		2,8	8,5				192,4	14,9		4,6
Construction		2,4	7,0				113,7	10,4		

Table A3-3: National energy balance for 2009 (continue)

ENERGY BALANCE 2009 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	164,3		107,1	18,2		101,8	49,3	120,6	200,2		
Import		3,4	118,1	30,9	9,0	133,2				6,4	51,6
Export	141,2	0,1	21,3	12,0	0,1	22,1		126,4			
Import-processing											
Export-processing											
Stock change	2,9			0,2	0,2	-0,6		12,9		76,5	-1,4
Bunkers											
Energy supplied	**26,0**	**3,3**	**203,9**	**37,3**	**9,1**	**212,3**	**49,3**	**7,1**	**200,2**	**82,9**	**50,2**
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	138,3		107,1	18,2		101,8		115,4	200,2		
NGL-plant	26,0						49,3	5,2			
Coke plant											
Gas works											
Total production	**164,3**		**107,1**	**18,2**		**101,8**	**49,3**	**120,6**	**200,2**		
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						2,8			5,6		
– in rafineries						2,8			5,6		
– in gas production											
Industrial heating plants											
Petroleum refineries	26,0							4,7		82,9	50,2
NGL-plant											
Coke plant											
Gas works											
Total transformation sector	**26,0**					**2,8**		**4,7**	**5,6**	**82,9**	**50,2**
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						69,1			194,6		
NGL-plant											
Gas works											
Total energy sector own use						**69,1**			**194,6**		
Losses											
Final energy demand	**0,0**	**3,3**	**203,9**	**37,3**	**9,1**	**140,4**	**49,3**	**2,4**			**0,0**
Non energy use		**3,3**	**203,9**	**37,3**	**9,1**		**49,3**	**2,4**			
Energy sector				2,6							
Petrochemical industry		3,3			8,3		49,3				
Other industry			40,4	3,8	0,8			2,4			
Construction			163,5	1,9							
Transport				27,3							
Agriculture				1,7							
Energy consumption	**0,0**					**140,4**					**0,0**
Industry						**140,4**					
Iron and steel											
Non-ferrous metals											
Non-metallic minerals											
Chemical											
Construction materials						140,4					
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 2009 (continue)

ENERGY BALANCE 2009 *natural units*	Gas works gas	Electricity	Steam and hot water	Industrial waste
	10^3 m^3	GWh	TJ	
Production	10596,0	12777,1	30722,8	373,0
Import		7580,7		
Export		1898,6		
Import-processing				
Export-processing				
Stock change				
Bunkers				
Energy supplied	**10596,0**	**18459,2**	**30722,8**	**373,0**
Production				
hydro power plants		6814,4		
– small HPP		99,5		
Wind power plants		54,2		
Solar power plants		0,1		
Geothermal power plants				
thermal power plants		3422,2		
public cogeneration plants		2085,3	8694,8	
public heating plants			2903,0	
industrial cogeneration plants		400,9	14850,0	
– in rafineries			7272,5	
– in gas production			1180,0	
Industrial heating plants			4275,0	
Petroleum refineries				
NGL-plant				
Coke plant				
Gas works	10596,0			
Total production	**10596,0**	**12777,1**	**30722,8**	
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		103,1	783,0	
Coal production			48,5	
Electric energy supply industry		32,0		
hydro power plants		156,5		
thermal power plants		259,2		
public cogeneration plants		110,5	788,5	
industrial cogeneration plants				
Industrial heating plants				
Petroleum refineries		277,3	7272,5	
NGL-plant		12,4	397,0	
Gas works				
Total energy sector own use		**951,0**	**9289,5**	
Losses	**360,7**	**2018,8**	**1259,6**	
Final energy demand	**10235,3**	**15489,4**	**20173,7**	**373,0**
Non energy use				
Energy sector				
Petrochemical industry				
Other industry				
Construction				
Transport				
Agriculture				
Energy consumption	**10235,3**	**15489,4**	**20173,7**	**373,0**
Industry	**301,0**	**3283,8**	**12429,6**	**373,0**
Iron and steel	12,0	281,9	100,6	
Non-ferrous metals		76,4		
Non-metallic minerals		113,4	131,8	
Chemical		456,7	4462,8	
Construction materials	146,0	565,7	1,2	373,0
Pulp and paper		244,5	1987,5	
Food production	26,0	615,6	3512,3	
Not elsewhere specified	117,0	929,6	2233,4	
Transport		**311,9**		
Rail		171,9		
Road				
Air		21,5		
– international				
– domestic		21,5		
Sea and River		23,9		
Public transport		68,7		
Not elsewhere specified		25,9		
Other sectors	**9934,3**	**11893,7**	**7744,1**	
Households	6795,2	6461,9	6141,6	
Services	3139,1	5084,6	1602,5	
Agriculture		70,3		
Construction		276,9		

Table A3-3: National energy balance for 2009 (continue)

PJ	Anthracite	Hard coal	Brown coal	Lignite	Crude oil	Natural gas
Production	-	-	-	-	33,07	93,498
Import	0,01	17,53	0,77	0,07	172,45	35,503
Export	-	-	-	-	-	27,367
Import-processing	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-
Stock change	-	2,11	-	-	- 0,86	0,520
Bunkers	-	-	-	-	-	-
Energy supplied	**0,01**	**19,64**	**0,77**	**0,07**	**204,66**	**102,15**
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	**0,01**	**19,64**	**0,77**	**0,07**	**204,66**	**102,15**
Transformation sector	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-
thermal power plants	-	15,75	-	-	-	4,89
public cogeneration plants	-	-	-	-	-	16,05
public heating plants	-	-	-	-	-	2,52
industrial cogeneration plants	-	-	0,66	-	-	10,15
– in rafineries	-	-	-	-	-	0,41
– in gas production	-	-	-	-	-	2,03
Industrial heating plants	-	-	-	-	-	2,37
Petroleum refineries	-	-	-	-	200,01	-
NGL-plant	-	-	-	-	4,65	1,87
Coke plant	-	-	-	-	-	-
Gas works	-	-	-	-	-	0,13
Total transformation sector	**-**	**15,75**	**0,66**	**-**	**204,66**	**37,98**
Energy sector own use	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	4,38
Coal production	-	-	-	-	-	-
Electric energy supply industry	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	0,62
NGL-plant	-	-	-	-	-	0,36
Gas works	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**5,37**
Losses	-	-	-	-	-	1,75
Final energy demand	**0,01**	**3,89**	**0,11**	**0,07**	**0,00**	**57,06**
Non energy use	**-**	**-**	**-**	**-**	**-**	**14,27**
Energy sector	-	-	-	-	-	-
Petrochemical industry	-	-	-	-	-	14,27
Other industry	-	-	-	-	-	-
Construction	-	-	-	-	-	-
Transport	-	-	-	-	-	-
Agriculture	-	-	-	-	-	-
Energy consumption	**0,01**	**3,89**	**0,11**	**0,07**	**0,00**	**42,79**
Industry	**0,01**	**3,89**	**0,00**	**-**	**-**	**12,77**
Iron and steel	0,01	0,01	-	-	-	0,99
Non-ferrous metals	-	-	-	-	-	0,04
Non-metallic minerals	-	-	-	-	-	1,72
Chemical	-	-	-	-	-	2,65
Construction materials	-	3,88	0,00	-	-	3,34
Pulp and paper	-	-	-	-	-	0,22
Food production	-	-	-	-	-	2,39
Not elsewhere specified	-	-	-	-	-	1,43
Transport	**-**	**-**	**-**	**-**	**-**	**0,05**
Rail	-	-	-	-	-	-
Road	-	-	-	-	-	0,05
Air	-	-	-	-	-	-
– international	-	-	-	-	-	-
– domestic	-	-	-	-	-	-
Sea and River	-	-	-	-	-	-
Public transport	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-
Other sectors	**-**	**-**	**0,11**	**0,07**	**-**	**29,97**
Households	-	-	0,04	0,07	-	23,78
Services	-	-	0,07	0,00	-	5,53
Agriculture	-	-	-	-	-	0,67
Construction	-	-	-	-	-	-

Table A3-3: National energy balance for 2009 (continue)

PJ	Hydro energy	Fuel wood	Wind energy	Solar energy	Geothermal energy	Landfill gas	Biofuels	Other biomass
Production	65,77	14,213	0,523	0,201	0,132	0,2763	0,207	3,754
Import	-	0,03	-	-	-	-	0,20	0,14
Export	-	2,39	-	-	-	-	0,11	1,33
Import-processing	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-
Stock change	-	-	-	-	-	-	-	-
Bunkers	-	-	-	-	-	-	-	-
Energy supplied	**65,77**	**11,85**	**0,52**	**0,20**	**0,13**	**0,2763**	**0,30**	**2,57**
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	**65,77**	**11,85**	**0,52**	**0,20**	**0,13**	**0,2763**	**0,30**	**2,57**
Transformation sector	-	-	-	-	-	-	-	-
hydro power plants	65,77	-	-	-	-	-	-	-
– small HPP	0,96	-	-	-	-	-	-	-
Wind power plants	-	-	0,52	-	-	-	-	-
Solar power plants	-	-	-	0,00	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	0,0556	-	-
public cogeneration plants	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	0,2207	-	0,11
– in rafineries	-	-	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	1,63
Petroleum refineries	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-
Total transformation sector	**65,77**	**-**	**0,52**	**0,00**	**-**	**0,2763**	**-**	**1,74**
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	**-**	**11,85**	**-**	**0,20**	**0,13**	**-**	**0,30**	**0,83**
Non energy use	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Energy sector	-	-	-	-	-	-	-	-
Petrochemical industry	-	-	-	-	-	-	-	-
Other industry	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-
Transport	-	-	-	-	-	-	-	-
Agriculture	-	-	-	-	-	-	-	-
Energy consumption	**-**	**11,85**	**-**	**0,20**	**0,13**	**-**	**0,30**	**0,83**
Industry	**-**	**0,40**	**-**	**-**	**-**	**-**	**-**	**0,43**
Iron and steel	-	0,02	-	-	-	-	-	-
Non-ferrous metals	-	0,01	-	-	-	-	-	-
Non-metallic minerals	-	0,00	-	-	-	-	-	-
Chemical	-	0,00	-	-	-	-	-	-
Construction materials	-	0,00	-	-	-	-	-	0,43
Pulp and paper	-	-	-	-	-	-	-	-
Food production	-	0,00	-	-	-	-	-	-
Not elsewhere specified	-	0,36	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**0,30**	**-**
Rail	-	-	-	-	-	-	-	-
Road	-	-	-	-	-	-	0,2952	-
Air	-	-	-	-	-	-	-	-
– international	-	-	-	-	-	-	-	-
– domestic	-	-	-	-	-	-	-	-
Sea and River	-	-	-	-	-	-	-	-
Public transport	-	-	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-
Other sectors	**-**	**11,45**	**-**	**0,20**	**0,13**	**-**	**-**	**0,39**
Households	-	11,34	-	0,20	-	-	-	0,38
Services	-	0,11	-	-	0,13	-	-	0,01
Agriculture	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-

Table A3-3: National energy balance for 2009 (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
Production	-	-	-	-	-	-	-	-	-	-
Import	0,69	0,77	9,81	0,04	0,04	-	22,22	2,76	2,44	0,57
Export	0,01	8,70	25,96	6,10	-	0,04	10,48	2,42	2,58	10,92
Import-processing	-	-	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-	-	-
Stock change	0,06	-0,08	1,11	-1,85	-	0,18	0,78	0,08	-0,04	2,78
Bunkers	-	-	-	-	-	-	0,06	-	-	0,23
Energy supplied	**0,74**	**-8,01**	**-15,03**	**-7,91**	**0,04**	**0,15**	**12,46**	**0,42**	**-0,18**	**-7,79**
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	-	13,85	45,86	7,95	0,00	4,11	52,11	11,46	2,62	40,22
NGL-plant	-	2,78	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-
Total production	**-**	**16,63**	**45,86**	**7,95**	**0,00**	**4,11**	**52,11**	**11,46**	**2,62**	**40,22**
Gross production	**0,74**	**8,61**	**30,83**	**0,04**	**0,04**	**4,26**	**64,58**	**11,88**	**2,44**	**32,43**
Transformation sector	-	-	-	-	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	0,07	-	12,25
public cogeneration plants	-	-	-	-	-	-	-	0,00	1,82	5,16
public heating plants	-	-	-	-	-	-	-	0,18	-	0,87
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	8,96
– in rafineries	-	-	-	-	-	-	-	-	-	8,24
– in gas production	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	0,07	-	-	-	-	-	0,03	-	1,12
Petroleum refineries	-	-	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	0,08	-	-	-	-	-	-	-	-
Total transformation sector	**-**	**0,15**	**-**	**-**	**-**	**-**	**-**	**0,29**	**1,82**	**28,35**
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	-	-	-	-	-	-	-	-	-	1,91
NGL-plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,91**
Losses	-	-	-	-	-	-	-	-	-	-
Final energy demand	**0,74**	**8,47**	**30,83**	**0,04**	**0,04**	**4,26**	**64,58**	**11,59**	**0,62**	**2,17**
Non energy use	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Energy sector	-	-	-	-	-	-	-	-	-	-
Petrochemical industry	-	-	-	-	-	-	-	-	-	-
Other industry	-	-	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-	-	-
Transport	-	-	-	-	-	-	-	-	-	-
Agriculture	-	-	-	-	-	-	-	-	-	-
Energy consumption	**0,74**	**8,47**	**30,83**	**0,04**	**0,04**	**4,26**	**64,58**	**11,59**	**0,62**	**2,17**
Industry	**0,74**	**0,76**	**0,00**	**-**	**-**	**-**	**0,84**	**0,88**	**0,62**	**1,19**
Iron and steel	0,03	0,10	-	-	-	-	-	0,05	0,01	0,00
Non-ferrous metals	-	0,13	-	-	-	-	-	0,01	0,09	-
Non-metallic minerals	-	0,02	-	-	-	-	-	0,00	0,08	-
Chemical	-	-	-	-	-	-	-	0,01	-	0,29
Construction materials	0,53	0,25	0,00	-	-	-	0,84	0,18	0,21	0,29
Pulp and paper	-	0,00	-	-	-	-	-	0,00	-	0,07
Food production	0,17	0,05	-	-	-	-	-	0,35	0,10	0,51
Not elsewhere specified	0,01	0,20	-	-	-	-	-	0,27	0,13	0,02
Transport	**-**	**3,26**	**30,13**	**0,04**	**-**	**4,26**	**50,67**	**-**	**-**	**0,02**
Rail	-	-	-	-	-	-	1,22	-	-	-
Road	-	3,26	30,13	-	-	-	46,34	-	-	-
Air	-	-	-	0,04	-	4,26	-	-	-	-
– international	-	-	-	-	-	1,87	-	-	-	-
– domestic	-	-	-	0,04	-	2,39	-	-	-	-
Sea and River	-	-	-	-	-	-	1,96	-	-	0,02
Public transport	-	-	-	-	-	-	1,14	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-
Other sectors	**-**	**4,45**	**0,69**	**-**	**0,04**	**-**	**13,07**	**10,72**	**-**	**0,96**
Households	-	3,65	-	-	0,04	-	-	6,29	-	0,43
Services	-	0,56	-	-	-	-	-	3,34	-	0,34
Agriculture	-	0,13	0,38	-	-	-	8,22	0,64	-	0,18
Construction	-	0,11	0,31	-	-	-	4,86	0,44	-	-

Table A3-3: National energy balance for 2009 (continue)

PJ	Naphta	White spirit	Bitumen	Other oils	Lubricants	Petroleum coke	Etan	Other derivates	Refinery gas	Refinery semiproducts	Aditives
Production	-	-	-	-	-	-	-	-	-	-	-
Import	-	0,11	3,96	1,04	0,30	4,13	-	-	-	0,27	2,20
Export	6,30	0,00	0,71	0,40	0,00	0,69	-	5,08	-	-	-
Import-processing	-	-	-	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-	-	-	-
Stock change	0,13	-	-	0,01	0,01	- 0,02	-	0,52	-	3,26	- 0,06
Bunkers	-	-	-	-	-	-	-	-	-	-	-
Energy supplied	**- 6,17**	**0,11**	**3,24**	**0,64**	**0,30**	**3,43**	**-**	**- 4,56**	**-**	**3,53**	**2,14**
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	6,17	-	3,59	0,61	-	3,16	-	4,64	9,72	-	-
NGL-plant	1,16	-	-	-	-	-	2,33	0,21	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total production	**7,33**	**-**	**3,59**	**0,61**	**-**	**3,16**	**2,33**	**4,85**	**9,72**	**-**	**-**
Gross production	**1,16**	**0,11**	**6,83**	**1,25**	**0,30**	**6,58**	**2,33**	**0,29**	**9,72**	**3,53**	**2,14**
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	-	-	-	-	-	0,09	-	-	0,27	-	-
– in rafineries	-	-	-	-	-	0,09	-	-	0,27	-	-
– in gas production	-	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	1,16	-	-	-	-	-	-	0,19	-	3,53	2,14
NGL-plant	-	-	-	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total transformation sector	**1,16**	**-**	**-**	**-**	**-**	**0,09**	**-**	**0,19**	**0,27**	**3,53**	**2,14**
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	-	-	-	-	-	2,14	-	-	9,45	-	-
NGL-plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**2,14**	**-**	**-**	**9,45**	**-**	**-**
Losses	-	-	-	-	-	-	-	-	-	-	-
Final energy demand	**0,00**	**0,11**	**6,83**	**1,25**	**0,30**	**4,35**	**2,33**	**0,10**	**-**	**- 0,00**	**-**
Non energy use	**-**	**0,11**	**6,83**	**1,25**	**0,30**	**-**	**2,33**	**0,10**	**-**	**-**	**-**
Energy sector	-	-	-	0,09	-	-	-	-	-	-	-
Petrochemical industry	-	0,11	-	-	0,28	-	2,33	-	-	-	-
Other industry	-	-	1,35	0,13	0,03	-	-	0,10	-	-	-
Construction	-	-	5,48	0,06	-	-	-	-	-	-	-
Transport	-	-	-	0,91	-	-	-	-	-	-	-
Agriculture	-	-	-	0,06	-	-	-	-	-	-	-
Energy consumption	**0,00**	**-**	**-**	**-**	**-**	**4,35**	**-**	**-**	**-**	**- 0,00**	**-**
Industry	**-**	**-**	**-**	**-**	**-**	**4,35**	**-**	**-**	**-**	**-**	**-**
Iron and steel	-	-	-	-	-	-	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-	-	-	-	-	-
Non-metallic minerals	-	-	-	-	-	-	-	-	-	-	-
Chemical	-	-	-	-	-	-	-	-	-	-	-
Construction materials	-	-	-	-	-	4,35	-	-	-	-	-
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 2009 (continue)

PJ	Gas works gas	Electricity	Steam and hot water	Industrial waste
Production	-	-	-	0,373
Import	-	27,29	-	-
Export	-	6,83	-	-
Import-processing	-	-	-	-
Export-processing	-	-	-	-
Stock change	-	-	-	-
Bunkers	-	-	-	-
Energy supplied	**-**	**20,46**	**-**	**0,373**
Production	-	-	-	-
hydro power plants	-	24,53	-	-
– small HPP	-	0,36	-	-
Wind power plants	-	0,20	-	-
Solar power plants	-	0,00	-	-
Geothermal power plants	-	-	-	-
thermal power plants	-	12,32	-	-
public cogeneration plants	-	7,51	8,69	-
public heating plants	-	-	2,90	-
industrial cogeneration plants	-	1,44	14,85	-
– in rafineries	-	-	7,27	-
– in gas production	-	-	1,18	-
Industrial heating plants	-	-	4,28	-
Petroleum refineries	-	-	-	-
NGL-plant	-	-	-	-
Coke plant	-	-	-	-
Gas works	0,20	-	-	-
Total production	**0,20**	**46,00**	**30,72**	**-**
Gross production	**0,20**	**66,45**	**30,72**	**0,373**
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	-	0,37	0,78	-
Coal production	-	-	0,05	-
Electric energy supply industry	-	0,12	-	-
hydro power plants	-	0,56	-	-
thermal power plants	-	0,93	-	-
public cogeneration plants	-	0,40	0,79	-
industrial cogeneration plants	-	-	-	-
Industrial heating plants	-	-	-	-
Petroleum refineries	-	1,00	7,27	-
NGL-plant	-	0,04	0,40	-
Gas works	-	-	-	-
Total energy sector own use	**-**	**3,42**	**9,29**	**-**
Losses	0,01	7,27	1,26	-
Final energy demand	**0,19**	**55,76**	**20,17**	**0,373**
Non energy use	**-**	**-**	**-**	**-**
Energy sector	-	-	-	-
Petrochemical industry	-	-	-	-
Other industry	-	-	-	-
Construction	-	-	-	-
Transport	-	-	-	-
Agriculture	-	-	-	-
Energy consumption	**0,19**	**55,76**	**20,17**	**0,373**
Industry	**0,01**	**11,82**	**12,43**	**0,373**
Iron and steel	0,00	1,01	0,10	-
Non-ferrous metals	-	0,28	-	-
Non-metallic minerals	-	0,41	0,13	-
Chemical	-	1,64	4,46	-
Construction materials	0,00	2,04	0,00	0,373
Pulp and paper	-	0,88	1,99	-
Food production	0,00	2,22	3,51	-
Not elsewhere specified	0,00	3,35	2,23	-
Transport	**-**	**1,12**	**-**	**-**
Rail	-	0,62	-	-
Road	-	-	-	-
Air	-	0,08	-	-
– international	-	-	-	-
– domestic	-	0,08	-	-
Sea and River	-	0,09	-	-
Public transport	-	0,25	-	-
Not elsewhere specified	-	0,09	-	-
Other sectors	**0,19**	**42,82**	**7,74**	**-**
Households	0,13	23,26	6,14	-
Services	0,06	18,30	1,60	-
Agriculture	-	0,25	-	-
Construction	-	1,00	-	-

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.A.2.2 Grassland converted to Forest Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	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.E.2.2 Cropland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.1 Forest Land converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.3 Grassland converted to Other Land	Dificulties in collecting adequate activity data.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory (cont.)

GHG	Sector	Source/sink category	Explanation
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Dificulies in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	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.E.2.2 Cropland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.1 Forest Land converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.3 Grassland converted to Other Land	Dificulties in collecting adequate activity data.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory (cont.)

GHG	Sector	Source/sink category	Explanation
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	no data avaliable
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Dificulies in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	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.E.2.2 Cropland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Dificulies in collecting adequate activity data.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory (cont.)

GHG	Sector	Source/sink category	Explanation
Carbon	5 LULUCF	5.F.2.1 Forest Land converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.3 Grassland converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	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.E.2.2 Cropland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Dificulies in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.1 Forest Land converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.3 Grassland converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	no data avaliable
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Dificulties in collecting adequate activity data.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory (cont.)

GHG	Sector	Source/sink category	Explanation
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	no data avaliable
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Dificulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	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

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory (cont.)

GHG	Sector	Source/sink category	Explanation
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 Sulphuric acid production	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	4 Agriculture	4.A 4.A Enteric Fermentation	No data available
CH4	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Dificulties in collecting adequate activity data.
CH4	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Dificulties in collecting adequate activity data.
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.
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.
CH4	6 Waste	6.C.2 Incineration of plastics	IPCC Guidelines do not provide default emission factor for CH4 emission calculation from incineration of plastics. There is no national information on these data. Information about categorisation of plastics and 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
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 Sulphuric acid production	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.
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 Sulphuric acid production	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 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	Activity data for emission calculation are presented by means of population. 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.A.1 5.A.1 Forest Land remaining Forest Land	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Dificulties in collecting adequate activity data.
N2O	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Dificulties 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.B.2.2 Grassland converted to Cropland	Dificulies in collecting adequate activity data.
N2O	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Dificulties in collecting adequate activity data.
N2O	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Dificulties in collecting adequate activity data.
N2O	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Dificulties in collecting adequate activity data.
N2O	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Dificulties 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.

Table A4-1: GHGs and source/sink categories not considered in the Croatian GHG inventory (cont.)

GHG	Sector	Source/sink category	Explanation
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.
N2O	6 Waste	6.C.2 Incineration of plastics	IPCC Guidelines do not provide default emission factor for N2O emission calculation from incineration of plastics. There is no national information on these data. Information about categorisation of plastics 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, 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.

Uncertainty in the Emissions excluding LULUCF

The overall uncertainty of the key source emission was estimated at around 16% in year 2009 and 12% in year 1990 (bottom of the Table A5-2).
The central estimate of CO_2-eq emissions in 2009 was estimated at 28,865.485 Gg CO_2-eq.
The central estimate of CO_2-eq emissions in 1990 was estimated at 31,439.935 Gg CO_2-eq.
All key sources (level/trend) represent 97.76% (28178.39 Gg CO_2-eq.) of the total inventory emission for the year 2009, and 97.29% 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 2009 varies between 23,668.91 Gg CO_2-eq (2.5% percentile) and 32,679.41 Gg CO_2-eq (97.5% percentile).

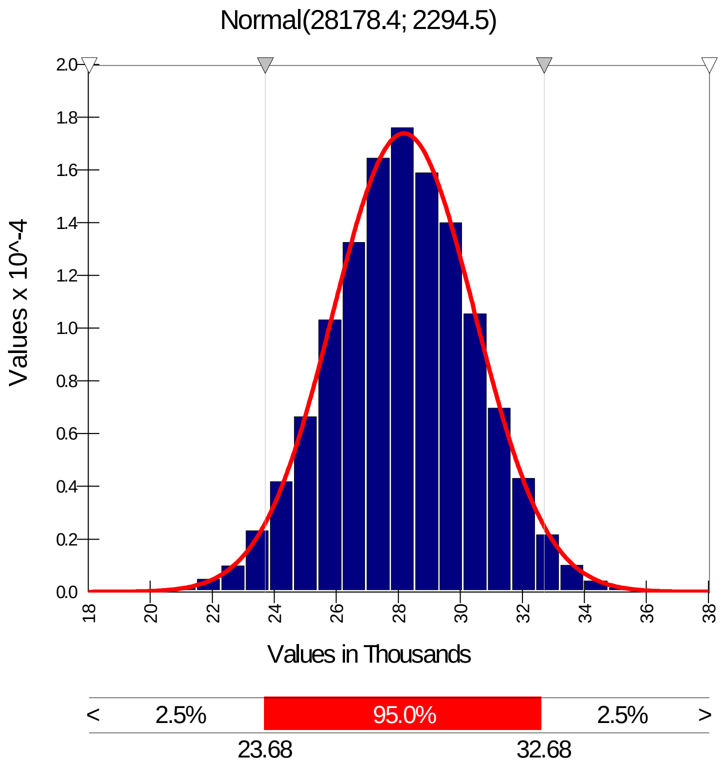

Figure A5.1-1: Distribution of total $C0_2$ emission for year 2009

Figure A5.1-1 shows the distribution of total $C0_2$ emission for year 2009 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 26,864 Gg CO_2-eq (2.5% percentile) and 34,307 Gg CO_2-eq (97.5%percentile) (12%).

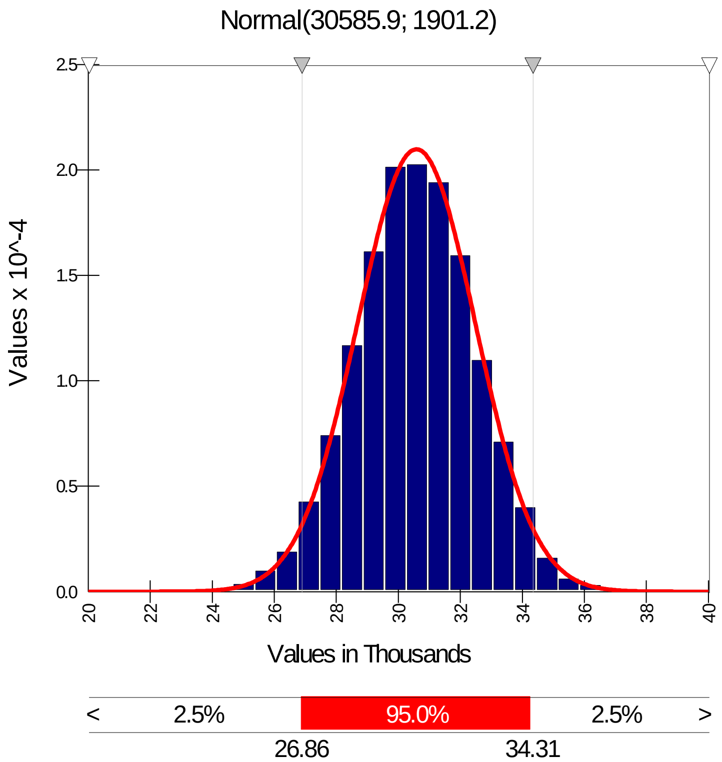

Figure A5.1-2: Distribution of total CO_2 emission for year 1990

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 2009 was estimated. In running this simulation it was necessary to make assumptions about the degree of correlation between sources in year 1990 and 2009.
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 2009 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 -7.9%, and the 95% probability range of the trend is -24.82 % (2.5% percentile) to 11.94 % (97.5% percentile), so the uncertainty in trend is from -17% to 19.9% with respect to the base year emissions.

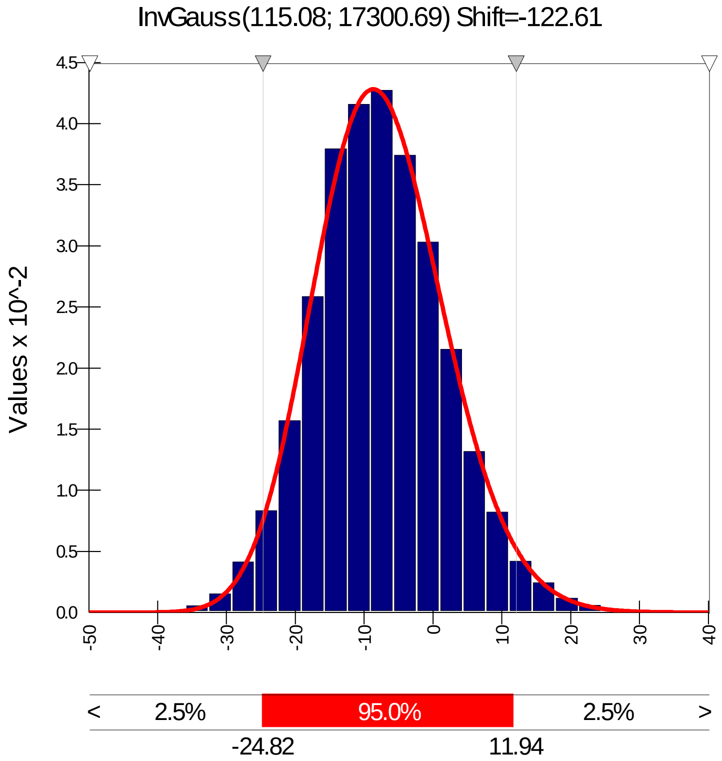

Figure A5.1-3: Distribution of trend for year 2009 respect to year 1990

Figure A5.1-3: shows the distribution of trend for year 2009 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 24.4% in year 2009 and 16.6% in year 1990 (bottom of the Table A5.1-3).

The central estimate of CO_2-eq emissions in 2009 was estimated at 24,506.357 Gg CO_2-eq including LULUCF.

The central estimate of CO_2-eq emissions in 1990 was estimated at 20,153.427 Gg CO_2-eq including LULUCF.

All key sources (level/trend) represent 96.59% (Gg CO_2-eq.) of the total inventory emission for the year 2009, and 96.51% 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 (19,466.4 Gg CO_2-eq) for the year 2009 varies between 14,713.53 Gg CO_2-eq and 24,190.98 Gg CO_2-eq (+/-24%).

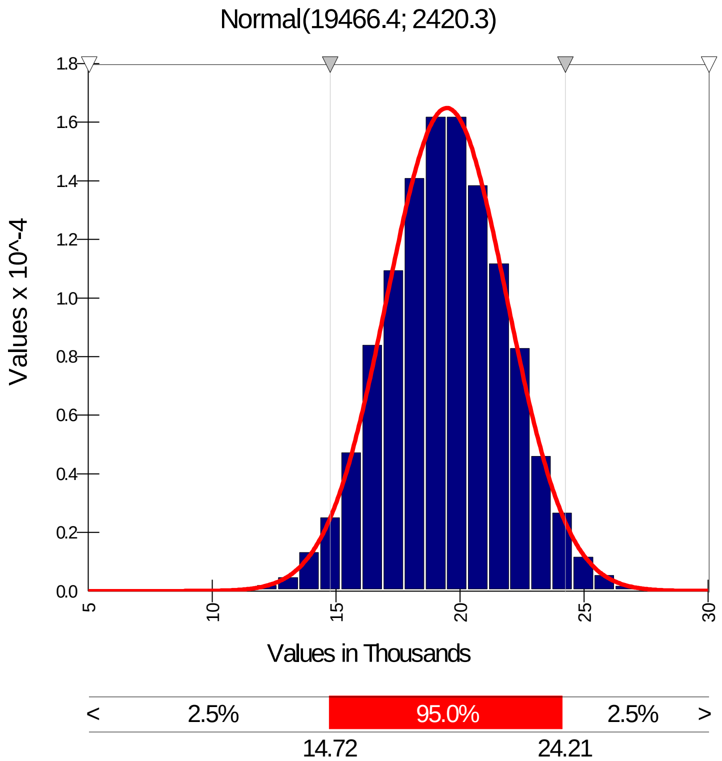

Figure A5.1-4: Distribution of total $C0_2$ emission for year 2009

Figure A5.1-4 shows the distribution of total $C0_2$ emission for year 2009 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 (23,651.99 Gg CO_2-eq) varies between 19,690.93 Gg CO_2-eq and 27,620.4 Gg CO_2-eq (+/-16.6%).

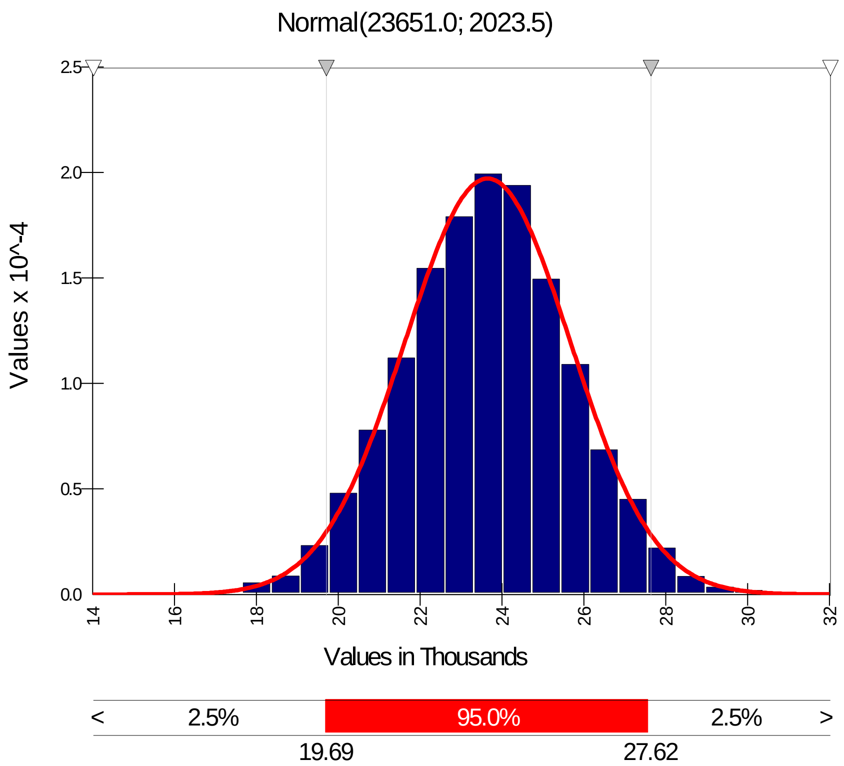

Figure A5.1-5: Distribution of total $C0_2$ emission for year 1990

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 -17.7%, and the 95% probability range of the trend is -39.56 % to 8.53 %, so the uncertainty in trend is from -21.86% to 26.23% with respect to the base year emissions.

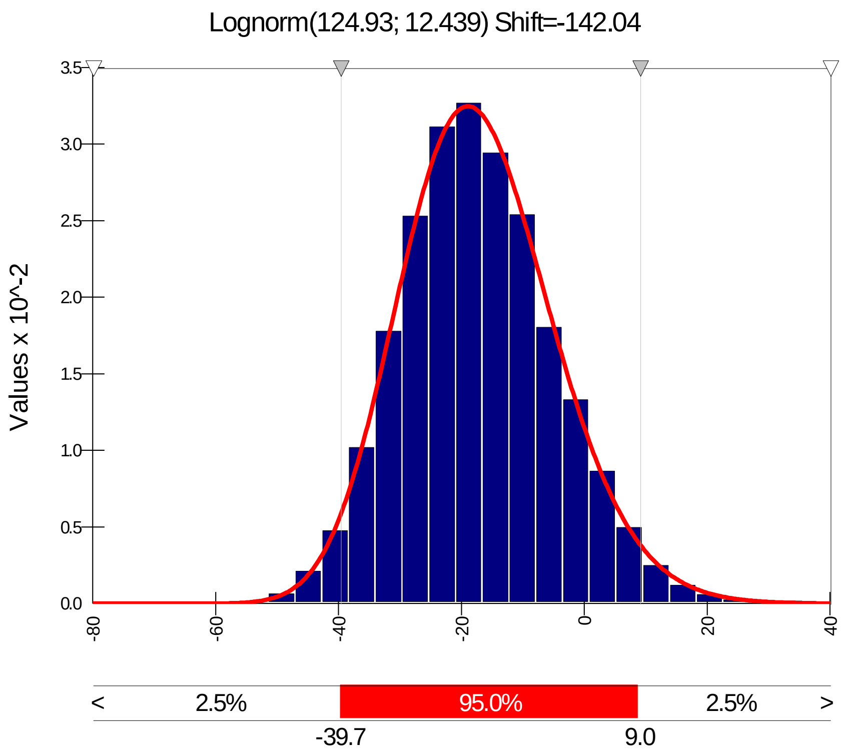

Figure A5.1-6: Distribution of trend for year 2009 respect to year 1990

Figure A5.1-6: shows the distribution of trend for year 2009 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 2009

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
1	**ENERGY SECTOR**													
1.1	**CO2 Emissions from Stationary Combustion: Coal**	CO2	2780.45	1969.36										
	1.A.1. Energy Industries	CO2												
	a. Public Electricity and Heat Production	CO2	589.30	1449.25	1.5	1.5	2.0	2.0	2.42	2.55	145.93	-17.53	19.68	
	1.A.2 Manufacturing Industries and Construction	CO2												
	a. Iron and Steel	CO2	IE,NO	5.09	2.5	2.5	5.0	5.0	5.60	5.62				5,6
	e. Food Processing, Beverages and Tobacco	CO2	IE,NO	80.72	4.0	4.0	5.0	5.0	6.17	6.49				5,6
	Mineral industry	CO2	IE	417.07	2.5	2.5	5.0	5.0	5.61	5.60				5,6
	Manufacturing Industries and Construction Total (1990-	CO2	1676.79	IE										1,5
	1.A.4 Other Sectors	CO2												
	a. Commercial/Institutional	CO2	86.49	6.90	4.0	4.0	5.0	5.0	6.36	6.47	-92.02	-0.69	0.75	
	b. Residential	CO2	427.86	10.34	4.0	4.0	5.0	5.0	6.45	6.47	-97.58	-0.21	0.23	
	Summary results for a given category	**CO2**	**2780.45**	**1969.38**					**2.13**	**2.20**	**-29.17**	**-2.99**	**3.12**	
1.2	**CO2 Emissions from Stationary Combustion: Oil**	CO2	8497.04	5481.20										
	1.A.1. Energy Industries													
	a. Public Electricity and Heat Production	CO2	2132.15	1558.07	5.0	5.0	5.0	5.0	6.96	7.24	-26.92	-6.98	7.79	
	b. Petroleum Refining	CO2	2552.06	1642.79	2.5	2.5	5.0	5.0	5.53	5.64	-35.63	-4.88	5.26	
	c. Manufacture of Solid Fuels and Other Energy Industries	CO2	39.22	IE	4.0	4.0	5.0	5.0						
	1.A.2 Manufacturing Industries and Construction	CO2												
	a. Iron and Steel	CO2	IE,NO	13.91	2.5	2.5	5.0	5.0	5.55	5.64				5,6
	b. Non-Ferrous Metals	CO2	IE,NO	15.61	2.5	2.5	5.0	5.0	5.55	5.67				5,6

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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	84.05	4.0	4.0	5.0	5.0	6.33	6.60				5,6
	d. Pulp, Paper and Print	CO2	IE,NO	36.31	4.0	4.0	5.0	5.0	6.43	6.49				5,6
	e. Food Processing, Beverages and Tobacco	CO2	IE,NO	113.99	4.0	4.0	5.0	5.0	6.31	6.46				5,6
	Mineral industry	CO2	IE,NO	985.42	2.5	2.5	5.0	5.0	5.54	5.69				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	305.91	4.0	4.0	5.0	5.0	6.22	6.53	-41.78	-5.06	5.63	
	b. Residential	CO2	1112.67	725.14	4.0	4.0	5.0	5.0	6.33	6.45	-34.83	-5.69	6.24	
	Summary results for a given category	**CO2**	**8497.04**	**5481.20**					**2.91**	**3.07**	**-35.49**	**-2.66**	**2.75**	
1.3	**CO2 Emissions from Stationary Combustion: Gas**	CO2	4458.54	4994.52										
	1.A.1. Energy Industries	CO2												
	a. Public Electricity and Heat Production	CO2	964.76	1287.40	5.0	5.0	5.0	5.0	6.90	7.08	33.44	-12.55	-14.06	
	b. Petroleum Refining	CO2	13.85	57.70	2.5	2.5	5.0	5.0	5.61	5.72	316.44	-32.66	-34.93	
	c. Manufacture of Solid Fuels and Other Energy Industries	CO2	835.19	378.24	4.0	4.0	5.0	5.0	6.33	6.57	-54.71	-3.89	-4.37	
	1.A.2 Manufacturing Industries and Construction	CO2												
	a. Iron and Steel	CO2	IE,NO	59.79	2.5	2.5	5.0	5.0	5.55	5.60				5,6
	b. Non-Ferrous Metals	CO2	IE,NO	2.28	2.5	2.5	5.0	5.0	5.59	5.64				5,6
	c. Chemicals	CO2	IE,NO	415.82	4.0	4.0	5.0	5.0	6.30	6.40				5,6
	d. Pulp, Paper and Print	CO2	IE,NO	111.02	4.0	4.0	5.0	5.0	6.28	6.47				5,6
	e. Food Processing, Beverages and Tobacco	CO2	IE,NO	293.24	4.0	4.0	5.0	5.0	6.34	6.49				5,6
	Mineral industry	CO2	IE	393.09	2.5	2.5	5.0	5.0	5.59	5.71				5,6

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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 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
	Manufacturing Industries and Construction Total (1990-2000)	CO2	1635.00	IE										1,5
	Petrochemical Production	CO2	395.62	351.16	4.0	4.0	5.0	5.0	6.42	6.42	-11.24	-7.67	8.41	
	1.A.4 Other Sectors	CO2												
	a. Commercial/Institutional	CO2	159.30	311.19	4.0	4.0	5.0	5.0	6.39	6.45	95.35	-17.07	18.61	
	b. Residential	CO2	454.82	1333.58	4.0	4.0	5.0	5.0	6.34	6.39	193.21	-25.08	28.23	
	Summary results for a given category	**CO2**	**4458.54**	**4994.52**					**2.60**	**2.66**	**12.02**	**-4.43**	**4.60**	
1.4	**Mobile Combustion: Road Vehicles**	CO2	3559.02	5764.89										
	Gasoline	CO2	2417.08	2106.96	3.0	3.0	3.0	5.0	4.23	4.22	-12.83	-5.06	5.27	
	Diesel	CO2	1141.95	3447.83	3.0	3.0	2.0	1.0	3.55	3.67	201.93	-15.22	15.85	
	LPG	CO2	NO	210.10	3.0	3.0	2.0	4.0	3.57	3.62				1,5
	Biofuels (Biodiesel)	CO2	NO	3.67	3.0	3.0	18.0	16.0	18.14	18.16				1,5
	Summary results for a given category		**3559.02**	**5764.89**					**2.69**	**2.67**	**61.98**	**-6.47**	**6.70**	
1.5	**Combustion: Agriculture/Forestry/Fishing**	**CO2**	**839.19**	**734.77**										
	Gasoline	CO2	12.24	26.00	3.0	3.0	3.0	5.0	4.25	4.36	112.50	-8.88	9.31	
	Other kerosene	CO2	0.32	NO	3.0	3.0	2.0	2.0						5
	Diesel	CO2	728.45	649.21	3.0	3.0	2.0	1.0	3.61	3.76	-10.88	-4.49	4.70	
	Fuel oil	CO2	37.86	14.16	3.0	3.0	3.0	2.0	4.29	4.29	-62.60	-2.19	2.30	
	LPG	CO2	12.88	8.20	3.0	3.0	2.0	4.0	3.57	3.62	-36.36	-3.18	3.36	
	Natural gas	CO2	47.45	37.20	3	3	3	4	4.27	4.33	-21.60	-3.28	3.39	
	Summary results for a given category		**839.19**	**734.77**					**3.19**	**3.33**	**-12.44**	**-3.85**	**4.06**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (cont.)

Emissions, removals and uncertainties are from National Inventory of Croatia for year 2009														
YEAR 2009														
	A	B	C	D	E		F		G		H	I		J
	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 base year (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to base year		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(%of base year)	(-)%	(+)%	Approach 2
1.6	**Mobile Combustion: Aircraft**	CO2												
	Jat Gasoline	CO2	NO	3.06	3.0	3.0	4.0	4.0	4.94	4.98				
	Jet kerosene	CO2	154.72	74.36	3.0	3.0	3.0	4.0	4.22	4.26	-51.94	-2.76	3.00	
	Summary results for a given category		**154.72**	**77.42**					**4.03**	**4.09**	**-49.96**	**-2.81**	**3.07**	
1.7	**Fugitive Emissions from Oil and Gas Operations**	CH4	1201.18	1472.58	5.0	5.0	300.0	300.0						
	Summary results for a given category		**1201.18**	**1472.58**					**300.15**	**300.00**	**22.59**	**-1631.76**	**1494.94**	
1.8	**CO2 Emissions from Natural Gas Scrubbing**	CO2	415.95	516.44										
	b. Natural Gas	CO2			10.0	10.0	3.0	3.0						
	ii Production	CO2												
	Summary results for a given category		**415.95**	**516.44**					**10.31**	**10.29**	**24.16**	**-17.12**	**19.47**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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
2	**INDUSTRIAL PROCESSES**													
2.1	**2(I)A.1. CO2 Emissions from Cement Production**	CO2												
	Portland cement		1071.58	1198.06	3	3	3	3	4.19	4.35	11.80	-6.49	6.81	
	Aluminate cement		14.21	26.12	3	3	3	3	4.11	4.28	83.76	-10.74	11.39	
	Summary results for a given category		**1085.79**	**1224.17**					4.10	4.26	**12.75**	**-6.43**	**6.76**	
2.2	**2(I)A.2. CO2 Emissions from Lime Production**	CO2												
	Quicklime		154.13	80.76	3	3	3	3	4.24	4.29	-47.60	-3.06	3.21	
	Dolomitic lime		6.50	75.57	3	3	3	3	4.19	4.26	1063.00	-68.05	72.59	
	Summary results for a given category		**160.63**	**156.33**					**2.99**	**3.04**	**-2.67**	**-4.88**	**5.06**	
2.3	**2(I)B.1. CO2 Emissions from Ammonia Production**	CO2												
	Natural gas consumption in process				3	3	5	5	5.83	5.89	-4.47	-7.58	8.15	
	Summary results for a given category		**466.01**	**445.19**					**5.83**	**5.89**	**-4.47**	**-7.58**	**8.15**	
2.4.	**2(I)C.2. CO2 Emissions from Ferroalloys Production**	CO2												
	Coke from coal		112.27	NO										5
	Coal electrode		6.57	NO										5
	Summary results for a given category		**118.84**	**NO**										**5**
2.5.	**2(I)C.3. CO2 Emissions from Aluminium Production**	CO2												5
	Aluminium production													5
	Summary results for a given category		**111.37**	**NO**										**5**
2.6.	**2(I)B.5.CH4 Emissions from Production of Other Chemicals**	CH4												
	Carbon black		7.07	0.92	8	8	30	30	30.52	31.19	-87.02	-1.31	1.47	
	Ethylene		1.53	0.81	8	8	30	30	30.55	31.28	-46.58	-5.41	5.95	
	Dichloroethylene		0.61	NO	8	8	30	30						5
	Styrene		0.75	NO	8	8	30	30						5
	Coke		5.84	NO	8	8	30	30						5
	Summary results for a given category		**15.80**	**1.73**					**22.06**	**22.14**	**-89.03**	**-1.86**	**2.04**	
2.7.	**2(I)B.2. N2O Emissions from Nitric Acid Production**	N2O	803.89	632.25										
	Nitric acid production				3	3	30	30	30.10	30.44	-21.35	-3.30	3.39	
	Summary results for a given category								**30.10**	**30.44**	**-21.35**	**-3.30**	**3.39**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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	Base year emissions or removals 1990	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 base year (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to base year		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(%of base year)	(-)%	(+)%	Approach 2
2.8.	**2(II)F(a) HFC Emissions from Consumption of HFCs, PFCs, SF6**		10.95	443.07										
	2(II)F(a)1.Refrigeration and air conditioning equipment													
	Domestic Refrigeration		NO											
	HFC-134a	HFC-134a		0.38	50	50	50	50	0.63	0.80				5
	Commercial Refrigeration		**NO**	**78.89**										5
	HFC-125	HFC-125	NO	29.81	50	50	50	50	0.62	0.79				5
	HFC-134a	HFC-134a	NO	1.26	50	50	50	50	0.62	0.81				5
	HFC-143a	HFC-143a	NO	47.82	50	50	50	50	0.63	0.80				5
	Transport Refrigeration													5
	HFC-134a	HFC-134a	NO	175.34	50	50	50	50	0.62	0.80				5
	Industrial Refrigeration		**NO**	**19.27**										5
	HFC-125	HFC-125	NO	12.54	50	50	50	50	0.62	0.80				5
	HFC-134a	HFC-134a	NO	3.89	50	50	50	50	0.63	0.79				5
	HFC-32	HFC-32	NO	2.84	50	50	50	50	0.62	0.80				5
	Stationary Air-Conditioning		**NO**	**18.78**										5
	HFC-125	HFC-125	NO	12.15	50	50	50	50	0.62	0.80				5
	HFC-134a	HFC-134a	NO	3.89	50	50	50	50	0.62	0.81				5
	HFC-32	HFC-32	NO	2.74	50	50	50	50	0.62	0.83				5
	Mobile Air-Conditioning													5
	HFC-134a	HFC-134a	NO	126.75	50	50	50	50	0.62	0.80				5
	2(II)F(a)1. Refrigeration and Air Conditioning Equipment - potential													5
	PFC-218	PFC-218	NO	0.22	50	50	50	50	0.50	0.50				5
	2(II)F(a)3. Fire Extinguishers		NO	1.44										5
	HFC-227ea	HFC-227ea	NO	1.38	50	50	50	50						5
	HFC-125	HFC-125	NO	0.06	50	50	50	50	0.63	0.82				5
	2(II)F(a)4. Aerosols/Metered Dose Inhalers													5
	HFC-134a	HFC-134a	NO	7.89	50	50	50	50	0.50	0.50				
	2(II)F(a)8. Electrical Equipment													
	SF6	SF6	10.95	14.11	50	50	50	50	0.50	0.50	28.82	-70.18	155.42	
	Summary results for a given category		**10.95**	**443.07**					**0.33**	**0.40**	**3944.97**	**-1769.74**	**4523.16**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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	Base year emissions or removals 1990	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 base year (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to base year		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(%of base year)	(-)%	(+)%	Approach 2
2.9.	**2.(I)C.3. PFC Emissions from Aluminium Production**		936.56	NO										
	Aluminium production													
	CF4	CF4	820.44	NO										5
	C2F6	C2F6	116.12	NO										5
	Summary results for a given category		**936.56**	**NO**										**5**
3	**SOLVENT AND OTHER PRODUCT USE**													
3.1	**3.CO2 Emissions from Solvent and Other Product use**	CO2	72.19	97.54										
	3.A. Paint application	CO2	25.35	17.53	50	50	50	50	62.29	79.92	-30.84	-46.78	139.49	
	3.B.Degreasing and dry cleaning	CO2	15.40	14.28	50	50	50	50	50.04	49.97	-7.30	-50.34	112.43	
	3.C. Chemical products	CO2	17.08	5.56	50	50	50	50	62.01	79.44	-67.43	-21.66	69.04	
	3.D. Other use of solvent	CO2	14.37	60.17	50	50	50	50	62.21	80.10	318.87	-280.84	874.70	
	Summary results for a given category		**72.19**	**97.54**					**41.80**	**51.74**	**35.12**	**-62.21**	**107.81**	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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
4	**AGRICULTURE SECTOR**													
4.1	**4.A.CH4 Emissions from Enteric Fermentation in Domestic**	CH4												
	Dairy Cattle	CH4	751.97	439.95	10.0	10.0	20.0	20.0	21.91	22.55	-41.49	-15.99	22.35	
	Mature non-dairy	CH4	66.13	38.71	10.0	10.0	20.0	20.0	21.86	23.01	-41.45	-16.10	21.48	
	Young	CH4	275.56	176.84	10.0	10.0	20.0	20.0	21.64	22.53	-35.82	-17.49	24.20	
	Sheep	CH4	78.86	103.99	10.0	10.0	20.0	20.0	21.67	22.90	31.88	-37.00	50.18	
	Goats	CH4	18.06	7.99	10.0	10.0	20.0	20.0	21.60	22.78	-55.74	-12.13	17.05	
	Horses	CH4	14.74	6.43	10.0	10.0	20.0	20.0	22.06	22.88	-56.41	-12.13	16.74	
	Mules & Asses	CH4	3.57	0.81	10.0	10.0	20.0	20.0	21.69	23.12	-77.33	-6.05	8.58	
	Swine	CH4	33.03	39.37	10.0	10.0	20.0	20.0	21.71	22.63	19.19	-33.15	43.17	
	Poultry	CH4												5
	Summary results for a given category		**1241.92**	**814.10**					**13.23**	**13.65**	**-34.45**	**-11.88**	**14.88**	
4.2.	**4.B(a) CH4 Emissions from Manure Management**													
	Dairy Cattle	CH4	58.01	26.76	10.0	10.0	20.0	20.0	21.67	23.42	-53.87	-12.48	17.21	
	Mature non-dairy	CH4	4.03	2.36	10.0	10.0	20.0	20.0	21.94	23.01	-41.45	-15.69	22.33	
	Young	CH4	27.05	17.36	10.0	10.0	20.0	20.0	21.45	23.06	-35.82	-17.52	24.74	
	Sheep	CH4	1.58	2.47	10.0	10.0	20.0	20.0	21.79	23.21	56.60	-43.31	59.27	
	Goats	CH4	0.40	0.19	10.0	10.0	20.0	20.0	21.61	23.06	-51.72	-13.15	17.98	
	Horses	CH4	0.90	0.50	10.0	10.0	20.0	20.0	21.99	23.31	-44.52	-15.25	20.81	
	Mules & Asses	CH4	0.21	0.06	10.0	10.0	20.0	20.0	21.83	23.30	-71.28	-7.87	10.77	
	Swine	CH4	132.13	104.99	10.0	10.0	20.0	20.0	21.92	22.58	-20.54	-21.97	29.95	
	Poultry	CH4	4.31	17.67	10.0	10.0	20.0	20.0	21.70	22.80	309.99	-112.40	154.69	
	Summary results for a given category		**228.62**	**172.36**					**14.42**	**14.58**	**-24.61**	**-14.07**	**17.06**	
4.3.	**4.B(b) N2O Emissions from Manure Management**	N2O												
	Anaerobic lagoons	N2O	0.72	0.46										
	Mature non-dairy	N2O	0.09	0.05	10.0	10.0	50.0	100.0	50.39	81.43	-41.45	-7.68	9.05	
	Young	N2O	0.63	0.40	10.0	10.0	50.0	100.0	50.44	82.51	-35.82	-8.47	9.73	
	Liquid systems	N2O	12.18	7.95										
	Dairy Cattle	N2O	2.83	1.30	10.0	10.0	50.0	100.0	50.39	80.24	-53.87	-6.03	6.92	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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
	Mature non-dairy	N2O	0.46	0.27	10.0	10.0	50.0	100.0	50.86	81.26	-41.45	-7.72	8.81	
	Young	N2O	3.06	1.96	10.0	10.0	50.0	100.0	50.22	81.36	-35.82	-8.52	9.75	
	Swine	N2O	4.44	3.53	10.0	10.0	50.0	100.0	50.32	81.77	-20.54	-10.33	12.24	
	Poultry	N2O	1.40	0.88	10.0	10.0	50.0	100.0	50.78	79.78	-36.92	-8.33	9.63	
	Solid storage & drylot	N2O	307.25	157.97										
	Dairy Cattle	N2O	213.52	98.50	10.0	10.0	50.0	100.0	50.51	80.93	-53.87	-6.02	6.99	
	Mature non-dairy	N2O	12.16	7.12	10.0	10.0	50.0	100.0	50.28	78.54	-41.45	-7.71	8.82	
	Young	N2O	81.57	52.35	10.0	10.0	50.0	100.0	50.38	80.92	-35.82	-8.53	9.71	
	Other	N2O	61.69	45.86										
	Mature non-dairy	N2O	0.06	0.03	10.0	10.0	50.0	100.0	58.39	101.91	-41.45	-7.80	8.99	
	Young	N2O	0.39	0.25	10.0	10.0	50.0	100.0	58.07	104.00	-35.82	-8.50	9.95	
	Sheep	N2O	7.90	6.51	10.0	10.0	50.0	100.0	58.22	101.94	-17.58	-10.76	12.41	
	Goats	N2O	0.84	0.37	10.0	10.0	50.0	100.0	58.21	102.72	-55.74	-5.95	6.79	
	Horses	N2O	0.19	0.08	10.0	10.0	50.0	100.0	58.23	104.11	-56.41	-5.75	6.64	
	Mules & Asses	N2O	0.08	0.02	10.0	10.0	50.0	100.0	58.01	101.93	-77.33	-3.01	3.45	
	Swine	N2O	34.48	27.40	10.0	10.0	50.0	100.0	58.17	103.14	-20.54	-10.60	12.04	
	Poultry	N2O	17.75	11.19	10.0	10.0	50.0	100.0	58.19	102.58	-36.92	-8.41	9.61	
	Summary results for a given category		**381.84**	**212.24**					**30.86**	**43.66**	**-44.42**	**-5.78**	**6.39**	
4.4.	**4.D Agricultural Soils**													
	Direct N2O Emissions from Agricultural Soils	N2O	1330.87	1179.86										
	Synthetic fertiliser (FSN)	N2O	616.15	614.58	50.0	50.0	80.0	80.0	81.07	92.28	-0.25	-41.89	107.99	
	Animal waste (FAW)	N2O	407.63	255.49	10.0	10.0	80.0	80.0	80.22	82.03	-37.32	-8.31	9.74	
	N-fixing crops (FBN)	N2O	105.36	95.34	10.0	10.0	80.0	80.0	80.09	81.66	-9.51	-12.04	13.58	
	Crop residue (FCR)	N2O	195.98	208.70	10.0	10.0	80.0	80.0	80.00	80.69	6.49	-14.20	16.47	
	Histosols	N2O	5.74	5.74	20.0	20.0	60.0	60.0	61.01	66.95		-25.49	33.45	
	Summary results for a given category		**1330.87**	**1179.86**					**48.40**	**53.93**	**-11.35**	**-21.43**	**37.51**	
	N2O Emissions from Pasture Range and Paddock Manure	N2O	261.13	177.39										
	Dairy Cattle	N2O	40.82	18.83	10.0	10.0	63.0	63.0	63.57	64.25	-53.87	-6.21	7.08	
	Sheep	N2O	85.46	70.44	10.0	10.0	63.0	63.0	63.22	64.85	-17.58	-10.93	12.51	

Table A.5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009 (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
	Goats	N2O	38.54	17.06	10.00	10.00	63.00	63.00	63.11	64.96	-55.74	-5.91	6.68	
	Horses	N2O	8.74	3.81	10.00	10.00	63.00	63.00	63.62	64.68	-56.41	-5.87	6.81	
	Mules & Asses	N2O	3.81	0.86	10.00	10.00	63.00	63.00	63.18	64.52	-77.33	-3.07	3.42	
	Swine	N2O	82.76	65.76	10.00	10.00	63.00	63.00	63.02	64.53	-20.54	-10.75	12.20	
	Poultry	N2O	1.00	0.63	10.00	10.00	63.00	63.00	63.10	63.59	-36.92	-8.49	9.53	
	Summary results for a given category	N2O	**261.13**	**177.39**					**36.19**	**35.83**	**-32.07**	**-7.52**	**7.46**	
	Indirect N2O Emissions from Nitrogen Used in Agriculture	**N2O**												
	Deposition	N2O	137.97	104.72					64.74	78.83	-24.10	-8.76	11.62	
	Synthetic fertiliser	N2O	30.34	35.89										
	Livestock excretion	N2O	107.64	68.84										
	Leaching	N2O	796.09	653.80/614.2*					89.48	294.02	-22.84	-17.03	27.12	4,7
	Synthetic fertiliser	N2O	392.44	395.66										4,7
	Livestock excretion	N2O	403.65	258.14										4,7
	Summary results for a given category	N2O	**934.07**	**758.52/718.92***					**78.00**	**257.00**	**-23.03**	**-14.27**	**20.97**	4,7
6	**WASTE SECTOR**													
6.1.	**6 A.CH4 Emissions from Solid Waste Disposal Sites**													
	Managed SWDS	CH4			50.00	50.00	50.00	50.00	68.65	89.34	4018.67	-2953.10	8985.20	
	Unmanaged SWDS > 5m	CH4			50.00	50.00	50.00	50.00	62.70	81.29	34.80	-90.13	272.60	
	Unmanaged SWDS < 5m	CH4			50.00	50.00	50.00	50.00	62.58	80.36	-74.37	-17.40	54.24	
	Summary results for a given category		**242.62**	**718.14**					**51.74**	**64.46**	**195.99**	**-167.90**	**343.66**	
6.2.	**6 B.CH4 Emissions from Wastewater Handling**													
	6 B 1. Industrial Wastewater	CH4			50.00	50.00	30.00	30.00	54.02	63.10	-49.46	-30.30	73.80	
	6 B.2 Domestic and Commercial Wastewater	CH4			50.00	50.00	30.00	30.00	53.02	64.61	-14.19	-50.46	127.19	
	Summary results for a given category		**278.73**	**175.75**					**38.88**	**44.69**	**-36.95**	**-29.04**	**55.99**	

Table A5.1-1: Uncertainty estimates from the Monte Carlo simulation for year 2009(cont.) including LULUCF

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	Base year emissions or removals 1990	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 base year (distribution function)	Uncertainty introduced into the trend in total national emissions with respect to base year		Approach and Comments
			Gg CO_2 equivalent	Gg CO_2 equivalent	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	(%of base year)	(-)%	(+)%	Approach 2
5	**LULUCF****													
5.1	**5.A.Forest land remaining forest land**	CO2-eq	-7059.33	-8642										
	State forests - Croatian Forests	CO2	-4929.87	-4444										
	Increment		-11387.50	-11900	10	10	2	2	10.20	10.19	4.50	-14.00	16.25	
	Fellings		6457.63	7456	10	10	2	2	10.20	10.20	15.46	-15.29	17.93	
	State forests - Other	CO2	-199.30	-721										
	Increment		-246.82	-721	10	10	2	2	10.20	10.19	192.11	-72.06	130.89	
	Fellings		47.52	NO										5
	Private forests	CO2	-1930.18	-3477										
	Increment		-2133.26	-3670	10	10	2	2	10.20	10.19	72.02	-33.11	47.45	
	Fellings		203.08	193	0	30	2	2	0.00	30.04	-5.20	-19.97	24.92	
	Biomass burning - All forests	CH4	0.0125	0.0019										
	Area		0.0125	0.0019	40	40	70	70	80.63	80.56	-84.74	-58.65	91.80	
	Biomass burning - All forests	N2O	0.00286	0.000436										
	Area		0.00286	0	40	40	70	70	80.65	80.59	-84.74	-58.47	92.89	
	Summary results for a given category		**-7059.33**	**-8642**					**17.16**	**17.14**	**22.42**	**-28.49**	**38.02**	
5.2	**5.A.Land converted to Forest land**	**CO2**												
	Increment													
	Summary results for a given category		**-11.03**	**-145**	50	50	2	2	**50.07**	**50.01**	**1210.73**	**-715.72**	**1652.32**	
	5.E Settlements	CO2												
5.3	**Land converted to Settlements**	**CO2**												
	Growing stock													
	Summary results for a given category		**136.79**	**75**	40	40	2	2	**40.07**	**40.02**	**-45.53**	**-25.58**	**46.87**	

<u>Approach and Comments:</u>

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 2009 excluding LULUCF

SUMMARY TABLE OF KEY SOURCE EMISSIONS AND THEIR UNCERTAINTIES FOR YEAR 1990 AND 2009														
IPCC Source Category	Greenhouse Gas	1990 Emissions	2009 Emissions	Uncertainty in 1990 emissions as % of emissions in category		Uncertainty introduced on national total in 1990		Uncertainty in 2009 emissions as % of emissions in category		Uncertainty introduced on national total in 2009		% change in emissions between 2009 and 1990	Range of likely % change between 2009 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	1969.36	2676.58	2884.26	4%	4%	1925.58	2012.58	2%	2%	-29.17	-32.11	-25.97
CO2 Emissions from Stationary Combustion: Oil	CO2	8497.04	5481.20	8241.04	8744.81	3%	3%	5322.37	5643.19	3%	3%	-35.49	-38.11	-32.76
CO2 Emissions from Stationary Combustion: Gas	CO2	4458.54	4994.52	4328.54	4591.68	3%	3%	4857.22	5131.53	3%	3%	12.02	7.59	16.62
Mobile Combustion: Road Vehicles	CO2	3559.02	5764.90	3449.04	3670.00	3%	3%	5609.70	5918.75	3%	3%	61.98	55.51	68.68
Combustion: Agriculture/Forestry/Fishing	CO2	839.19	734.77	813.49	865.50	3%	3%	711.90	758.17	3%	3%	-12.44	-16.20	-8.50
Fugitive Emissions from Oil and Gas Operations	CH4	1201.18	1472.58	-2403.62	4805.07	300%	300%	-2949.96	5889.96	300%	300%	22.59	-1613.90	1371.12
CO2 Emissions from Natural Gas Scrubbing	CO2	415.95	516.44	373.08	458.78	10%	10%	463.23	569.62	10%	10%	24.16	7.44	43.58
Mobile Combustion: Aircraft	CO2	154.72	77.42	148.27	161.23	4%	4%	74.29	80.58	4%	4%	-49.96	-52.82	-46.96
INDUSTRIAL PROCESSES														
CO_2 Emissions from Cement Production	CO2	1085.79	1224.17	1039.47	1131.14	4%	4%	1174.04	1275.76	4%	4%	12.75	6.41	19.71
CO_2 Emissions from Lime Production	CO2	160.63	156.33	154.12	167.14	4%	4%	151.68	160.97	3%	3%	-2.67	-7.37	2.40
CO_2 Emissions from Ammonia Production	CO2	466.01	445.19	439.41	493.83	6%	6%	419.79	471.42	6%	6%	-4.47	-11.88	3.67
CO_2 Emissions from Ferroalloys Production	CO2	118.84	NO	84.37	153.99	29%	30%							
CO_2 Emissions from Aluminium Production	CO2	111.37	NO	77.85	144.82	30%	30%							
CH4 Emissions from Production of Other Chemicals	CH4	15.80	1.73	12.88	18.76	18%	19%	1.35	2.11	22%	22%	-89.03	-90.89	-86.96
N_2O Emissions from Nitric Acid Production	N20	803.89	632.25	561.24	1047.23	30%	30%	442.40	825.58	30%	31%	-21.35	-24.62	-17.89
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	10.95	443.07	5.47	16.43	50%	50%	295.51	614.79	33%	39%	3944.97	2156.29	8559.17
PFC Emissions from Aluminium production	PFC	936.56	NO	686.66	1182.34	27%	26%							
SOLVENT AND OTHER PRODUCT USE														
CO_2 Emissions from solvent and other product use	CO2	72.19	97.54	48.98	99.82	32%	38%	56.38	147.29	42%	51%	35.12	-27.50	137.61
AGRICULTURE SECTOR														
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.92	814.10	1063.18	1422.82	14%	15%	706.46	926.59	13%	14%	-34.45	-46.07	-19.73
CH4 Emissions from Manure Management	CH4	228.62	172.36	196.34	262.44	14%	15%	148.19	197.50	14%	15%	-24.61	-38.69	-7.29
N2O Emissions from Manure Management	N20	381.84	212.24	257.71	565.25	33%	48%	147.26	302.50	31%	43%	-44.42	-50.18	-38.12
Direct N2O Emissions from Agricultural Soils	N20	1330.87	1179.86	685.06	2079.82	49%	56%	606.30	1811.06	49%	53%	-11.35	-33.34	25.27
N2O Emissions from Pasture Range and Paddock Manure	N20	261.13	177.39	178.79	345.04	32%	32%	114.67	241.45	35%	36%	-32.07	-39.80	-24.65
Indirect N2O Emissions from Nitrogen Used in Agriculture	N20	934.07	758.53			78%	254%			78%	257%	-23.03	-14.27	20.97
LULUCF**														
WASTE SECTOR														
CH_4 Emissions from Solid Waste Disposal Sites	CH4	242.62	718.14	134.72	376.04	44%	55%	346.57	1181.17	52%	64%	195.99	28.09	539.65
CH_4 Emissions from Wastewater Handling	CH4	278.73	175.75	164.28	407.53	41%	46%	107.43	254.30	39%	45%	-36.95	-65.99	19.04
TOTAL		30585.57	28178.46	26859.01	34265.79	12%	12%	23668.92	32679.41	16%	16%	-7.87	-25.10	11.97

Table A5.1-3: Summary uncertainty table for year 1990 and 2009 including LULUCF

SUMMARY TABLE OF KEY SOURCE EMISSIONS AND THEIR UNCERTAINTIES FOR YEAR 1990 AND 2009														
IPCC Source Category	Greenhouse Gas	1990 Emissions	2009 Emissions	Uncertainty in 1990 emissions as % of emissions in category		Uncertainty introduced on national total in 1990		Uncertainty in 2009 emissions as % of emissions in category		Uncertainty introduced on national total in 2009		% change in emissions between 2009 and 1990	Range of likely % change between 2009 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	1969.36	2676.58	2884.26	4%	4%	1925.58	2012.58	2%	2%	-29.17	-32.11	-25.97
CO2 Emissions from Stationary Combustion: Oil	CO2	8497.04	5481.20	8241.04	8744.81	3%	3%	5322.37	5643.19	3%	3%	-35.49	-38.11	-32.76
CO2 Emissions from Stationary Combustion: Gas	CO2	4458.54	4994.52	4328.54	4591.68	3%	3%	4857.22	5131.53	3%	3%	12.02	7.59	16.62
Mobile Combustion: Road Vehicles	CO2	3559.02	5764.90	3449.04	3670.00	3%	3%	5609.70	5918.75	3%	3%	61.98	55.51	68.68
Combustion: Agriculture/Forestry/Fishing	CO2	839.19	734.77	813.49	865.50	3%	3%	711.90	758.17	3%	3%	-12.44	-16.20	-8.50
Fugitive Emissions from Oil and Gas Operations	CH4	1201.18	1472.58	-2403.62	4805.07	300%	300%	-2949.96	5889.96	300%	300%	22.59	-1613.90	1371.12
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Mobile Combustion: Aircraft	CO2	154.72	77.42	148.27	161.23	4%	4%	74.29	80.58	4%	4%	-49.96	-52.82	-46.96
INDUSTRIAL PROCESSES														
CO_2 Emissions from Cement Production	CO2	1085.79	1224.17	1039.47	1131.14	4%	4%	1174.04	1275.76	4%	4%	12.75	6.41	19.71
CO_2 Emissions from Lime Production	CO2	160.63	156.33	154.12	167.14	4%	4%	151.68	160.97	3%	3%	-2.67	-7.37	2.40
CO_2 Emissions from Ammonia Production	CO2	466.01	445.19	439.41	493.83	6%	6%	419.79	471.42	6%	6%	-4.47	-11.88	3.67
CO_2 Emissions from Ferroalloys Production	CO2	118.84	NO	84.37	153.99	29%	30%							
CO_2 Emissions from Aluminium Production	CO2	111.37	NO	77.85	144.82	30%	30%							
CH4 Emissions from Production of Other Chemicals	CH4	15.80	1.73	12.88	18.76	18%	19%	1.35	2.11	22%	22%	-89.03	-90.89	-86.96
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HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	10.95	443.07	5.47	16.43	50%	50%	295.51	614.79	33%	39%	3944.97	2156.29	8559.17
PFC Emissions from Aluminium production	PFC	936.56	NO	686.66	1182.34	27%	26%							
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AGRICULTURE SECTOR														
CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH4	1241.92	814.10	1063.18	1422.82	14%	15%	706.46	926.59	13%	14%	-34.45	-46.07	-19.73
CH4 Emissions from Manure Management	CH4	228.62	172.36	196.34	262.44	14%	15%	148.19	197.50	14%	15%	-24.61	-38.69	-7.29
N2O Emissions from Manure Management	N20	381.84	212.24	257.71	565.25	33%	48%	147.26	302.50	31%	43%	-44.42	-50.18	-38.12
Direct N2O Emissions from Agricultural Soils	N20	1330.87	1179.86	685.06	2079.82	49%	56%	606.30	1811.06	49%	53%	-11.35	-33.34	25.27
N2O Emissions from Pasture Range and Paddock Manure	N20	261.13	177.39	178.79	345.04	32%	32%	114.67	241.45	35%	36%	-32.07	-39.80	-24.65
Indirect N2O Emissions from Nitrogen Used in Agriculture	N20	934.07	758.53			78%	254%			78%	257%	-23.03	-14.27	20.97
LULUCF**														
Forest land remaining forest land	CO2,CH4,N20	-7059.33	-8641.96	-8460.47	-5644.79	20%	20%	-10128.65	-7155.31	17%	17%	22.42	-6.07	60.44
Land converted to Forest land	CO2	-11.03	-144.61	-16.55	-5.52	50%	50%	-217.00	-72.26	50%	50%	1210.73	495.01	2863.05
Land converted to Settlements	CO2	136.79	74.52	82.01	191.55	40%	40%	44.66	104.35	40%	40%	-45.53	-71.10	1.35
WASTE SECTOR														
CH_4 Emissions from Solid Waste Disposal Sites	CH4	242.62	718.14	134.72	376.04	44%	55%	346.57	1181.17	52%	64%	195.99	28.09	539.65
CH_4 Emissions from Wastewater Handling	CH4	278.73	175.75	164.28	407.53	41%	46%	107.43	254.30	39%	45%	-36.95	-65.99	19.04
TOTAL		23651.99	19466.40	19722.93	27590.36	17%	17%	14713.54	24190.99	24%	24%	-17.70	-39.56	8.54

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.

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 2010)

There have been no substantial changes to error propagation model since the last inventory (NIR 2010).
In the Report of individual review of annul submission of Croatia submitted in 2010 it was stated that Croatia had entered both emissions and removals as positive values for the table 6.1. of the IPCC good practice guidance for combining uncertainties (Annex 5 of the NIR), and therefore the uncertainty analysis with LULUCF didn't provide correct results. In this report removals as negative values have been entered so the results have changed in the uncertainty analysis including LULUCF.

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.

Uncertainty in the Emissions

The error propagation analysis, including LULUCF emissions, shows an uncertainty of +/- 24.78% in the combined GWP total emission in 2009, the latest reported year in this inventory.

The error propagation analysis, excluding LULUCF emissions, shows an uncertainty of +/- 16.47 % in the combined GWP total emission in 2009, the latest reported year in this inventory.

Uncertainty in the Trend

The analysis, including LULUCF emissions, estimates an uncertainty of +/- 8.81 % in the trend between the year 1990 and 2009, the latest reported year in this inventory.

The analysis, excluding LULUCF emissions, estimates an uncertainty of +/- 4.17 % in the trend between the year 1990 and 2009, 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
	IPCC Source Category	GHG	Base year emissions 1990	Year t emissions 2009	Activ. data uncert.	Emission factor uncert.	Combined uncertainty	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
			Gg CO_2 equiv.	Gg CO_2 equiv.	%	%	%	%	%	%	%	%	%
1A	CO2 Emissions from Stationary Combustion - Coal	CO_2	2 780.4	1 969.4	1.3	1.8	2.22	0.15	-0.02	0.06	-0.03	0.08	0.09
1A	CO2 Emissions from Stationary Combustion - Oil	CO_2	8 497.0	5 481.2	1.8	2.4	3.00	0.5697	-0.0736	0.1743	-0.18	0.31	0.3601
1A	CO2 Emissions from Stationary Combustion - Gas	CO_2	4 458.5	4 994.5	1.8	2.1	2.77	0.4786	0.0286	0.1589	0.06	0.29	0.2922
1A	Mobile Combustion - Road Vehicles	CO_2	3 559.0	5 764.9	2	1.6	2.56	0.5115	0.0793	0.1834	0.13	0.37	0.3881
1A	Mobile Combustion: Water-borne Navigation	CO_2	133.0	145.3	5	5	7.07	0.0356	0.0007	0.0046	0.00	0.02	0.0234
1A	Mobile Combustion: Domestic Aviation	CO_2	154.7	77.4	5	5	7.07	0.0190	-0.0021	0.0025	-0.01	0.01	0.0160
1A	Mobile Combustion: Railways	CO_2	138.1	89.3	5	5	7.07	0.0219	-0.0012	0.0028	-0.01	0.01	0.0154
1A	Combustion - Agriculture/Forestry/Fishing	CO_2	839.2	734.8	2.6	1.8	3.16	0.0805	-0.0011	0.0234	0.00	0.06	0.0608
1B	CO2 Emissions from Natural Gas Scrubbing*	CO_2	415.9	516.4	10	3	10.44	0.1868	0.0043	0.0164	0.01	0.16	0.1648
2A	CO2 Emissions from Cement Production	CO_2	1 085.8	1 224.2	3	3	4.24	0.1799	0.0072	0.0389	0.02	0.12	0.1188
2A	CO2 Emissions from Lime Production	CO_2	160.6	156.3	2.1	2.2	3.04	0.0165	0.0003	0.0050	0.00	0.01	0.0105
2A	CO2 Emissions from Limestone and Dolomite Use	CO_2	51.5	30.4	7.5	30	30.92	0.0325	-0.0005	0.0010	-0.02	0.01	0.0177
2A	CO2 Emissions from Soda Ash Production and Use	CO_2	25.7	17.2	7.5	30	30.92	0.0184	-0.0002	0.0005	-0.01	0.00	0.0074
2C	CO2 Emissions from Iron and Steel Production	CO_2	21.4	11.3	7.5	30	30.92	0.0121	-0.0003	0.0004	-0.01	0.00	0.0084
2B	CO2 Emissions from Ammonia Production	CO_2	466.0	445.2	3	5	5.83	0.0899	0.0006	0.0142	0.00	0.04	0.0426
2C	CO2 Emissions from Ferroalloys Production	CO_2	118.8	0.0	7.5	30	30.92	0.0000	-0.0035	0.0000	-0.10	0.00	0.1041
2C	Aluminium Production	CO_2	111.4	0.0	3	30	30.15	0.0000	-0.0033	0.0000	-0.10	0.00	0.0976
6C	Emissions from Waste Incineration	CO_2	0.0	0.1	50	30	58.31	0.0003	0.0000	0.0000	0.00	0.00	0.0002
3C	Total Solvent and Other Product Use	CO_2	72.2	97.5	35	40	53.15	0.1796	0.0010	0.0031	0.04	0.11	0.1156
6C	Other non-specified NEU	CO_2			5	50	50.25	0.0000	0.0000	0.0000	0.00	0.00	0.0000
			CO_2 Total	**23 089.6**	**21 755.4**								

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
	IPCC Source Category	GHG	Base year emissions 1990	Year t emissions 2006	Activity data uncert.	Emission factor uncert.	Combined uncertainty	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
			Gg CO_2 equiv.	Gg CO_2 equiv.	%	%	%	%	%	%	%	%	%
1A	Fuel Combustion - Stationary Sources	CH_4	168.6	91.8	5	50	50.25	0.1597	-0.0020	0.0029	-0.10	0.01	0.1014
1A	Mobile Combustion - Road Vehicles	CH_4	33.0	14.8	5	40	40.31	0.0206	-0.0005	0.0005	-0.02	0.00	0.0199
1A	Mobile Combustion: Water-borne Navigation	CH_4	0.2	0.2	5	40	40.31	0.0003	0.0000	0.0000	0.00	0.00	0.0001
1A	Mobile Combustion: Aircraft	CH_4	0.0	0.0	5	40	40.31	0.0000	0.0000	0.0000	0.00	0.00	0.0000
1A	Mobile Combustion: Railways	CH_4	0.2	0.1	5	40	40.31	0.0002	0.0000	0.0000	0.00	0.00	0.0001
1A	Combustion - Agriculture/Forestry/Fishing	CH_4	1.3	1.1	5	40	40.31	0.0015	0.0000	0.0000	0.00	0.00	0.0002
1B	Fugitive Emissions from Coal Mining and Handling	CH_4	48.8	0.0	5	250	250.05	0.0000	-0.0014	0.0000	-0.36	0.00	0.3559
1B	Fugitive Emissions from Oil and Gas Operations	CH_4	1 201.2	1 472.6	5	300	300.04	15.3067	0.0118	0.0468	3.53	0.23	3.5347
2B	Production of Chemicals	CH_4	15.8	1.7	6.8	22	23.03	0.0014	-0.0004	0.0001	-0.01	0.00	0.0126
4A	CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	1 241.9	814.1	8.2	12	14.53	0.4099	-0.0104	0.0259	-0.12	0.21	0.2461
4B	CH4 Emissions from Manure Management	CH_4	228.6	172.4	8.2	12	14.53	0.0868	-0.0012	0.0055	-0.02	0.04	0.0493
6A	Solid Waste Disposal Sites	CH_4	242.6	718.1	35	42	54.67	1.3602	0.0158	0.0228	0.66	0.80	1.0378
6B	Emissions from Waste Water Handling	CH_4	278.7	175.7	30	32	43.86	0.2671	-0.0025	0.0056	-0.08	0.17	0.1865
			CH_4 Total	**3 461.0**	**3 462.7**								

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
	IPCC Source Category	GHG	Base year emissions 1990	Year t emissions 2006	Activity data uncert.	Emission factor uncert.	Combined uncertainty	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
			Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%	%	%	%	%	%
1A	Fuel Combustion - Stationary Sources	N_2O	62.4	42.1	5	200	200.06	0.2915	-0.0005	0.0013	-0.10	0.01	0.0970
1A	Mobile Combustion - Road Vehicles	N_2O	38.6	62.8	5	200	200.06	0.4355	0.0009	0.0020	0.17	0.01	0.1743
1A	Mobile Combustion: Water-borne Navigation	N_2O	0.3	0.4	5	200	200.06	0.0026	0.0000	0.0000	0.00	0.00	0.0004
1A	Mobile Combustion: Aircraft	N_2O	1.4	0.7	5	200	200.06	0.0047	0.0000	0.0000	0.00	0.00	0.0036
1A	Mobile Combustion: Railways	N_2O	0.4	0.2	5	200	200.06	0.0016	0.0000	0.0000	0.00	0.00	0.0008
1A	Combustion - Agriculture/Forestry/Fishing	N_2O	2.0	1.8	5	200	200.06	0.0125	0.0000	0.0001	0.00	0.00	0.0006
2B	Nitric Acid Production	N_2O	803.9	632.4	3	30	30.15	0.6605	-0.0034	0.0201	-0.14	0.06	0.1548
3C	Total Solvent and Other Product Use	N_2O	34.72	33.6	50	50	70.71	0.082280	0.000054	0.001068	0.00	0.05	0.053486
4B	N2O Emissions from Manure Management	N_2O	381.8	212.2	6	35	35.51	0.2611	-0.0044	0.0068	-0.22	0.04	0.2215
4B	Direct N2O Emissions from Agricultural Soils	N_2O	1 330.9	1 179.9	16	47	49.65	2.0294	-0.0013	0.0375	-0.09	0.60	0.6070
4D	N2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.1	177.4	8.5	37	37.96	0.2333	-0.0020	0.0056	-0.10	0.05	0.1143
4F	Indirect N2O Emissions from Nitrogen Used in Agriculture	N_2O	934.1	758.5	40	200	203.96	5.3597	-0.0031	0.0241	-0.89	0.97	1.3134
6B	Emissions from Waste Water Handling	N_2O	90.2	102.4	10	30	31.62	0.1122	0.0006	0.0033	0.03	0.03	0.0419
			N_2O Total	**3 941.9**	**3 204.4**								
2F	HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	10.95	443.1	25	30	39.05	0.5994	0.0138	0.0141	0.41	0.35	0.5430
2C	PFC Emissions from Aluminium production	PFC	936.6	0.0	3	27	27.17	0.0000	-0.0273	0.0000	-0.74	0.00	0.7382
	Total GHG Emissions		**CO_2-eq**	**31 439.935**	**28 865.485**								
	Total Uncertainties (Level/Trend)							**16.47**					**4.16**

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
	IPCC Source Category	GHG	Base year emissions 1990	Year t emissions 2009	Activ. data uncert.	Emission factor uncert.	Combined uncertainty	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
			Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%	%	%	%	%	%
1A	CO2 Emissions from Stationary Combustion - Coal	CO_2	2780.4	1969.4	1.3	1.8	2.22	0.2170	-0.0129	0.0804	-0.0233	0.1045	0.1070
1A	CO2 Emissions from Stationary Combustion - Oil	CO_2	8497.0	5481.2	1.8	2.4	3.00	0.8159	-0.0613	0.2237	-0.1470	0.4026	0.4286
1A	CO2 Emissions from Stationary Combustion - Gas	CO_2	4458.5	4994.5	1.8	2.1	2.77	0.6855	0.0541	0.2038	0.1136	0.3668	0.3840
1A	Mobile Combustion - Road Vehicles	CO_2	3559.0	5764.9	2	1.6	2.56	0.7326	0.1156	0.2352	0.1850	0.4705	0.5056
1A	Mobile Combustion: Water-borne Navigation	CO_2	133.0	145.3	5	5	7.07	0.0510	0.0015	0.0059	0.0073	0.0296	0.0305
1A	Mobile Combustion: Domestic Aviation	CO_2	154.7	77.4	5	5	7.07	0.0272	-0.0020	0.0032	-0.0102	0.0158	0.0188
1A	Mobile Combustion: Railways	CO_2	138.1	89.3	5	5	7.07	0.0313	-0.0010	0.0036	-0.0050	0.0182	0.0189
1A	Combustion - Agriculture/Forestry/Fishing	CO_2	839.2	734.8	2.6	1.8	3.16	0.1153	0.0018	0.0300	0.0033	0.0780	0.0780
1B	CO2 Emissions from Natural Gas Scrubbing*	CO_2	415.9	516.4	10	3	10.44	0.2675	0.0071	0.0211	0.0213	0.2107	0.2118
2A	CO2 Emissions from Cement Production	CO_2	1085.8	1224.2	3	3	4.24	0.2577	0.0135	0.0500	0.0405	0.1499	0.1552
2A	CO2 Emissions from Lime Production	CO_2	160.6	156.3	2.1	2.2	3.04	0.0236	0.0010	0.0064	0.0022	0.0134	0.0136
2A	CO2 Emissions from Limestone and Dolomite Use	CO_2	51.5	30.4	7.5	30	30.92	0.0466	-0.0005	0.0012	-0.0147	0.0093	0.0174
2A	CO2 Emissions from Soda Ash Production and Use	CO_2	25.7	17.2	7.5	30	30.92	0.0264	-0.0002	0.0007	-0.0049	0.0053	0.0072
2C	CO2 Emissions from Iron and Steel Production	CO_2	21.4	11.3	7.5	30	30.92	0.0173	-0.0003	0.0005	-0.0078	0.0035	0.0085
2B	CO2 Emissions from Ammonia Production	CO_2	466.0	445.2	3	5	5.83	0.1288	0.0025	0.0182	0.0126	0.0545	0.0559
2C	CO2 Emissions from Ferroalloys Production	CO_2	118.8	0.0	7.5	30	30.92	0.0000	-0.0040	0.0000	-0.1196	0.0000	0.1196
2C	Aluminium Production	CO_2	111.4	0.0	3	30	30.15	0.0000	-0.0037	0.0000	-0.1121	0.0000	0.1121
5A	Forest land remaining forest land	CO_2	-7059.3	-8642.0	17	2	17.12	-7.3400	-0.1161	-0.3526	-0.2322	-5.9949	5.9994
5A	Land converted to Forest land	CO_2	-11.0	-144.6	50	2	50.04	-0.3591	-0.0055	-0.0059	-0.0111	-0.2951	0.2953
5E	Land converted to Settlements	CO_2	136.8	74.5	40	2	40.05	0.1481	-0.0015	0.0030	-0.0031	0.1216	0.1217
6C	Emissions from Waste Incineration	CO_2	0.0	0.1	50	30	58.31	0.0004	0.0000	0.0000	0.0001	0.0003	0.0003
3C	Total Solvent and Other Product Use	CO_2	72.2	97.5	35	40	53.15	0.2572	0.0016	0.0040	0.0623	0.1393	0.1526
6C	Other non-specified NEU	CO_2	0.0	0.0	5	50	50.25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	C02 Total	**CO_2**	**16156.0**	**13043.3**									

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
	IPCC Source Category	GHG	Base year emissions 1990	Year t emissions 2009	Activity data uncert.	Emission factor uncert.	Combined uncertainty	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
			Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%	%	%	%	%	%
1A	Fuel Combustion - Stationary Sources	CH_4	168.6	91.8	5	50	50.25	0.2288	-0.0019	0.0037	-0.0957	0.0187	0.0975
1A	Mobile Combustion - Road Vehicles	CH_4	33.0	14.8	5	40	40.31	0.0295	-0.0005	0.0006	-0.0201	0.0030	0.0204
1A	Mobile Combustion: Water-borne Navigation	CH_4	0.2	0.2	5	40	40.31	0.0004	0.0000	0.0000	0.0001	0.0000	0.0001
1A	Mobile Combustion: Aircraft	CH_4	0.0	0.0	5	40	40.31	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1A	Mobile Combustion: Railways	CH_4	0.2	0.1	5	40	40.31	0.0003	0.0000	0.0000	-0.0001	0.0000	0.0001
1A	Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.3	1.1	5	40	40.31	0.0022	0.0000	0.0000	0.0001	0.0002	0.0002
1B	Fugitive Emissions from Coal Mining and Handling	CH_4	48.8	0.0	5	250	250.05	0.0000	-0.0016	0.0000	-0.4090	0.0000	0.4090
1B	Fugitive Emissions from Oil and Gas Operations	CH_4	1201.2	1472.6	5	300	300.04	21.9236	0.0198	0.0601	5.9314	0.3004	5.9390
2B	Production of Other Chemicals	CH_4	15.8	1.7	6.8	22	23.03	0.0020	-0.0005	0.0001	-0.0101	0.0005	0.0101
4A	CH4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	1241.9	814.1	8.2	12	14.53	0.5871	-0.0085	0.0332	-0.1014	0.2724	0.2907
4B	CH4 Emissions from Manure Management	CH_4	228.6	172.4	8.2	12	14.53	0.1243	-0.0006	0.0070	-0.0077	0.0577	0.0582
5A	Forest land remaining forest land	CH_4	0.0	0.0	60	0	60.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6A	Solid Waste Disposal Sites	CH_4	242.6	718.1	35	42	54.67	1.9482	0.0212	0.0293	0.8887	1.0257	1.3571
6B	Emissions from Waste Water Handling	CH_4	278.7	175.7	30	32	43.86	0.3825	-0.0022	0.0072	-0.0698	0.2151	0.2262
	CH_4 Total		**3461.0**	**3462.7**									

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
	IPCC Source Category	GHG	Base year emissions 1990	Year t emissions 2009	Activity data uncert.	Emission factor uncert.	Combined uncertainty	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
			Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%	%	%	%	%	%
1A	Fuel Combustion - Stationary Sources	N_2O	62.4	42.1	5	200	200.06	0.4175	-0.0004	0.0017	-0.0754	0.0086	0.0759
1A	Mobile Combustion - Road Vehicles	N_2O	38.6	62.8	5	200	200.06	0.6237	0.0013	0.0026	0.2535	0.0128	0.2538
1A	Mobile Combustion: Water-borne Navigation	N_2O	0.3	0.4	5	200	200.06	0.0037	0.0000	0.0000	0.0007	0.0001	0.0008
1A	Mobile Combustion: Aircraft	N_2O	1.4	0.7	5	200	200.06	0.0067	0.0000	0.0000	-0.0036	0.0001	0.0036
1A	Mobile Combustion: Railways	N_2O	0.4	0.2	5	200	200.06	0.0022	0.0000	0.0000	-0.0008	0.0000	0.0008
1A	Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.0	1.8	5	200	200.06	0.0178	0.0000	0.0001	0.0010	0.0004	0.0010
2B	Nitric Acid Production	N_2O	803.9	632.4	3	30	30.15	0.9461	-0.0012	0.0258	-0.0351	0.0774	0.0850
3C	Total Solvent and Other Product Use	N_2O	34.7	33.6	50	50	70.71	0.1178	0.0002	0.0014	0.0103	0.0685	0.0693
4B	N2O Emissions from Manure Management	N_2O	381.8	212.2	6	35	35.51	0.3740	-0.0042	0.0087	-0.1453	0.0520	0.1544
4B	Direct N2O Emissions from Agricultural	N_2O	1330.9	1179.9	16	47	49.65	2.9066	0.0035	0.0481	0.1637	0.7703	0.7875
4D	N2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.1	177.4	8.5	37	37.96	0.3342	-0.0015	0.0072	-0.0564	0.0615	0.0835
4F	Indirect N2O Emissions from Nitrogen Used in Agriculture	N_2O	934.1	758.5	40	200	203.96	7.6766	-0.0004	0.0310	-0.0785	1.2381	1.2406
5A	Forest land remaining forest land	N_2O	0.0	0.0	45	30	54.08	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6B	Emissions from Waste Water Handling	N_2O	90.2	102.4	10	30	31.62	0.1607	0.0012	0.0042	0.0345	0.0418	0.0542
			N_2O Total	**3941.9**	**3204.4**								
2F	HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	11.0	443.1	25	30	39.05	0.8585	0.0177	0.0181	0.5314	0.4520	0.6976
2C	PFC Emissions from Aluminium production	PFC	936.6	0.0	3	27	27.17	0.0000	-0.0314	0.0000	-0.8483	0.0000	0.8483
			HFC/PFC/	**947.5**	**443.1**								
	Total GHG Emissions	**CO_2-eq**	**24506.4**	**20153.4**									
	Total Uncertainties (Level/Trend)							24.785					**8.81**

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), 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 (+/-16%)** for error propagation approach and approach 2 (Monte Carlo) for year 2009 (excluding LULUCF).
Total uncertainty for all key sources is **approximately equal (+/-24%)** for error propagation approach and approach 2 (Monte Carlo) for year 2009 (Including LULUCF).

Trend uncertainty (variability) using Monte Carlo simulation model is higher 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 2009, 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 2009, but in year 1990 they had emission which varied in accordance with the uncertainty of input parameters.

If we are talking about 95%-confidence interval for the trend, the range is much larger using Approach 2 for calculation.

In the future improvements “probable errors” in the approach of calculating trend using applied software for the implementation of Monte Carlo simulations will be solved.

ANNEX 6

ARCHIVING

INVENTORY DATA RECORD SHEET, UNFCCC SEF APPLICATION

Table A6-1: An example of Inventory Data Record Sheet for 2009 in Waste

INVENTORY DATA RECORD SHEET

Year: 2009

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 2009, 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: 1,031.25 Gg

Unmamaged – deep: 528.78 Gg

Unmanaged – shallow: 106.97 Gg

Country-specific methane correction factor (MCF): 0.898

Country-specific fraction of degradable organic carbon (DOC): 0.16

Recovered methane: 2.15 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 Protection, Physical Planning and Construction (2006) *Guidelines Development for starting implementation of Waste Management Plan in the Republic of Croatia,* EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (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:

-

RESPONSIBILITY:

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UNFCCC SEF application

Version 1.2

Workflow

Settings

Party:	Croatia
ISO:	HR
Submission year:	2011
Reported year:	2010
Commitment period:	1
Completeness check:	YES
Consistency check:	YES
File locked:	YES
Lock timestamp:	21.3.2011 16:51
Submission version number:	1
Submission type:	Official

Functions

Export XML

Party	Croatia
Submission year	2011
Reported year	2010
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

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Party Croatia
Submission year 2011
Reported year 2010
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	2011
Reported year	2010
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	2011
Reported year	2010
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	2011
Reported year	2010
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	2011
Reported year	2010
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	2011
Reported year	2010
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	**20976.03**	**69.20**	**1453.27**	**0.34**	**105.12**	**NO**	**22534.42**	**71.67**
A. Fuel Comb (Sectoral Appr.)	20560.08	9.68	203.33	0.50	105.12	NO	20868.54	66.38
1. Energy Industries	7126.54	0.17	3.61	0.06	13.63	NO	7143.78	22.72
2. Man. Ind. and Constr.	5842.92	0.52	10.83	0.09	18.18	NO	5871.93	18.68
3. Transport	3984.87	1.59	33.39	0.19	40.72	NO	4058.98	12.91
4. Comm./Inst, Resid., Agric.	3605.76	7.40	155.50	0.16	32.59	NO	3793.85	12.07
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	5.30
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	**2041.31**	**0.75**	**15.80**	**2.59**	**803.89**	**947.52**	**3808.51**	**12.11**
A. Mineral Products	1323.65	NE,NO	NE,NO	NE,NO	NE,NO	NO	1323.65	4.21
B. Chemical Industry	466.01	15.80	15.80	2.59	803.89	NO	1285.69	4.09
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	**72.19**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**106.91**	**0.34**
4. Agriculture	**NO**	**70.03**	**1470.54**	**9.38**	**2907.91**	**NO**	**4378.46**	**13.93**
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	8.15	2526.07	NO	2526.07	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	**-8293.04**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8293.02**	**-26.38**
A. Forest Land	-8438.89	0.00	0.01	0.00	0.00	NO	-8438.88	-26.84
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	145.86	NE,NO	NE,NO	NE,NO	NE,NO	NO	145.86	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	**0.04**	**24.83**	**521.36**	**0.29**	**90.24**	**NO**	**611.63**	**1.95**
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	**14796.54**	**164.81**	**3460.97**	**12.60**	**3907.16**	**947.52**	**23146.91**	**73.62**
Total Emissions without LUCF	**23089.58**	**164.81**	**3460.97**	**12.60**	**3907.16**	**947.52**	**31439.93**	**100.0**
Share of Gases in Total Em./Rem.	**63.92**		**14.95**		**16.88**		**100.00**	
Share of Gases in Total Emissions	**73.44**		**11.01**		**12.43**		**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	**15531.67**	**62.11**	**1304.22**	**0.23**	**72.14**	**NO**	**16908.03**	**68.26**
A. Fuel Comb (Sectoral Appr.)	15075.84	6.38	134.03	0.34	72.14	NO	15282.01	61.70
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	2927.58	1.20	25.29	0.13	27.98	NO	2980.85	12.03
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	455.83	55.72	1170.19	NO	NO	NO	1626.02	6.56
1. Solid Fuels	NO	NO	43.45	NO	NO	NO	43.45	NO
2. Oil and Natural Gas	455.83	53.65	1126.74	NO	NO	NO	1582.57	6.39
2. Industrial Processes	**1551.13**	**0.55**	**11.49**	**2.28**	**706.05**	**653.27**	**2921.95**	**11.80**
A. Mineral Products	870.62	NE,NO	NE,NO	NE,NO	NE,NO	NO	870.62	3.51
B. Chemical Industry	447.00	11.49	11.49	2.28	706.05	NO	1164.54	4.70
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	**70.43**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**105.15**	**0.42**
4. Agriculture	**NO**	**64.92**	**1363.31**	**9.23**	**2860.60**	**NO**	**4223.91**	**17.05**
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	8.08	2505.62	NO	2505.62	10.12
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	**-7597.67**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-7597.66**	**-30.67**
A. Forest Land	-7705.55	0.00	0.01	0.00	0.00	NO	-7705.54	-31.11
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	107.88	NE,NO	NE,NO	NE,NO	NE,NO	NO	107.88	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	**0.04**	**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	9555.61	152.60	3204.61	12.01	3723.06	653.27	17171.27	69.33
Total Emissions without LUCF	17153.28	152.60	3204.61	12.01	3723.06	653.27	24768.93	100.0
Share of Gases in Total Em./Rem.	55.65		18.66		21.68		100.00	
Share of Gases in Total Emissions	69.25		12.94		15.03		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	**14872.76**	**60.88**	**1278.56**	**0.21**	**64.22**	**NO**	**16215.54**	**70.26**
A. Fuel Comb (Sectoral Appr.)	14395.42	5.22	109.61	0.31	64.22	NO	14569.26	63.13
1. Energy Industries	5338.81	0.11	2.35	0.05	9.79	NO	5350.95	23.18
2. Man. Ind. and Constr.	3680.56	0.35	7.39	0.05	10.30	NO	3698.25	16.02
3. Transport	2826.90	1.07	22.38	0.12	25.70	NO	2874.99	12.46
4. Comm./Inst, Resid., Agric.	2549.15	3.69	77.50	0.09	18.43	NO	2645.07	11.46
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	7.13
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	6.99
2. Industrial Processes	**1600.40**	**0.46**	**9.74**	**2.98**	**923.19**	**10.92**	**2544.24**	**11.02**
A. Mineral Products	930.19	NE,NO	NE,NO	NE,NO	NE,NO	NO	930.19	4.03
B. Chemical Industry	575.22	9.74	9.74	2.98	923.19	NO	1508.14	6.53
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	**51.67**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**86.39**	**0.37**
4. Agriculture	**NO**	**51.17**	**1074.54**	**8.23**	**2550.65**	**NO**	**3625.20**	**15.71**
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	2268.13	NO	2268.13	9.83
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	**-7456.83**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-7456.83**	**-32.31**
A. Forest Land	-7558.58	0.00	0.00	0.00	0.00	NO	-7558.57	-32.75
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	101.74	NE,NO	NE,NO	NE,NO	NE,NO	NO	101.74	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	**0.04**	**25.23**	**529.77**	**0.25**	**78.34**	**NO**	**608.15**	**2.64**
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	1.49
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	**9068.04**	**137.74**	**2892.61**	**11.67**	**3616.40**	**10.92**	**15622.69**	**67.69**
Total Emissions without LUCF	**16524.87**	**137.74**	**2892.61**	**11.67**	**3616.40**	**10.92**	**23079.52**	**100.0**
Share of Gases in Total Em./Rem.	**58.04**		**18.52**		**23.15**		**100.00**	
Share of Gases in Total Emissions	**71.60**		**12.53**		**15.67**		**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	**15634.32**	**67.07**	**1408.53**	**0.21**	**65.65**	**NO**	**17108.51**	**74.03**
A. Fuel Comb (Sectoral Appr.)	14958.20	4.95	103.87	0.31	65.65	NO	15127.73	65.46
1. Energy Industries	5918.93	0.14	2.93	0.05	10.07	NO	5931.93	25.67
2. Man. Ind. and Constr.	3515.57	0.34	7.04	0.05	9.82	NO	3532.42	15.29
3. Transport	2992.50	1.04	21.84	0.14	28.36	NO	3042.71	13.17
4. Comm./Inst, Resid., Agric.	2531.21	3.43	72.06	0.08	17.40	NO	2620.67	11.34
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	8.57
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	8.43
2. Industrial Processes	**1283.55**	**0.50**	**10.48**	**2.24**	**695.91**	**11.04**	**2000.98**	**8.66**
A. Mineral Products	797.98	NE,NO	NE,NO	NE,NO	NE,NO	NO	797.98	3.45
B. Chemical Industry	446.83	10.48	10.48	2.24	695.91	NO	1153.22	4.99
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	**55.32**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**90.04**	**0.39**
4. Agriculture	**NO**	**50.27**	**1055.75**	**7.23**	**2241.55**	**NO**	**3297.30**	**14.27**
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	1965.34	NO	1965.34	8.50
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	**-7503.70**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-7503.67**	**-32.47**
A. Forest Land	-7547.87	0.00	0.02	0.00	0.01	NO	-7547.84	-32.66
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	44.16	NE,NO	NE,NO	NE,NO	NE,NO	NO	44.16	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	**0.04**	**25.46**	**534.59**	**0.25**	**77.64**	**NO**	**612.27**	**2.65**
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	**9469.53**	**143.30**	**3009.39**	**9.94**	**3080.76**	**11.04**	**15605.44**	**67.53**
Total Emissions without LUCF	**16973.24**	**143.30**	**3009.39**	**9.94**	**3080.76**	**11.04**	**23109.11**	**100.0**
Share of Gases in Total Em./Rem.	**60.68**		**19.28**		**19.74**		**100.00**	
Share of Gases in Total Emissions	**73.45**		**13.02**		**13.33**		**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	**14779.99**	**60.71**	**1274.92**	**0.21**	**66.42**	**NO**	**16121.34**	**72.66**
A. Fuel Comb (Sectoral Appr.)	14175.12	5.21	109.42	0.32	66.42	NO	14350.97	64.68
1. Energy Industries	4670.54	0.12	2.48	0.04	7.45	NO	4680.47	21.10
2. Man. Ind. and Constr.	3700.16	0.33	6.88	0.04	9.25	NO	3716.28	16.75
3. Transport	3188.63	1.14	23.95	0.15	31.14	NO	3243.72	14.62
4. Comm./Inst, Resid., Agric.	2615.80	3.62	76.11	0.09	18.58	NO	2710.49	12.22
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	7.98
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	7.85
2. Industrial Processes	**1450.74**	**0.48**	**10.06**	**2.43**	**752.57**	**11.16**	**2224.52**	**10.03**
A. Mineral Products	963.54	NE,NO	NE,NO	NE,NO	NE,NO	NO	963.54	4.34
B. Chemical Industry	450.03	10.06	10.06	2.43	752.57	NO	1212.66	5.47
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	**63.19**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**97.91**	**0.44**
4. Agriculture	**NO**	**46.29**	**972.03**	**7.24**	**2245.52**	**NO**	**3217.54**	**14.50**
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	6.41	1988.08	NO	1988.08	8.96
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	**-7689.82**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-7689.81**	**-34.66**
A. Forest Land	-7724.68	0.00	0.01	0.00	0.00	NO	-7724.66	-34.82
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	34.85	NE,NO	NE,NO	NE,NO	NE,NO	NO	34.85	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	**0.04**	**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	**8604.13**	**128.74**	**2703.57**	**10.14**	**3144.00**	**11.16**	**14497.58**	**65.34**
Total Emissions without LUCF	**16293.96**	**128.74**	**2703.57**	**10.14**	**3144.00**	**11.16**	**22187.39**	**100.0**
Share of Gases in Total Em./Rem.	**59.35**		**18.65**		**21.69**		**100.00**	
Share of Gases in Total Emissions	**73.44**		**12.19**		**14.17**		**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	**15700.93**	**61.17**	**1284.53**	**0.23**	**70.11**	**NO**	**17055.57**	**74.23**
A. Fuel Comb (Sectoral Appr.)	15004.00	5.36	112.61	0.33	70.11	NO	15186.73	66.10
1. Energy Industries	5262.46	0.14	2.93	0.05	9.58	NO	5274.96	22.96
2. Man. Ind. and Constr.	3540.91	0.32	6.71	0.04	9.13	NO	3556.75	15.48
3. Transport	3375.08	1.19	24.97	0.15	32.32	NO	3432.38	14.94
4. Comm./Inst, Resid., Agric.	2825.55	3.71	78.00	0.09	19.09	NO	2922.64	12.72
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	696.92	55.81	1171.92	NO	NO	NO	1868.84	8.13
1. Solid Fuels	NO	NO	23.07	NO	NO	NO	23.07	NO
2. Oil and Natural Gas	696.92	54.71	1148.84	NO	NO	NO	1845.77	8.03
2. Industrial Processes	**1218.75**	**0.40**	**8.41**	**2.33**	**723.70**	**60.85**	**2011.71**	**8.76**
A. Mineral Products	743.86	NE,NO	NE,NO	NE,NO	NE,NO	NO	743.86	3.24
B. Chemical Industry	438.77	8.41	8.41	2.33	723.70	NO	1170.88	5.10
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	60.85	60.85	0.26
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**62.87**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**97.59**	**0.42**
4. Agriculture	**NO**	**44.05**	**925.08**	**6.91**	**2142.11**	**NO**	**3067.19**	**13.35**
A. Enteric Fermentation	NO	36.53	767.22	0.00	0.00	NO	767.22	3.34
B. Manure Management	NO	7.52	157.86	0.78	242.06	NO	399.92	1.74
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.13	1900.05	NO	1900.05	8.27
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	**-7474.84**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-7474.84**	**-32.53**
A. Forest Land	-7556.35	0.00	0.00	0.00	0.00	NO	-7556.34	-32.89
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	81.50	NE,NO	NE,NO	NE,NO	NE,NO	NO	81.50	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	**0.04**	**31.33**	**657.95**	**0.28**	**85.67**	**NO**	**743.67**	**3.24**
A. Solid Waste Disp. on Land	NE,NO	14.54	305.26	0.00	0.00	NO	305.26	1.33
B. Waste-water Handling	0.00	16.80	352.70	0.28	85.67	NO	438.37	1.91
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	**9507.75**	**136.95**	**2875.97**	**9.75**	**3021.60**	**60.85**	**15500.89**	**67.47**
Total Emissions without LUCF	**16982.59**	**136.95**	**2875.97**	**9.75**	**3021.60**	**60.85**	**22975.73**	**100.0**
Share of Gases in Total Em./Rem.	**61.34**		**18.55**		**19.49**		**100.00**	
Share of Gases in Total Emissions	**73.92**		**12.52**		**13.15**		**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	**16134.28**	**61.80**	**1297.83**	**0.25**	**78.36**	**NO**	**17510.5**	**74.60**
A. Fuel Comb (Sectoral Appr.)	15490.24	6.26	131.54	0.37	78.36	NO	15700.1	66.88
1. Energy Industries	5110.55	0.13	2.80	0.04	8.83	NO	5122.2	21.82
2. Man. Ind. and Constr.	3507.98	0.31	6.58	0.04	9.06	NO	3523.6	15.01
3. Transport	3642.66	1.27	26.73	0.18	37.44	NO	3706.8	15.79
4. Comm./Inst, Resid., Agric.	3229.05	4.54	95.42	0.11	23.03	NO	3347.5	14.26
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	644.04	55.54	1166.30	NO	NO	NO	1810.3	7.71
1. Solid Fuels	NO	NO	18.61	NO	NO	NO	18.6	NO
2. Oil and Natural Gas	644.04	54.65	1147.69	NO	NO	NO	1791.7	7.63
2. Industrial Processes	**1322.72**	**0.38**	**7.94**	**2.17**	**673.86**	**80.28**	**2084.8**	**8.88**
A. Mineral Products	827.84	NE,NO	NE,NO	NE,NO	NE,NO	NO	827.8	3.53
B. Chemical Industry	476.59	7.94	7.94	2.17	673.86	NO	1158.4	4.93
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	80.28	80.3	0.34
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**72.67**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**107.4**	**0.46**
4. Agriculture	**NO**	**42.24**	**886.94**	**6.98**	**2163.23**	**NO**	**3050.2**	**12.99**
A. Enteric Fermentation	NO	34.82	731.26	0.00	0.00	NO	731.3	3.12
B. Manure Management	NO	7.41	155.68	0.73	227.64	NO	383.3	1.63
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.24	1935.58	NO	1935.6	8.25
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	**-9217.48**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-9217.5**	**-39.27**
A. Forest Land	-9306.53	0.00	0.01	0.00	0.00	NO	-9306.5	-39.65
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	89.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	89.0	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	**0.04**	**30.47**	**639.96**	**0.26**	**81.19**	**NO**	**721.2**	**3.07**
A. Solid Waste Disp. on Land	NE,NO	15.32	321.80	0.00	0.00	NO	321.8	1.37
B. Waste-water Handling	0.00	15.15	318.16	0.26	81.19	NO	399.3	1.70
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	8312.22	134.89	2832.68	9.67	2996.62	80.28	14256.5	60.73
Total Emissions without LUCF	17529.70	134.89	2832.68	9.67	2996.62	80.28	23474.0	100.0
Share of Gases in Total Em./Rem.	58.30		19.87		21.02		100.0	
Share of Gases in Total Emissions	74.68		12.07		12.77		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	**17051.07**	**64.88**	**1362.41**	**0.28**	**85.62**	**NO**	**18499.10**	**74.43**
A. Fuel Comb (Sectoral Appr.)	16451.30	6.32	132.73	0.41	85.62	NO	16669.65	67.07
1. Energy Industries	5593.10	0.12	2.62	0.05	10.65	NO	5606.36	22.56
2. Man. Ind. and Constr.	3594.79	0.34	7.24	0.05	9.74	NO	3611.77	14.53
3. Transport	3983.16	1.34	28.21	0.20	42.28	NO	4053.65	16.31
4. Comm./Inst, Resid., Agric.	3280.24	4.51	94.67	0.11	22.95	NO	3397.86	13.67
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	599.78	58.56	1229.68	NO	NO	NO	1829.46	7.36
1. Solid Fuels	NO	NO	13.61	NO	NO	NO	13.61	NO
2. Oil and Natural Gas	599.78	57.91	1216.07	NO	NO	NO	1815.84	7.31
2. Industrial Processes	**1500.30**	**0.34**	**7.15**	**2.28**	**708.21**	**102.85**	**2318.51**	**9.33**
A. Mineral Products	934.87	NE,NO	NE,NO	NE,NO	NE,NO	NO	934.87	3.76
B. Chemical Industry	517.83	7.15	7.15	2.28	708.21	NO	1233.19	4.96
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	**60.31**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**95.03**	**0.38**
4. Agriculture	**NO**	**41.91**	**880.13**	**7.77**	**2408.70**	**NO**	**3288.82**	**13.23**
A. Enteric Fermentation	NO	34.63	727.27	0.00	0.00	NO	727.27	2.93
B. Manure Management	NO	7.28	152.86	0.72	223.74	NO	376.59	1.52
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.05	2184.96	NO	2184.96	8.79
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	**-9582.34**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-9582.33**	**-38.56**
A. Forest Land	-9678.92	0.00	0.01	0.00	0.00	NO	-9678.91	-38.94
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	96.58	NE,NO	NE,NO	NE,NO	NE,NO	NO	96.58	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	**0.04**	**27.13**	**569.72**	**0.26**	**81.55**	**NO**	**651.32**	**2.62**
A. Solid Waste Disp. on Land	NE,NO	16.20	340.30	0.00	0.00	NO	340.30	1.37
B. Waste-water Handling	0.00	10.92	229.42	0.26	81.55	NO	310.97	1.25
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	9029.38	134.26	2819.42	10.59	3284.08	102.85	15270.45	61.44
Total Emissions without LUCF	18611.72	134.26	2819.42	10.59	3284.08	102.85	24852.78	100.0
Share of Gases in Total Em./Rem.	59.13		18.46		21.51		100.00	
Share of Gases in Total Emissions	74.89		11.34		13.21		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	**17956.55**	**57.19**	**1200.95**	**0.29**	**89.47**	**NO**	**19246.98**	**76.79**
A. Fuel Comb (Sectoral Appr.)	17367.39	6.10	128.13	0.43	89.47	NO	17584.99	70.16
1. Energy Industries	6271.37	0.14	2.88	0.06	11.67	NO	6285.91	25.08
2. Man. Ind. and Constr.	3770.72	0.34	7.10	0.05	9.85	NO	3787.68	15.11
3. Transport	4184.09	1.39	29.11	0.22	46.50	NO	4259.71	17.00
4. Comm./Inst, Resid., Agric.	3141.20	4.24	89.03	0.10	21.45	NO	3251.69	12.97
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	6.63
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	6.57
2. Industrial Processes	**1421.30**	**0.32**	**6.65**	**1.72**	**533.19**	**130.78**	**2091.92**	**8.35**
A. Mineral Products	1003.51	NE,NO	NE,NO	NE,NO	NE,NO	NO	1003.51	4.00
B. Chemical Industry	388.43	6.65	6.65	1.72	533.19	NO	928.26	3.70
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	130.78	130.78	0.52
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**66.01**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**100.73**	**0.40**
4. Agriculture	**NO**	**41.31**	**867.41**	**6.92**	**2144.64**	**NO**	**3012.06**	**12.02**
A. Enteric Fermentation	NO	34.14	716.89	0.00	0.00	NO	716.89	2.86
B. Manure Management	NO	7.17	150.52	0.70	217.94	NO	368.46	1.47
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.22	1926.70	NO	1926.70	7.69
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	**-9692.75**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-9692.72**	**-38.67**
A. Forest Land	-9790.55	0.00	0.02	0.00	0.01	NO	-9790.53	-39.06
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	97.80	NE,NO	NE,NO	NE,NO	NE,NO	NO	97.80	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	**0.04**	**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	1.44
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	**9751.15**	**124.14**	**2606.90**	**9.18**	**2846.96**	**130.78**	**15370.51**	**61.33**
Total Emissions without LUCF	**19443.90**	**124.14**	**2606.90**	**9.18**	**2846.96**	**130.78**	**25063.23**	**100.0**
Share of Gases in Total Em./Rem.	**63.44**		**16.96**		**18.52**		**100.00**	
Share of Gases in Total Emissions	**77.58**		**10.40**		**11.36**		**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	**18461.20**	**55.96**	**1175.15**	**0.30**	**92.60**	**NO**	**19728.95**	**75.20**
A. Fuel Comb (Sectoral Appr.)	17935.95	5.86	122.97	0.44	92.60	NO	18151.52	69.18
1. Energy Industries	6467.55	0.14	2.94	0.06	11.81	NO	6482.31	24.71
2. Man. Ind. and Constr.	3506.30	0.30	6.26	0.04	8.37	NO	3520.93	13.42
3. Transport	4412.93	1.41	29.58	0.24	51.42	NO	4493.92	17.13
4. Comm./Inst, Resid., Agric.	3549.17	4.01	84.19	0.10	20.99	NO	3654.36	13.93
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	525.25	50.10	1052.18	NO	NO	NO	1577.43	6.01
1. Solid Fuels	NO	NO	4.29	NO	NO	NO	4.29	NO
2. Oil and Natural Gas	525.25	49.90	1047.89	NO	NO	NO	1573.14	6.00
2. Industrial Processes	**1773.47**	**0.27**	**5.73**	**2.03**	**629.16**	**155.22**	**2563.57**	**9.77**
A. Mineral Products	1252.87	NE,NO	NE,NO	NE,NO	NE,NO	NO	1252.87	4.78
B. Chemical Industry	492.14	5.73	5.73	2.03	629.16	NO	1127.03	4.30
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	155.22	155.22	0.59
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**56.09**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**90.81**	**0.35**
4. Agriculture	**NO**	**41.92**	**880.22**	**7.52**	**2330.28**	**NO**	**3210.50**	**12.24**
A. Enteric Fermentation	NO	33.97	713.41	0.00	0.00	NO	713.41	2.72
B. Manure Management	NO	7.94	166.81	0.72	222.82	NO	389.63	1.49
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.80	2107.45	NO	2107.45	8.03
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	**-9837.35**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-9837.35**	**-37.49**
A. Forest Land	-9878.58	0.00	0.00	0.00	0.00	NO	-9878.58	-37.65
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	41.23	NE,NO	NE,NO	NE,NO	NE,NO	NO	41.23	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	**0.04**	**26.56**	**557.70**	**0.28**	**85.38**	**NO**	**643.12**	**2.45**
A. Solid Waste Disp. on Land	NE,NO	18.18	381.84	0.00	0.00	NO	381.84	1.46
B. Waste-water Handling	0.00	8.37	175.86	0.28	85.38	NO	261.24	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	**10453.44**	**124.71**	**2618.81**	**10.12**	**3137.41**	**155.22**	**16399.59**	**62.51**
Total Emissions without LUCF	**20290.80**	**124.70**	**2618.81**	**10.12**	**3137.41**	**155.22**	**26236.95**	**100.0**
Share of Gases in Total Em./Rem.	**63.74**		**15.97**		**19.13**		**100.00**	
Share of Gases in Total Emissions	**77.34**		**9.98**		**11.96**		**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	**17938.60**	**59.21**	**1243.51**	**0.32**	**99.01**	**NO**	**19281.12**	**74.11**
A. Fuel Comb (Sectoral Appr.)	17305.59	6.30	132.40	0.47	99.01	NO	17536.99	67.41
1. Energy Industries	5877.59	0.14	3.00	0.07	14.56	NO	5895.15	22.66
2. Man. Ind. and Constr.	3616.74	0.30	6.40	0.04	8.72	NO	3631.87	13.96
3. Transport	4422.10	1.36	28.62	0.25	52.61	NO	4503.33	17.31
4. Comm./Inst, Resid., Agric.	3389.15	4.49	94.38	0.11	23.11	NO	3506.65	13.48
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	6.70
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	6.70
2. Industrial Processes	**1924.95**	**0.29**	**6.04**	**2.39**	**740.39**	**182.86**	**2854.25**	**10.97**
A. Mineral Products	1409.36	NE,NO	NE,NO	NE,NO	NE,NO	NO	1409.36	5.42
B. Chemical Industry	497.96	6.04	6.04	2.39	740.39	NO	1244.40	4.78
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	**55.57**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**90.29**	**0.35**
4. Agriculture	**NO**	**40.79**	**856.63**	**7.35**	**2278.52**	**NO**	**3135.15**	**12.05**
A. Enteric Fermentation	NO	33.42	701.73	0.00	0.00	NO	701.73	2.70
B. Manure Management	NO	7.38	154.90	0.70	216.08	NO	370.98	1.43
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.65	2062.44	NO	2062.44	7.93
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	**-10080.01**	**0.00**	**0.05**	**0.00**	**0.01**	**NO**	**-10079.95**	**-38.74**
A. Forest Land	-10112.09	0.00	0.05	0.00	0.01	NO	-10112.03	-38.87
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	32.08	NE,NO	NE,NO	NE,NO	NE,NO	NO	32.08	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	**0.04**	**27.26**	**572.49**	**0.27**	**83.10**	**NO**	**655.64**	**2.52**
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	0.97
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	9839.16	127.56	2678.73	10.33	3201.04	182.86	15936.51	61.26
Total Emissions without LUCF	19919.17	127.56	2678.73	10.33	3201.04	182.86	26016.46	100.0
Share of Gases in Total Em./Rem.	61.74		16.81		20.09		100.00	
Share of Gases in Total Emissions	76.56		10.30		12.30		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	**18762.55**	**64.25**	**1349.26**	**0.45**	**138.84**	**NO**	**20250.64**	**74.31**
A. Fuel Comb (Sectoral Appr.)	18074.91	5.13	107.66	0.66	138.84	NO	18321.41	67.23
1. Energy Industries	6376.31	0.16	3.42	0.07	15.23	NO	6394.96	23.47
2. Man. Ind. and Constr.	3613.71	0.29	6.10	0.04	8.67	NO	3628.47	13.32
3. Transport	4479.21	1.16	24.38	0.46	95.64	NO	4599.23	16.88
4. Comm./Inst, Resid., Agric.	3605.68	3.51	73.76	0.09	19.30	NO	3698.74	13.57
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	7.08
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	7.08
2. Industrial Processes	**2032.20**	**0.31**	**6.41**	**2.01**	**622.72**	**205.72**	**2867.05**	**10.52**
A. Mineral Products	1619.21	NE,NO	NE,NO	NE,NO	NE,NO	NO	1619.21	5.94
B. Chemical Industry	403.70	6.41	6.41	2.01	622.72	NO	1032.83	3.79
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	205.72	205.72	0.75
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**61.64**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**96.36**	**0.35**
4. Agriculture	**NO**	**41.67**	**875.01**	**7.91**	**2450.86**	**NO**	**3325.87**	**12.21**
A. Enteric Fermentation	NO	34.25	719.27	0.00	0.00	NO	719.27	2.64
B. Manure Management	NO	7.42	155.74	0.70	218.31	NO	374.05	1.37
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.20	2232.55	NO	2232.55	8.19
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	**-10189.37**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-10189.35**	**-37.39**
A. Forest Land	-10217.87	0.00	0.01	0.00	0.00	NO	-10217.86	-37.50
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	28.50	NE,NO	NE,NO	NE,NO	NE,NO	NO	28.50	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	**0.04**	**29.55**	**620.60**	**0.29**	**89.30**	**NO**	**709.94**	**2.61**
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	10667.06	135.78	2851.29	10.65	3301.72	205.72	17060.51	62.61
Total Emissions without LUCF	20856.43	135.78	2851.29	10.65	3301.72	205.72	27249.87	100.0
Share of Gases in Total Em./Rem.	62.52		16.71		19.35		100.00	
Share of Gases in Total Emissions	76.54		10.46		12.12		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	**19832.76**	**66.73**	**1401.33**	**0.32**	**99.49**	**NO**	**21333.58**	**75.50**
A. Fuel Comb (Sectoral Appr.)	19167.44	5.18	108.71	0.47	99.49	NO	19375.64	68.57
1. Energy Industries	7261.63	0.19	3.94	0.09	17.91	NO	7283.48	25.78
2. Man. Ind. and Constr.	3436.58	0.28	5.86	0.04	8.51	NO	3450.96	12.21
3. Transport	4777.42	1.12	23.58	0.25	53.31	NO	4854.31	17.18
4. Comm./Inst, Resid., Agric.	3691.81	3.59	75.33	0.09	19.75	NO	3786.89	13.40
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	665.32	61.55	1292.62	NO	NO	NO	1957.94	6.93
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	665.32	61.55	1292.62	NO	NO	NO	1957.94	6.93
2. Industrial Processes	**1976.37**	**0.26**	**5.39**	**1.95**	**604.48**	**237.72**	**2823.96**	**9.99**
A. Mineral Products	1607.43	NE,NO	NE,NO	NE,NO	NE,NO	NO	1607.43	5.69
B. Chemical Industry	363.78	5.39	5.39	1.95	604.48	NO	973.65	3.45
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	237.72	237.72	0.84
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**84.91**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**119.63**	**0.42**
4. Agriculture	**NO**	**41.32**	**867.78**	**7.83**	**2426.36**	**NO**	**3294.14**	**11.66**
A. Enteric Fermentation	NO	33.79	709.67	0.00	0.00	NO	709.67	2.51
B. Manure Management	NO	7.53	158.11	0.69	212.85	NO	370.96	1.31
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.14	2213.51	NO	2213.51	7.83
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	**-10231.74**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-10231.73**	**-36.21**
A. Forest Land	-10259.67	0.00	0.01	0.00	0.00	NO	-10259.66	-36.31
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	27.93	NE,NO	NE,NO	NE,NO	NE,NO	NO	27.93	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	**0.04**	**28.03**	**588.56**	**0.31**	**94.86**	**NO**	**683.46**	**2.42**
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	**11662.34**	**136.34**	**2863.07**	**10.40**	**3225.19**	**237.72**	**18023.04**	**63.79**
Total Emissions without LUCF	**21894.07**	**136.34**	**2863.07**	**10.40**	**3225.19**	**237.72**	**28254.77**	**100.0**
Share of Gases in Total Em./Rem.	**64.71**		**15.89**		**17.89**		**100.00**	
Share of Gases in Total Emissions	**77.49**		**10.13**		**11.41**		**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	**21268.49**	**68.21**	**1432.45**	**0.35**	**108.97**	**NO**	**22809.91**	**76.31**
A. Fuel Comb (Sectoral Appr.)	20584.45	6.16	129.37	0.52	108.97	NO	20822.79	69.66
1. Energy Industries	7926.94	0.22	4.55	0.09	19.73	NO	7951.22	26.60
2. Man. Ind. and Constr.	3575.58	0.31	6.54	0.05	9.56	NO	3591.68	12.02
3. Transport	5161.83	1.07	22.43	0.27	55.82	NO	5240.08	17.53
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	684.04	62.05	1303.08	NO	NO	NO	1987.12	6.65
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	684.04	62.05	1303.08	NO	NO	NO	1987.12	6.65
2. Industrial Processes	**2020.60**	**0.28**	**5.83**	**1.84**	**569.79**	**275.90**	**2872.12**	**9.61**
A. Mineral Products	1602.71	NE,NO	NE,NO	NE,NO	NE,NO	NO	1602.71	5.36
B. Chemical Industry	409.38	5.83	5.83	1.84	569.79	NO	985.00	3.30
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	**93.44**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**128.16**	**0.43**
4. Agriculture	**NO**	**43.23**	**907.78**	**7.41**	**2296.18**	**NO**	**3203.96**	**10.72**
A. Enteric Fermentation	NO	35.34	742.09	0.00	0.00	NO	742.09	2.48
B. Manure Management	NO	7.89	165.69	0.72	222.78	NO	388.47	1.30
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.69	2073.40	NO	2073.40	6.94
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	**-10460.08**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-10460.05**	**-34.99**
A. Forest Land	-10491.35	0.00	0.02	0.00	0.01	NO	-10491.32	-35.10
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	31.28	NE,NO	NE,NO	NE,NO	NE,NO	NO	31.28	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	**0.04**	**37.24**	**781.94**	**0.31**	**95.37**	**NO**	**877.35**	**2.94**
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	12922.49	148.95	3128.03	9.90	3070.31	275.90	19431.45	65.01
Total Emissions without LUCF	23382.57	148.95	3128.03	9.90	3070.31	275.90	29891.50	100.0
Share of Gases in Total Em./Rem.	66.50		16.10		15.80		100.00	
Share of Gases in Total Emissions	78.22		10.46		10.27		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	**20631.41**	**69.37**	**1456.77**	**0.51**	**159.47**	**NO**	**22247.65**	**74.38**
A. Fuel Comb (Sectoral Appr.)	19921.41	5.98	125.68	0.76	159.47	NO	20206.56	67.56
1. Energy Industries	6813.84	0.21	4.40	0.08	17.75	NO	6835.99	22.86
2. Man. Ind. and Constr.	3976.89	0.36	7.55	0.05	11.36	NO	3995.80	13.36
3. Transport	5297.15	0.99	20.81	0.51	107.16	NO	5425.13	18.14
4. Comm./Inst, Resid., Agric.	3833.52	4.42	92.92	0.11	23.20	NO	3949.64	13.21
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	710.00	63.39	1331.09	NO	NO	NO	2041.09	6.82
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	710.00	63.39	1331.09	NO	NO	NO	2041.09	6.82
2. Industrial Processes	**2210.68**	**0.27**	**5.73**	**2.24**	**695.34**	**313.16**	**3224.91**	**10.78**
A. Mineral Products	1700.36	NE,NO	NE,NO	NE,NO	NE,NO	NO	1700.36	5.68
B. Chemical Industry	495.43	5.73	5.73	2.24	695.34	NO	1196.49	4.00
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	313.16	313.16	1.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**117.96**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**152.68**	**0.51**
4. Agriculture	**NO**	**45.25**	**950.32**	**8.05**	**2496.02**	**NO**	**3446.34**	**11.52**
A. Enteric Fermentation	NO	36.75	771.66	0.00	0.00	NO	771.66	2.58
B. Manure Management	NO	8.51	178.66	0.73	227.73	NO	406.39	1.36
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.32	2268.29	NO	2268.29	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	**-10707.63**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-10707.63**	**-35.80**
A. Forest Land	-10739.44	0.00	0.00	0.00	0.00	NO	-10739.44	-35.91
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	31.82	NE,NO	NE,NO	NE,NO	NE,NO	NO	31.82	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	**0.04**	**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	**12252.46**	**150.30**	**3156.27**	**11.12**	**3445.92**	**313.16**	**19202.52**	**64.20**
Total Emissions without LUCF	**22960.08**	**150.30**	**3156.27**	**11.12**	**3445.92**	**313.16**	**29910.15**	**100.0**
Share of Gases in Total Em./Rem.	**63.81**		**16.44**		**17.95**		**100.00**	
Share of Gases in Total Emissions	**76.76**		**10.55**		**11.52**		**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	**20988.58**	**69.08**	**1450.75**	**0.52**	**159.71**	**NO**	**22599.03**	**74.65**
A. Fuel Comb (Sectoral Appr.)	20297.58	5.73	120.23	0.76	159.71	NO	20577.51	67.97
1. Energy Industries	6841.09	0.20	4.26	0.09	18.45	NO	6863.80	22.67
2. Man. Ind. and Constr.	4081.03	0.33	6.92	0.05	10.39	NO	4098.34	13.54
3. Transport	5508.50	0.91	19.17	0.52	108.63	NO	5636.31	18.62
4. Comm./Inst, Resid., Agric.	3866.95	4.28	89.88	0.11	22.24	NO	3979.06	13.14
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	691.00	63.36	1330.52	NO	NO	NO	2021.52	6.68
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	691.00	63.36	1330.52	NO	NO	NO	2021.52	6.68
2. Industrial Processes	**2239.78**	**0.25**	**5.33**	**2.19**	**678.84**	**347.30**	**3271.25**	**10.81**
A. Mineral Products	1743.89	NE,NO	NE,NO	NE,NO	NE,NO	NO	1743.89	5.76
B. Chemical Industry	484.65	5.33	5.33	2.19	678.84	NO	1168.82	3.86
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	347.30	347.30	1.15
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**142.63**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**177.35**	**0.59**
4. Agriculture	**NO**	**45.78**	**961.34**	**8.12**	**2516.31**	**NO**	**3477.65**	**11.49**
A. Enteric Fermentation	NO	38.37	805.76	0.00	0.00	NO	805.76	2.66
B. Manure Management	NO	7.41	155.58	0.72	224.03	NO	379.61	1.25
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.39	2292.28	NO	2292.28	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	**-10752.58**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-10752.57**	**-35.52**
A. Forest Land	-10788.55	0.00	0.00	0.00	0.00	NO	-10788.55	-35.64
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	35.98	NE,NO	NE,NO	NE,NO	NE,NO	NO	35.98	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	**0.03**	**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	12618.44	146.17	3069.59	11.13	3450.78	347.30	19520.83	64.48
Total Emissions without LUCF	23371.01	146.17	3069.59	11.13	3450.78	347.30	30273.40	100.0
Share of Gases in Total Em./Rem.	64.64		15.72		17.68		100.00	
Share of Gases in Total Emissions	77.20		10.14		11.40		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	**20972.46**	**75.73**	**1590.36**	**0.36**	**112.18**	**NO**	**22675.00**	**73.95**
A. Fuel Comb (Sectoral Appr.)	20309.46	5.65	118.62	0.53	112.18	NO	20540.26	66.99
1. Energy Industries	6629.02	0.19	4.05	0.08	17.31	NO	6650.38	21.69
2. Man. Ind. and Constr.	4181.48	0.34	7.10	0.05	11.07	NO	4199.64	13.70
3. Transport	5869.07	0.88	18.49	0.29	61.90	NO	5949.46	19.40
4. Comm./Inst, Resid., Agric.	3629.88	4.24	88.99	0.10	21.90	NO	3740.77	12.20
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	663.00	70.08	1471.74	NO	NO	NO	2134.74	6.96
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	663.00	70.08	1471.74	NO	NO	NO	2134.74	6.96
2. Industrial Processes	**2364.39**	**0.34**	**7.09**	**2.17**	**671.21**	**378.52**	**3421.21**	**11.16**
A. Mineral Products	1873.79	NE,NO	NE,NO	NE,NO	NE,NO	NO	1873.79	6.11
B. Chemical Industry	477.34	7.09	7.09	2.17	671.21	NO	1155.65	3.77
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	378.52	378.52	1.23
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**170.55**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**205.27**	**0.67**
4. Agriculture	**NO**	**47.65**	**1000.70**	**8.06**	**2497.54**	**NO**	**3498.24**	**11.41**
A. Enteric Fermentation	NO	39.09	820.84	0.00	0.00	NO	820.84	2.68
B. Manure Management	NO	8.57	179.87	0.75	231.79	NO	411.66	1.34
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.31	2265.74	NO	2265.74	7.39
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	**-10784.86**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-10784.86**	**-35.17**
A. Forest Land	-10821.51	0.00	0.00	0.00	0.00	NO	-10821.51	-35.29
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	36.65	NE,NO	NE,NO	NE,NO	NE,NO	NO	36.65	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	**0.04**	**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	1.86
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	**12722.58**	**160.02**	**3360.45**	**10.91**	**3381.35**	**378.52**	**19877.61**	**64.83**
Total Emissions without LUCF	**23507.44**	**160.02**	**3360.45**	**10.91**	**3381.35**	**378.52**	**30662.47**	**100.0**
Share of Gases in Total Em./Rem.	**64.00**		**16.91**		**17.01**		**100.00**	
Share of Gases in Total Emissions	**76.67**		**10.96**		**11.03**		**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	**22205.55**	**82.05**	**1723.11**	**0.37**	**115.18**	**NO**	**24043.85**	**74.65**
A. Fuel Comb (Sectoral Appr.)	21540.55	5.01	105.31	0.55	115.18	NO	21761.04	67.57
1. Energy Industries	7737.32	0.22	4.69	0.09	18.94	NO	7760.95	24.10
2. Man. Ind. and Constr.	4204.52	0.35	7.39	0.05	10.97	NO	4222.89	13.11
3. Transport	6297.29	0.85	17.81	0.32	66.47	NO	6381.57	19.81
4. Comm./Inst, Resid., Agric.	3301.42	3.59	75.41	0.09	18.81	NO	3395.64	10.54
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	665.00	77.04	1617.80	NO	NO	NO	2282.80	7.09
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	665.00	77.04	1617.80	NO	NO	NO	2282.80	7.09
2. Industrial Processes	**2437.41**	**0.31**	**6.43**	**2.39**	**741.40**	**418.71**	**3603.96**	**11.19**
A. Mineral Products	1903.49	NE,NO	NE,NO	NE,NO	NE,NO	NO	1903.49	5.91
B. Chemical Industry	521.51	6.43	6.43	2.39	741.40	NO	1269.34	3.94
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	418.71	418.71	1.30
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**193.60**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**228.32**	**0.71**
4. Agriculture	**NO**	**45.62**	**958.09**	**8.00**	**2481.08**	**NO**	**3439.17**	**10.68**
A. Enteric Fermentation	NO	37.70	791.66	0.00	0.00	NO	791.66	2.46
B. Manure Management	NO	7.93	166.44	0.72	222.15	NO	388.59	1.21
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.29	2258.92	NO	2258.92	7.01
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	**- 11170.92**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**- 11170.91**	**-34.68**
A. Forest Land	- 11218.21	0.00	0.01	0.00	0.00	NO	- 11218.21	-34.83
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	47.30	NE,NO	NE,NO	NE,NO	NE,NO	NO	47.30	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	**0.08**	**37.67**	**791.10**	**0.33**	**101.09**	**NO**	**892.27**	**2.77**
A. Solid Waste Disp. on Land	NE,NO	29.14	611.87	0.00	0.00	NO	611.87	1.90
B. Waste-water Handling	0.00	8.53	179.23	0.33	101.09	NO	280.32	0.87
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	**13665.73**	**165.65**	**3478.75**	**11.09**	**3438.75**	**418.71**	**21036.66**	**65.32**
Total Emissions without LUCF	**24836.64**	**165.65**	**3478.75**	**11.09**	**3438.75**	**418.71**	**32207.57**	**100.0**
Share of Gases in Total Em./Rem.	**64.96**		**16.54**		**16.35**		**100.00**	
Share of Gases in Total Emissions	**77.11**		**10.80**		**10.68**		**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	**21070.61**	**77.72**	**1632.21**	**0.36**	**110.13**	**NO**	**22812.95**	**73.68**
A. Fuel Comb (Sectoral Appr.)	20494.78	5.03	105.63	0.52	110.13	NO	20710.54	66.89
1. Energy Industries	6703.90	0.19	3.90	0.08	17.36	NO	6725.15	21.72
2. Man. Ind. and Constr.	4197.67	0.33	6.95	0.05	10.07	NO	4214.68	13.61
3. Transport	6162.16	0.78	16.33	0.30	63.30	NO	6241.80	20.16
4. Comm./Inst, Resid., Agric.	3431.06	3.74	78.44	0.09	19.40	NO	3528.90	11.40
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	6.79
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	6.79
2. Industrial Processes	**2371.23**	**0.23**	**4.81**	**2.44**	**756.66**	**437.38**	**3570.09**	**11.53**
A. Mineral Products	1817.34	NE,NO	NE,NO	NE,NO	NE,NO	NO	1817.34	5.87
B. Chemical Industry	530.39	4.81	4.81	2.44	756.66	NO	1291.85	4.17
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	437.38	437.38	1.41
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**183.99**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**218.71**	**0.71**
4. Agriculture	**NO**	**46.65**	**979.56**	**7.90**	**2447.86**	**NO**	**3427.42**	**11.07**
A. Enteric Fermentation	NO	39.05	820.08	0.00	0.00	NO	820.08	2.65
B. Manure Management	NO	7.59	159.47	0.68	209.80	NO	369.27	1.19
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.22	2238.06	NO	2238.06	7.23
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	**- 11166.58**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**- 11166.57**	**-36.07**
A. Forest Land	- 11215.59	0.00	0.00	0.00	0.00	NO	- 11215.59	-36.22
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	49.02	NE,NO	NE,NO	NE,NO	NE,NO	NO	49.02	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	**0.25**	**39.51**	**829.80**	**0.33**	**101.79**	**NO**	**931.84**	**3.01**
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	0.87
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	**12459.50**	**164.11**	**3446.38**	**11.02**	**3416.44**	**437.38**	**19794.43**	**63.93**
Total Emissions without LUCF	**23626.08**	**164.11**	**3446.38**	**11.02**	**3416.44**	**437.38**	**30961.00**	**100.0**
Share of Gases in Total Em./Rem.	**62.94**		**17.41**		**17.26**		**100.00**	
Share of Gases in Total Emissions	**76.31**		**11.13**		**11.03**		**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 2008	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**19773.15**	**75.27**	**1580.57**	**0.35**	**107.95**	**NO**	**21461.67**	**74.35**
A. Fuel Comb (Sectoral Appr.)	19256.72	5.14	107.98	0.51	107.95	NO	19472.65	67.46
1. Energy Industries	6373.45	0.19	4.07	0.07	14.82	NO	6392.34	22.15
2. Man. Ind. and Constr.	3378.56	0.30	6.20	0.04	8.83	NO	3393.59	11.76
3. Transport	6076.86	0.72	15.11	0.31	64.10	NO	6156.08	21.33
4. Comm./Inst, Resid., Agric.	3427.84	3.93	82.59	0.10	20.21	NO	3530.65	12.23
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	6.89
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	6.89
2. Industrial Processes	**1884.56**	**0.08**	**1.73**	**2.04**	**632.40**	**443.07**	**2961.76**	**10.26**
A. Mineral Products	1428.07	NE,NO	NE,NO	NE,NO	NE,NO	NO	1428.07	4.95
B. Chemical Industry	445.19	1.73	1.73	2.04	632.40	NO	1079.32	3.74
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	443.07	443.07	1.53
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
3. Solvent and Other Product Use	**97.54**	**NO**	**NO**	**0.11**	**33.59**	**NO**	**131.13**	**0.45**
4. Agriculture	**NO**	**46.97**	**986.46**	**7.51**	**2328.01**	**NO**	**3314.47**	**11.48**
A. Enteric Fermentation	NO	38.77	814.10	0.00	0.00	NO	814.10	2.82
B. Manure Management	NO	8.21	172.36	0.68	212.24	NO	384.60	1.33
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.83	2115.77	NO	2115.77	7.33
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	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**0.00**	**0.00**
A. Forest Land	0.00	0.00	0.00	0.00	0.00	NO	0.00	0.00
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	0.00	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.00	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	**0.13**	**42.57**	**893.89**	**0.33**	**102.43**	**NO**	**996.44**	**3.45**
A. Solid Waste Disp. on Land	NE,NO	34.20	718.14	0.00	0.00	NO	718.14	2.49
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	**21755.39**	**164.89**	**3462.65**	**10.23**	**3170.79**	**443.07**	**28865.49**	**100.00**
Total Emissions without LUCF	**21755.39**	**164.89**	**3462.65**	**10.23**	**3170.79**	**443.07**	**28865.49**	**100.0**
Share of Gases in Total Em./Rem.	**75.37**		**12.00**		**10.98**		**100.00**	
Share of Gases in Total Emissions	**75.37**		**12.00**		**10.98**		**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	1,523.84	NO	NO	NO	NO	NO	1523.84	

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 2009

Fuel	Net Caloric Value			Carbon emission factor[28] (t C/TJ)	CO_2 emission factor (t CO_2/TJ) (with OF=1.0)	Real oxidation factor (OF)
	Unit	1990	2009			
SOLID FUELS						
Anthracite	TJ/Gg	29.29	29.31	26.8	98.27	0.98
Other Bituminous Coal	TJ/Gg	25.14	24.60	25.8	94.60	0.98
Sub-Bituminous Coal	TJ/Gg	16.74	18.00	26.2	96.07	0.98
Lignite	TJ/Gg	10.90	11.70	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	18.72	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

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