Republic of Croatia

Ministry of Environmental Protection,
Physical Planning and Construction

NATIONAL INVENTORY REPORT 2010

Submission to the UNFCCC and the Kyoto Protocol

EKONERG – Energy and Environmental Protection Institute
Koranska 5, 10000 Zagreb, Croatia

Ordered by: Croatian Environment Agency

Contract No.: 10-09-501/1

Title:

NATIONAL INVENTORY REPORT 2010

Croatian greenhouse gas inventory for the period 1990-2008

Project Coordinator: Andrea Hublin

List of Authors:
Iva Švedek (Energy, CRF Database manager)
Mirela Poljanac (support for Road Transport)
Andrea Hublin (Industrial processes, Solvent and Other Product Use, Waste)
Renata Kos (support for Industrial processes, Solvent and Other Product Use)
Duška Šaša (Agriculture, LULUCF)
Berislav Marković (support for Agriculture, LULUCF)
Davor Vešligaj (QA/QC manager)

External Authors:
Branko Vuk, Energy Institute Hrvoje Požar
Milan Mesić, Faculty of Agriculture

Atmospheric Protection Department Manager:	General Manager:
Davor Vešligaj	Zdravko Mužek

Zagreb, April 2010

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*

LIST OF TABLES AND FIGURES

LIST OF TABLES

LIST OF FIGURES

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.

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

[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.

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. 2/07) 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 2008. 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 five reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005, 2006 and 2009. 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 2010 inventory submission.

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

Source	Emissions and removals of GHG (Gg CO_2-eq)						
	1990	1995	2000	2005	2006	2007	2008
Energy	22160	16463	18766	22226	22378	23628	22473
Industrial Processes	4198	2574	3229	3691	3873	4082	4130
Solvent and Other Product Use	131	124	115	203	231	236	82
Agriculture	4336	3046	3120	3470	3487	3432	3349
Waste	590	727	643	800	855	887	930
Total emission (excluding net CO_2 from LULUCF)	**31416**	**22934**	**25873**	**30390**	**30825**	**32265**	**30963**
Removals (LULUCF)	-4185	-9154	-5281	-8227	-9018	-7990	-6479
Total emission (including LULUCF)	**27231**	**13780**	**20592**	**22163**	**21807**	**24276**	**24485**

Table ES.3-2: Emissions/removals of GHG by gases for the period 1990-2008 (Gg CO_2-eq)

Source	Emissions and removals of GHG (Gg CO_2-eq)						
	1990	1995	2000	2005	2006	2007	2008
Carbon dioxide (CO_2)	23108	17001	19927	23378	23520	24814	23516
Methane (CH_4)	3442	2867	2674	3129	3357	3475	3374
Nitrous oxide (N_2O)	3918	3047	3237	3519	3501	3495	3471
HFCs, PFCs and SF_6	948	20	35	365	447	482	602
Total emission (excluding net CO_2 from LULUCF)	**31416**	**22934**	**25873**	**30390**	**30825**	**32265**	**30963**
Removals (LULUCF)	-4185	-9154	-5281	-8227	-9018	-7990	-6479
Total emission (including LULUCF)	**27231**	**13780**	**20592**	**22163**	**21807**	**24276**	**24485**

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 2008 has the Energy Sector with 72.6 percent, followed by Industrial Processes with 13.3 percent, Agriculture with 10.8 percent, Waste with 3.0 percent and Solvent and Other product Use with 0.7 percent. This structure is with minor changes consistent through all the observed period from 1990 to 2008. In the year 2008, the amount of removed emissions of the greenhouse gases by CO_2 from the forestry sector was 20.9 percent.

Energy sector is the largest contributor to greenhouse gas emissions. In this sector, in the year 2008, the total energy consumption was 4.8 percent lower than in the former year 2007, whereat the total largest increase was in consumption of liquid fuels (7.2 percent) from the Energy Industries sector (22.6 percent). Decrease in total energy consumption is mostly due to favourable hydrological conditions which leaded to increase in hydro power utilisation by 21.0 percent. The CO_2 emission from Energy industries sector was 6704 Gg in 2008, representing 21.7 percent in total greenhouse emission in the Republic of Croatia.

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). 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. In 2007 and 2008, cattle number decreased; in 2008, the number of cattle decreased by 2.9 percent when compared with the previous year. Direct N_2O emission from cultivation of agricultural soils, emission from animal manure (Manure Management) and indirect emission have been more or less stable for the past ten years.

In Industrial Processes sector the key emission sources are Cement Production, Lime Production, Ammonia Production, Nitric Acid Production and Consumption of HFCs in Refrigeration and Air Conditioning Equipment, which all together contribute with 99 percent in total sectoral emission in 2008. 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. 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 2008, 3.2 millions of tons of clinker was produced. The ammonia production in 2008 was 8.6 percent higher in comparison to the previous year. Also, the nitric acid production in 2008 was 10.1 percent higher in comparison to 2007. 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 2008 with 0.7 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 2005-2008 have been included in emission estimation. It should be emphasized that Solid Waste Disposal on Land contributes with 70.5 percent in total sectoral emission in 2008. Waste sector contributes to total greenhouse gas emissions with 2.1 percent in 2008.

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 1990-2008 (Gg CO_2)

Sector	1990	1995	2000	2005	2006	2007	2008
Energy	20581	15090	17400	20569	20576	21762	20703
Industrial processes	2430	1822	2446	2641	2747	2851	2766
Solvent and Other Product Use	96	89	80	169	197	201	47
LULUCF	-4185	-9154	-5281	-8227	-9018	-7990	-6479
Total CO_2 emission	**23108**	**17001**	**19927**	**23378**	**23520**	**24814**	**23516**
Net CO_2 emission	**18923**	**7847**	**14646**	**15151**	**14502**	**16825**	**17038**

ES.3.1.1. ENERGY SECTOR

This sector covers all the activities which include fossil fuel consumption 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 75.9 percent in total greenhouse gas emission. CO_2 emission from fuel combustion makes the largest part of it (90.2 percent of emission in the Energy sector). Emission by sub-sectors is presented in table ES.3-4.

Table ES.3-4: CO_2 emission by sub-sectors from 1990-2008 (Gg CO_2)

Source	1990	1995	2000	2005	2006	2007	2008
Energy Industries	7144	5275	5895	6864	6650	7761	6725
Manufacturing Industries & Constr.	5475	2943	3091	3675	3797	3780	3784
Transport (Road & Off-Road)	4082	3454	4529	5687	6055	6409	6242
Comm./Inst., Resid., Agr /For./Fish.)	3794	2923	3699	3979	3741	3396	3529
Fugitive emissions	1666	1869	1987	2022	2135	2283	2193
Total CO_2 emission	**22160**	**16463**	**16995**	**22226**	**22378**	**23628**	**22473**

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 sectoral and reference approach for Croatia is around 1.5 percent which is within the acceptable values (table ES.3-5).

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

	1990	1995	2000	2005	2006	2007	2008
Reference appr.	20342	14176	16923	20257	20128	21442	20304
Sectoral appr.	20165	14393	16767	19878	19913	21097	20037
Relative Diff (%)	**0.9**	**-1.5**	**0.9**	**1.9**	**1.1**	**1.6**	**1.3**

Two energy most intensive sub-sectors are energy transformation (thermal power plants, heating plants, refineries and oil and gas field combustion) and manufacturing industry and construction. In the framework of the sub-sector Manufacturing Industry and Construction, the largest CO_2 emissions are the result of fuel combustion in construction material industry and than in iron and steel industry, non-metal industry, chemical industry, industry of pulp, paper and print, food and drink production, tobacco production etc. Furthermore, this sub-sector includes electricity and heat production in manufacturing industry for manufacturing processes.

Transport is also one of more important CO_2 emission sources. The largest part of the emission arises from Road transportation (86-95 percent depending on the year) followed by navigation, railways and domestic civil aviation. Emission from fuel sold for the international aviation and marine transportation is reported separately and it's not included in total national emission balance. In the year 2008, emission from Transport sector contributed with 19.8 percent to total greenhouse gas emission.

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. The natural gas exploited on Croatian fields is rich in carbon dioxide (more than 15 percent) and before the natural gas is distributed in commercial gas pipeline it is necessary to remove the CO_2 (scrubbing) so that the maximum volume share of CO_2 in natural gas is 3 percent.

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 in 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 monthly 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 1990-2008 (Gg CO_2)

Source	1990	1995	2000	2005	2006	2007	2008
Cement production	1085.8	628.7	1243.6	1499.9	1588.0	1611.9	1526.9
Lime production	160.6	83.4	137.8	198.4	244.5	254.5	251.4
Limestone and dolomite use	51.5	17.4	16.1	26.5	24.0	21.5	23.5
Soda ash production and use	25.7	14.4	11.3	17.2	15.1	13.4	13.4
Ammonia production	871.0	1044.3	1022.1	894.6	870.4	945.0	942.5
Ferroalloys production	118.8	31.9	12.2	NO	NO	NO	942.5
Aluminium production	111.4	NO	NO	NO	NO	NO	NO
Iron and steel production	5.5	1.5	3.0	4.3	5.1	5.1	8.6
Total CO_2 emission	**2430.3**	**1821.6**	**2446.2**	**2640.8**	**2747.1**	**2851.4**	**3708.8**

The most significant CO_2 industrial processes emission sources are production of cement, ammonia and lime. In 2008, cement production contributes in total sectoral CO_2 emission with 39.6 percent, lime production with 6.2 percent and ammonia production with 23.2 percent. Generally, CO_2 emissions from industrial processes declined from 1990 to 1995, due to the decline in industrial activities. However in the next period from 1996-2008 the emission was increasing to the level reported in 1990.

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 natural gas provides both feedstock and fuel. Emission of CO_2 from natural gas used as feedstock and fuel is stehiometrically determined based on carbon content in natural gas. Emissions of CH_4 and N_2O from natural gas used as fuel have been calculated by means of multiplying annual energy consumption of natural gas by default emission factors. 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

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

The Forest Management Area Plan of the Republic of Croatia for the period 2006-2015 determines 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 quality and quantity of increment can be improved by different methods of forest cultivation. Annual cut is a part of the forest timber stock planned for commercial harvesting for a certain period (1 year, 10 years, 20 years) expressed in timber stock (m^3) or timber stock per area (m^3/ha). To satisfy the basic principles of the sustainable forest management, the annual cut must not be larger than the increment value. 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.

The methodology used for CO_2 removal calculation is taken from the IPCC and it is based on data on annual increment, commercial roundwood fellings, fuelwood gathering and wildfires. GHG emissions are estimated only for aboveground and belowground biomass. Other carbon pools, dead wood, litter and soil, are not included due to lack of activity data. Table ES.3-7 shows the CO_2 emission removal trend in the forestry sector.

Table ES.3-7: CO_2 emission removal in forestry sector from 1990-2008 (Gg CO_2)

	1990	1995	2000	2005	2006	2007	2008
Removals	4185	9154	5281	8227	9018	7990	6479

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 1990-2008 (Gg CH_4)

Source	1990	1995	2000	2005	2006	2007	2008
Energy	69.6	61.5	59.5	69.3	76.0	82.3	77.9
Industrial Processes	0.8	0.4	0.3	0.3	0.4	0.3	0.3
Agriculture	69.7	44.0	40.8	45.8	47.7	45.6	43.4
Waste	23.8	30.5	26.6	33.6	35.8	37.2	39.1
Total CH_4 emission	163.9	136.5	127.3	149.0	159.9	165.5	160.7

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 about 44.2 percent; venting and flaring of gas/oil production accounts with approximately 1.1 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.

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 1990-2008 (Gg N_2O)

Source	1990	1995	2000	2005	2006	2007	2008
Energy	0.4	0.3	0.4	0.7	0.7	0.4	0.4
Industrial Processes	2.6	2.3	2.4	2.2	2.2	2.4	2.4
Agriculture	9.3	6.8	7.3	8.1	8.0	8.0	7.9
Waste	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total N_2O emission	12.6	9.8	10.4	11.4	11.3	11.3	11.2

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. 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 the sector Industrial Processes, 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. According to survey carried out among major agents, users and consumers of these gases, information related to import and export of HFCs (provided by the Ministry of Environmental Protection, Physical Planning and Construction, 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: Halogenated carbons emission in the period from 1990-2008 (Gg CO_2-eq)

	1990	1995	2000	2005	2006	2007	2008
HFC, PFC and SF_6 emission	948	20	35	365	447	482	602

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 2008* Submission to the Convention on Long-range Transboundary Air Pollution'.

The calculations of aggregated results for the emissions of indirect gases in the period 1990-2008 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
NO_x Emission	**88.84**	**61.81**	**70.81**	**69.93**	**70.39**	**74.18**	**70.41**
Energy Industries	13.61	11.54	11.99	12.04	11.15	13.39	9.80
Manufacturing Ind. & Construction	17.38	8.80	9.15	9.91	11.16	14.56	15.35
Transport	39.88	30.80	34.24	32.50	32.68	32.42	30.76
Other Energy (fuel combustion)	15.03	8.13	12.85	13.15	13.24	12.86	13.51
Fugitive Emission from Fuels	0.41	0.32	0.31	0.30	0.28	0.30	0.26
Industrial Processes	2.38	2.22	2.28	2.04	1.87	0.64	0.73
Agriculture	0.15	0.00	0.00	0.00	0.00	0.00	0.00
LULUCF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO Emission	**537.29**	**368.34**	**389.70**	**293.85**	**313.70**	**287.96**	**250.24**
Energy Industries	1.54	1.11	1.21	0.93	1.35	1.89	1.09
Manufacturing Ind. & Construction.	39.71	40.36	36.43	32.93	36.69	42.30	36.51
Transport	240.26	177.19	175.05	109.22	102.51	92.73	82.91
Other Energy (fuel combustion)	203.95	116.68	146.39	132.96	133.47	115.58	120.06
Fugitive Emission from Fuels	0.62	0.48	0.46	0.45	0.42	0.46	0.39
Industrial Processes	46.86	32.52	30.12	17.36	39.25	35.00	9.27
Agriculture	4.34	0.00	0.00	0.00	0.00	0.00	0.00
LULUCF	0.01	0.00	0.03	0.00	0.00	0.01	0.01
NMVOC Emission	**112.60**	**79.75**	**82.88**	**101.16**	**109.59**	**109.91**	**55.49**
Energy Industries	0.32	0.23	0.28	0.29	0.29	0.34	0.27
Manufacturing Ind. & Construction	1.69	1.35	1.43	1.76	1.86	2.01	2.11
Transport	33.53	25.45	28.60	17.52	17.64	16.09	15.00
Other Energy (fuel combustion)	12.14	6.91	9.01	8.29	8.37	7.41	7.72
Fugitive Emission from Fuels	9.75	7.77	9.73	9.05	9.03	8.89	8.09
Industrial Processes	22.32	7.64	6.36	6.69	5.32	6.58	6.33
Solvent Use	32.84	30.40	27.46	57.56	67.09	68.60	15.98
SO_2 Emission	**170.39**	**83.52**	**63.49**	**64.41**	**61.39**	**71.44**	**54.74**
Energy Industries	78.51	44.48	25.39	32.76	30.44	38.94	25.21
Manufacturing Ind. & Construction	53.32	24.54	18.94	10.18	10.19	15.82	13.84
Transport	5.46	3.52	6.01	8.36	8.88	5.24	5.13
Other Energy (fuel combustion)	23.87	4.65	6.50	6.63	5.85	4.89	4.62
Fugitive Emission from Fuels	6.38	4.96	4.80	4.60	4.39	4.72	4.01
Industrial Processes	2.84	1.36	1.85	1.88	1.64	1.83	1.93

1. INTRODUCTION

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 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

[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.

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. 2/07) 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 2008. 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.

1.2. 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 2010 inventory submission.

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
- 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:
  - o Draft of National implementation strategy and action plan
  - o 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 five reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005, 2006 and 2009. 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, CO, NO_x, NMVOCs, and SO_2.

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% 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.

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 Level Assessment including/excluding LULUCF for 1990 and 2008 are shown in Tables A1-2 to A1-7 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 Trend Assessment including/excluding LULUCF are shown in Tables from A1-8 to A1-12, 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.

Finally, the results of the Key Category analysis including/excluding LULUCF are summarized by sector and gas in Table A1-13 and A1-14 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 2008.

Some changes in the Key Categories occurred in NIR 2010 in relation to NIR 2009, e.g. CO_2 Emissions from Stationary Combustion: Coal, Mobile Combustion: Agriculture/Forestry/Fishing, N_2O Emissions from Nitric Acid Production, CO_2 Emissions from Ferroalloys Production, CO_2 Emissions from Aluminium Production, HFC Emissions from Consumption of HFCs, PFC Emissions from Aluminium production, CH_4 Emissions from Manure Management, N_2O Emissions from Manure Management, Direct N_2O Emissions from Agricultural Soils, CH_4 Emissions from Waste Water Handling are included to Trend assessment. These changes are shown in Table A1-12.

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. Therefore, QA/QC plan defines procedures to assure quality of the greenhouse gas inventory. Accordingly, Croatian Environment Agency prepared QA/QC programme upon which yearly QA/QC plan is prepared. The Programme reflects roles and responsibilities of institutions being part of the National System, and provides background for the preparation of the yearly Quality Assurance and Quality Control Plan.

Croatia has prepared QA/QC plan for 2008 reporting cycle following the recommendations from documents: *Quality Assurance and Quality Control Plan, Samples and Manual for Development* which was prepared under regional UNDP/GEF project Capacity building for improving the quality of GHG inventories (RER/01/G31), *Quality Assurance and Quality Control Plan, Samples and Manual for Development* which was prepared dr. Natalya Parasyuk for project "Capacity building for improving the quality of GHG inventories" (RER/01/G31) and Good Practice Guidance and Uncertainty Management in National GHG Inventories.

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 process:

- Gathering, entering and handling activity data;
- Documenting and archiving activity data;
- Emission calculation and its verification.

General (Tier 1) and source-specific (Tier 2) QC procedures are outlined in *Good Practice Guidance and Uncertainty Management in National GHG Inventories* were followed. Accordingly, within the regional UNDP/GEF project Capacity building for improving the quality of GHG inventories (RER/01/G31), *Manuals of procedures for Compiling, Archiving, Updating and Managing of GHG Inventory for each IPCC sector*[3] were prepared in order to support Authorized Institution in selecting methodology, emission factors and activity data, estimating uncertainties, QA/QC activities, reporting, documenting and improving the inventory. These manuals also contain detail information on national circumstances particularly related to status of activity data, data gaps and short- and medium-term actions for improvement of the inventory.

For the purposes of transparency of the emission calculation, 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 carries out an audit which covers all IPCC sectors in the NIR with purpose to check which quality control elements, both general and specific, 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.

[3] UNDP/GEF regional project “Capacity building for improving the quality of GHG inventories”

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 Croatian inventory team estimates uncertainties using Tier 1 method described by the IPCC, which provides 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 uncertainty analysis the total uncertainty excluding LULUCF is 15.5 percent, while the total uncertainty including LULUCF is 15.8 percent. The uncertainty introduced into the trend in total national emissions excluding LULUCF is estimated to be 14.8 percent and including LULUCF 9.3 percent. The combined uncertainty as a share of total emissions is dominated by CH_4 emissions from fugitive emissions from oil and gas operations (uncertainty of the 3.2 percent excluding LULUCF and 13.3 percent including LULUCF). Furthermore, LULUCF sources/sink shows quite large uncertainty of 9.4 percent.

The results of the Tier 1 approach are shown in Table A5-1 and A5-2 (Annex 5), where the shaded rows represent key categories.

1.8. GENERAL ASSESSMENT OF THE COMPLETENESS

Croatian inventory consists of the emission estimates for the period from 1990-2008.

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 2008, excluding removals by sinks, amounted to 30.963 mil. t CO_2-eq (equivalent CO_2 emissions), which represents 1.4 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 2007. Emission has been reduced by 4 percent in 2008 regarding 2007.

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 2008 is favourable hydrological conditions which leaded to increase in hydro power utilisation by 27.0%, as well as slightly decrease in cement and lime production.

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 2008, the shares of GHG emissions were as follows: 75.9 percent CO_2, 10.9 percent CH_4, 11.2 percent N_2O, 1.9 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 (1990-2008)

Gas	Emissions and removals of GHG (Gg CO_2-eq)						
	1990	1995	2000	2005	2006	2007	2008
CO_2	23108	17001	19927	23378	23520	24814	23516
CH_4 as CO_2-eq	3442	2867	2674	3129	3357	3475	3374
N_2O as CO_2-eq	3918	3047	3237	3519	3501	3495	3471
HFCs as CO_2-eq	NO	8	23	349	431	465	585
PFCs as CO_2-eq	937	0	0	0	0	0	0
SF_6 as CO_2-eq	11	12	12	16	16	17	17
Total GHG emission	**31416**	**22934**	**25873**	**30390**	**30825**	**32265**	**30963**
Removals (CO_2)	-4185	-9154	-5281	-8227	-9018	-7990	-6479
Total emission (including LULUCF)	**27231**	**13780**	**20592**	**22163**	**21807**	**24276**	**24485**

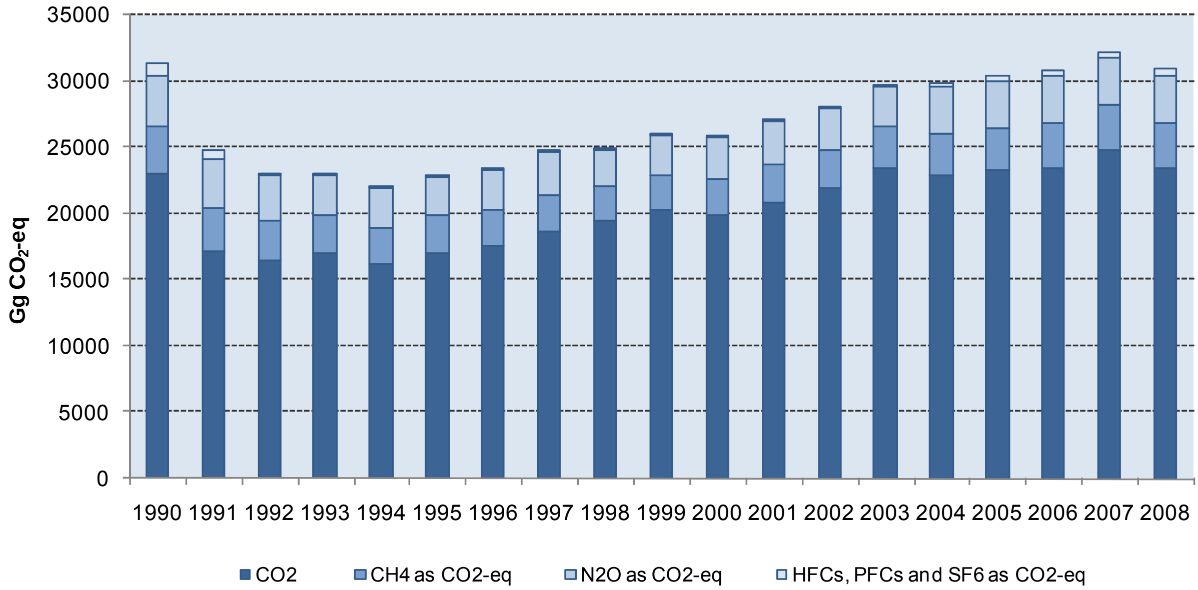


Figure 2.2-1: Trend of GHG emissions, by gases

2.2.1. CARBON DIOXIDE – CO_2

The most significant anthropogenic greenhouse gas is carbon dioxide (CO_2). In 2008, CO_2 emission was 1.4 percent lower than in 1990. CO_2 removals by sinks were almost 55 percent larger than removals in 1990. The largest CO_2 emission growth was in Energy sector (Road Transport and Public Electricity & Heat Production) and Industrial processes. There was a permanent increase in mobility (number of road vehicles) and therefore increase in motor fuel consumption in last ten years. There was also a significant increase in electricity demand and supply. Consequently, two new thermal power plants were installed in last few years (coal burned thermal power plant - 210 MW and combined cycled gas turbine – 200 MW). 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 2008 was 2.0 percent under the emission in 1990, largely due to a decrease in emission in Agriculture.

2.2.3. NITROUS OXIDE – N_2O

The N_2O emission in 2008 was 11.1 percent lower than emission in 1990. Decrease of emission was in Energy sector (Manufacturing industries and construction and Transport sectors), Industrial processes (Nitric acid production) and Agriculture (N_2O emission from Manure management, Indirect emission from nitrogen used in agriculture, Direct N_2O emissions from animals).

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 were used as substitutes for cooling gases in refrigerating and air-conditioning systems that deplete the ozone layer. According to provided calculations, the contribution of F-gases in total national GHG emission in 2008 was approximately 1.9 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 2008 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 (1990-2008)

Source	Emissions and removals of GHG (Gg CO_2-eq)						
	1990	1995	2000	2005	2006	2007	2008
Energy	22160	16463	18766	22226	22378	23628	22473
Industrial Processes	4198	2574	3229	3691	3873	4082	4130
Solvent and Other Product Use	131	124	115	203	231	236	82
Agriculture	4336	3046	3120	3470	3487	3432	3349
Waste	-4185	-9154	-5281	-8227	-9018	-7990	-6479
Total GHG emission	**31416**	**22934**	**25873**	**30390**	**30825**	**32265**	**30963**
Removals (LULUCF)	-4185	-9154	-5281	-8227	-9018	-7990	-6479
Total emission (including LULUCF)	**27231**	**13780**	**20592**	**22163**	**21807**	**24276**	**24485**

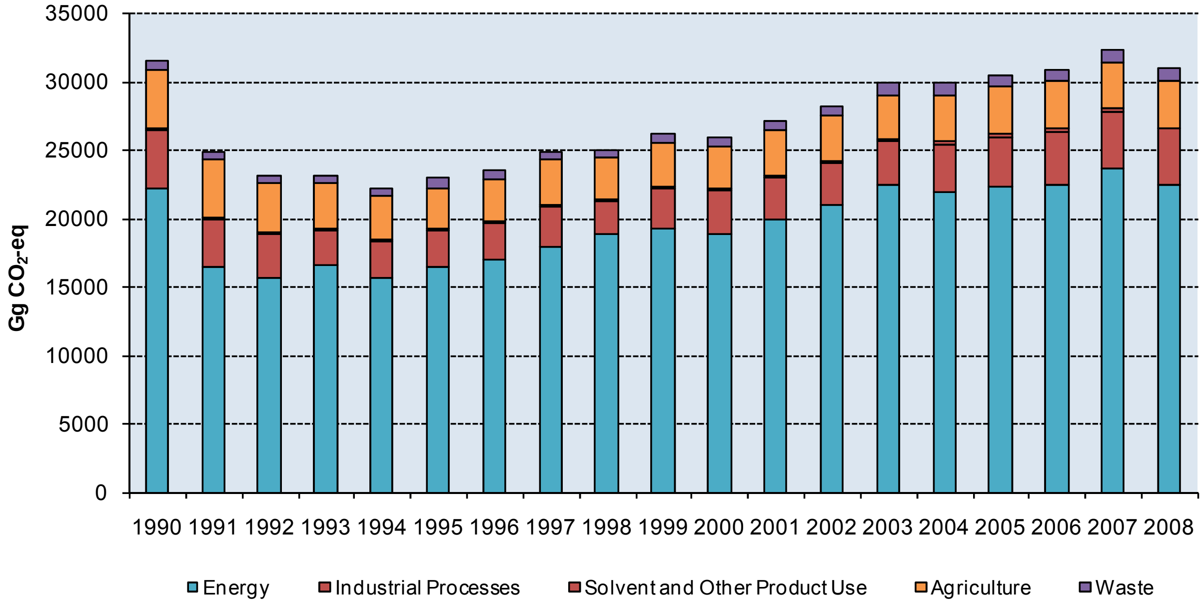


Figure 2.3-1: Trend of GHG emissions, by sectors

2.3.1. ENERGY

The most important IPCC sector in Croatia is Energy sector. The Energy sector accounted for some 72.6 percent of the total national GHG emissions (presented as equivalent emission of CO_2). In 2008, the GHG emission from Energy was 1.4 percent larger than emission in 1990.

2.3.2. INDUSTRIAL PROCESSES

Industrial Processes contributes to total GHG emission with approximately 13 percent, depending on the year. There was a slight decrease of GHG emission from Industrial Processes. The GHG emission in 2008 was approximately 3 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 0.7 percent of the total national GHG emissions (presented as equivalent emission of CO_2). The GHG emission in 2008 was 78 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 2008 was about 23 percent lower in comparison with 1990 emission. According to estimation of Croatian experts for agriculture, approximately 10.8 percent of total GHG emissions belong to Agriculture.

2.3.5. WASTE

Emissions from Waste sector have been constantly increasing in the period 1990-2008. Increasing emissions are a consequence of greater quantities of waste, activities in wastewater handling and waste incineration. The GHG emission in 2008 was over 50 percent larger in comparison with 1990 emission. Contribution of waste sector to the total GHG emission is 3 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 2008* 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
NO_x Emission	**88.84**	**61.81**	**70.81**	**69.93**	**70.39**	**74.18**	**70.41**
Energy Industries	13.61	11.54	11.99	12.04	11.15	13.39	9.80
Manufacturing Ind. & Construction	17.38	8.80	9.15	9.91	11.16	14.56	15.35
Transport	39.88	30.80	34.24	32.50	32.68	32.42	30.76
Other Energy (fuel combustion)	15.03	8.13	12.85	13.15	13.24	12.86	13.51
Fugitive Emission from Fuels	0.41	0.32	0.31	0.30	0.28	0.30	0.26
Industrial Processes	2.38	2.22	2.28	2.04	1.87	0.64	0.73
Agriculture	0.15	0.00	0.00	0.00	0.00	0.00	0.00
LULUCF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO Emission	**537.29**	**368.34**	**389.70**	**293.85**	**313.70**	**287.96**	**250.24**
Energy Industries	1.54	1.11	1.21	0.93	1.35	1.89	1.09
Manufacturing Ind. & Construction.	39.71	40.36	36.43	32.93	36.69	42.30	36.51
Transport	240.26	177.19	175.05	109.22	102.51	92.73	82.91
Other Energy (fuel combustion)	203.95	116.68	146.39	132.96	133.47	115.58	120.06
Fugitive Emission from Fuels	0.62	0.48	0.46	0.45	0.42	0.46	0.39
Industrial Processes	46.86	32.52	30.12	17.36	39.25	35.00	9.27
Agriculture	4.34	0.00	0.00	0.00	0.00	0.00	0.00
LULUCF	0.01	0.00	0.03	0.00	0.00	0.01	0.01
NMVOC Emission	**112.60**	**79.75**	**82.88**	**101.16**	**109.59**	**109.91**	**55.49**
Energy Industries	0.32	0.23	0.28	0.29	0.29	0.34	0.27
Manufacturing Ind. & Construction	1.69	1.35	1.43	1.76	1.86	2.01	2.11
Transport	33.53	25.45	28.60	17.52	17.64	16.09	15.00
Other Energy (fuel combustion)	12.14	6.91	9.01	8.29	8.37	7.41	7.72
Fugitive Emission from Fuels	9.75	7.77	9.73	9.05	9.03	8.89	8.09
Industrial Processes	22.32	7.64	6.36	6.69	5.32	6.58	6.33
Solvent Use	32.84	30.40	27.46	57.56	67.09	68.60	15.98
SO_2 Emission	**170.39**	**83.52**	**63.49**	**64.41**	**61.39**	**71.44**	**54.74**
Energy Industries	78.51	44.48	25.39	32.76	30.44	38.94	25.21
Manufacturing Ind. & Construction	53.32	24.54	18.94	10.18	10.19	15.82	13.84
Transport	5.46	3.52	6.01	8.36	8.88	5.24	5.13
Other Energy (fuel combustion)	23.87	4.65	6.50	6.63	5.85	4.89	4.62
Fugitive Emission from Fuels	6.38	4.96	4.80	4.60	4.39	4.72	4.01
Industrial Processes	2.84	1.36	1.85	1.88	1.64	1.83	1.93

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 2007 is presented in the table 3.1-1.

Table 3.1-1: Primary energy production

PJ	1990	1995	2000	2005	2006	2007	2008
Coal and coke	4.21	1.96	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
Crude oil	104.54	62.81	51.35	40.11	38.9	37.27	35.42
Natural gas	74.27	69.12	59.4	79.76	94.27	100.12	94.05
Hydro power	38.55	51.75	56.93	62.4	58.18	42.21	50.19
Renewables	0.00	0.00	0.00	0.2	0.24	0.71	1.03
Total	**244.25**	**199.16**	**183.32**	**197.24**	**208.77**	**195.42**	**197.28**

Figure 3.1-1 presents the trends in the primary energy production from 1990 to 2007.

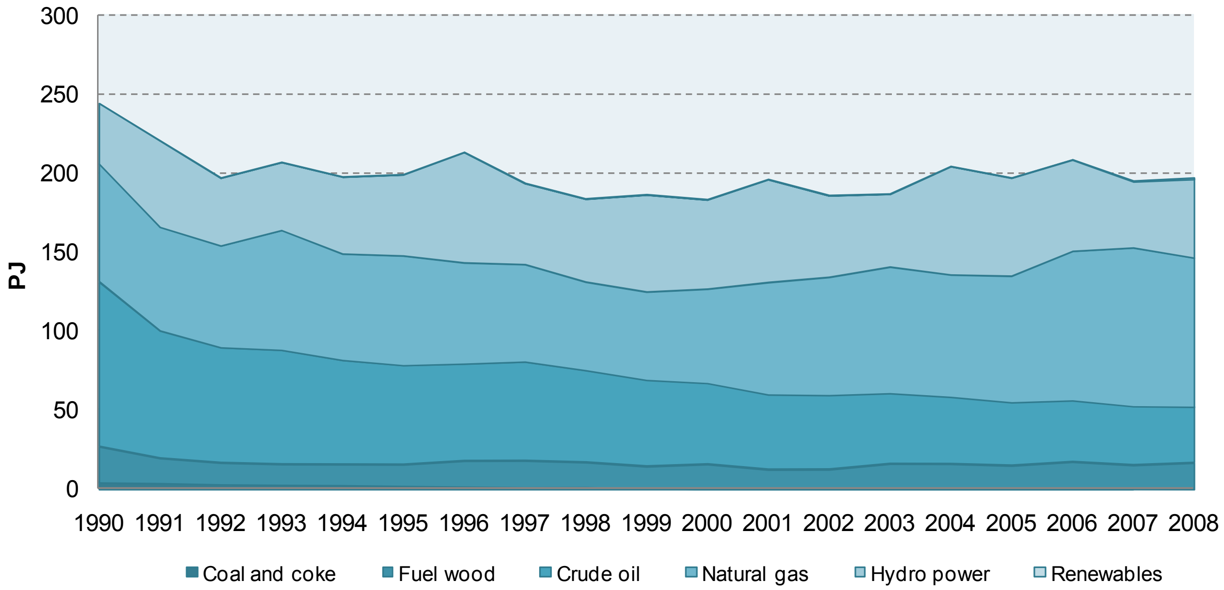


Figure 3.1-1: Trends in primary energy production for the period from 1990 to 2008

In 1990 primary energy production was about 244 PJ, which is 19.2% higher comparing to 2008. In 2008, the total primary energy production increased by 1.0% with relation to the 2007. Comparing to 2007, the energy production from renewable sources increased 1.5 times in 2008. The production of natural gas decreased 5.6% as well as production of crude oil (5.0%) while production of fuel wood increased by 0.1%. Hydro power utilization increased by 15.9%.

While in 1990 the share of crude oil in primary energy production was the highest one with 42.8%, in 2008 its' share was only 18.0%. In 2008, the share of natural gas (47.7%) was the highest one. It was followed by hydro power with the share of 25.4%. The comparison of shares in primary energy productions for the 1990 and 2008 are presented in Figure 3.1-2.

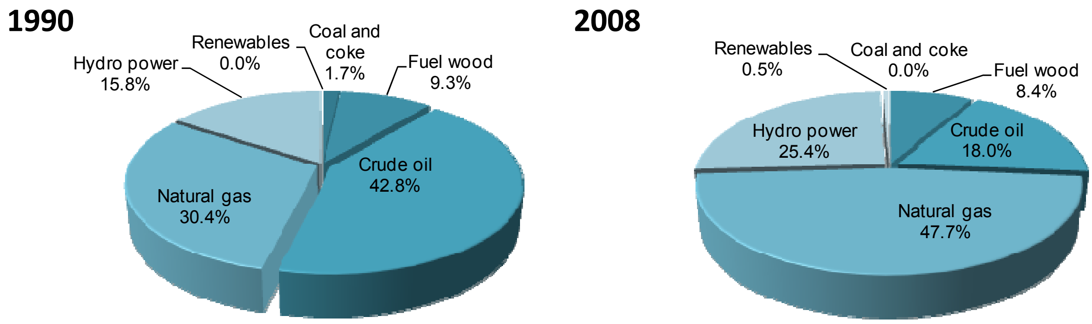


Figure 3.1-2: Shares of individual energy forms in the total production for the 1990 and 2008

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 2008 is presented in the Table 3.1-2.

Table 3.1-2: Primary energy supply

PJ	1990	1995	2000	2005	2006	2007	2008
Coal and coke	34.07	7.42	17.15	32.95	31.61	33.74	34.65
Fuel wood	22.68	13.52	15.64	14.77	15.28	13.31	13.38
Liquid fuels	192.6	146.03	160.52	181.88	185.15	189.7	180.15
Natural gas	98.22	82.77	94.98	101.06	99.86	114.22	110.22
Hydro power	38.55	51.75	56.93	62.40	58.18	42.21	50.19
Electricity	25.42	12.59	14.4	18.41	20.24	22.9	23.68
Renewables	0	0	0	0.20	0.24	0.69	0.97
Total	**411.54**	**314.08**	**359.62**	**411.67**	**410.56**	**416.77**	**413.24**

Figure 3.1-3 presents the trends in the primary energy supply from 1990 to 2008.

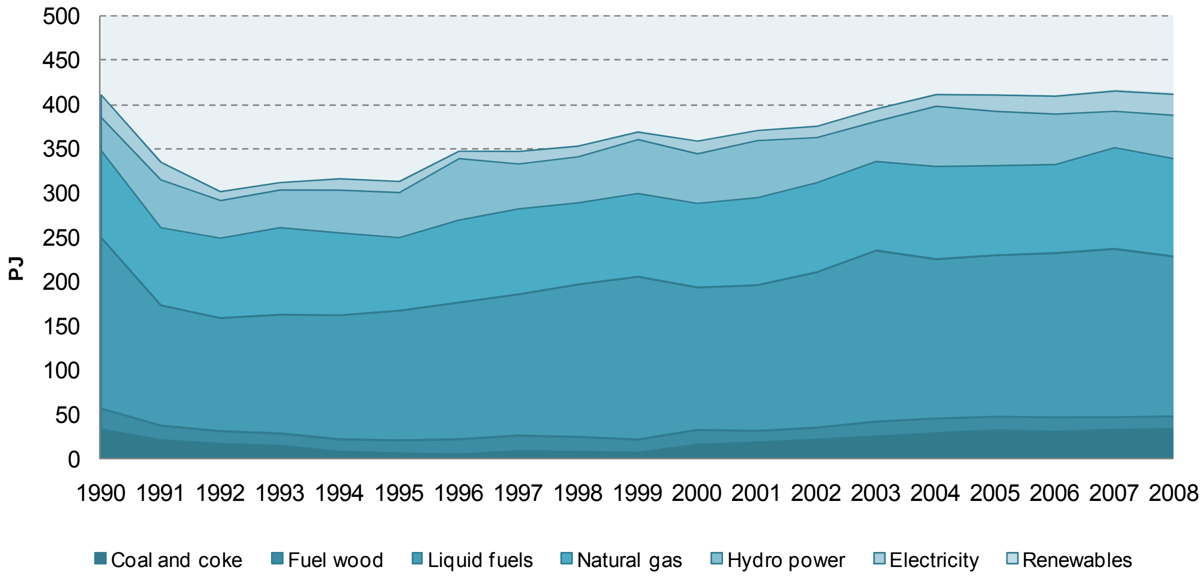


Figure 3.1-3: Trends in primary energy supply for the period from 1990 to 2008

In 1990 primary energy supply was about 412 PJ, which is 0.4% lower comparing to 2008. In 2008, the total primary energy supply increased by 0.9% with relation to the previous year. There was an increase in coal and coke, electricity and renewable energy sources while consumption of natural gas and liquid fuels decreased. Due to good hydrology conditions, hydro power energy supply increased by 21.0% with relation to the 2007. Figure 3.1-4 presents comparison of the shares of individual energy forms in the total primary energy supply for the 1990 and 2008.

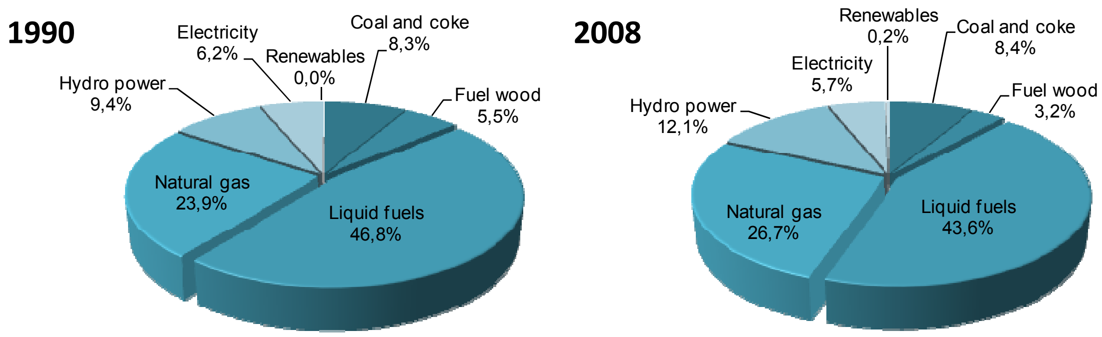


Figure 3.1-4: Comparison of the shares of individual energy forms for the 1990 and 2008

Liquid fuels had the largest share in total primary energy supply in 1990 as well as in 2008 (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.

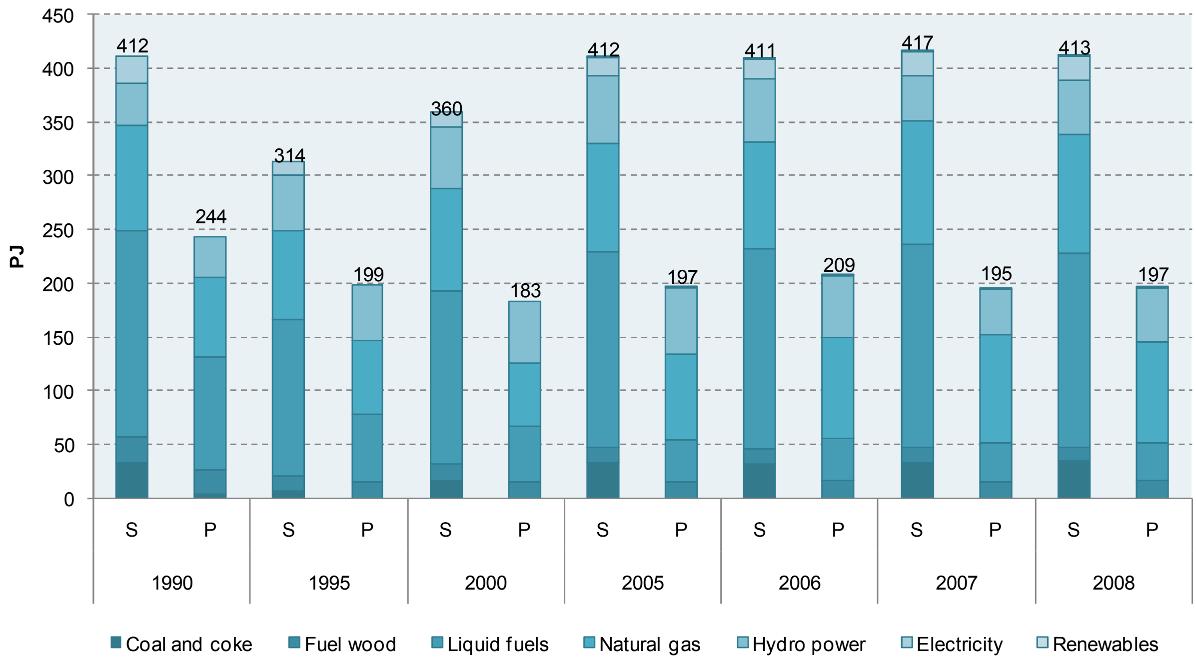


Figure 3.1-5: Total primary energy supply (S) and production (P)

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 2008 amounted 47.7%. Total hydro power and fuel wood supply were fully covered from the territory of Croatia. Own natural gas supply in 2008 amounted 85.3% while own oil supply amounted 19.7%. 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 (J). National energy balance for 2008 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 2008

Fuel	Net Caloric Value			Carbon emission factor[4] (t C/TJ)	CO_2 emission factor (t CO_2/TJ) (without OF)	Oxidation factor (OF)
	Unit	1990	2008			
SOLID FUELS						
Anthracite	TJ/Gg	29.29	-	26.8	98.27	0.98
Other Bituminous Coal	TJ/Gg	25.14	24.90	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	11.80	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	-	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	19.62	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

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

The structure of energy consumption of fossil fuels from 1990 to 2008 is shown in Figure 3.1-6.

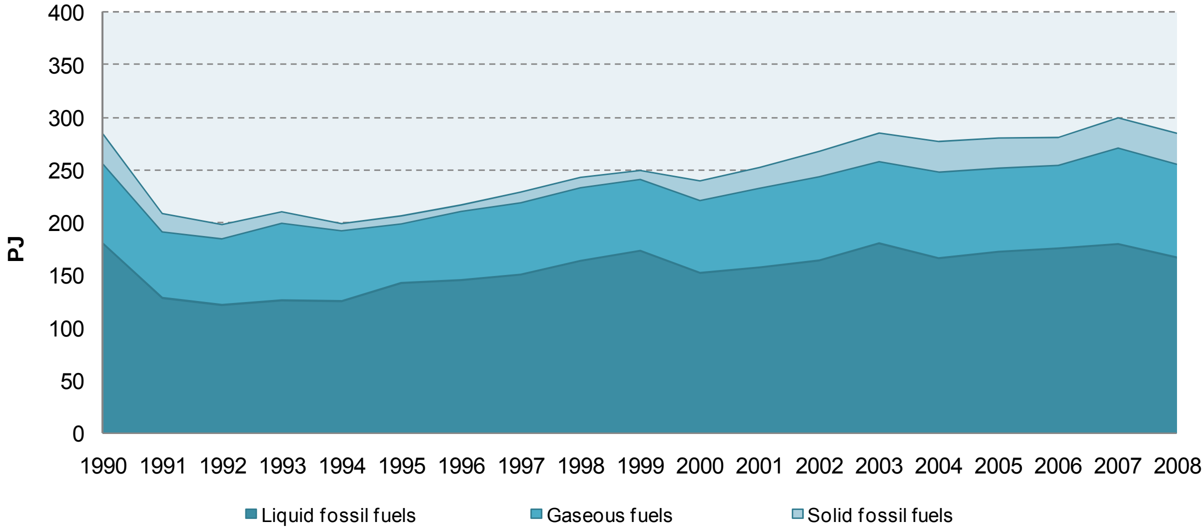


Figure 3.1-6: Structure of energy consumption

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 3-11 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 (49 percent) while the contribution of nitrous oxide (N_2O) is quite small (about 6 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 is believed to have a negative impact on the greenhouse effect because the creation of aerosols removes heat from the environment.

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 (2008), is presented in the Table 3.1-4 while contribution of individual subsectors to GHG emission for the period 1990-2008 is presented in Figure 3.1-7.

Table 3.1-4: Contribution of individual subsectors to emission of greenhouse gases, for 2008

GHG categories	Gg			Total	
	CO_2	CH_4	N_2O	CO_2-eq (Gg)	%
ENERGY	**20,702.91**	**75.829**	**0.4322**	**22429.30**	**100.00**
A. Fuel combustion activities	20,036.91	5.196	0.4322	20280.01	90.42
1. Energy industries	6,703.90	0.186	0.0560	6725.15	29.98
a) Electricity and heat production	5,021.22	0.127	0.0450	5037.83	22.46
b) Petroleum refining	1,437.28	0.054	0.0106	1441.70	6.43
c) Manufacture of solid fuels	245.39	0.004	0.0004	245.62	1.10
2. Manufacturing ind. and constr.	3,768.11	0.293	0.0317	3784.11	16.87
3. Transport	6,133.84	0.982	0.2819	6241.84	27.83
a) Civil aviation	88.23	0.001	0.0025	89.01	0.40
b) Road transport	5,813.63	0.965	0.2775	5919.93	26.39
c) Railways	101.16	0.007	0.0008	101.56	0.45
d) Navigation (domestic)	130.83	0.009	0.0011	131.35	0.59
4. Other sectors	3,431.06	3.735	0.0626	3528.90	15.73
5. Other	NO	NO	NO	-	-
B. Fugitive emissions from fuels	666	70.633	NO	2149.29	9.58
1 Solid fuels	NO	NO	NO	-	-
2 Oil and natural gas	666	70.633	NO	2149.29	9.58

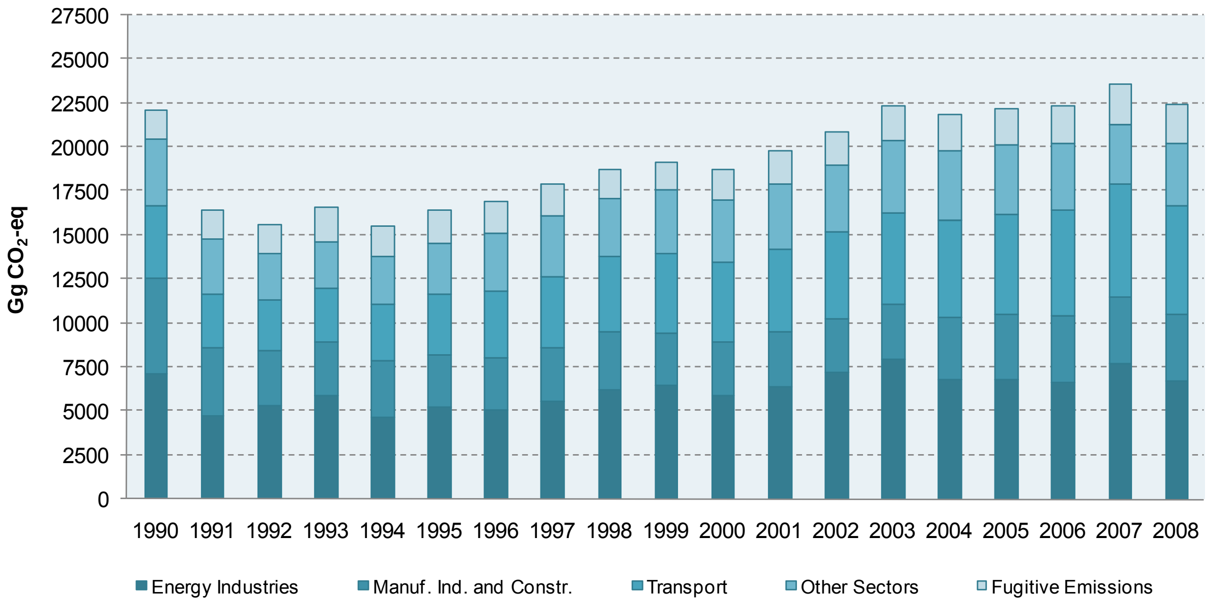


Figure 3.1-7: CO_2-eq emissions from energy sector by subsectors in 1990-2008

The largest part (28 to 35 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; 28 percent in 2008) and the combustion in Manufacturing Industries and Construction with decreasing trend (26 percent in 1990; 17 percent in 2008). Small stationary energy sources, such as Commercial/Institutional, Residential and Agriculture/Forestry/Fishing, contribute to total emission from Energy sector with 17 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 8 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.

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
Fuel cons. (PJ)							
Reference appr.	292.9	206.0	241.3	285.3	284.0	304.1	289.6
Sectoral appr.	285.6	207.5	240.6	281.2	281.7	300.2	285.4
Relative Dif. (%)	**2.6**	**-0.7**	**0.3**	**1.4**	**0.8**	**1.3**	**1.5**
CO_2 Emission (Gg)							
Reference appr.	20342.1	14176.3	16922.6	20257.3	20127.8	21441.8	20303.8
Sectoral appr.	20165.4	14393.3	16767.1	19877.5	19913.1	21096.9	20036.9
Relative Dif (%)	**0.9**	**-1.5**	**0.9**	**1.9**	**1.1**	**1.6**	**1.3**

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

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) for International Aviation and Marine Bunkers and GHG emissions for observed period is shown in the Table 3.2-2.

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 GHG emissions for International aviation and marine bunkers, from 1990 to 2008

	1990	1995	2000	2005	2006	2007	2008
Fuel combustion (PJ)							
Aviation bunkers	4,85	2,64	2,39	3,19	3,25	3,35	3,75
Marine bunkers	1,44	1,36	0,76	1,05	0,81	1,00	0,87
Total bunkers	**6,29**	**4,00**	**3,15**	**4,24**	**4,05**	**4,35**	**4,62**
CO_2-eq emission (Gg)							
Aviation bunkers	346,35	188,42	170,91	228,16	231,87	240,51	270,37
Marine bunkers	108,96	102,40	57,24	79,29	61,22	75,94	67,05
Total bunkers	**455,31**	**290,82**	**228,15**	**307,45**	**293,09**	**316,45**	**337,42**

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 1.3.1.2.

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 1990-2008, 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
Public El. and Heat Prod.	3694	2988	3809	4703	4671	5531	5038
Petroleum Refining	2575	1892	1792	1811	1671	1868	1442
Other Energy Industries	875	395	293	351	309	362	246
Total Energy Industries	7144	5275	5895	6864	6650	7761	6725

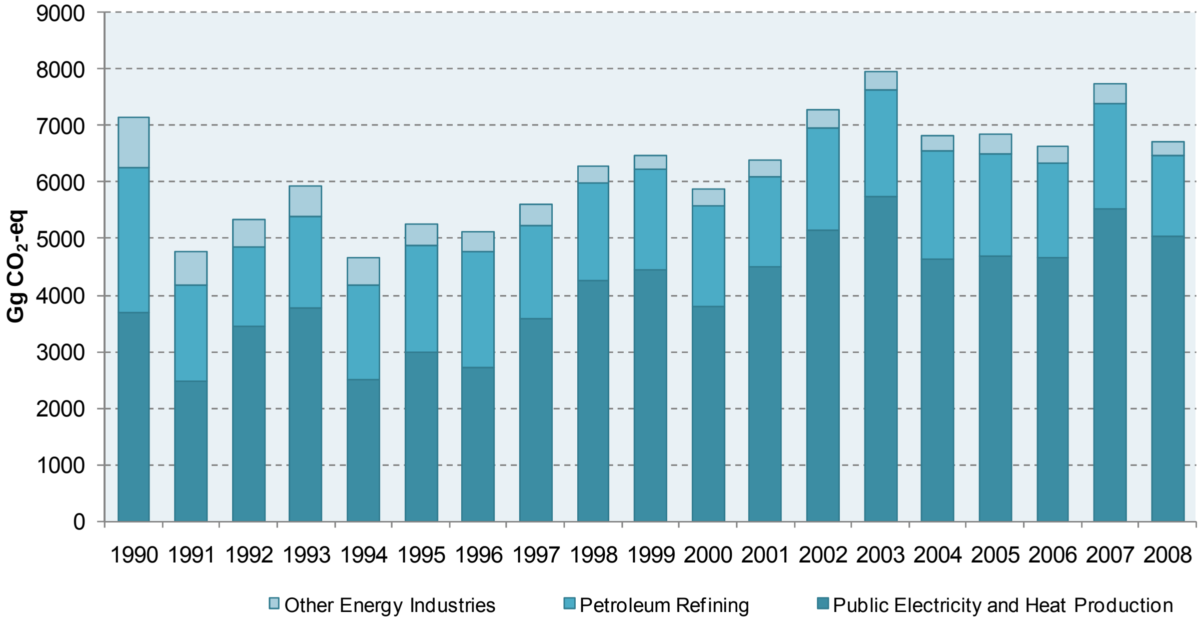


Figure 3.2-1: The CO_2-eq emissions from Energy Industries

It should be stressed out that approximately 53 percent of the electricity is generated in Hydro power plants; therefore the emission from this sector is relatively small, 28-35 percent of emission from total Energy sector. The largest part (53-73 percent) of the emission is a consequence of fuel combustion in thermal power plants, then the combustion in oil refineries 24-40 percent. The remaining combustion in oil and gas fields, coal mines and the coke plant accounts for some 3-9 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 3653 MW (including TPP Plomin and excluding NPP Krško). Total capacities serving the needs of the Croatian electric power system amount to 4001 MW (with 50% of Krško capacities). Out of this amount, 1565 MW is placed in thermal power plant, 2088 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	2088	water
NPP Krško*	348	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)	312	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	72	natural gas / extra light oil
Emergency diesel (4)	29	D2
Emergency diesel (1)	13	2GT
Total (HPPs+NPP+TPPs)	**4001**	

UO_2 - uranium oxide
D2/2GT - special fuel oil for operation of emergency TPPs

* - 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 2008 in Croatia only 18 to 38 percent of Croatian electricity demands were covered by thermal power plants. The largest contribution to electricity production in Croatia had hydro power plants 48 to 74 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 2008, the import of electricity was about 43 percent of total electricity consumption in Croatia. Electricity supply for the period from 1990 to 2008 is presented in Figure 3.2-2.

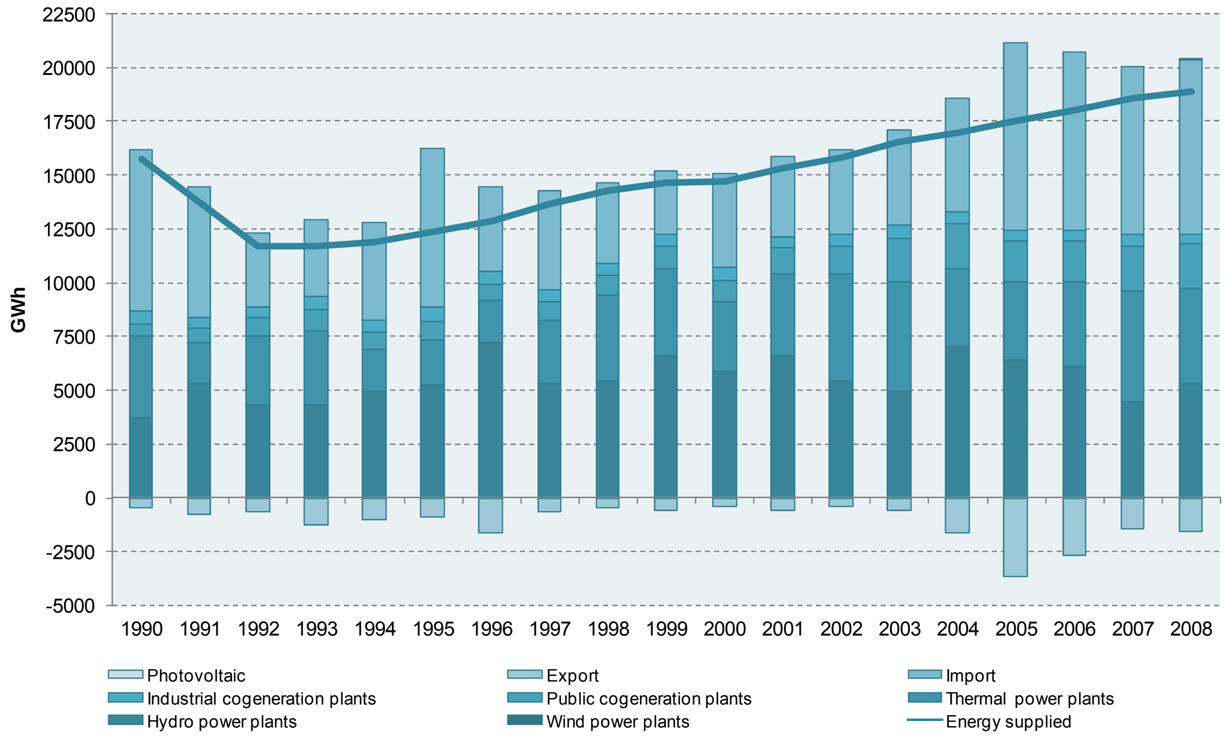


Figure 3.2-2: Electricity supply for the period from 1990 to 2008

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 2008.

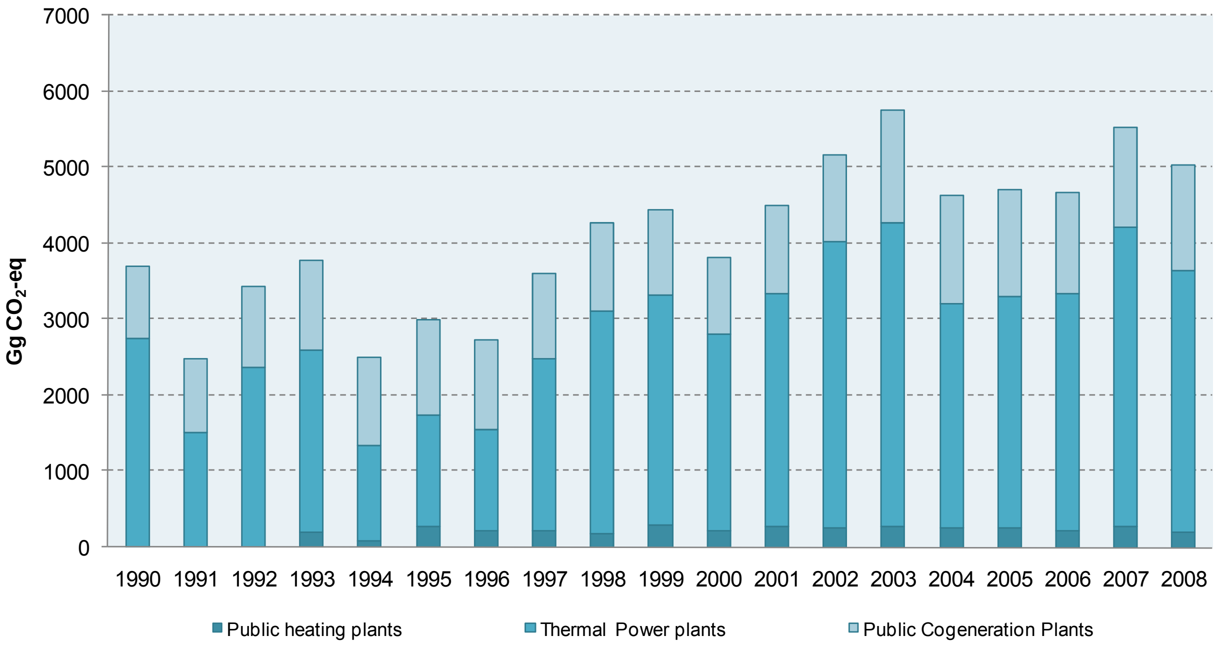


Figure 3.2-3: Public electricity and Heat production subsector's CO_2-eq emissions for the period from 1990 to 2008

Production of electricity has increasing trend trough the years, from 8 TWh (1990) to 13 TWh (2008) 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 power plants, which consequently leads to large GHG emissions. So, it can be sad that CO_2 emission trend depends primarily on hydrological conditions (Figure 3.2-4). In 2008, the total electricity production was 0.7 percent higher than in the former year. Decrease in total energy consumption is mostly due to favourable hydrological conditions which leaded to increase in hydro power utilisation by 21.0% (Table 3.2-5).

Table 3.2-5: Differences between electricity production in 2007 and 2008

ENERGY BALANCE	Electricity, GWh		Difference 2008-2007	Difference %
	2007	2008		
Production	12245.1	12325.6	80.5	0.66
Hydro power plants	4400.2	5325.9	925.7	21.04
Wind power plants	34.9	39.9	5	14.33
Photovoltaic	0	0.1	0.1	-
Thermal power plants	5181.4	4414.3	-767.1	-14.80
Public cogeneration plants	2115.5	2085.7	-29.8	-1.41
Industrial cogeneration plants	513.1	459.7	-53.4	-10.41
Import	7811.8	8163.8	352	4.51
Export	1450.7	1586.9	136.2	9.39
TOTAL CONSUMPTION	**18606.2**	**18902.5**	**296.3**	**1.59**

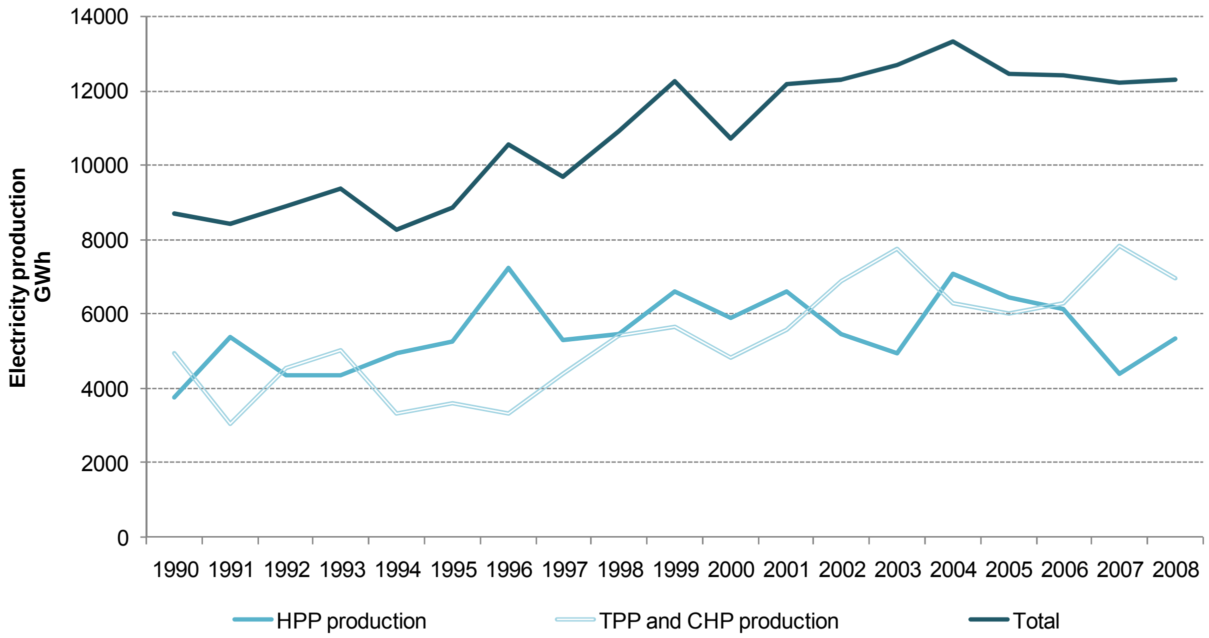


Figure 3.2-4: Domestic production of electricity by sources for the period from 1990 to 2008

Electricity and heat production, fuel consumption and GHG emissions for the years 1990, 1995 and 2000-2008 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. 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	230
deoiling	30
bitumen	350
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.

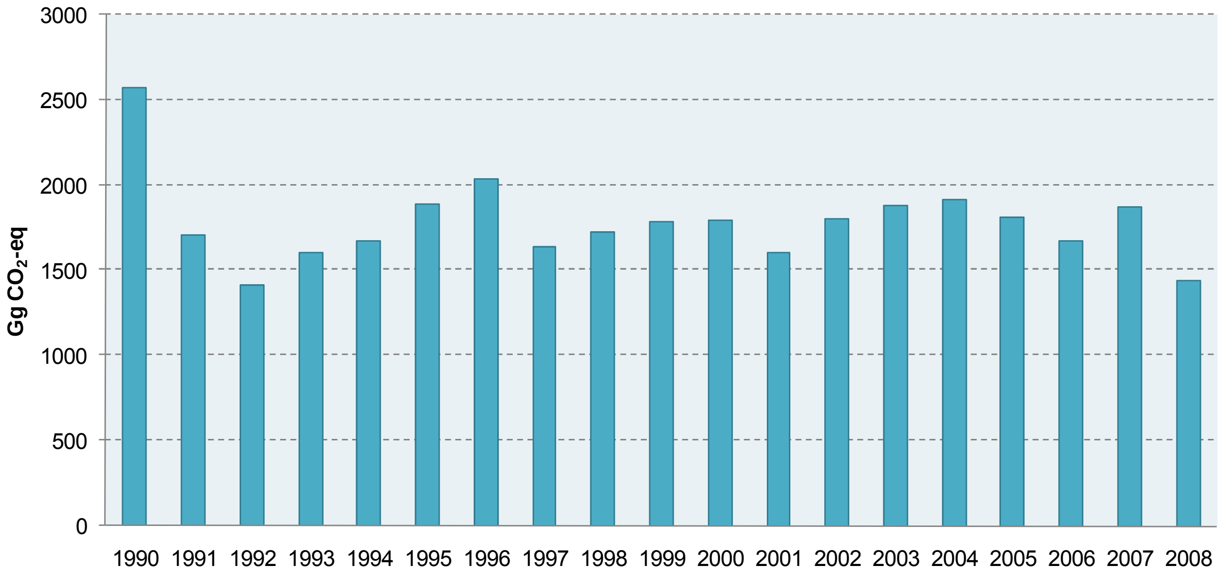


Figure 3.2-5: CO_2-eq emissions from Petroleum refining subsector for the period from 1990 to 2008

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. Crude oil is produced from 34 oil fields and gas condensation products from 10 gas-condensations fields, which covers about 35 percent of the total domestic demand.

Natural gas is produced from 20 gas fields from on-shore and 5 off-shore gas fields, which covers about 87.5 percent of the total demand in 2008. The largest quantities come from the Molve, Kalinovac and Stari Gradec, where the Central Gas Stations (CGS Molve) for gas processing and transport preparation were built – 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 550 mill. m^3. Maximal injection capacity is 3.8 mill. m^3/day and maximal drawdown capacity is 5 mill. m^3/day.

CO_2-eq emissions from this subsector for the whole period from 1990 to 2008 are presented in Figure 3.2-6.

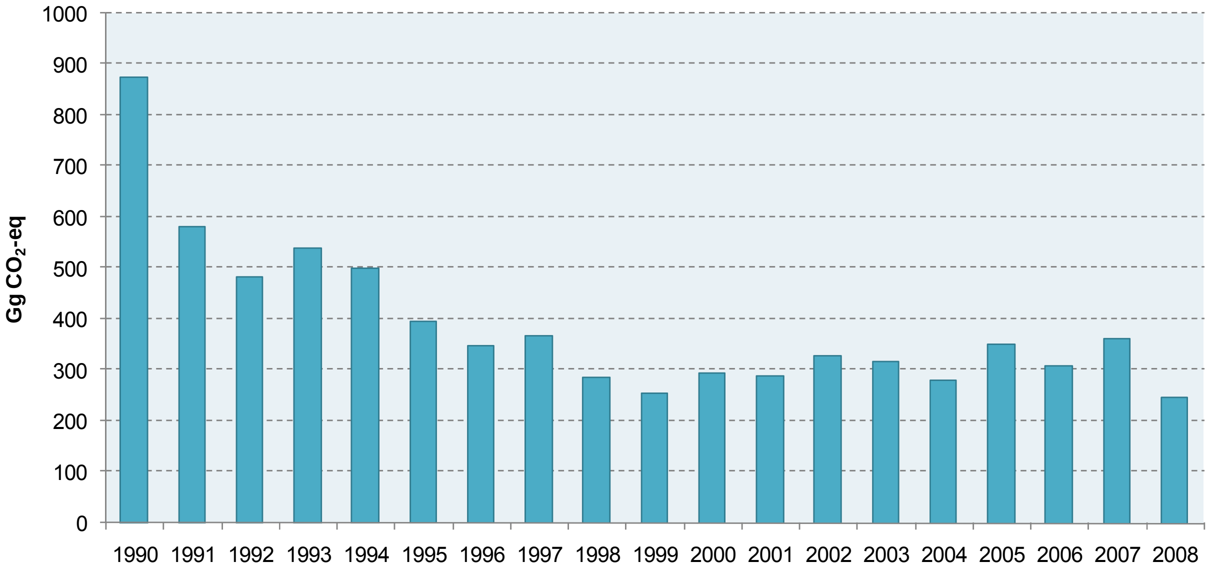


Figure 3.2-6: CO_2-eq emissions from Manufacturing of Solid fuels and Other Energy Industries for the period from 1990 to 2008

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. 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 2001-2008. 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
Iron & Steel Industry	IE	IE	IE	89	102	104	104
Non-Ferrous Metals	IE	IE	IE	21	18	21	21
Chemical	IE	IE	IE	578	670	625	627
Pulp. Paper & Print	IE	IE	IE	174	181	171	172
Food Proc. Bev. & Tab.	IE	IE	IE	589	588	539	540
Other (constr. mater…)	IE	IE	IE	2224	2238	2319	2324
Total Manuf. Ind. & Cons.	5475	2943	3091	3675	3797	3780	3789

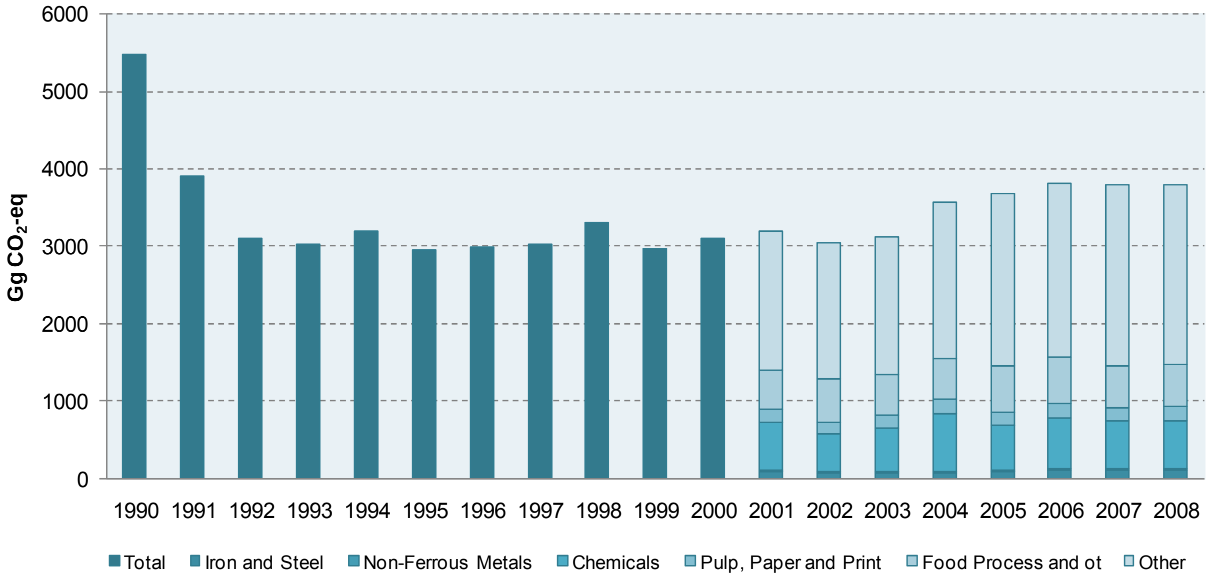


Figure 3.2-7: The CO_2-eq emissions from Manufacturing Industries and Construction

The emission from this sector contributes 14-25 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 2001-2008 (Industry analysis balance). The largest contributor to emissions is fuel combustion in industry of construction materials (subsector:

Other in Figure 3.2-6), followed by chemical industry, food processing industry, iron and steel industry, industry of glass and non-metal, non-ferrous metal and paper 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 Transport

	1990	1995	2000	2005	2006	2007	2008
Civil Aviation	156	79	55	67	74	77	86
Road Transport	3653	3169	4302	5424	5775	6122	5920
Railways	139	107	86	96	102	103	102
National Navigation	134	99	86	100	104	108	131
Total Transport	**4082**	**3454**	**4529**	**5687**	**6055**	**6409**	**6239**

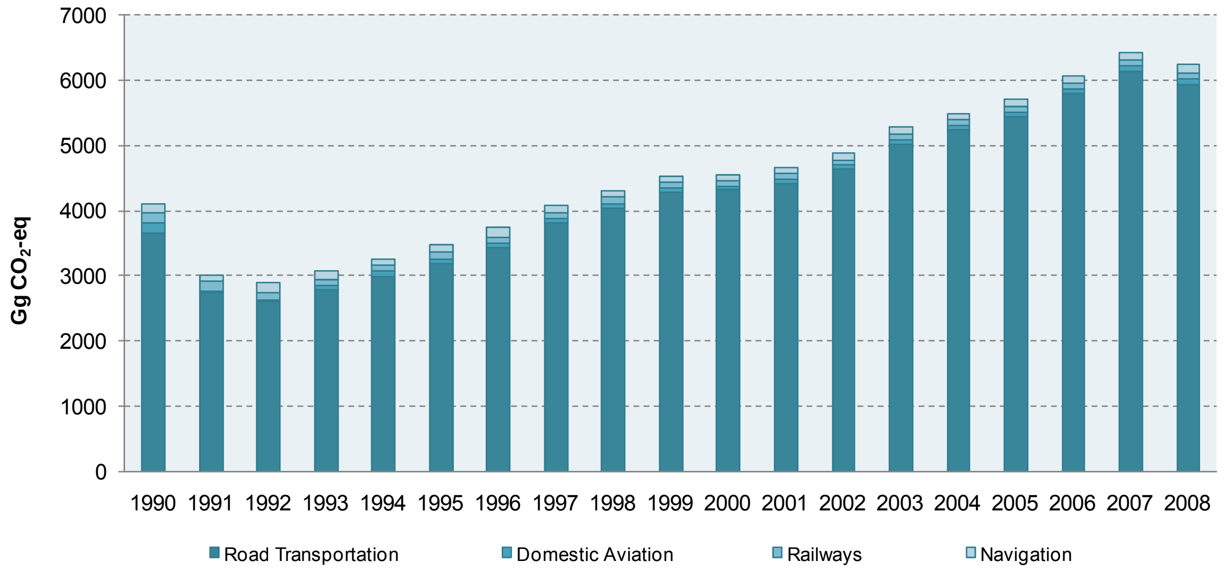


Figure 3.2-8: The CO_2-eq emissions from Transport

The emissions from fuel consumption in aircraft or marine vessel engaged in international transport are excluded from the national total. These emissions are reported separately.

The contribution from Transport to total emissions from Energy sector is 18-25 percent. The most of the emission comes from road transport (86-94 percent), than from domestic air, rail and marine transport (Figure 3.2-3). The increase of emissions from this sector is a consequence of growth of number of road vehicles and fuel consumption.

Civil aviation

During in country review the ERT recommended Croatia to estimate emissions from domestic aviation 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
Total jet kerosene (10^3 t)	160.0	85.0	72.0	93.0	96.3	99.6	112.7
Passengers carried - Total (10^3)		679	1072	2099	2148	2288	2329
Passengers carried – inter. (10^3)		346	712	1633	1698	1796	1775
Passengers carried – dom. (10^3)		333	360	466	450	492	554
Passengers kilometres- total (10^6)		444.0	763.0	1989.0	1959.0	2055.0	1945.0
Passengers kilometres -inter.		317.0	656.0	1842.0	1813.0	1896.0	1768.0
Passengers kilometres -dom.		127.0	107.0	147.0	146.0	159.0	177.0
Passengers dom/km		381.4	297.2	315.5	324.4	323.2	319.5
Passengers int/km		916.2	921.3	1128.0	1067.7	1055.7	996.1
Passengers int+dom		1297.6	1218.1	1443.4	1392.2	1378.9	1315.6
share dom	0.311	0.294	0.244	0.219	0.233	0.234	0.243
Jet kerosene in dom. aviation	**49.68**	**24.98**	**17.56**	**20.32**	**22.44**	**23.34**	**27.37**
Jet kerosene in inter. aviation	**110.32**	**60.02**	**54.44**	**72.68**	**73.86**	**76.26**	**85.33**

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).

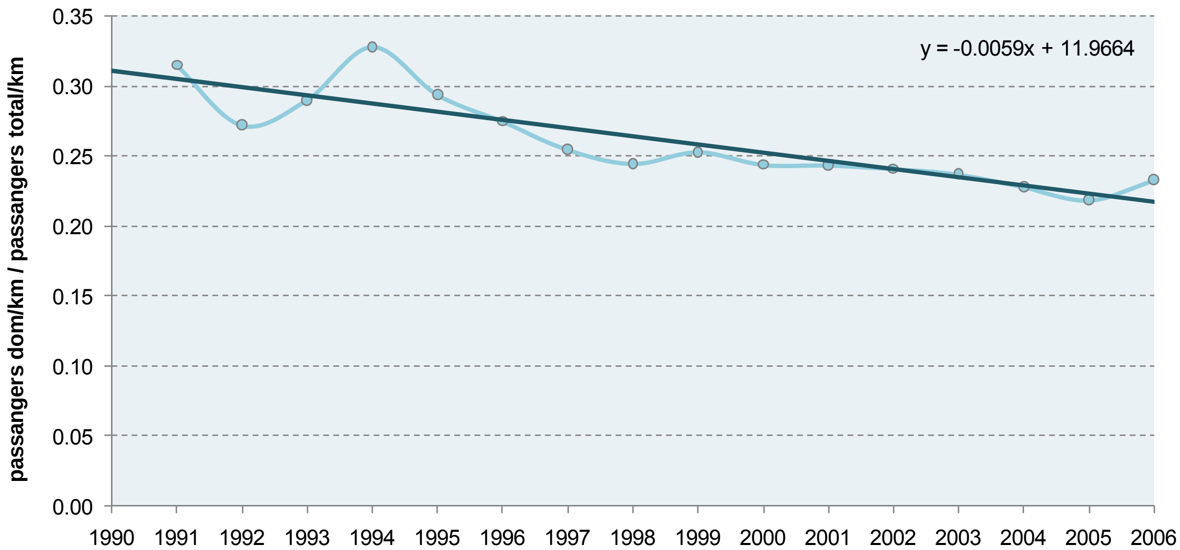


Figure 3.2-9: The average km traveled per passenger on domestic/international routes for the period 1991-2006

The GHG emissions were calculated using Tier 1 approach based on jet fuel consumption and aviation kerosene (calculated as explained) provided by national energy balance and default IPCC emission factors. The fuel consumption and appropriate GHG emissions for domestic air transport are shown in Table A2-12 of the Annex 2.

Road Transport

The COPERT IV package (Tier 2/3 method) was used for CO_2, CH_4 and N_2O emissions (and other pollutants) calculation from road transport in the period from 1990 to 2008. For calculating emissions, COPERT IV emission factors per fuel types were used. Corresponding to the COPERT IV 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

Sector	Subsector	Trip speed (km/h)			Driving share		
		Urban	Rural	Highway	Urban	Rural	Highway
Passenger Cars	Gasoline <1,4 l	30	60	110	40	35	25
Passenger Cars	Gasoline 1,4 - 2,0 l	30	60	110	40	35	25
Passenger Cars	Gasoline >2,0 l	30	60	110	40	35	25
Passenger Cars	Diesel <2,0 l	30	60	110	40	35	25
Passenger Cars	LPG	30	60	110	40	35	25
Light Duty Vehicles	Gasoline <3,5t	30	60	100	30	50	20
Light Duty Vehicles	Diesel <3,5 t	30	60	100	30	50	20
Heavy Duty Vehicles	Gasoline >3,5 t	30	50	80	30	55	15
Heavy Duty Vehicles	Diesel 3,5 - 7,5 t	30	50	80	30	55	15
Heavy Duty Vehicles	Diesel 7,5 - 16 t	30	50	80	30	55	15
Heavy Duty Vehicles	Diesel 16 - 32 t	30	50	80	30	55	15
Heavy Duty Vehicles	Diesel >32t	30	50	80	30	55	15
Buses	Urban Buses	30	50	0	90	10	0
Buses	Coaches	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
Motorcycles	4-stroke <250 cmł	30	50	70	48	50	2
Motorcycles	4-stroke 250 - 750 cmł	30	50	80	45	51	4
Motorcycles	4-stroke >750 cmł	30	50	90	35	60	5

The aggregate number of road motor vehicles is presented in the Table A2-10 of the Annex 2 while the vehicle numbers per sub-classes are shown in Figure 3.2-10.

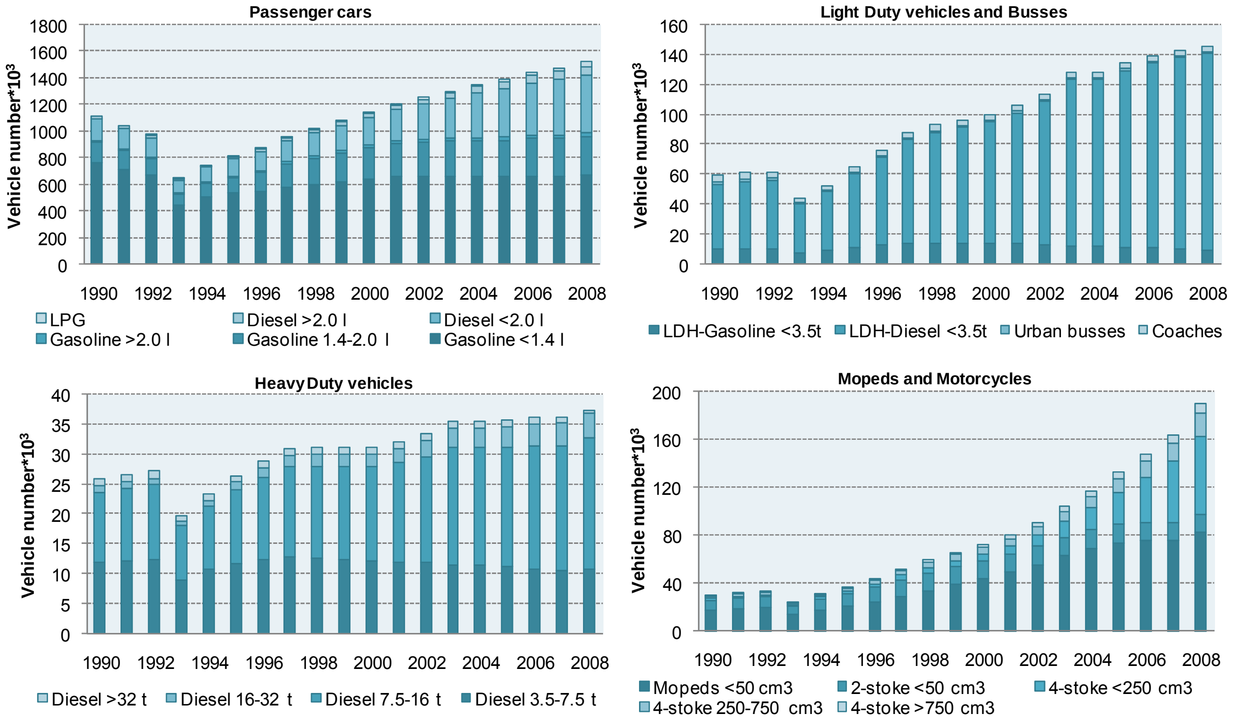


Figure 3.2-10: Number of vehicles in sub-classes in the period from 1990 to 2008

Total number of vehicles in 2008 increased 2.2 times in comparison with 1990. The increase in total number of vehicles is mostly due to growth in the number of passenger cars. In 1990 the share of passenger cars in total number of vehicles was 91%, while this share in 2008 amounted 80%. Comparing 2008 with 1990, the increase in total number of passenger cars is mostly due to growth in the number of diesel cars (61%) with engine size <2.0 l and gasoline cars with engine size between 1.4 - 2.0 l (48%) while number gasoline vehicles with engine smaller than 1.4 l decreased for 12%. Concerning Duty vehicles, there has been growth in the number of diesel Light duty vehicles for 67% as well as number of Heavy duty vehicles for 31%, comparing with 1990. Number of Mopeds and Motorcycles increased 6.2 times due to growth in the number of mopeds engine size smaller than 50 cm^3 and motorcycles engine size smaller than 250 cm^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.

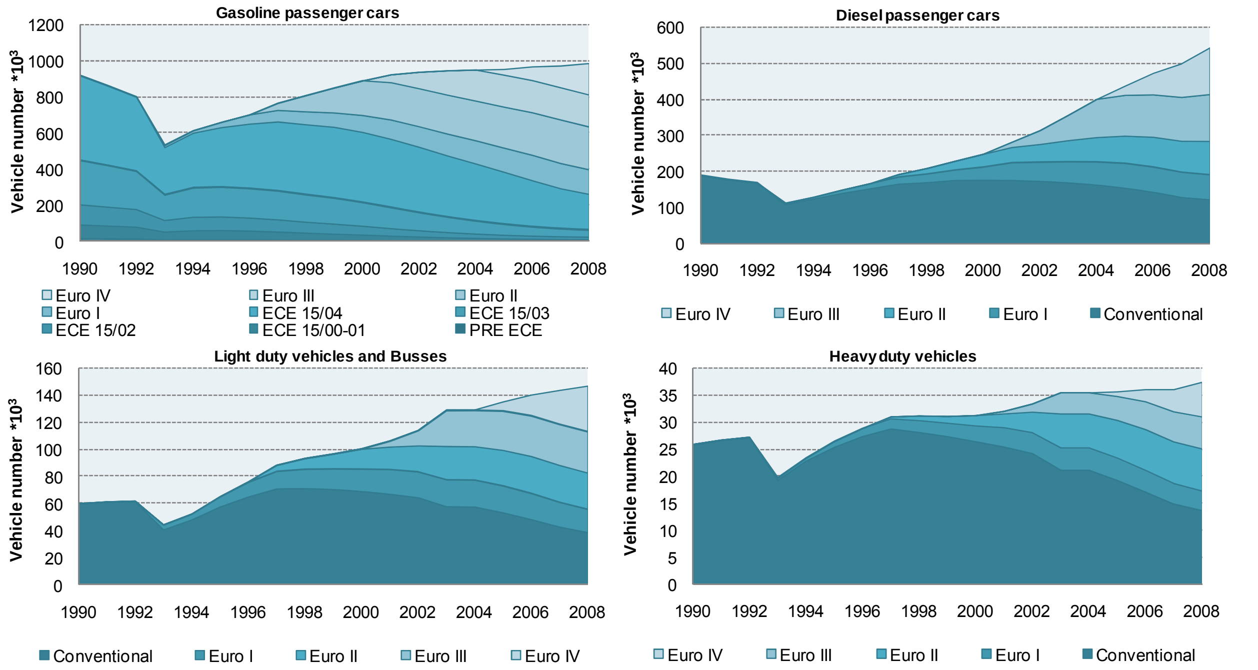


Figure 3.2-11: Layer distribution of vehicle numbers per vehicle type for the period from 1990 to 2008

Fuel consumption and GHG emissions from Road Transport are presented in the Table A2-11 of the Annex 2.

The GHG emissions were calculated for the whole period from 1990 to 2008 using COPERT IV 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 with appropriate data from national energy balance (difference is less than 1%).

The total GHG emissions from Road transport sector by fuel type consumed are shown on the Figure 3.2-12.

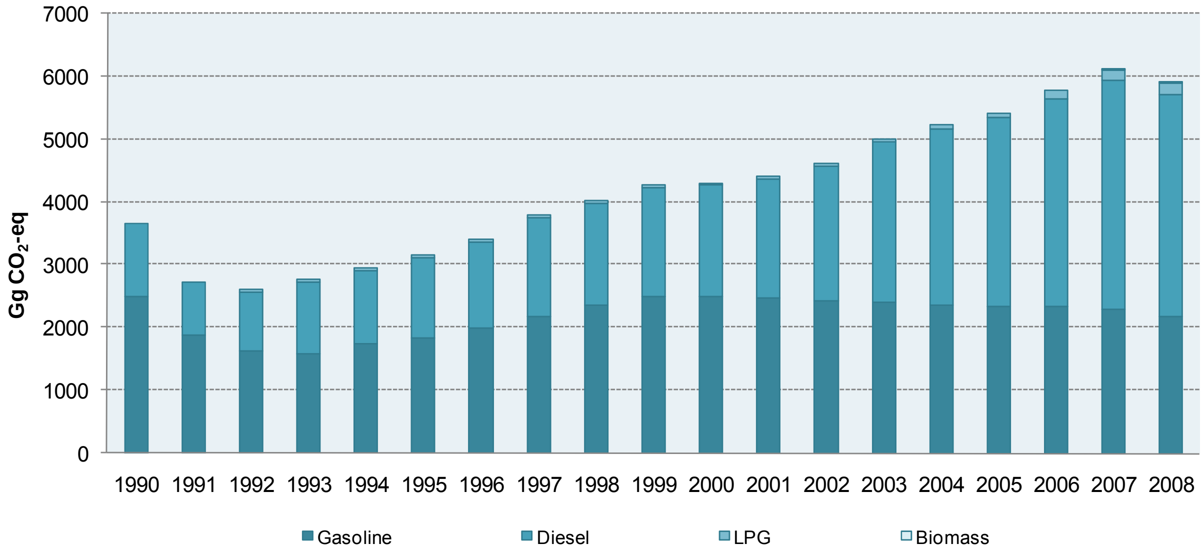


Figure 3.2-12: CO_2-eq emission from Road transport sector by fuel for the period from 1990 to 2008

Railways and Navigation

The GHG emission calculation from railways and navigation sub sectors were calculated using Tier 1 approach, based on fuel consumption data (national energy balance) and default IPCC emission factors. The fuel consumption and appropriate GHG emissions are shown in Tables A2-13 and A2-14 of the Annex 2.

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 sector.

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
Commerc./Institutional	775	652	638	786	723	611	619
Residential	2176	1688	2008	2481	2286	2060	2117
Agric./Forestry/Fishing	843	583	861	712	732	725	787
Total	**3794**	**2923**	**3507**	**3979**	**3741**	**3396**	**3522**

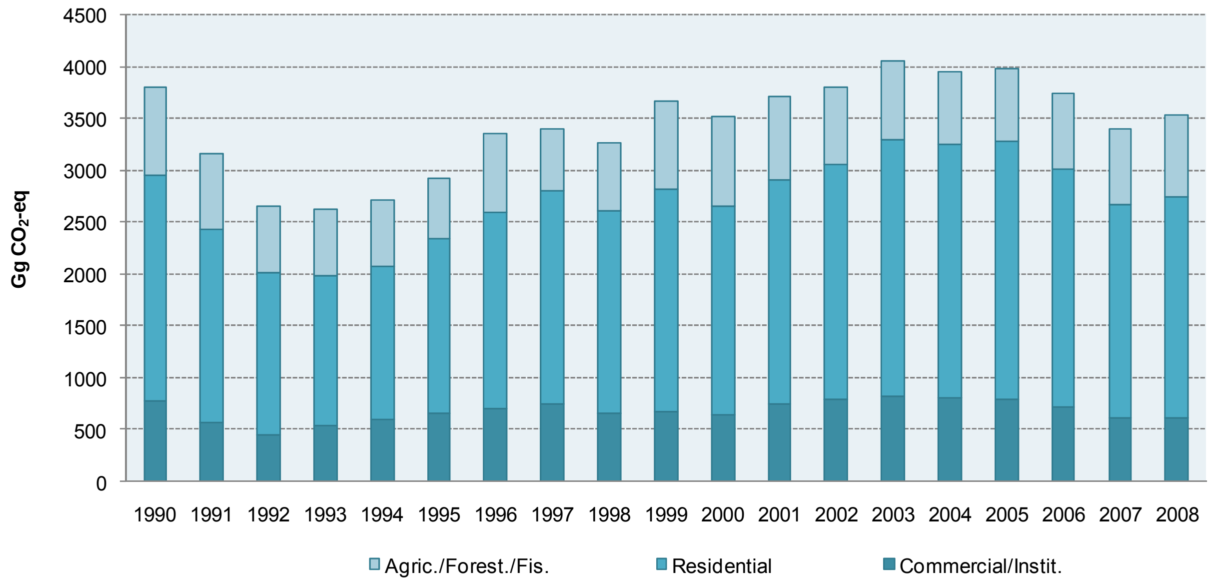


Figure 3.2-13: The CO_2-eq emissions from Small Stationary Sources

The CO_2-eq emissions from these subsectors were about 17-20 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 (15-21 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.

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 (1990-2008) 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 2008* 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).

NO_X emissions

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

The emission of NO_x for Energy sector in 2008 was 69.4 kt which is 5.2% lower than the year before and 19.2% lower compared to 1990. The NO_X emissions from Energy sector contribute with 87.9% to national total NO_X emission. The structure of NO_x emission in Energy sector has not changed significantly in the period from 1990 – 2008 (Figure 3.2-14). The main source of NO_x emission is still transport (44.3% of total emission), but its contribution has been decreasing steadily since 1990 (-22.9 %), as a result of vehicles gradually being equipped with catalytic converters. Emission of NO_x from industry sectors accounted with 22.1% to the national total.

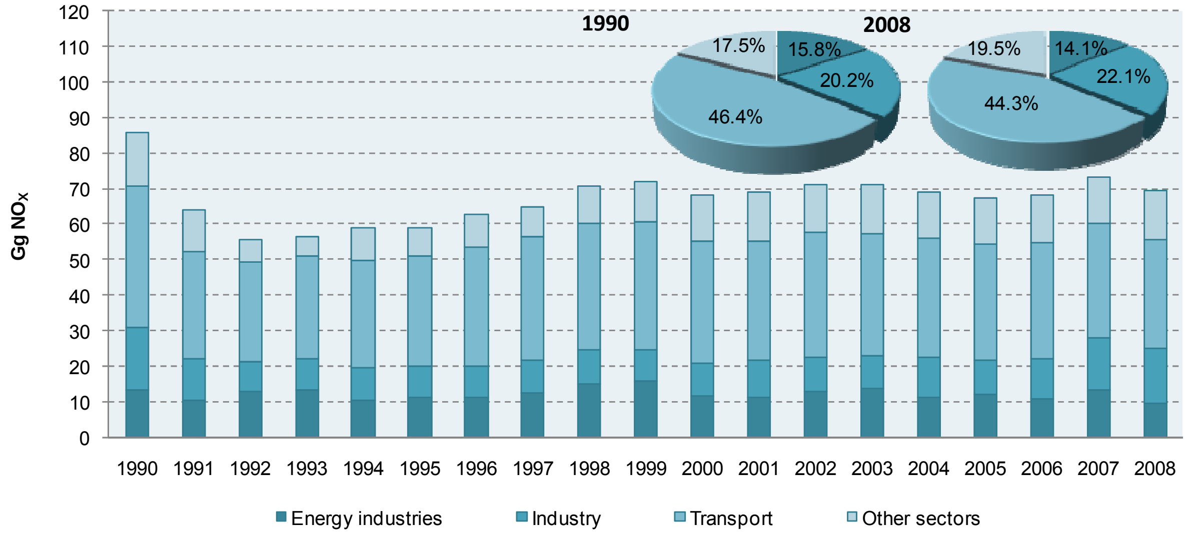


Figure 3.2-14: Energy sector NO_x emissions in the period 1990-2008

<u>CO emissions</u>

In 2008, the emission of CO in Energy sector was 240.5 kt which is 4.7% lower than in the year before and 50.4% lower compared to 1990, the year with maximum emission (485.5 kt) of CO in the observed period. The CO emissions from Energy sector contribute with 94.5% to national total CO emission. 34.5% of CO emission in Energy sector in 2008 was the result of incomplete fossil fuel combustion in Road transport sector and 49.9% in Commercial and residential sector (Figure 3.2-15).

Road transport is still the largest sector of CO emission in the period from 1990 to 2008. Significant decrease is due to new vehicles equipped with catalytic converters. Among the stationary energy sectors, Non-industrial combustion plants sector (the residential sector) has the highest contribution to CO emission, due to the consumption of low quality coal and fuel wood. Large combustion plants have automatic regulation of air throughput and combustion control, so CO emissions are low (about 0.5% of national total emission).

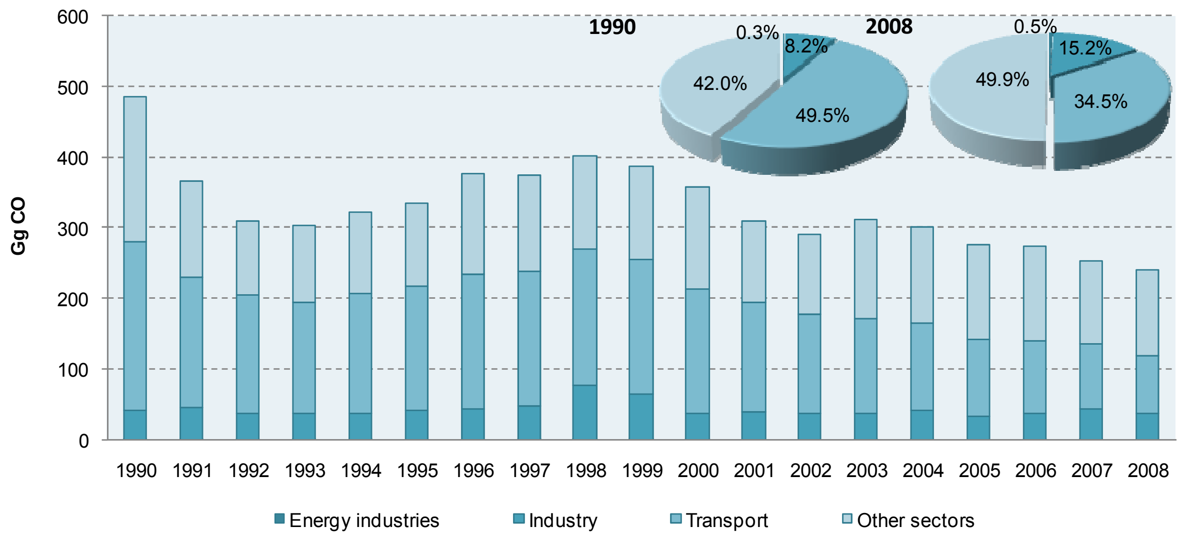


Figure 3.2-15: Energy sector CO emissions in the period 1990-2008

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 in Energy sector were 25.1 kt in 2008 which was 2.9% lower than the year before and 47.4% lower than 1990. The NMVOC emissions from Energy sector contribute only with 19.7% to national total NMVOC emission.

The structure of NMVOC emission from Energy sector has not changed significantly in the period from 1990 – 2008 (Figure 3.2-16). The main source of NMVOC emission is still transport sources sector (59.7% of total emission of energy sector). Emission of NMVOC from stationary combustion sectors accounted with 9.5% to the national total, mainly from the industry sector (8.5%).

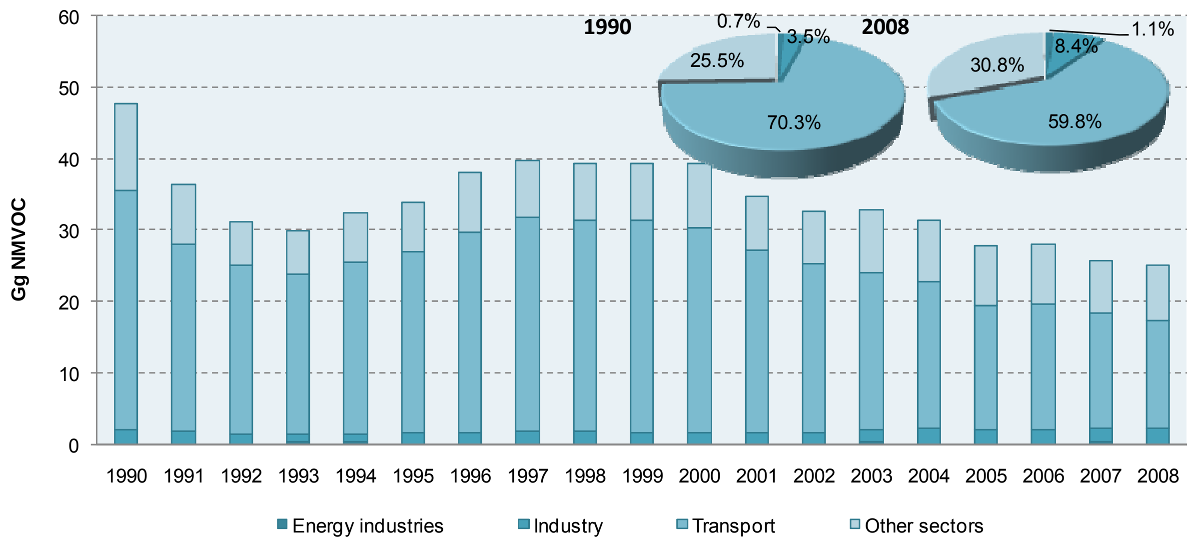


Figure 3.2-16: Energy sector NMVOC emissions in the period 1990-2008

SO_2 emissions

In accordance with the calculated results, the level of SO_2 emission from energy sector in 2008 reached 48.8 kt which is 88.1% of total national SO_2 emission. The trend shows that emissions of SO_2 have decreased by 24.8% compared to the emission in 2007 and decreased by 69.7 % 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 non-industrial combustion plants and combustion in manufacturing industry sector. In years ahead, emissions from these two sectors were reduced by 50%.

During the period from 1990 to 2008, the decrease of SO_2 emissions was achieved in almost all sectors and the greatest decrease of SO_2 emission was in industrial combustion plants sector (-74.3%). Emission trend for SO_2 in the period of 1990 to 2008 as well as the share of the particular sectors in total emission of SO_2 in Energy sector 1990 and 2008 is presented in Figure 3.2-17.

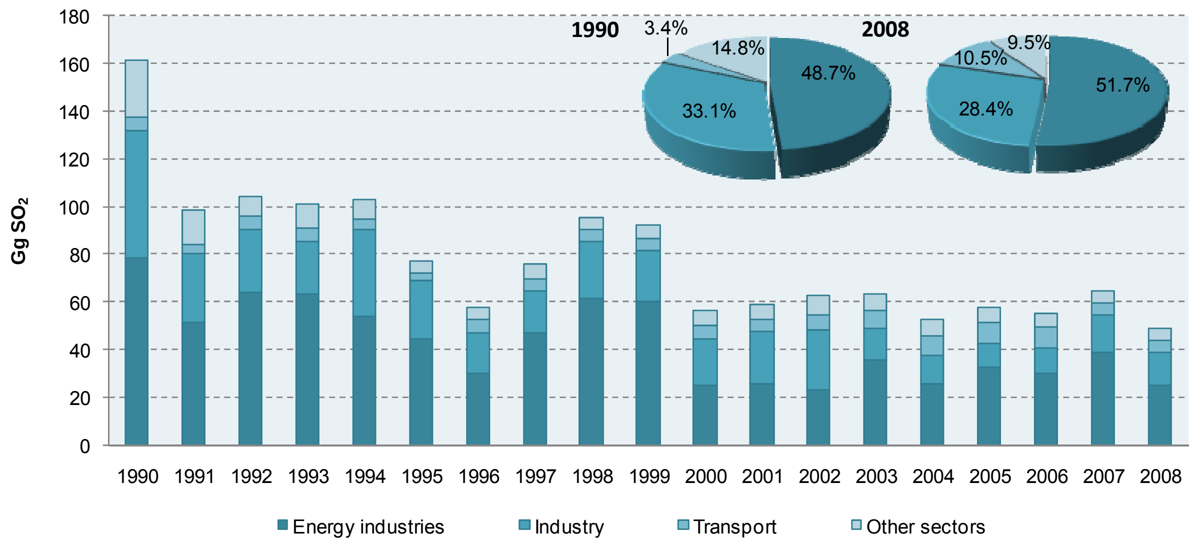


Figure 3.2-17: Energy sector SO_2 emissions in the period 1990-2008

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 (Gg)

Emission (Gg)	1990	1995	2000	2005	2006	2007	2008
NO_x Emission	**85.90**	**59.26**	**68.22**	**67.60**	**68.23**	**73.23**	**69.42**
Energy Industries	13.61	11.54	11.99	12.04	11.15	13.39	9.80
Manuf. Ind. & Cons.	17.38	8.80	9.15	9.91	11.16	14.56	15.35
Transport	39.88	30.80	34.24	32.50	32.68	32.42	30.76
Other Energy	15.03	8.13	12.85	13.15	13.24	12.86	13.51
CO Emission	**485.46**	**335.34**	**359.08**	**276.04**	**274.03**	**252.50**	**240.57**
Energy Industries	1.54	1.11	1.21	0.93	1.35	1.89	1.09
Manuf. Ind. & Cons.	39.71	40.36	36.43	32.93	36.69	42.30	36.51
Transport	240.26	177.19	175.05	109.22	102.51	92.73	82.91
Other Energy	203.95	116.68	146.39	132.96	133.47	115.58	120.06
NMVOC Emission	**47.68**	**33.94**	**39.32**	**27.86**	**28.15**	**25.84**	**25.10**
Energy Industries	0.32	0.23	0.28	0.29	0.29	0.34	0.27
Manuf. Ind. & Cons.	1.69	1.35	1.43	1.76	1.86	2.01	2.11
Transport	33.53	25.45	28.60	17.52	17.64	16.09	15.00
Other Energy	12.14	6.91	9.01	8.29	8.37	7.41	7.72
SO_2 Emission	**161.17**	**77.20**	**56.85**	**57.93**	**55.36**	**64.89**	**48.80**
Energy Industries	78.51	44.48	25.39	32.76	30.44	38.94	25.21
Manuf. Ind. & Cons.	53.32	24.54	18.94	10.18	10.19	15.82	13.84
Transport	5.46	3.52	6.01	8.36	8.88	5.24	5.13
Other Energy	23.87	4.65	6.50	6.63	5.85	4.89	4.62

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 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)

3.2.7.1. Tier 1 Approach

CO_2 emissions

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, N_2O and indirect greenhouse gases (NO_x, CO and NMVOC) 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 2008* 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).

3.2.7.2. 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 1990-2008, 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 (<1.4 lit, 1.4-2.0 lit, >2.0 lit)
- weight class (<3.5 t, 3.5-7.5 t, 7.5-16 t, 16-32 t, >32 t)
- age of vehicles (distribution of vehicles per ECE categories according to EC directives)

Fuel consumption data (from Energy Institute “Hrvoje Požar”) are also necessary for calculation of emissions 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, beta value (the fraction of the monthly mileage driven before the engine and any exhaust components have reached their nominal operation temperature) and temperature per month are estimated (based on data from statistics) or COPERT default data are used.

COPERT calculates emission factors according to driving conditions data (the average speed per vehicle type and per road), 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 5 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 7 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 1990-2008, 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 (1990-2008). This model requires a very detailed set of input data and could be considered as a Tier 3 methodology. Activity data for vehicle fleet were obtained from three different sources: Ministry of Interior, Central Bureau of Statistics and Centre for Vehicles. It was decided that database from Ministry of Interior is relevant because it contains the complete data set on each registered vehicle in Croatia. In Mobile combustion – Domestic and International Aviation, a data from Central Bureau of Statistics was used in order to reduce trend inconsistency, but it was point out that uncertainty of international bunkers is relatively higher comparing to other data.

3.2.10. SOURCE-SPECIFIC RECALCULATIONS

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

In this sector three recalculations were performed as follows:

a) CO_2 emission from SO_2 scrubbing in TPP Plomin 2 was relocated from Energy to Industrial processes sector (Limestone and dolomite use) as ERT recommended. Recalculations were performed for the period from 2000-2007.

b) For the period from 1990-1994 in TPP Rijeka gas coke was used as a fuel for electricity production. Consumption of gas coke as well as emissions were located under the solid fuels. This explains the fact that implied emission factor for solid fuels were below the IPCC default range. Mistake is corrected by relocating gas coke from solid to gaseous fuels for the whole period of time.

c) Some inconsistencies in data occurred because two different approaches were used for emission calculation (bottom up for large point sources and top down for the rest of the sector). Recalculations are carried out to reconcile these two approaches for emission calculation. Fuel consumption from CHP and TPP plants (tier 2) were compared to same subsector in national energy balance. The differences which occurred were added to consumption of PHP plants. In such way total consumption of this sector is equal to total consumption in national energy balance. This approach assures that neither double-counting nor omissions occur. Recalculation was performed for the whole period of time (1990-2007).

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

Table 3.2-13: Differences between previous and last submission in Energy industries sector

Energy industries	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2, %	-0.01		0.00	1.67	-0.90	1.48	-0.05	0.27	0.11	0.47	-0.20
CH_4, %				2.82	-0.45	2.30	-0.14	0.41	0.21	0.94	-0.52
N_2O, %	-1.26			2.38	-0.06	2.07	-0.15	0.27	0.14	0.69	-0.36

Energy industries	2000	2001	2002	2003	2004	2005	2006	2007
CO_2, %	-0.20	1.07	0.69	0.63	-0.33	-0.37	-0.20	1.29
CH_4, %	-0.52	0.95	0.52	0.47	-0.12	-0.10	3.79	1.14
N_2O, %	-0.36	0.42	0.16	0.16	-0.04	0.00	2.65	0.77

Manufacturing industry and construction (1.A.2.)

During the QC proceeding (comparison of activity data from national energy balance and data from balance for industry) was observed that the fuel consumed in industrial cogeneration plants was not included in so called 'Industry analysis balance'. Recalculations are carried out to add fuel consumption in industrial cogenerations to industry sector. Recalculations were performed for the period from 2001 to 2007.

Table 3.2-14 gives an overview of the differences in emissions before and after recalculation in Manufacturing industry and construction sector.

Table 3.2-14: Differences between previous and last submission in Manufacturing industry and construction sector

Manufacturing Industries and Construction	2001	2002	2003	2004	2005	2006	2007
CO_2, %	-1.49	1.08	-1.72	0.01	0.22	0.91	-2.89
CH_4, %	-1.65	-1.16	-1.77	0.01	0.13	5.75	-3.63
N_2O, %	-0.33	2.35	-0.32	0.01	0.24	7.18	-0.70

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

Recalculations were performed because new COPERT version for calculating the pollutant emissions from the road traffic implemented (COPERT IV). The use of this version of COPERT is recommended by ERT after centralized review of 2009 annual submission. Usage of these COPERT tool for calculating road transport emissions provides transparent and standardized, and thus consistent and comparable reporting of emissions in accordance with the requirements of international conventions and protocols and EU legislation. In addition to the methodology changes, in this report is generated a model, which automatically count the number of vehicles carried by a COPERT requirements, which until now was not the case. The model is built on the Access database. This step is a reduced likelihood of human error and increased accuracy. The result of application of this model are revised population certain categories of vehicles which is one of the key input parameters for calculation of emissions from road transport with COPERT IV. Further, the new value for the minimum and maximum average months temperatures observed were input in COPERT. That is because earlier values of the minimum and maximum average monthly temperature in Croatia were input. In accordance with the recommendations of the team responsible for developing COPERT model (training organized by the EEA and ETC / ACC in June of 2009) to take values of the minimum and maximum average months temperature for the largest cities in Croatia, mentioned was done for the purposes of this report. Emissions of this sector have been recalculated for the whole period (1990-2007). Table 3.2-15 gives an overview of the differences in emissions before and after recalculation.

Table 3.2-15: Differences between previous and last submission in Transport sector

Transport	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2, %		-0.16	0.00	-0.37	-0.63	-0.21	-0.29	-0.33	-0.41	-0.49
CH_4, %	32.26	31.65	30.91	32.33	33.23	30.92	27.57	25.07	22.51	20.12
N_2O, %	4.95	6.93	-5.76	-14.88	-8.37	-12.29	-10.95	-16.41	-21.16	-22.89

Transport	2000	2001	2002	2003	2004	2005	2006	2007
CO_2, %	-0.48	-0.54	-0.61	-0.71	-0.67	-0.68	-0.66	-0.78
CH_4, %	17.05	7.72	6.59	3.93	-1.10	-24.23	-26.11	-29.21
N_2O, %	-28.86	20.05	-41.56	-45.45	-2.91	0.19	-7.55	-52.91

Other sectors (1.A.3.b.)

For CH_4 emission calculation wrong emission factor for gas works gas was used (107.6 Gg/TJ was used instead if 47.4 Gg/TJ). Emission factor was corrected for the whole period (1990-2007). Table 3.2-16 gives an overview of the differences in emissions before and after recalculation.

Table 3.2-16: Differences between previous and last submission in Other sectors

Other Sectors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CH_4, %	0,02	0,08	0,07	0,04	0,02	0,02	0,02	0,02	0,02	0,02

Other Sectors	2000	2001	2002	2003	2004	2005	2006	2007
CH_4, %	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02

Aviation bunkers (1.C.)

In 2007 wrong Net calorific value was used to calculate consumption of jet kerosene (44.96 TJ/Gg was used instead if 43.96 TJ/Gg). As ERT recommended, this error is corrected.

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.

As a result of comprehensive analysis of GHG inventory quality, short-term and long-term goals for GHG inventory improvement are obtained.

Short-term goals (< 1 years)

Generally, 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.

Long-term goals (> 1 years)

The extensive use of plant-specific data which will be collected in the newly established Register of Environmental Pollution is highly recommended (“bottom up” approach). In addition, usage of more source-specific QA/QC procedures will improve the quality of GHG inventory in Energy sector.

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.

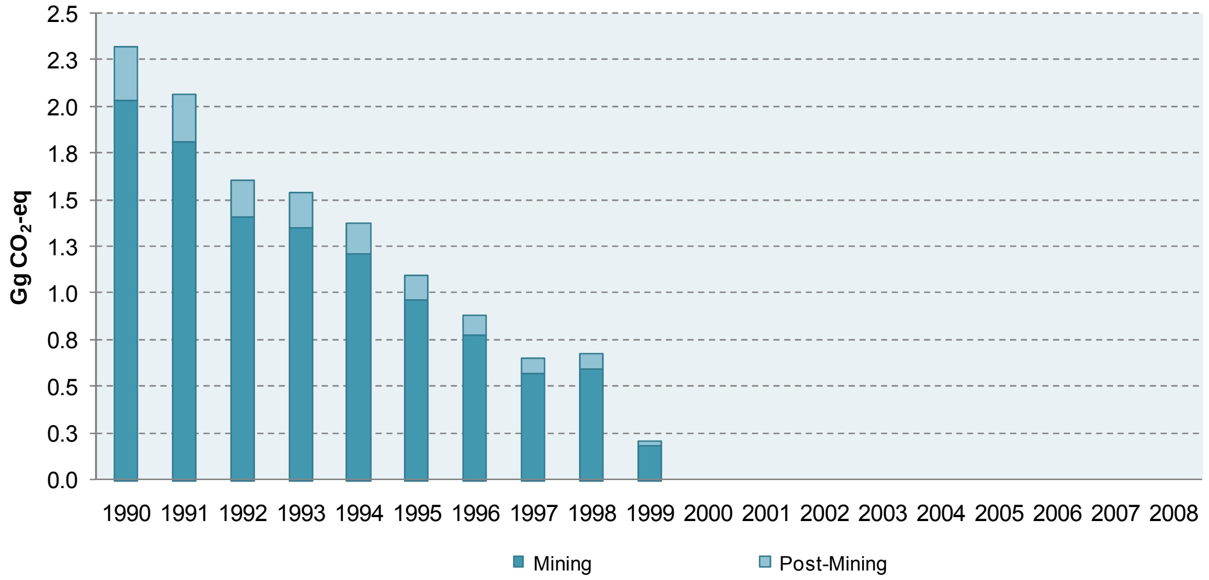


Figure 3.3-1: The fugitive emissions of methane from coal mines

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 NO_x, CO and SO_2 during various processes in oil refineries.

Fugitive emission of methane

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

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

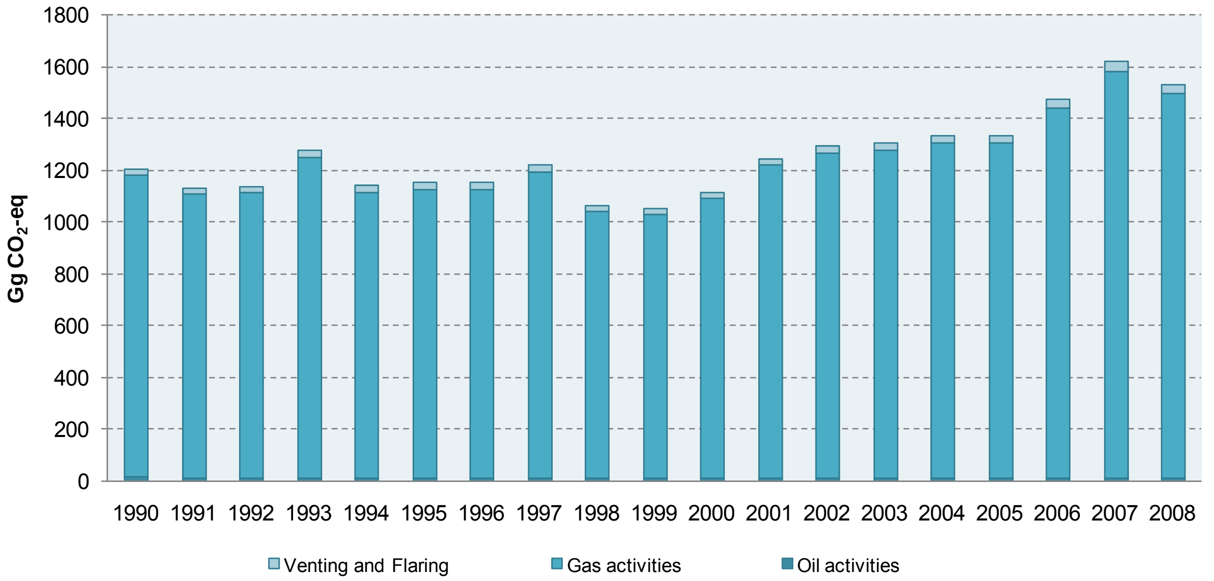


Figure 3.3-2: The fugitive emissions of methane from oil and gas activities

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

Fugitive emission of ozone precursors and SO_2

Emissions of indirect GHGs for whole time period (1990-2008) 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 2008* 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).

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 2008. 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, NO_x 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
CO emission	0.64	0.49	0.47	0.45	0.43	0.46	0.39
NO_x emission	0.64	0.44	0.33	0.32	0.31	0.33	0.28
NMVOC emission	9.75	7.77	9.73	9.05	9.03	8.89	8.09
SO_2 emission	6.38	4.96	4.80	4.60	4.39	4.72	4.01

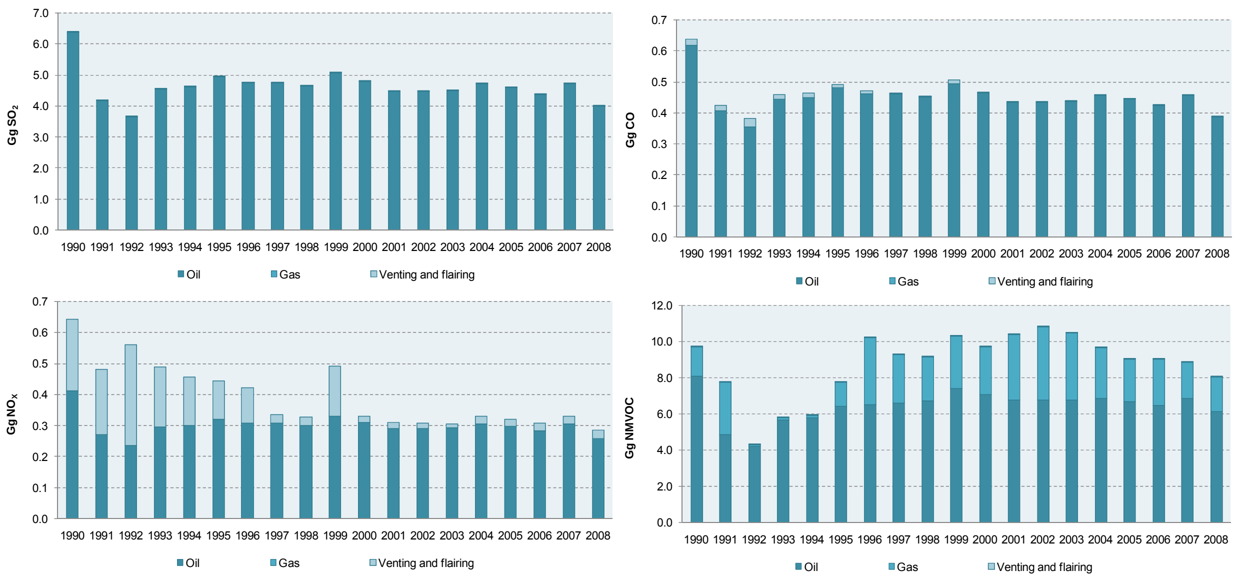


Figure 3.3-3: The fugitive emissions of CO, NO_X, NMVOC and SO_2

<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, Kalinovac and Stari Gradac) 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
Central Gas Station MOLVE	416	697	633	691	663	665	576

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, energy supply and demand.

Inputs on processed crude oil in refineries are taken from national energy balance while emission factors are taken from *IPCC Guidelines* (Reference Manual, page 1.133 and 1.134).

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 ($\pm$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

Quality control activities were divided in two phases, first phase included activities during the 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 2010 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 report, no source-specific recalculations were performed in Fugitive emissions from fuels sector.

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 Manual*. 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 of rigorous source-specific evaluations approach (Tier 3).

3.4. REFERENCES

Central Bureau of Statistics (2009) *Statistical Yearbook – for period from 1990 till 2008, Zagreb*

Croatian Environment Agency (2010) Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2008* Submission to the Convention on Long-range Transboundary Air Pollution, EKONERG Ltd., Zagreb

FCC/IRR/2008/HRV *Report of the review of the initial report of Croatia*, 26 August 2009

FCC/ARR/2008/HRV *Report of the initial review of the greenhouse gas inventories of Croatia submitted in 2007 and 2008*, 5 November 2009 (advance version)

FCCC/ARR/2009/HRV *Report of the individual review of the individual review of the annual submission of Croatia submitted in 2009* (advance version)

EEA (2000) *COPERT IV Computer Programme to Calculate Emissions from Road Transport,* Denmark

HEP (2006) *Annual Report of Air Emissions from HEP's Thermal Power Plants (draft)*, prepared by EKONERG, Zagreb

INA (2006) *Data about natural gas scrubbing in Central Gas Station MOLVE and sulphur content in liquid fossil fuels*, INA – Oil and Gas Company, data sent by fax or by mail

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, Japan

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory – Workbook*, Revised 1996 IPCC Guidelines for National Greenhouse Inventories, Volume 2, United Kingdom

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory – Reference Manual*, Revised 1996 IPCC Guidelines for National Greenhouse Inventories, Volume 3, United Kingdom

Ministry of Economy, Labour and Entrepreneurship (2009) *Energy in Croatia 2008,* Annual Energy Report, Energy Institute "Hrvoje Požar", Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2009) *National Inventory Report 2009, Croatian greenhouse gas inventory for the period 1990 – 2007,* EKONERG, Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2010) *Fifth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)*, Zagreb

Ministry of Interior (2009) *Motor Vehicle Databases for 1990-2008*, data on CD

Vuk B. *National Energy Balances – for period from 1990 till 2008*, Energy Institute Hrvoje Požar, Zagreb

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), which are used as substitution gases in refrigeration and air conditioning systems, foam blowing and fire extinguishers, is 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 exist.

Some industrial process, 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 indirect contribute to 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 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 were stopped in 1992.

The total annual emissions of GHGs, expressed in Gg CO_2-eq, from Industrial Processes in the period 1990-2008 are presented in the Figure 4.1-1.

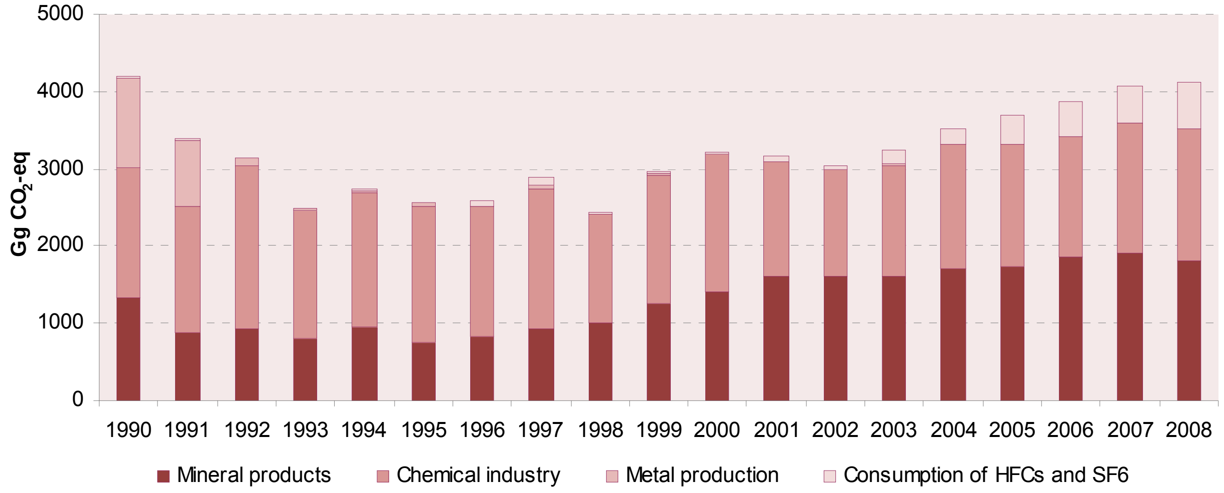


Figure 4.1-1: Emissions of GHGs from Industrial Processes (1990-2008)

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 - 2008)

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	2017840	44585	2103674	0.521	0.319
1991	1296146	40974	1363862	0.521	0.327
1992	1538923	27378	1597627	0.521	0.307
1993	1264565	40511	1331178	0.523	0.312
1994	1548980	34702	1615356	0.526	0.317
1995	1148756	48854	1221562	0.523	0.317
1996	1245692	60570	1332387	0.524	0.312
1997	1470234	63541	1564451	0.515	0.314
1998	1571767	77344	1682093	0.517	0.309
1999	2063838	87175	2194033	0.517	0.311
2000	2308148	73999	2429790	0.518	0.312
2001	2645180	94065	2794030	0.517	0.306
2002	2627934	70667	2752573	0.511	0.315
2003	2609349	82741	2745932	0.510	0.307
2004	2764331	87911	2909287	0.512	0.307
2005	2827258	99320	2985110	0.510	0.299
2006	3007818	96549	3166454	0.508	0.314
2007	3046209	114311	3223730	0.507	0.310
2008	2883266	111787	3054954	0.507	0.311

[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 - 2008)

Year	Clinker import / tonnes		Clinker export / tonnes		Change in clinker stocks* / tonnes	
	Portland	Aluminate	Portland	Aluminate	Portland	Aluminate
1990	0	0	0	0	9484	-113
1991	0	0	0	0	-35932	7790
1992	0	0	4376	0	51763	-3154
1993	0	0	0	0	-25265	-3616
1994	0	0	0	2200	-16847	1003
1995	52500	0	0	5504	10313	3619
1996	0	0	32715	5500	10521	3416
1997	57973	0	63529	5000	16034	-824
1998	116397	0	82451	14	-22552	8827
1999	0	0	114868	287	-13736	7145
2000	0	0	111226	576	-15574	-9775
2001	0	100	131565	519	47038	8999
2002	0	0	5029	2987	-12673	-8991
2003	112467	0	0	285	-16320	690
2004	51791	0	53387	157	33581	-1643

Table 4.2.2: Import/export quantities of clinker (1990 - 2008), cont.

Year	Clinker import / tonnes		Clinker export / tonnes		Change in clinker stocks* / tonnes	
	Portland	Aluminate	Portland		Portland	Aluminate
2005	0	0	195888	238	-88696	-1151
2006	0	0	243708	438	-32078	-1710
2007	24000	1632	309431	1115	4442	4467
2008	0	153	234849	626	-21949	2602

* During the period 2002-2005, Portland clinker was sent off in one plant which didn‘t produce clinker (only cement), in the following quantities: 153138 tonnes (2002), 159321 tonnes (2003), 172020 tonnes (2004) and 56459 tonnes (2005).

The resulting emissions of CO_2 from Cement Production in the period 1990-2008 are presented in the Figure 4.2-1.

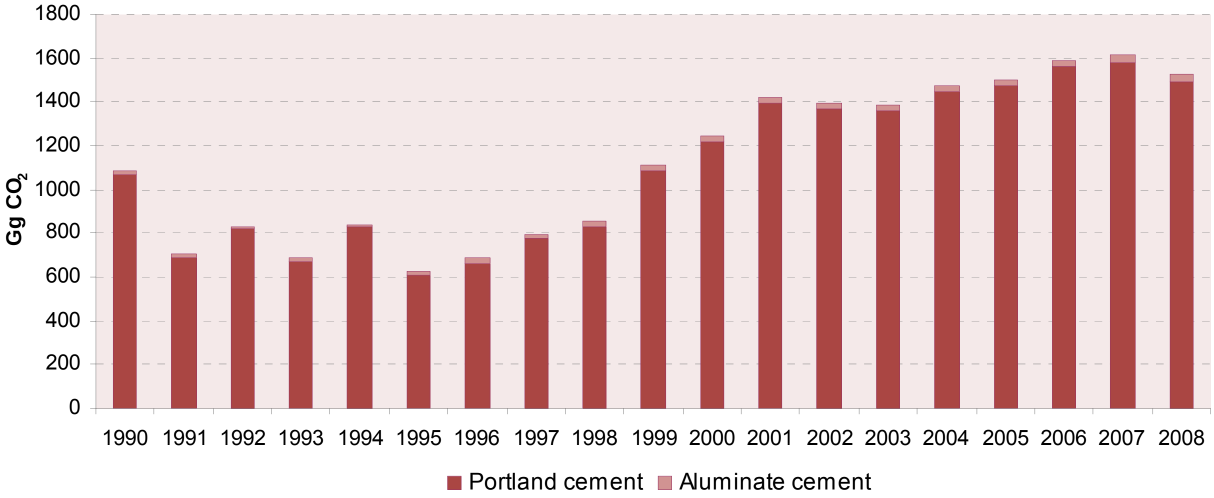


Figure 4.2-1: Emissions of CO_2 from Cement Production (1990-2008)

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 Monthly Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

Table 4.2-3: Cement production (1990-2008)

Year	Cement production / tonnes	
	Portland	Aluminate
1990	2598066	44698
1991	1702589	33184
1992	1810780	30532
1993	1596244	36895
1994	2049140	31499
1995	1571415	39731
1996	1643049	51654
1997	1906133	59365
1998	2161827	68503
1999	2549726	79743
2000	2909466	83388

Table 4.2-3: Cement production (1990-2008), cont.

Year	Cement production / tonnes	
	Portland	Aluminate
2001	3152805	84655
2002	3415011	76737
2003	3607840	81860
2004	3553985	89563
2005	3528544	100509
2006	3657889	98041
2007	3613548	111624
2008	3671826	108891

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 2008* 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 1990-2008 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.2.1.3. Uncertainties and time-series consistency

Uncertainty estimate associated with emission factors amounts 3 percent, accordingly to values (1 to 5 percent) reported in *Good Practice Guidance*. Uncertainty estimate associated with activity data amounts 3 percent (1 to 5 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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

In NIR 2009, activity data for the year 2007 have been estimated due to the insufficient data (data from one plant have not been collected). Since those data were subsequently obtained, recalculations were made accordingly.

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 (900-1200 ^oC) 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, among one manufacturer produce both quicklime and dolomitic lime and the others produce 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 (1990-2008)

Year	Quicklime		Dolomitic lime	
	Production (tonnes)	EF (t CO_2/t lime)	Production (tonnes)	EF (t CO_2/t lime)
1990	211801	0.728	7474	0.869
1991	155258	0.732	0	-
1992	106393	0.720	0	-
1993	116893	0.723	0	-
1994	117178	0.725	0	-
1995	113452	0.735	0	-
1996	109185	0.722	38070	0.862
1997	100863	0.720	55171	0.850
1998	105261	0.733	53367	0.874
1999	90794	0.738	52704	0.870
2000	105374	0.731	68572	0.887
2001	118161	0.741	84838	0.887
2002	129134	0.746	94378	0.892
2003	124617	0.749	96191	0.879
2004	181306	0.747	56689	0.895
2005	173710	0.757	76351	0.875
2006	199784	0.750	105653	0.895
2007	198790	0.759	115315	0.899
2008	190344	0.752	120680	0.900

The resulting emissions of CO_2 from Lime Production in the period 1990-2008 are presented in the Figure 4.2-2.

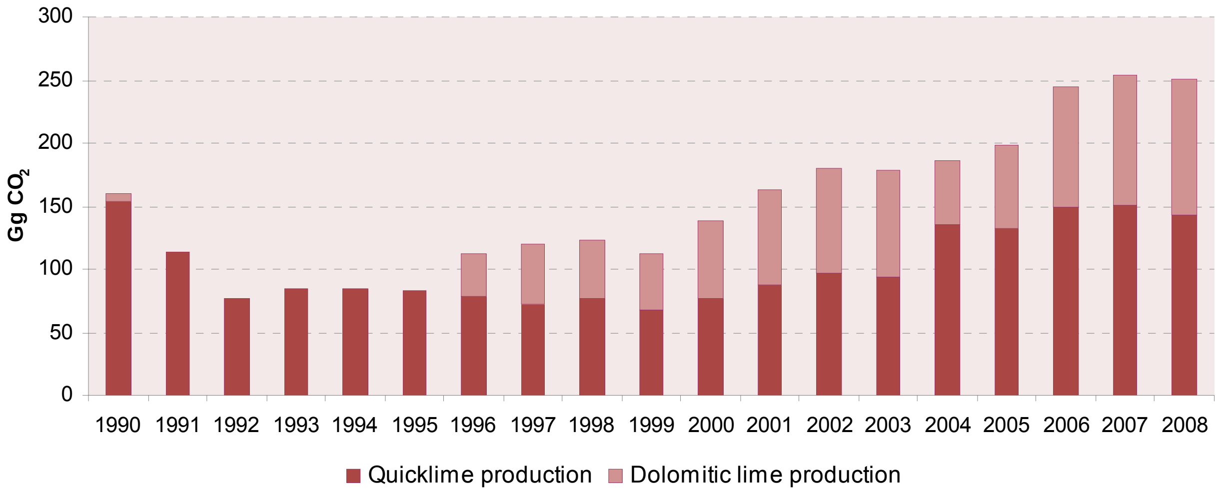


Figure 4.2-2: Emissions of CO_2 from Lime Production (1990-2008)

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 2008* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of CO from Lime Production in the period 1990-2008 are presented in the review on indirect GHG emissions from non-energy industrial processes.

4.2.2.3. Uncertainties and time-series consistency

Uncertainty estimate associated with emission factors amounts 3 percent, accordingly to values (1 to 5 percent) reported in *Good Practice Guidance*. Uncertainty estimate associated with activity data amounts 3 percent (1 to 5 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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 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, 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 from use of limestone and dolomite 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, ceramic and refractory materials manufacture 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 dolomite use in glass, ceramic and refractory materials manufacture in that period. 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 manufacturer. The activity data for dolomite use in glass manufacture in the period 1997-2008 were collected by survey of glass manufacturer. Some of these activities (from the period 1990-1996) were halted in the meantime. Data for the period from 2000-2008 were updated by adding the limestone use in desulphurization process in TPP Plomin 2 (previously included in the energy sector) (see Table 4.2-5).

Table 4.2-5: Limestone and dolomite use (1990-2008)

Year	Limestone use (tonnes)	Dolomite use (tonnes)
1990	60609	52031
1991	30500	40452
1992	9946	21505
1993	9588	20134
1994	13701	32504
1995	14080	23461
1996	12935	25063
1997	10745	14762
1998	12957	17565
1999	11782	16205
2000	18585	16695
2001	22233	18596
2002	26226	20022
2003	30870	23975
2004	32871	24088
2005	32759	25269
2006	30275	22350
2007	27138	20018
2008	31759	20018

The resulting emissions of CO_2 from Limestone and Dolomite Use in the period 1990-2008 are presented in the Figure 4.2-3.

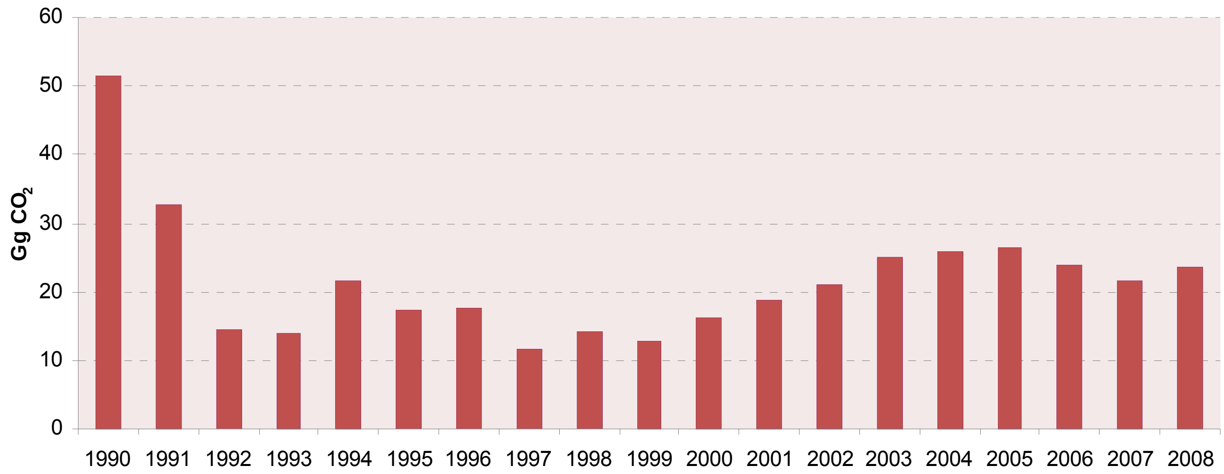


Figure 4.2-3: Emissions of CO_2 from Limestone and Dolomite Use (1990-2008)

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 default emission factors amounts 30 percent, based on expert judgements. Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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 1997-2008. As abovementioned, in the period 1990-1996 national classification of activities distinguished dolomite use in glass, 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 manufacturer. Some of these 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

According to ERT recommendation during the in-country review, data for the period from 2000-2008 were updated by adding the limestone use in desulphurization process in TPP Plomin 2 (previously included in the energy sector). Emissions of CO_2 have been recalculated according to the corrected activity data.

4.2.3.6. Source–specific planned improvements

For the purpose of accurate calculation of national emission factors, knowledge of chemical composition of limestone dolomite which is used as raw materials in abovementioned commercial applications (glass, ceramic and refractory materials manufacture) is favourably and plans to investigate. For now, detailed data have been collected from only one glass manufacturer.

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 1990-2008. 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 manufacturer. The activity data for soda ash use in glass manufacture in the period 1997-2008 were collected by survey of glass manufacturers (see Table 4.2-6).

Table 4.2-6: Soda ash use (1990-2008)

Year	Soda ash use (tonnes)
1990	62024
1991	52415
1992	35376
1993	30202
1994	36659
1995	34668
1996	29706
1997	25125
1998	28499
1999	25121
2000	26536
2001	29134
2002	29179
2003	34178
2004	39730

Table 4.2-6: Soda ash use (1990-2008), cont.

Year	Soda ash use (tonnes)
2005	41498
2006	36487
2007	32329
2008	32329

The resulting emissions of CO_2 from Soda Ash Use in the period 1990-2008 are presented in the Figure 4.2-4.

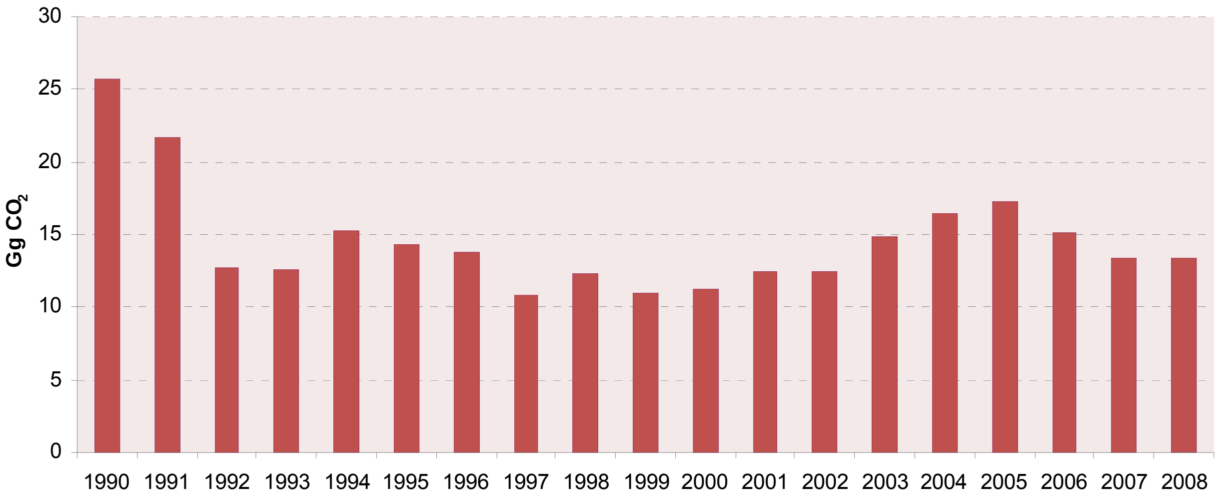


Figure 4.2-4: Emissions of CO_2 from Soda Ash Use (1990-2008)

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 default emission factors amounts 30 percent, based on expert judgements. Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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 1997-2008. As abovementioned, in the period 1990-1996 national classification of activities distinguished soda ash use in glass and ceramic manufacture and in the production of soap and detergents. After this period national classification of activities did not distinguish soda ash use in abovementioned activities and because of that, AD was collected by survey of manufacturers. Some of these 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.

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.

4.2.4.5. Source specific recalculations

There are no source-specific recalculations in this report.

4.2.4.6. Source–specific planned improvements

For the purpose of accurate calculation of national emission factors, investigation of specific information characterizing the emissions from particular end-use processes is favourably and plans to investigate.

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 2008* 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 1990-2008 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

For the purpose of accurate calculation of national emission factors, analyze and 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 and fuel have been calculated by means of multiplying annual consumption of natural gas (both feedstock and fuel) by carbon content of natural gas and molecular weight ratio between CO_2 and carbon (Tier 1a, *Revised 1996 IPCC Guidelines*).

Emissions of CH_4 and N_2O from natural gas used as fuel have been calculated by means of multiplying annual energy consumption of natural gas by default emission factors (Tier 1, *Revised 1996 IPCC Guidelines*).

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

Carbon content of gas (kg C/m^3) has been estimated from volume fraction of CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}, CO_2 and N_2 in natural gas. Measurements were performed at the standard condition (1 atm, 15 ^{o}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 (1990-2008)

Year	Natural gas consumption (m^3)		Carbon content of gas (kg C/m^3)
	Feedstock	Fuel	
1990	242905233	211094767	0.5232
1991	230492226	248307774	0.5289
1992	299567927	316032073	0.5237
1993	238269046	265730954	0.5114
1994	239717137	273782863	0.5120
1995	232773362	321226638	0.5141
1996	254116356	279183644	0.5115
1997	277311935	308688065	0.5093
1998	207973360	251626640	0.5094
1999	262772017	286027983	0.5108

Table 4.3-1: Consumption and composition of natural gas in Ammonia Production (1990-2008), cont.

Year	Natural gas consumption (m^3)		Carbon content of gas (kg C/m^3)
	Feedstock	Fuel	
2000	266433375	280466625	0.5097
2001	214441408	232458592	0.5134
2002	193045364	212154636	0.5139
2003	216859822	245040178	0.5148
2004	264367950	220332050	0.5111
2005	259004302	219095698	0.5103
2006	253861433	209038567	0.5128
2007	280232850	227567150	0.5075
2008	284633920	221166080	0.5082

The resulting emissions of CO_2 from Ammonia Production in the period 1990-2008 are presented in the Figure 4.3-1.

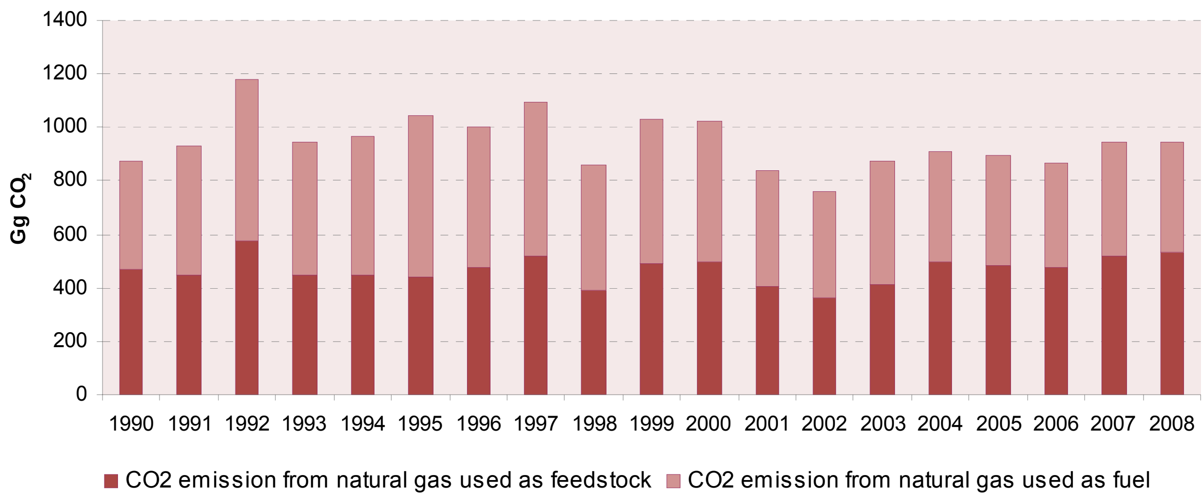


Figure 4.3-1: Emissions of CO_2 from Ammonia Production (1990-2008)

Emissions of CH_4 and N_2O from natural gas used as fuel in Ammonia production in the period 1990-2008 are presented in the Table 4.3-2.

Table 4.3-2: Emission of CH_4 and N_2O in Ammonia Production from consumption of natural gas as fuel (1990-2008)

Year	CH_4 (Gg)	N_2O (Gg)
1990	0.03104	0.00062
1991	0.03652	0.00073
1992	0.04648	0.00093
1993	0.03908	0.00078
1994	0.04026	0.00081
1995	0.04724	0.00094
1996	0.04106	0.00082
1997	0.04540	0.00091

Table 4.3-2: Emission of CH_4 and N_2O in Ammonia Production from consumption of natural gas as fuel (1990-2008), cont.

Year	CH_4 (Gg)	N_2O (Gg)
1998	0.03700	0.00074
1999	0.04206	0.00084
2000	0.04125	0.00082
2001	0.03419	0.00068
2002	0.03120	0.00062
2003	0.03604	0.00072
2004	0.03240	0.00065
2005	0.03222	0.00064
2006	0.03074	0.00061
2007	0.03347	0.00067
2008	0.03252	0.00065

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.

Uncertainty estimate associated with emission factors amounts 5 percent, accordingly to value recommended in *Good Practice Guidance*. Uncertainty estimate associated with activity data amounts 3 percent (1 to 5 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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

There are no source-specific recalculations in this report.

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 (1990-2008)

Year	Nitric acid production (tonnes)
1990	332459
1991	291997
1992	381797
1993	287805
1994	311236
1995	299297
1996	278683
1997	292892
1998	220509
1999	260198
2000	306201

Table 4.3-3: Nitric acid production (1990-2008), cont.

Year	Nitric acid production (tonnes)
2001	257534
2002	249992
2003	235645
2004	287567
2005	280746
2006	277590
2007	306619
2008	312928

The resulting emissions of N_2O from Nitric Acid Production in the period 1990-2008 are presented in the Figure 4.3-2.

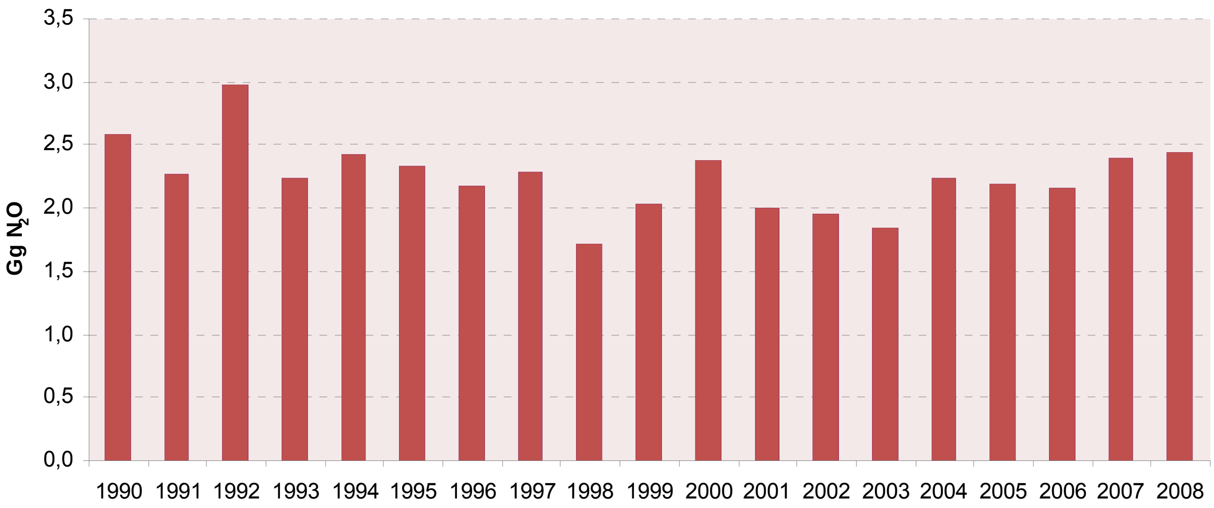


Figure 4.3-2: Emissions of N_2O from Nitric Acid Production (1990-2008)

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.

Uncertainty estimate associated with default emission factors amounts 30 percent, based on expert judgements. Uncertainty estimate associated with activity data amounts 3 percent (1 to 5 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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 continuously 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 1990-2008 are reported in Table 4.3-5.

Table 4.3-4: Production of other chemicals (1990-2008)

Year	Carbon black (tonnes)	Ethylene (tonnes)	Dichloro-ethylene (tonnes)	Styrene (tonnes)	Coke (tonnes)
1990	30624	72631	72653	8923	556084
1991	18783	66871	68325	6376	441584
1992	13479	68318	92089	1381	409371
1993	17123	68634	79608	0	420676
1994	21468	65285	97528	0	276854
1995	27185	67547	84374	0	0
1996	26735	64782	48630	0	0
1997	24214	63554	26264	0	0
1998	22165	60148	31308	0	0
1999	17589	60295	47686	0	0
2000	20029	38918	71364	0	0
2001	21180	46632	64442	0	0
2002	19385	43554	0	0	0
2003	21497	41252	0	0	0
2004	20271	49886	0	0	0
2005	18498	50263	0	0	0
2006	26264	48824	0	0	0
2007	23724	45438	0	0	0
2008	16903	43045	0	0	0

Table 4.3-5: Emissions of CH_4 from Production of Other Chemicals (1990-2008)

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

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’.

The emissions of indirect GHGs from Production of Other Chemicals for the period 1990-2008 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 default emission factor for CH_4 emissions amounts 30 percent, based on expert judgements. Uncertainty estimate associated with activity data for CH_4 emissions amounts 7.5 percent (5 to 10 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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.

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.

4.3.3.5. Source–specific recalculations

Activity data and emissions for the whole time period of the previous report (1990-2007) were rechecked and some of the data were corrected according to the emission inventory report ‘Republic of Croatia *Informative Inventory Report to LRTAP Convention for the Year 2008* 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).

4.3.3.6. Source–specific planned improvements

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

4.4. METAL PRODUCTION (CRF 2.C.)

4.4.1. IRON AND STEEL PRODUCTION

4.4.1.1. Source category description

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

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

4.4.1.2. Methodological issues

Pig Iron Production

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

The activity data for pig iron were extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining and cross-checked with iron and steel manufacturer[5].

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

A higher tier method based on annual steel consumption of carbon donors in EAFs has been used for CO_2 emission calculation. The carbon emission factor is based on carbon loss from carbon donors - electrode, coke, carburizing agent and steel scrap. Carbon in input material, which transformed into CO_2, is expressed by conversion factor which is defined as fraction. Conversion factor is not implemented if it is included in emission factor.
CO_2 emission has been calculated by the following equation:

CO_2 emission (t CO_2) = consumed quantity of input material (t) * emission factor (t CO2/t) * conversion factor

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

The activity data for steel production (see Table 4.4-1) were collected by bottom up analysis from two steel manufacturers.

Table 4.4-1: Steel production (1990-2008)

Year	Steel production (tonnes)
1990	171138
1991	119734
1992	101943
1993	74082
1994	63352
1995	45371
1996	45754
1997	69932
1998	103203
1999	76832
2000	71021
2001	57993
2002	33851
2003	43380
2004	86108
2005	68901
2006	80516
2007	76252
2008	138865

The resulting emissions of CO_2 from Steel Production in the period 1990-2008 are presented in the Figure 4.4-1.

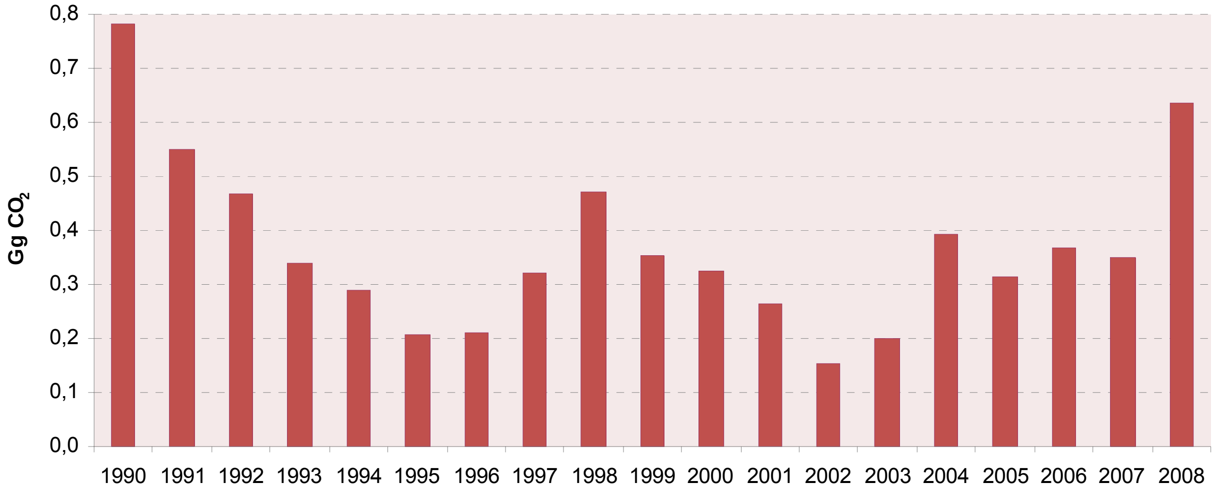


Figure 4.4-1: Emissions of CO_2 from Steel Production (1990-2008)

4.4.1.3. Uncertainties and time-series consistency

The main uncertainties concerning the emission of CO_2 from steel production are due to applied emission factor, because data from one manufacturer are still in the process of verification.

Uncertainty estimate associated with emission factors amounts 30 percent, based on expert judgements. Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

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 NIR 2009 emissions of CO_2 have been calculated by multiplying annual steel production with related emission factor provided by *Revised 1996 IPCC Guidelines*.

In this report a higher tier method based on annual steel consumption of carbon donors in EAFs has been used for CO_2 emission calculation. New activity data have been provided by steel manufacturers. Thereupon, CO_2 emissions have been recalculated for the period 1990-2007.

4.4.1.6. Source–specific planned improvements

For the purpose of accurate calculation of national emission factors, Croatia planned in addition investigate the plant-specific emission factor from one manufacturer.

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 4.4-2) 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 was halted in 2003.

Table 4.4-2: Reducing agents (1990-2008)

Year	Coke from coal (tonnes)	Coal electrodes (tonnes)
1990	36216	1824
1991	41981	2533
1992	25619	1645
1993	8519	799
1994	8566	988
1995	9529	650
1996	3860	266
1997	11867	0818
1998	5166	0356
1999	6054	0417
2000	3624	0250
2001	1195	082
2002	4	0.28
2003	7597	524
2004	0	0
2005	0	0
2006	0	0
2007	0	0
2008	0	0

The resulting emissions of CO_2 from Ferroalloys Production in the period 1990-2008 are presented in the Figure 4.4-2.

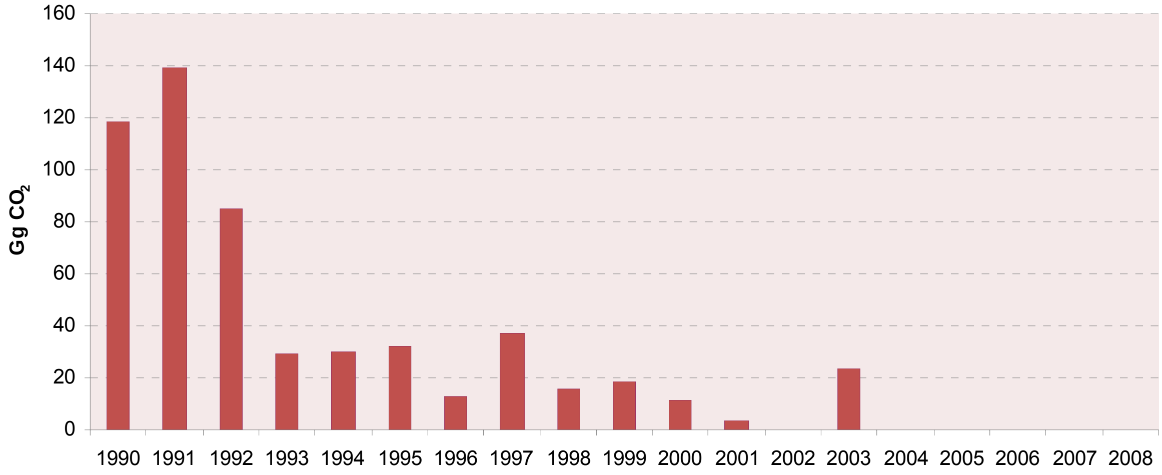


Figure 4.4-2: Emissions of CO_2 from Ferroalloys Production (1990-2008)

4.4.2.3. Uncertainties and time-series consistency

Uncertainty estimate associated with default emission factors amounts 30 percent, based on expert judgements. Uncertainty estimate associated with activity data amounts 7.5 percent (5 to 10 percent), based on expert judgements since statistics and manufacturers have not been particularly assessed the uncertainties.

Emissions from Ferroalloys Production have been calculated using the same method and data sets for every year in the time series, except insufficient data for 1999, which was obtained by interpolation method.

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[6] .

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

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

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

4.4.3.3. Uncertainties and time-series consistency

Uncertainties related to calculation of CO_2 emissions are primarily due to applied emission factor.

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

Uncertainty estimate associated with default emission factor for CO_2 emissions amounts 30 percent, based on expert judgements. Uncertainty estimate associated with activity data for CO_2

[6] 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.

emissions amounts 3 percent (1 to 5 percent), based on expert judgements since statistics and manufacturer have not been particularly assessed the uncertainties.

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. Uncertainty estimate associated with default emission factor for PFCs emissions amounts 50 percent, based on expert judgements. Uncertainty estimate associated with activity data for PFCs emissions amounts 30 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 2008* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of indirect GHGs from Pulp and Paper in the period 1990-2008 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 2008* Submission to the Convention on Long-range Transboundary Air Pollution’.

The resulting emissions of NMVOC from Food and Drink in the period 1990-2008 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

Activity data and emissions for the whole time period of the previous report (1990-2007) were rechecked and some of the data were corrected according to the emission inventory report ‘Republic of Croatia *Informative Inventory Report to LRTAP Convention for the Year 2008* 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).

4.6. CONSUMPTION OF HALOCARBONS AND SF_6 (CRF 2.F.)

4.6.1. REFRIGERATION AND AIR CONDITIONING EQUIPMENT

4.6.1.1. Source category description

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are synthetic greenhouse gases whose present contribution to greenhouse effect is relatively small comparing to major greenhouse gases but due to their extremely long lifetime and Global Warming Potentials (GWP) they will continue to accumulate in the atmosphere as long as emissions continue.

Emissions are released by the handling and consumption of synthetic greenhouse gases. HFCs (HFC-32, HFC-125, HFC-134a and HFC-143a) are used as substitutes for cooling gases in refrigerating and air-conditioning systems that deplete the ozone layer. There is no production of HFCs in Croatia, therefore all quantities of HFCs are imported. Minor quantities of some substances are exported.

4.6.1.2. Methodological issues

In order to estimate consumption of HFCs in the period 1990-2008 a questionnaires have been sent to trading, service and manufacturing companies previously identified as possible sources of handling or consumption of these compounds. Several institutions such as Ministry of Environmental Protection, Physical Planning and Construction, Customs Department and Central Bureau of Statistics were contacted and asked to provide information on import and export of HFCs as well as information on consumption of each individual gas at the rather detailed level in order to use Tier 2 method (*Revised 1996 IPCC Guidelines*).

Results of a survey were unable to provide certain data in required extent. Also, National Classification of Activities used by Central Bureau of Statistics, in the same manner, does not particularly mark HFCs, PFCs and SF_6. Customs Departments Tariff Number does not precisely distinguish these compounds from other fluorinated chemicals which are controlled with Montreal Protocol.

The only useful information is those related to import and export of HFCs provided by Ministry of Environmental Protection, Physical Planning and Construction, which is responsible for monitoring of consumption of substitutes and mixture of substitutes for gases that deplete the ozone layer. According to this information potential HFCs emissions from Refrigeration and Air Conditioning Equipment were calculated (Tier 1a method, *Revised 1996 IPCC Guidelines*) for the period 1990-2008. Cluster analysis of countries with similar circumstances was performed for the period 1990-1995 (HFCs emissions are identified as not occurred). For later period insufficient data were estimated by interpolation/extrapolation methods. Extrapolation method has been used for calculation of insufficient emission estimations for HFC 32. Taking into account the emissions trend; the pattern over three years from 2000 to 2002 has been used for calculation of HFC 32 emissions for the period 1996-1999. Data for 2003 and 2004 for HFC 32, HFC 125, HFC 134a and HFC 143a have been calculated by interpolation method using the pattern over entire time series and data for 2005 and 2006, which were obtained by Ministry of Environmental Protection, Physical Planning and Construction.

Annual emissions of HFCs, expressed in Gg CO_2-eq, in the period 1990-2008, are presented in the Table 4.6-1.

Table 4.6-1: Emissions of HFCs (Gg CO_2-eq) (1990 – 2008)

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
HFC 32	NO	NO	NO	NO	NO	NO	0.11	0.10	0.10	0.09
HFC 125	NO	NO	NO	NO	NO	NO	22.20	22.18	1.12	1.76
HFC 134a	NO	NO	NO	NO	NO	7.80	2.34	33.44	14.60	4.63
HFC 143a	NO	NO	NO	NO	NO	NO	35.61	35.57	1.82	2.70
***Total emission* (Gg CO_2-eq)**	**NO**	**NO**	**NO**	**NO**	**NO**	**7.80**	**60.26**	**91.29**	**17.64**	**9.18**

Table 4.6-1: Emissions of HFCs (Gg CO_2-eq) (1990 – 2008), cont.

Gas	2000	2001	2002	2003	2004	2005	2006	2007	2008
HFC 32	0.07	0.12	0.06	1.29	1.58	3.25	7.29	9.49	15.04
HFC 125	5.35	12.91	13.29	45.09	52.12	98.76	125.65	142.03	184.37
HFC 134a	8.92	14.53	14.32	41.80	47.81	82.71	86.16	86.47	108.84
HFC 143a	8.82	21.43	21.64	75.52	87.36	164.46	195.93	214.51	256.86
***Total emission* (Gg CO_2-eq)**	**23.16**	**48.99**	**49.31**	**163.71**	**188.87**	**349.18**	**430.68**	**465.10**	**584.01**

4.6.1.3. Uncertainties and time-series consistency

The main uncertainties of HFCs emissions estimation concerning to activity data. Quantities of HFCs contained in various products imported into or exported from a country were difficult to estimate. Also, the application of abovementioned methodology may lead to underestimation or overestimation of potential emissions, depending on whether the majority of HFC containing products is being imported or exported.

Uncertainty estimate associated with estimation of potential emissions of HFC-32, HFC-125, HFC-134a and HFC-143a amounts 70 percent for emission factor and 70 percent for activity data, based on expert judgements.

Emissions from Consumption of HFCs in Refrigeration and Air Conditioning Equipment have been calculated using the same method for every year in the time series. Two sources of information were used for data sets: data were provided by Ministry of Environmental Protection, Physical Planning and Construction and insufficient data were assessed by interpolation method.

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 shot-term period (see Chapter 4.6.1.6).

4.6.1.5. Source–specific recalculations

There are no source-specific recalculations in this report.

4.6.1.6. Source–specific planned improvements

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

According to requirement of Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official Gazette No. 1/07) each sources of HFCs emissions should report required activity data for more accurate emissions estimation (Tier 2 method). Regulation on controls of ozone-depleting substances (Official Gazette No. 120/05) prescribes control of import and export of these gases and providing of register to the Ministry of Environmental Protection, Physical Planning and Construction. Customs Departments Tariff Number of substitutes and mixture of substitutes has been introduced since 2007. Therefore, it is expected that information on consumption of each individual gas will be available at the rather detailed level in the future period in order to use Tier 2 method.

4.6.2. OTHER CONSUMPTION OF HFCS, PFCS AND SF6

4.6.2.1. Source category description

Potential emissions from Foam Blowing and Fire Extinguishers have been calculated only for the period 2006-2008, because the data for the period 1990-2005 are not available. The data on consumption of HFC 152-a (which is used for Foam Blowing), and HFC 125, HFC 227ea and HFC 236fa (which are used in Fire Extinguishers) have been provided by the Ministry of Environmental Protection, Physical Planning and Construction. There is no production of abovementioned HFCs in Croatia.

Emissions from Consumption of HFCs for Aerosols/Metered Dose Inhalers and Solvents have not been calculated because activity data are not available.

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.

4.6.2.2. Methodological issues

The information related to consumption of HFCs provided by the Ministry of Environmental Protection, Physical Planning and Construction have been used for potential HFCs emissions calculations from Foam Blowing and Fire Extinguishers (Tier 1a method, *Revised 1996 IPCC Guidelines*) for the period 2006-2008.

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 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

Annual emissions of SF_6, expressed in Gg CO_2-eq, in the period 1990-2008, are presented in the Table 4.6-2.

Table 4.6-2: Emissions of SF_6 (Gg CO_2-eq) (1990 – 2008)

Year	Emission of SF_6 (Gg CO_2-eq)
1990	11.01
1991	10.85
1992	10.85
1993	10.92
1994	11.20
1995	11.70
1996	12.01
1997	11.87
1998	12.47
1999	12.49
2000	12.33
2001	12.90
2002	13.76
2003	14.44
2004	15.00

Table 4.6-2: Emissions of SF_6 (Gg CO_2-eq) (1990 – 2008), cont.

Year	Emission of SF_6 (Gg CO_2-eq)
2005	15.84
2006	16.49
2007	16.76
2008	16.74

4.6.2.3. Uncertainties and time-series consistency

The main uncertainties of HFCs and SF_6 emissions estimation concerning to activity data. Uncertainty estimate associated with estimation of potential emissions of HFC-152a, HFC-125, HFC-227ea and HFC-236fa and SF_6 amounts 70 percent for emission factor and 70 percent for activity data, based on expert judgements.

Emissions from Consumption of HFCs in Foam Blowing and Fire Extinguishers have been calculated only for 2006, 2007 and 2008 because the data for the period 1990-2005 are not available. Data have been provided by the Ministry of Environmental Protection, Physical Planning and Construction. Emissions have been calculated using the same method.

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, additional data provided by one operator have been included for the period 1995-2008. Accordingly, SF_6 emissions have been recalculated for the period 1995-2007.

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.

According to requirement of Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official Gazette No. 1/07) each sources of HFCs and SF_6 emissions should report required activity data for more accurate emissions estimation (Tier 2 method). Regulation on controls of ozone-depleting substances (Official Gazette No. 120/05) prescribes control of import and export of these gases and providing of register to the Ministry of Environmental Protection, Physical Planning and Construction. Customs Departments Tariff Number of substitutes and mixture of substitutes has been introduced since 2007. Therefore, it is expected that information on consumption of each individual gas will be available at the rather detailed level in the future period in order to use Tier 2 method.

The resulting emissions of HFCs and SF_6 (Gg CO_2-eq) from Consumption of Halocarbons and SF_6 in the period 1990-2008 are presented in the Figure 4.6-1.

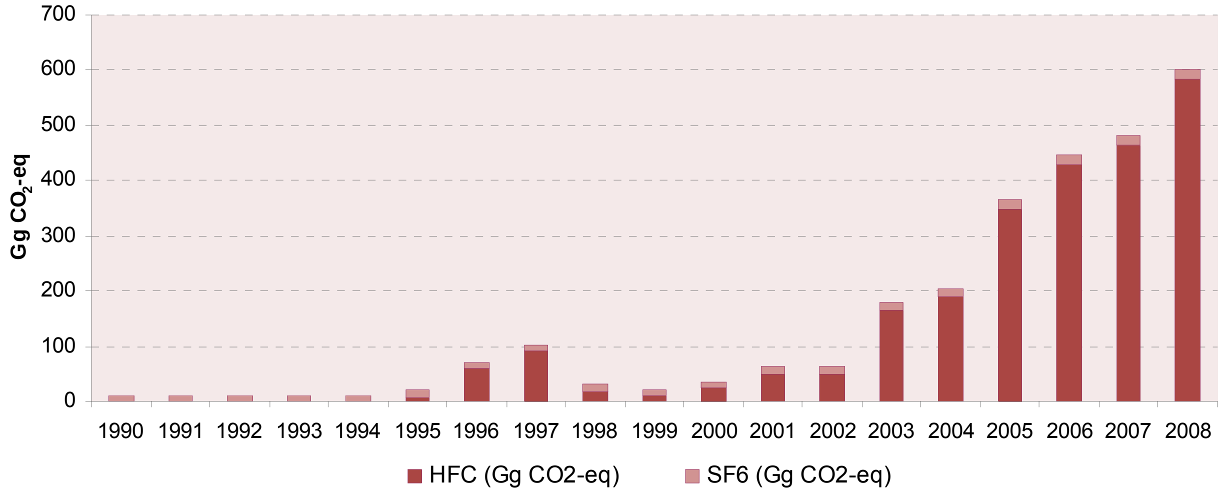


Figure 4.6-1: Emissions of HFCs and SF_6 (Gg CO_2-eq) from Consumption of Halocarbons and SF_6 (1990-2008)

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 1990-2008 are presented in Table 4.8-1.

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2008)

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	1085.79	1	1085.79	25.89	3.46
	1991		702.56		702.56	20.74	2.84
	1992		826.23		826.23	26.29	3.58
	1993		687.13		687.13	27.58	2.99
	1994		841.87		841.87	30.81	3.79
	1995		628.67		628.67	24.43	2.75
	1996		684.69		684.69	26.37	2.92
	1997		792.26		792.26	27.46	3.19
	1998		852.93		852.93	34.83	3.42
	1999		1115.06		1115.06	37.72	4.27
	2000		1243.59		1243.59	38.55	4.81
	2001		1423.55		1423.55	45.12	5.24
	2002		1392.12		1392.12	45.74	4.95
	2003		1383.62		1383.62	42.55	4.64
	2004		1470.38		1470.38	41.85	4.93
	2005		1499.86		1499.86	40.68	4.93
	2006		1588.04		1588.04	41.05	5.16
	2007		1611.88		1612.03	39.53	4.99
	2008		1526.87		1526.87	37.05	4.93
Lime production	1990	CO_2	160.63	1	160.63	3.83	0.51
	1991		113.60		113.60	3.35	0.46
	1992		76.58		76.58	2.44	0.33
	1993		84.48		84.48	3.39	0.37
	1994		84.92		84.92	3.11	0.38
	1995		83.42		83.42	3.24	0.36
	1996		111.65		111.65	4.30	0.48
	1997		119.51		119.51	4.14	0.48
	1998		123.79		123.79	5.06	0.50
	1999		112.82		112.82	3.82	0.43
	2000		137.85		137.85	4.28	0.53
	2001		162.84		162.84	5.17	0.60
	2002		180.56		180.56	5.94	0.64
	2003		177.83		177.83	5.48	0.59
	2004		186.09		186.09	5.31	0.62
	2005		198.36		198.36	5.39	0.65
	2006		244.47		244.47	6.33	0.79
	2007		254.46		254.46	6.25	0.79
	2008		251.36		251.36	6.10	0.81

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2008), 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	1.23	0.16
	1991		32.72		32.72	0.97	0.13
	1992		14.63		14.63	0.47	0.06
	1993		13.82		13.82	0.55	0.06
	1994		21.53		21.53	0.79	0.10
	1995		17.39		17.39	0.68	0.08
	1996		17.65		17.65	0.68	0.08
	1997		11.77		11.77	0.41	0.05
	1998		14.08		14.08	0.57	0.06
	1999		12.91		12.91	0.44	0.05
	2000		16.14		16.14	0.50	0.06
	2001		18.65		18.65	0.59	0.07
	2002		21.09		21.09	0.69	0.08
	2003		25.02		25.02	0.77	0.08
	2004		25.95		25.95	0.74	0.09
	2005		26.47		26.47	0.72	0.09
	2006		23.98		23.98	0.62	0.08
	2007		21.49		21.49	0.53	0.07
	2008		23.52		23.52	0.57	0.08
Soda ash production and use	1990	CO_2	25.74	1	25.74	0.61	0.08
	1991		21.75		21.75	0.64	0.09
	1992		12.76		12.76	0.41	0.06
	1993		12.54		12.54	0.50	0.05
	1994		15.21		15.21	0.56	0.07
	1995		14.39		14.39	0.56	0.06
	1996		13.86		13.86	0.53	0.06
	1997		10.88		10.88	0.38	0.04
	1998		12.27		12.27	0.50	0.05
	1999		11.03		11.03	0.37	0.04
	2000		11.32		11.32	0.35	0.04
	2001		12.50		12.50	0.40	0.05
	2002		12.47		12.47	0.41	0.04
	2003		14.83		14.83	0.46	0.05
	2004		16.49		16.49	0.47	0.06
	2005		17.22		17.22	0.47	0.06
	2006		15.14		15.14	0.39	0.05
	2007		13.42		13.42	0.33	0.04
	2008		13.42		13.42	0.33	0.04
Ammonia production	1990	CO_2	871.83	1	871.83	20.79	2.78
	1991		929.54		929.54	27.44	3.75
	1992		1183.31		1183.31	37.65	5.13
	1993		946.22		946.22	37.98	4.11
	1994		965.12		965.12	35.32	4.35
	1995		1045.56		1045.56	40.64	4.57
	1996		1001.32		1001.32	38.57	4.26
	1997		1095.47		1095.47	37.97	4.41
	1998		859.39		859.39	35.10	3.44
	1999		1028.98		1028.98	34.81	3.94
	2000		1023.27		1023.27	31.72	3.94
	2001		842.25		842.25	26.70	3.10
	2002		764.42		764.42	25.11	2.72
	2003		872.94		872.94	26.85	2.92
	2004		909.21		909.21	25.88	3.05
	2005		895.50		895.50	24.29	2.94

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2008), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Ammonia production	2006	CO_2	871.24	1	871.24	22.52	2.83
	2007		945.91		945.91	23.20	2.92
	2008		943.39		943.39	22.89	3.05
Nitric acid production	1990	N_2O	2.59	310	803.89	19.17	2.56
	1991		2.28		706.05	20.84	2.85
	1992		2.98		923.19	29.37	4.00
	1993		2.24		695.91	27.94	3.02
	1994		2.43		752.57	27.54	3.39
	1995		2.33		723.70	28.13	3.17
	1996		2.17		673.86	25.96	2.87
	1997		2.28		708.21	24.55	2.85
	1998		1.72		533.19	21.77	2.14
	1999		2.03		629.16	21.28	2.41
	2000		2.39		740.39	22.95	2.85
	2001		2.01		622.72	19.74	2.29
	2002		1.95		604.48	19.86	2.15
	2003		1.84		569.79	17.52	1.90
	2004		2.24		695.34	19.79	2.33
	2005		2.19		678.84	18.41	2.23
	2006		2.17		671.21	17.35	2.18
	2007		2.39		741.40	18.18	2.29
	2008		2.44		756.66	18.36	2.44
Production of other chemicals	1990	CH_4	0.75	21	15.80	0.38	0.05
	1991		0.55		11.49	0.34	0.05
	1992		0.46		9.74	0.31	0.04
	1993		0.50		10.48	0.42	0.05
	1994		0.48		10.06	0.37	0.05
	1995		0.40		8.41	0.33	0.04
	1996		0.38		7.94	0.31	0.03
	1997		0.34		7.15	0.25	0.03
	1998		0.32		6.65	0.27	0.03
	1999		0.27		5.73	0.19	0.02
	2000		0.29		6.04	0.19	0.02
	2001		0.31		6.41	0.20	0.02
	2002		0.26		5.39	0.18	0.02
	2003		0.28		5.83	0.18	0.02
	2004		0.27		5.73	0.16	0.02
	2005		0.25		5.33	0.14	0.02
	2006		0.34		7.09	0.18	0.02
	2007		0.31		6.43	0.16	0.02
	2008		0.23		4.81	0.12	0.02

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2008), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Steel production	1990	CO_2	0.78	1	0.78	0.02	0.002
	1991		0.55		0.55	0.02	0.002
	1992		0.47		0.47	0.01	0.002
	1993		0.34		0.34	0.01	0.001
	1994		0.15		0.15	0.01	0.001
	1995		0.08		0.08	0.00	0.0009
	1996		0.21		0.21	0.01	0.001
	1997		0.32		0.32	0.01	0.001
	1998		0.48		0.48	0.02	0.002
	1999		0.35		0.35	0.01	0.001
	2000		0.33		0.33	0.01	0.001
	2001		0.27		0.27	0.01	0.001
	2002		0.15		0.15	0.01	0.001
	2003		0.19		0.19	0.01	0.001
	2004		0.39		0.39	0.01	0.001
	2005		0.34		0.34	0.01	0.001
	2006		0.37		0.37	0.01	0.001
	2007		0.35		0.35	0.01	0.001
	2008		0.64		0.64	0.02	0.002
Ferroalloys	1990	CO_2	118.84	1	118.84	2.83	0.38
	1991		139.26		139.26	4.11	0.56
	1992		85.34		85.34	2.72	0.37
	1993		29.29		29.29	1.18	0.13
	1994		30.11		30.11	1.10	0.14
	1995		31.88		31.88	1.24	0.14
	1996		12.92		12.92	0.50	0.06
	1997		36.79		36.79	1.28	0.15
	1998		16.01		16.01	0.65	0.06
	1999		18.77		18.77	0.63	0.07
	2000		11.24		11.24	0.35	0.04
	2001		3.70		3.70	0.12	0.01
	2002		0.01		0.01	0.00	0.00004
	2003		23.55		23.55	0.73	0.08
	2004 - 2008		-		-	-	-
Aluminium	1990	CO_2	111.37	1	111.37	2.66	0.35
	1991		76.40		76.40	2.26	0.31
	1992 - 2008		-		-	-	-
	1990	CF_4	0.13	6500	820.44	19.56	2.62
	1991		0.09		562.79	16.62	2.27
	1992 - 2008		-		-	-	-
	1990	C_2F_6	0.013	9200	116.12	2.77	0.37
	1991		0.009		79.66	2.35	0.32
	1992 - 2008		-		-	-	-

Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2008), cont.

Source	Year	GHG	Emission (Gg)	GWP[1]	Emission (Gg CO_2-eq)	Percent in Industrial Processes	Percent in Total Country Emission
Consumption of HFCs, PFCs and SF_6	1990	HFC SF_6	[2]	[2]	11.01	0.26	0.03
	1991				10.85	0.32	0.04
	1992				10.85	0.35	0.05
	1993				10.92	0.44	0.05
	1994				11.20	0.41	0.05
	1995				19.41	0.75	0.08
	1996				72.11	2.78	0.31
	1997				102.91	3.57	0.41
	1998				29.90	1.22	0.12
	1999				21.45	0.73	0.08
	2000				35.31	1.10	0.14
	2001				61.74	1.96	0.23
	2002				62.94	2.07	0.22
	2003				178.00	5.48	0.59
	2004				203.77	5.81	0.68
	2005				364.91	9.91	1.20
	2006				447.11	11.57	1.45
	2007				481.79	11.83	1.49
	2008				600.70	14.58	1.94

[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=6300); SF6 (GWP=23900) - total emissions of HFCs and SF_6 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 2008* 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 1990-2008 are reported in table 4.8-3.

Table 4.8-3: Emissions of indirect GHGs from Industrial Processes (1990-2008)

Year	SO_2 (Gg)	NO_x (Gg)	CO (Gg)	NMVOC (Gg)
1990	2.85	2.42	46.57	22.33
1991	2.00	2.13	29.29	20.08
1992	1.42	2.64	16.09	11.89
1993	1.26	2.09	20.44	10.73
1994	1.61	2.18	25.62	7.77
1995	1.37	2.23	32.44	7.64
1996	1.32	2.16	31.90	9.04
1997	1.43	2.31	28.90	7.85
1998	1.24	1.89	0.00	7.73
1999	1.67	2.14	0.00	7.34
2000	1.85	2.29	30.00	6.37
2001	1.83	1.75	24.02	5.71
2002	1.99	1.84	26.80	5.85
2003	1.65	2.08	28.45	5.86
2004	1.87	1.11	17.78	5.59
2005	1.89	2.05	17.24	6.69
2006	1.65	1.89	39.11	5.32
2007	1.82	0.66	34.87	6.61
2008	1.93	0.73	9.27	6.33

4.9. REFERENCES

Central Bureau of Statistics, Department of Manufacturing and Mining, *Annual Industrial Reports (1990 – 2008),* Zagreb

Central Bureau of Statistics, *Statistical Yearbooks (1990-2009),* Zagreb

CROATIA CEMENT g.i.u (2007) *Report: Activity data for CO_2 emission calculations from Portland cement production*, in the framework of study Croatian Cement Industry and Climate Change, EKONERG Ltd., Zagreb

Croatian Environment Agency (2010) Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2008* Submission to the Convention on Long-range Transboundary Air Pollution, EKONERG Ltd., Zagreb

FCC/IRR/2008/HRV *Report of the review of the initial report of Croatia*, 26 August 2009

FCC/ARR/2008/HRV *Report of the initial review of the greenhouse gas inventories of Croatia submitted in 2007 and 2008*, 5 November 2009 (advance version)

FCCC/ARR/2009/HRV *Report of the individual review of the individual review of the annual submission of Croatia submitted in 2009* (advance version)

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, Japan

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Workbook*, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, United Kingdom

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Reference Manual*, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, United Kingdom

ISTRA CEMENT Ltd. (2008) *Report: Activity data for CO_2 emission calculations from Portland and Aluminate cement production*, in the framework of survey Programme of Reduction of CO_2 Emission in Istra Cement Ltd., EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2009) *National Inventory Report 2009, Croatian greenhouse gas inventory for the period 1990 – 2007,* EKONERG, Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2010) *Fifth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)*, Zagreb

PROMINS g.i.u (2008) *Report: Activity data for CO_2 emission calculations from lime production*, in the framework of study Croatian Lime Industry and Climate Change, EKONERG Ltd., Zagreb

Reports on data required for SF_6 emissions estimation (2009) – reports from HEP Electricity Production, HEP the Sole Transmission System Operator, HEP Distribution System Operator and Končar Group - High Voltage Switchgear

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 2008* Submission to the Convention on Long-range Transboundary Air Pollution'. The NMVOC emissions have been calculated by using simpler methodology. Default emission factor (*EMEP-CORINAIR Emission Inventory Guidebook*) has been applied for each source category. For several source categories (degreasing and dry cleaning, pharmaceutical products manufacturing and domestic solvent use) the NMVOC emissions calculation is based on population data. The activity data for the other sources were extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

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

Table 5.1-1: Activity data for NMVOC emissions from Solvent and Other Product Use (1990-2008)

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	1990-2008
Paint application																				
Paint application	21955	13872	9145	9066	10797	11083	13934	15003	15472	15193	15107	16793	15172	15331	14983	16393	17318	20097	20097	500
Degreasing, dry cleaning and electronics																				
Metal degreasing *	4778	4513	4470	4641	4649	4669	4494	4572.5	4501	4554	4381	4437	4443	4442	4439	4442	4440	4440	4440	0.85
Dry cleaning *	4778	4513	4470	4641	4649	4669	4494	4572.5	4501	4554	4381	4437	4443	4442	4439	4442	4440	4440	4440	0.25
Chemical products manufacturing or processing																				
Polyurethane process.– solid foam	147	81	16	21	35	29	22	44	39	60	60	95	180	70	60	120	120	266	266	15
Polyurethane process.– soft foam	3616	2717	1660	2025	2427	2880	1800	1710	1790	1770	1800	2655	5431	2855	2424	2799	2240	1607	1607	25
Polyester processing	6047	4159	3523	2570	2546	2225	3367	7022	8258	5609	12848	9661	14693	9704	10948	10886	14112	16548	16548	40
Polystyrene foam process.	39069	26383	57045	57666	58215	49356	56513	50894	54240	53047	16518	47146	45439	46361	34311	52933	47755	54069	6111	15
Polyvinylchloride processing	104602	67934	70969	44259	84546	99243	44791	23094	77811	34202	7368	1036	661	8387	10064	9396	8045	7866	9341	40
Rubber processing	5739	5442	2439	2477	2338	2285	1279	26	17	20	21	21	15	6	11	4	4	0	0	15
Pharmaceutical products manufac.*	4778	4513	4470	4641	4649	4669	4494	4572.5	4501	4554	4381	4437	4443	4442	4439	4442	4440	4440	4440	0.014
Paints manufacturing	21956	13827	9493	9064	10797	10773	13933	15002	15473	15194	15107	16794	15174	15332	14984	16393	17318	20097	20097	15
Inks manufacturing	4672	3605	1343	985	1416	1367	1420	1430	1071	797	916	822	863	789	673	630	684	438	6	30
Glues manufacturing	5139	13451	7151	10910	11166	10076	17197	10874	10379	8206	10355	12385	25851	30873	46119	56573	71330	81973	81973	20
Other use of solvents and related activities																				
Printing industry	4672	3605	1343	985	1416	1367	1420	1430	1071	797	916	822	863	789	673	630	684	910	910	100
Application of glues and adhesives	5139	13451	7151	10910	11166	10076	17197	10874	10379	8206	10355	12385	25851	30873	46119	56573	71330	81973	81973	600
Domestic solvent use*	4778	4513	4470	4641	4649	4669	4494	4572.5	4501	4554	4381	4437	4443	4442	4439	4442	4440	4440	4440	2

* - Activity data is number of inhabitants in Croatia (1000 capita)

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

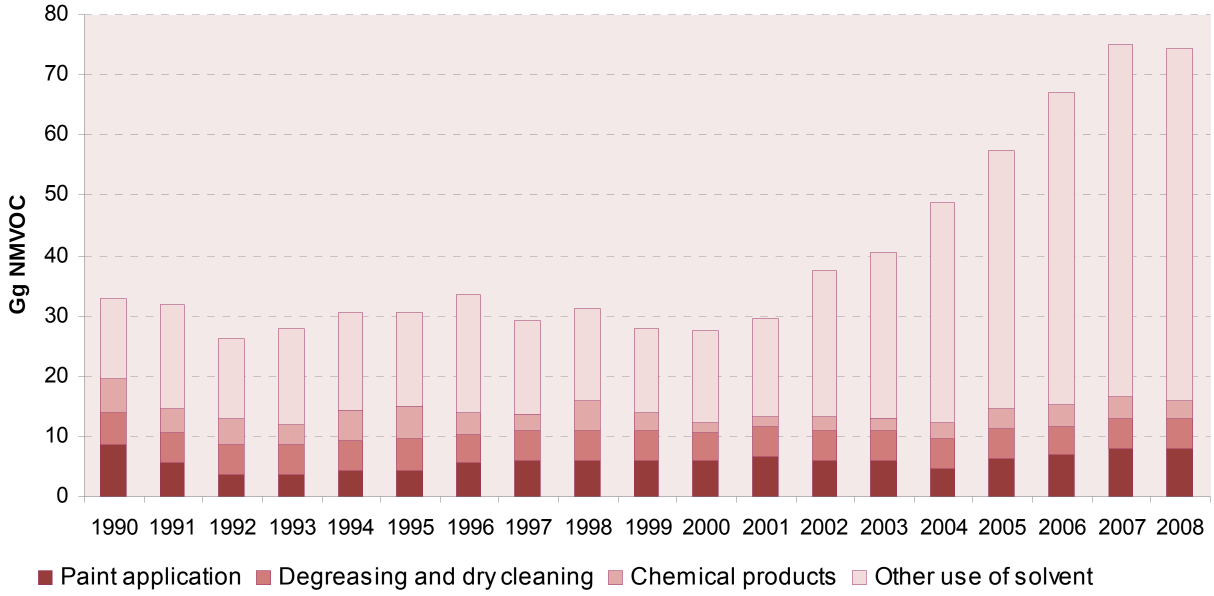


Figure 5.1-1: Emissions of NMVOC from Solvent and Other Product Use (1990-2008)

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.

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.) who provided constant data for N_2O usage over time (105 – 115 tonne N_2O/year for anaesthesia and 2 tonne N_2O/year for aerosol cans).

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 1990-2008 are presented in the Figure 5.1-2.

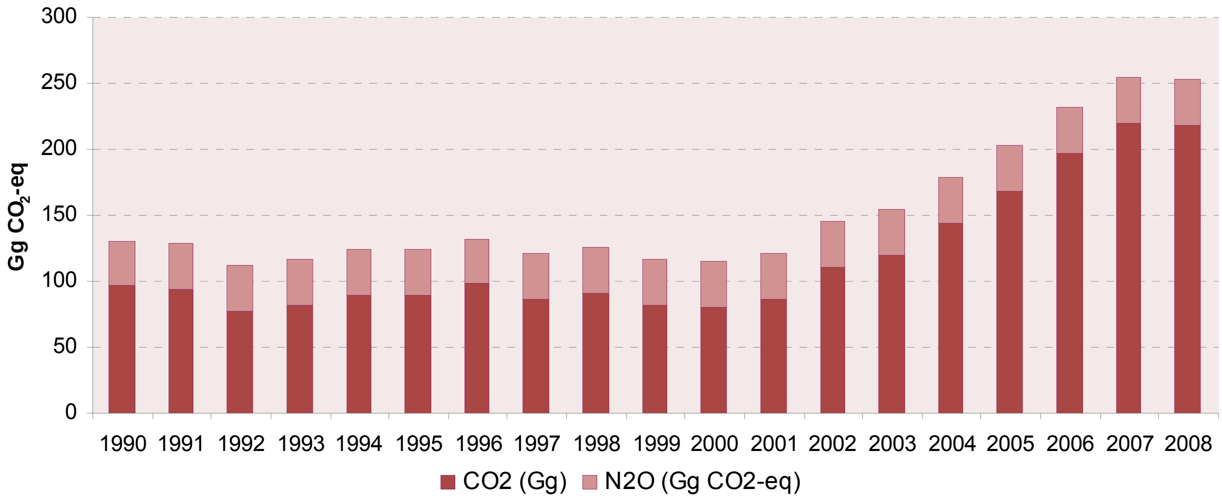


Figure 5.1-2: Emissions of CO_2 and N_2O from Solvent and Other Product Use (1990-2008)

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 emission factors amounts 50 percent. Uncertainty estimate associated with activity data amounts 50 percent.

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

Emissions of NMVOC 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'. NMVOC emissions have been changed for some years. Therefore, CO_2 emissions have been recalculated for the period 1990-2007 in this report.

5.1.6. SOURCE–SPECIFIC PLANNED IMPROVEMENTS

For the purpose of accurate emission calculations, Croatia plan 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.

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 and N_2O emissions from Solvent and Other Product Use should report required activity data for more accurate emissions estimation.

5.2. REFERENCES

Central Bureau of Statistics, Department of Manufacturing and Mining, *Annual Industrial Reports (1990 – 2008),* Zagreb

Central Bureau of Statistics, *Statistical Yearbooks (1990-2009),* Zagreb

Croatian Environment Agency (2010) Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2008* Submission to the Convention on Long-range Transboundary Air Pollution, EKONERG Ltd., Zagreb

EMEP/CORINAIR (1996) *Atmospheric Emission Inventory Guidebook*, European Environmental Agency, Denmark

FCC/IRR/2008/HRV *Report of the review of the initial report of Croatia*, 26 August 2009

FCC/ARR/2008/HRV *Report of the initial review of the greenhouse gas inventories of Croatia submitted in 2007 and 2008*, 5 November 2009 (advance version)

FCCC/ARR/2009/HRV *Report of the individual review of the individual review of the annual submission of Croatia submitted in 2009* (advance version)

Ministry of Environmental Protection, Physical Planning and Construction (2009) *National Inventory Report 2009, Croatian greenhouse gas inventory for the period 1990 – 2007,* EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2010) *Fifth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)*, Zagreb

6. AGRICULTURE (CRF sector 4)

6.1. OVERVIEW OF SECTOR

The agricultural activities contribute directly to the emission of greenhouse gases through various processes. The following sources have been identified to make a more complete break down in the emission calculation:

- Livestock: enteric fermentation (CH_4) and manure management (CH_4, N_2O)
- Agricultural soils (N_2O)

The total emissions in 2008 caused by agricultural activities were 3350 Gg CO_2-eq, which represents 10.82 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.

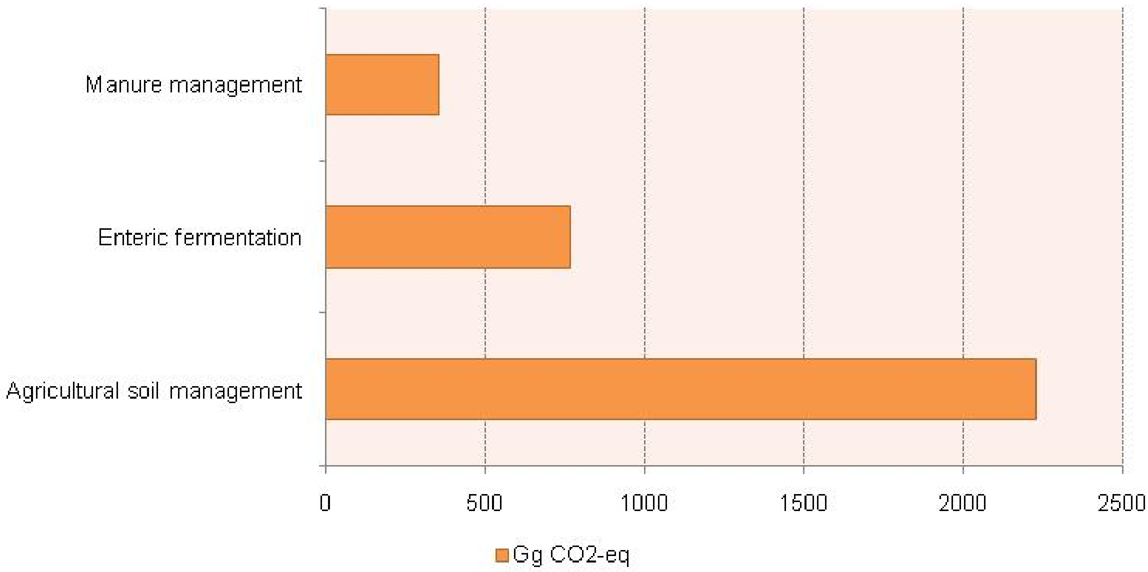


Figure 6.1-1: Agriculture GHG sources (year 2008)

Table 6.1-1 and Table 6.1-2 show the total emission from Agriculture by gases and by emission sources for the period 1990-2008. The emission in Table 6.1-2 is given in the equivalents of CO_2.

Table 6.1-1: Emission of greenhouse gases from agriculture (Gg)

Gas/Source	1990	1991	1992	1993	1994	1995	1996	1997	1998
CH_4	69.71	64.87	51.47	50.31	46.29	44.05	42.24	41.91	41.31
Enteric fermentation	58.85	54.18	43.37	41.99	37.94	36.53	34.82	34.63	34.14
Manure management	10.86	10.69	8.10	8.32	8.35	7.52	7.41	7.28	7.17
N_2O	9.27	9.13	8.16	7.15	7.17	6.84	6.92	7.71	6.86
Manure management	1.23	1.14	0.91	0.89	0.83	0.78	0.73	0.72	0.70
Agricultural soil	8.04	7.99	7.25	6.26	6.34	6.06	6.18	6.99	6.15
TOTAL	78.97	74.00	59.64	57.46	53.45	50.89	49.15	49.62	48.16

Table 6.1-1: Emission of greenhouse gases from agriculture (Gg), cont.

Gas/Source	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
CH_4	41.92	40.79	41.67	41.78	41.68	43.85	44.15	47.69	45.62	43.44
Enteric fermentation	33.98	33.42	34.25	34.25	33.79	35.34	36.75	39.12	37.70	36.57
Manure management	7.94	7.38	7.42	7.53	7.89	8.51	7.41	8.57	7.93	6.87
N_2O	7.46	7.30	7.85	7.78	7.35	8.02	8.09	8.02	7.98	7.86
Manure management	0.72	0.70	0.70	0.69	0.72	0.73	0.72	0.75	0.72	0.67
Agricultural soil	6.74	6.60	7.15	7.10	6.63	7.28	7.37	7.27	7.26	7.18
TOTAL	49.38	48.09	49.52	49.56	49.04	51.86	52.25	55.71	53.60	51.30

Table 6.1-2: Emission of greenhouse gases from agriculture CO_2-eq (Gg)

Gas/Source	1990	1991	1992	1993	1994	1995	1996	1997	1998
CH_4	1464.24	1363.38	1080.45	1057.30	972.14	925.62	887.54	880.46	867.70
Enteric fermentation	1235.80	1137.69	910.80	881.76	796.64	767.22	731.26	727.27	716.89
Manure management	228.44	225.68	169.65	175.54	175.50	158.40	156.28	153.19	150.82
N_2O	2870.90	2833.62	2525.37	2218.35	2220.16	2121.33	2144.72	2390.07	2124.90
Manure management	378.74	357.41	279.24	277.91	255.72	242.49	228.55	223.41	217.46
Agricultural soil	2492.16	2476.22	2246.13	1940.44	1964.44	1878.84	1916.17	2166.66	1907.44
TOTAL	4335.14	4197.00	3605.83	3275.65	3192.30	3046.95	3032.26	3270.53	2992.61

Table 6.1-2: Emission of greenhouse gases from agriculture CO_2-eq (Gg), cont.

Gas/Source	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
CH_4	880.53	856.73	875.17	877.50	875.53	920.91	927.51	980.26	958.09	912.20
Enteric fermentation	713.56	701.73	719.27	719.27	709.67	742.09	771.66	821.59	791.66	767.96
Manure management	166.97	155.00	155.90	158.22	165.86	178.82	155.84	158.66	166.44	144.24
N_2O	2310.75	2262.30	2433.53	2411.40	2278.14	2485.06	2508.62	2479.80	2474.03	2438.24
Manure management	221.77	214.98	217.31	211.94	221.72	227.10	223.67	226.34	222.15	209.80
Agricultural soil	2088.98	2047.31	2216.21	2199.45	2056.42	2257.96	2284.96	2253.46	2251.88	2228.44
TOTAL	3191.29	3119.03	3308.70	3288.89	3153.67	3405.97	3436.13	3460.05	3432.13	3350.44

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. Figure 6.2-1 shows emission of methane from Enteric fermentation for the period from 1990-2008. 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. CH_4 emission from Enteric fermentation is a key source. Dairy cattle is the single major source of emissions representing 60% of total CH_4 emission from Enteric fermentation, followed by non dairy cattle representing 25%. Jointly, cattle are responsible for 85% of total CH_4 emission from Enteric fermentation. No methodology for calculating CH_4 emission from poultry is available in Revised 1996 IPCC Guidelines.

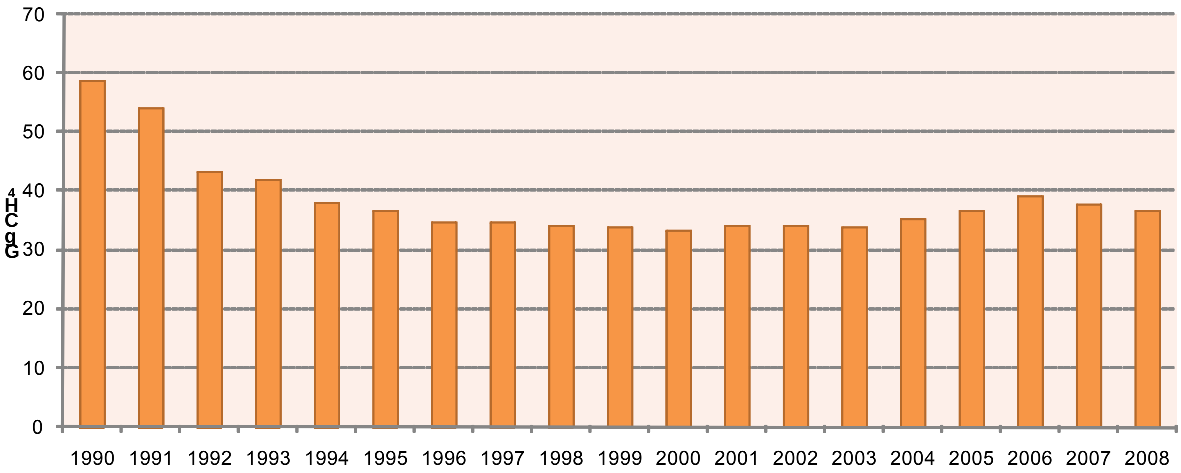


Figure 6.2-1: CH_4 emission from Enteric fermentation (Gg)

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, Tier1, method.

The Central Bureau of Statistics provided more detailed data on both cattle number and cattle classification for the entire period from 1990-2008. The latter enabled the inventory team to perform recommended reclassification which resulted in emission recalculation. Cattle categories after the reclassification are as follows:

- Mature dairy cows
- Mature females and mature males
- Calves, growing heifers, steers/bullocks and bulls

Therefore, the one of the main differences is that mature females are now included within the non dairy cattle and not only the males.
For the calculation of emission factor for dairy cattle, mature non dairy cattle and the young, default factors were used (see Table 6.2-1).

Table 6.2-1: 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	0.335	0.000	0.000	4.000	0.100	60.000	0.060
mature non-dairy	600	0.322	0.170	0.000			60.000	0.065
young	230	0.322	0.170	0.400			60.000	0.060

Milk yield per cow per day for the period from 1990-2008 is presented in Table 6.2-2.

Table 6.2-2: Milk yield per cow (kg/day)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Milk yield	5.47	5.03	5.28	5.12	5.03	5.26	5.77	6.12	6.45	6.37

Table 6.2-2: Milk yield per cow (kg/day), cont.

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Milk yield	6.54	7.08	7.44	7.67	7.90	9.08	9.94	10.04	10.34

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]

For other animals, Tier 1 has been used as well as default EF specific for the animal type, climate zone (cool), geographic region (Eastern Europe) and the degree of the region development (developing countries). The main two sources regarding the number of other animal are the Central Bureau of Statistics and FAO database (see Table 6.2-3).

Table 6.2-3: Sources of activity data regarding animals other than cattle

	CBS	FAO
Sheep	1990-2008	
Goats	1990-1991; 2000-2008	1992-1999
Horses	1990-2008	
Mules/assess	1990-1991	1992-2008
Swine	1990-2008	
Poultry	1990-2008	

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

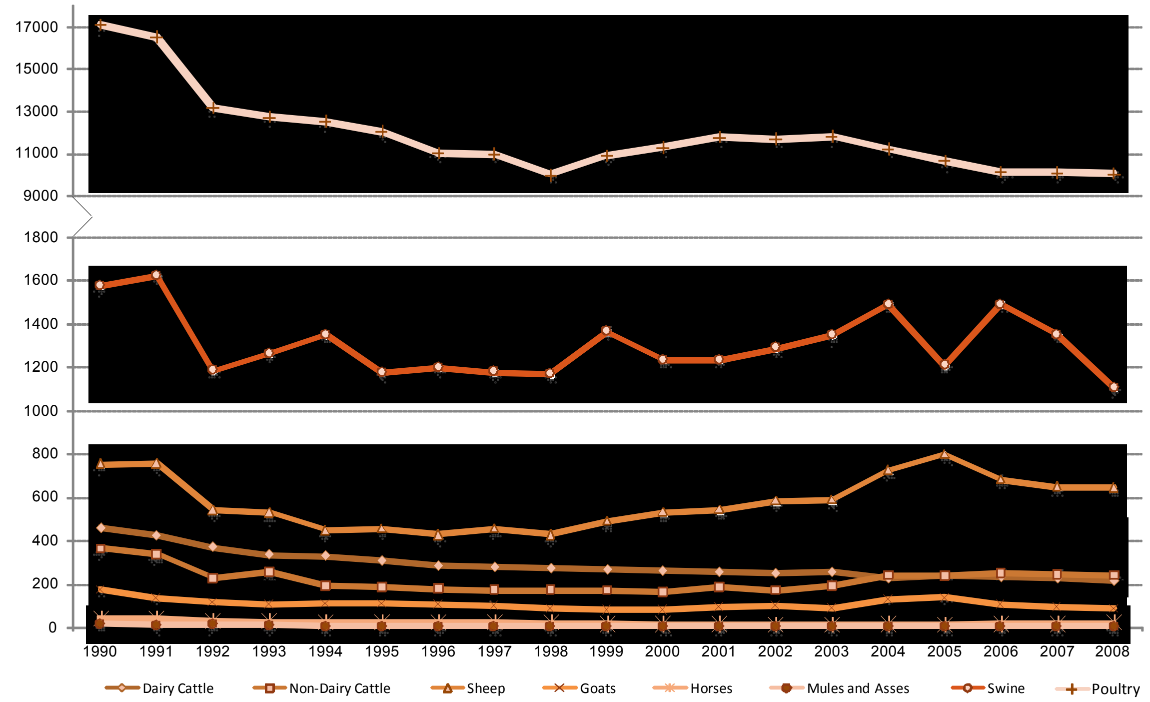


Figure 6.2-2: Trend of livestock number in the period from 1990-2008

6.2.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Uncertainty estimates are based on expert judgement. Uncertainty of activity data amounts 30%. Uncertainty of emission factors amounts 20%.

CH_4 emissions from Enteric Fermentation have been calculated using the same method and data sets for every year in the time series.

6.2.4. SOURCE SPECIFIC RECALCULATIONS

Recalculations regarding emissions from enteric fermentation subsector are the result of the following two reasons:

1)The Central Bureau of Statistics (CBS) performed important data revision for the period 2000-2007. The latter refers to, among other things, the revision of livestock number which resulted in certain, mostly not significant, changes of the following activity data:

- onumber of cattle,
- onumber of sheep,
- onumber of goats,
- onumber of horses,
- onumber of swine and
- onumber of poultry.

Another novelty is that the number of goats for the period from 2000-2008 was provided by the CBS; thus FAO database was used only for the 1990-1999 period. Since this database provides FAO estimations on the number of mules/assess for the entire 1990-2008 period, only the latter did not change.

2) In its *Report of the individual review of the annual submission of Croatia submitted in 2009*, the ERT recommended further investigation regarding cattle characterisation. Due to abovementioned data revision, the inventory team was able to perform reclassification of the cattle according to Tier 2 methodology. This specifically refers to the period from 2000-2007. Furthermore, CBS provided more detailed data for the previous period too, thus emission recalculation was performed for the entire period from 1990-2007. Details on the reclassification are presented in *Methodological issues* subchapter.

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 2008 is presented in Figure 6.3-1.

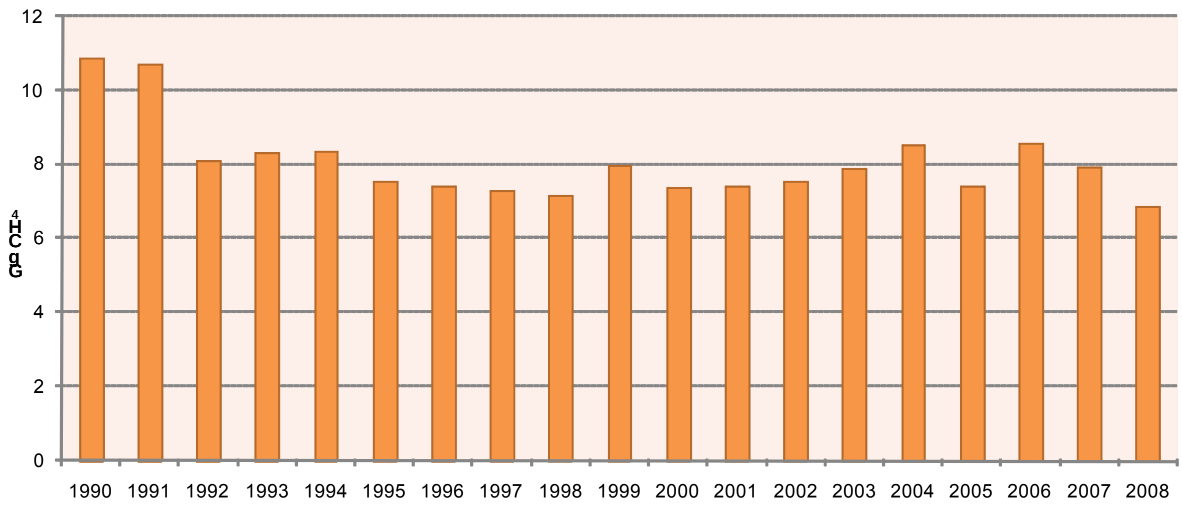


Figure 6.3-1: CH_4 emission from Manure management (Gg)

6.3.2. METHODOLOGICAL ISSUES

The IPCC methodology (Tier 1) has been used to calculate methane emission from Manure Management. The origin of related activity data is presented in Table 6.3-1.

Table 6.3-1: Activity data for emission calculation from Manure management

	CBS	FAO
Cattle	1990-2008	
Sheep	1990-2008	
Goats	1990-1991; 2000-2008	1992-1999
Horses	1990-2008	
Mules/assess	1990-1991	1992-2008
Swine	1990-2008	
Poultry	1990-2008	

Default emission factors specific for the animal type, climate zone (cool), geographic region (Eastern Europe) and the degree of region development (developing countries) were used for emission calculation according to IPCC Guidelines for National Greenhouse Gas Inventories Reference Manual.

In order to justify the usage of emission factors for developing countries, while calculating emissions from both enteric fermentation and manure management, inventory team performed an analysis of certain agricultural parameters. Agriculture, hunting and fishing activities make an important part of the economy in the rural areas of Croatia. According to statistical data for the period from 1998-2008, the percentage of gross value added regarding these activities has a decreasing trend. However, the percentage is notably lower than those of the majority of other countries, especially if we look at EU-27 and EU-15. Moreover, the *Rural Development Strategy* *of the Republic of Croatia for the period from 2008-2013*[7] indicates insufficiency in agricultural production of the majority of agricultural products, especially in regard to beef and pork, milk, vegetables and fruit. In line with the aforementioned, comparison of statistical data for the period from 1998-2008 shows that, for example, the amount of collected milk per dairy cow in Croatia is quite lower than in the majority of other countries. In the previous period, war, privatization, transition and unfavourable weather conditions have affected greenhouse gas emissions from agriculture. The sector revitalization is a long-standing process and certain measures, which would result in many improvements, could not be fully implemented, especially in manure management.

Subsequently, based on the abovementioned, the inventory team finds the usage of emission factors for developing countries justified.

6.3.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Uncertainty estimates are based on expert judgement. Uncertainty of activity data amounts 30%. Uncertainty of emission factors amounts 40%.

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

Recalculation of CH_4 emissions originating from Manure management was performed for the entire period from 1990-2007 for the same reasons presented and explained in enteric fermentation subsector.

[7]Prepared by the Ministry of Agriculture, Fishery and Rural Development in 2008.

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. Some projects are in pre-feasibility and feasibility studies and it is presumed that these projects will be implemented in the near future.

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

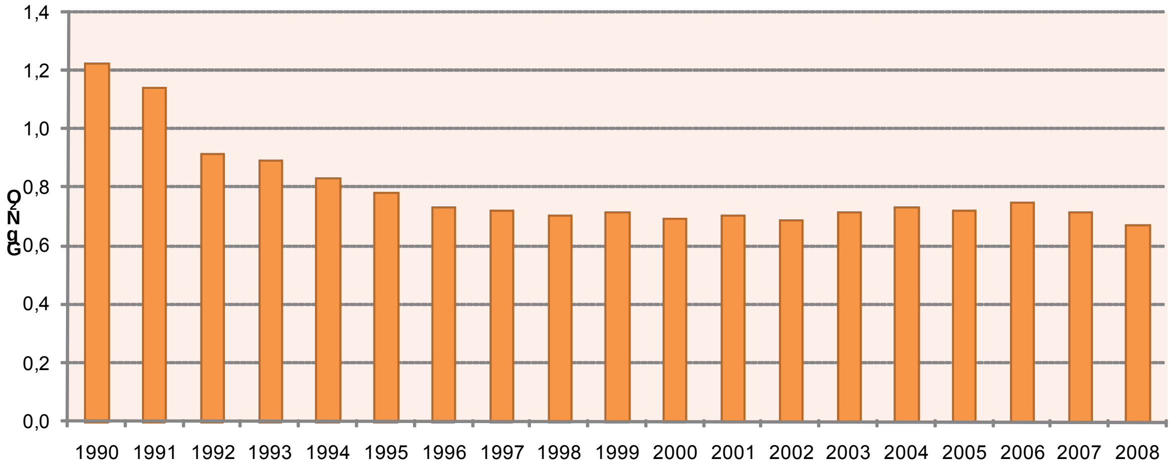
$Nex_{(AWMS)}$	stands for	N excretion per Animal Waste Management System
$N_{(T)}$	stands for	number of animals by type
$Nex_{(T)}$	stands for	N excretion of animals by type
$AMWS_{(T)}$	stands for	fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems
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 2008 are presented in Figure 6.4-1.



Fi

Figure 6.4-1: N_2O Emissions from Manure management (Gg)

Activity data regarding livestock number 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

Uncertainty estimates are based on expert judgement. Uncertainty of activity data amounts 30%. Uncertainty of emission factors amounts 60%.
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

Recalculation of N_2O emissions originating from Manure management was perfomed for the entire period from 1990-2007 due to:
1) the same reasons presented and explained in enteric fermentation subsector (valid also for manure management CH_4 emissions)
2) an error noticed in regard to manure management system usage of dairy cattle – previously used MS (Eastern Europe) for solid storage was 67% instead of 68%. The latter was corrected for the entire period.

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 2008 are presented in Figure 6.5-1.

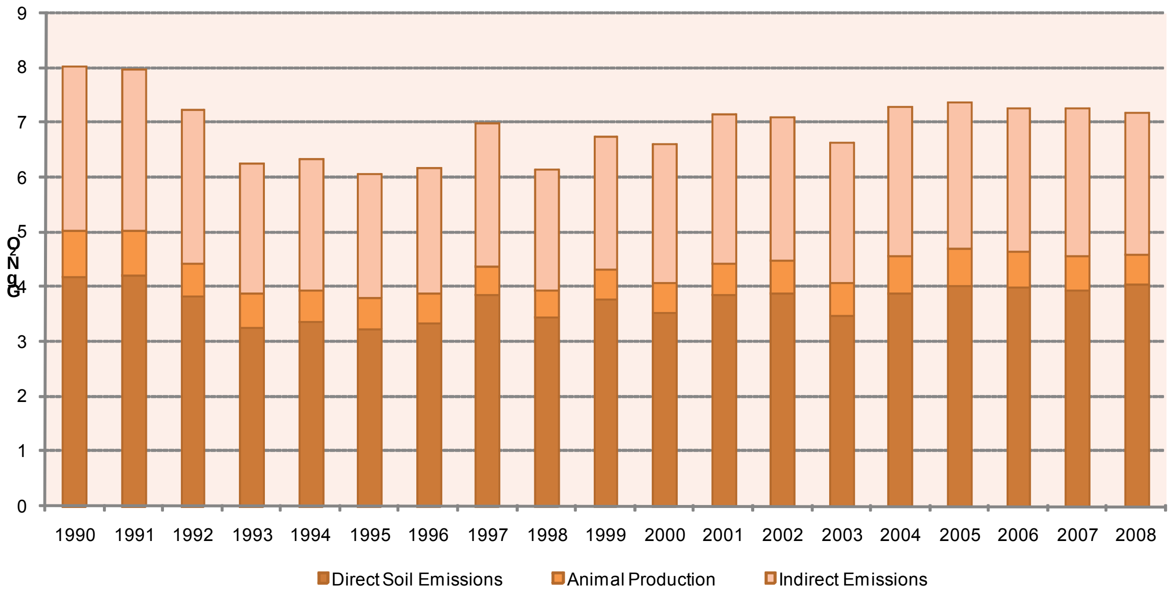


Figure 6.5-1: Total N_2O emissions from Agricultural soils (Gg)

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:

$$N_2O_{\ DIRECT}\ (kg\ N/yr) = (F_{SN} + F_{AW} + F_{CR} + F_{BN}) \times EF_1 + F_{OS}\ x\ EF_2$$

where

N_2O_{DIRECT}	stands for	direct N_2O emission from agricultural soils (kg N/yr)
F_{SN}	stands for	nitrogen from synthetic fertilizer excluding emissions of NH_3 and NO_x (kg N/yr)

F_{AW}	stands for	nitrogen from animal waste (kg N/yr)
F_{CR}	stands for	nitrogen from crop residues (kg N/yr)
F_{BN}	stands for	nitrogen from N-fixing crops (kg N/yr)
EF_1, EF_2	stands for	emission factors
F_{OS}	stands for	nitrogen from histosols, (kg N/yr)

Direct Emissions of N_2O from Agricultural soils for the period from 1990 to 2008 are shown in Figure 6.5-2.

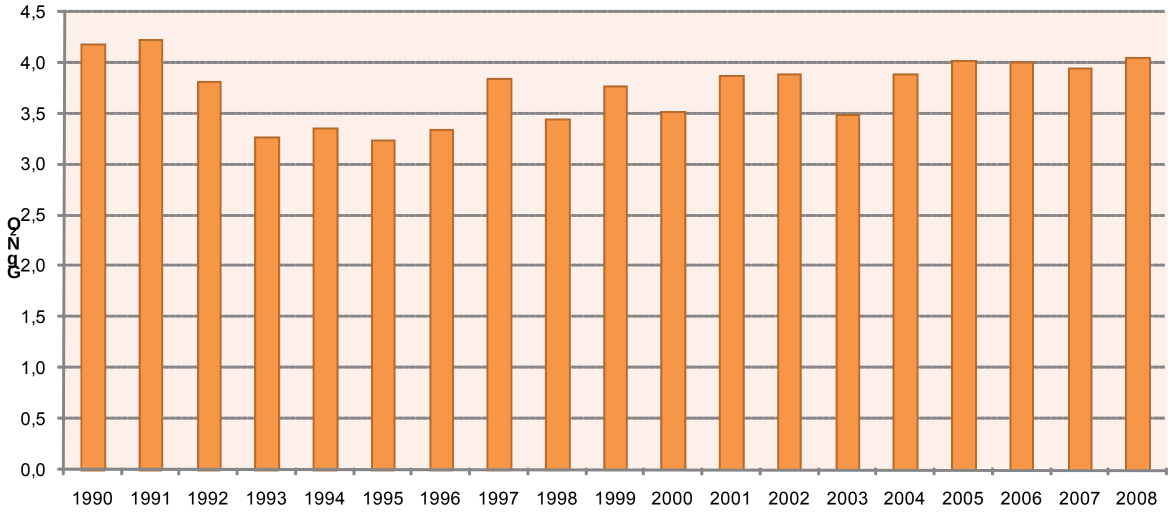


Figure 6.5-2: Direct N_2O emissions from Agricultural soils (Gg)

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.*

<u>Nitrous oxide from mineral fertilisers</u>

This estimate is based on the amount of N in mineral fertiliser that is annually consumed in the Republic of Croatia. Data on the consumption of mineral fertilisers that are produced and applied in Croatia were obtained from fertilizer company Petrokemija Kutina, for the period 1992-2008. 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 2000-2008. 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 1990-2008 are presented in Figure 6.5-3. Nitrogen dispersed into atmosphere in the form of NH_3 and NO_x was subtracted from the total estimated quantity of emitted nitrogen N.

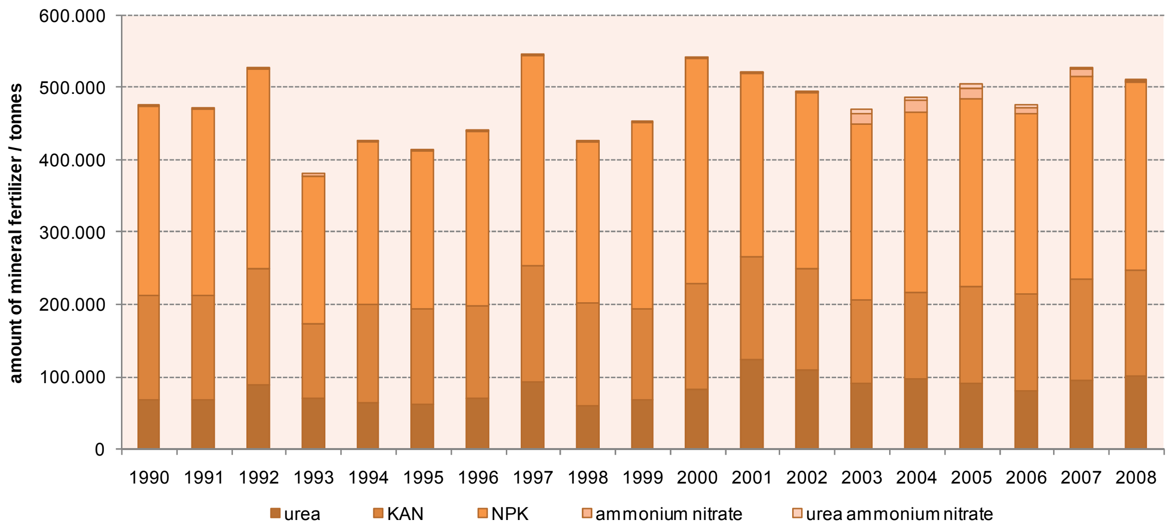


Figure 6.5-3: Mineral fertilizers applied to soil in the period from 1990-2008

More accurate data on the 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 6.5-1).

Table 6.5-1: Nitrogen fraction emitted as NH_3 and NO_x

Fertilizer type	Fraction of N emitted as NH_3 and NO_x
Urea	0.15
KAN	0.02
NPK	0.02
Ammonium nitrate	0.02
Urea ammonium nitrate	0.02

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 manure 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 and N that is dispersed into the atmosphere in the form of NH_3 and NO_x (20%, Revised 1996 IPCC Guidelines) was subtracted. 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 pulses and soyabeans produced in the country as dry biomass. Data on the production of N fixing crops were obtained from the Central Bureau of Statistics, FAO database and for certain years by extrapolation (see Table 6.5-2).

Table 6.5-2: Data sources regarding N-fixing crop production

	CBS	FAO	Extrapolation*
Soyabeans	1990-2008		
Beans, dry	1990-2008		
Cow peas, dry	2008	1992-2007	1990-1991
Lentils	1992-2008		1990-1991
Peas, dry	2008	1992-2007	1990-1991
Vetches	1992-2008		1990-1991
Clover	1990-2008		
Alfaalfa	1990-2008		

*Extrapolation was based on data for the period 1992-1995.

Activity data related to production of N-fixing crops is presented in Figure 6.5-4. 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.

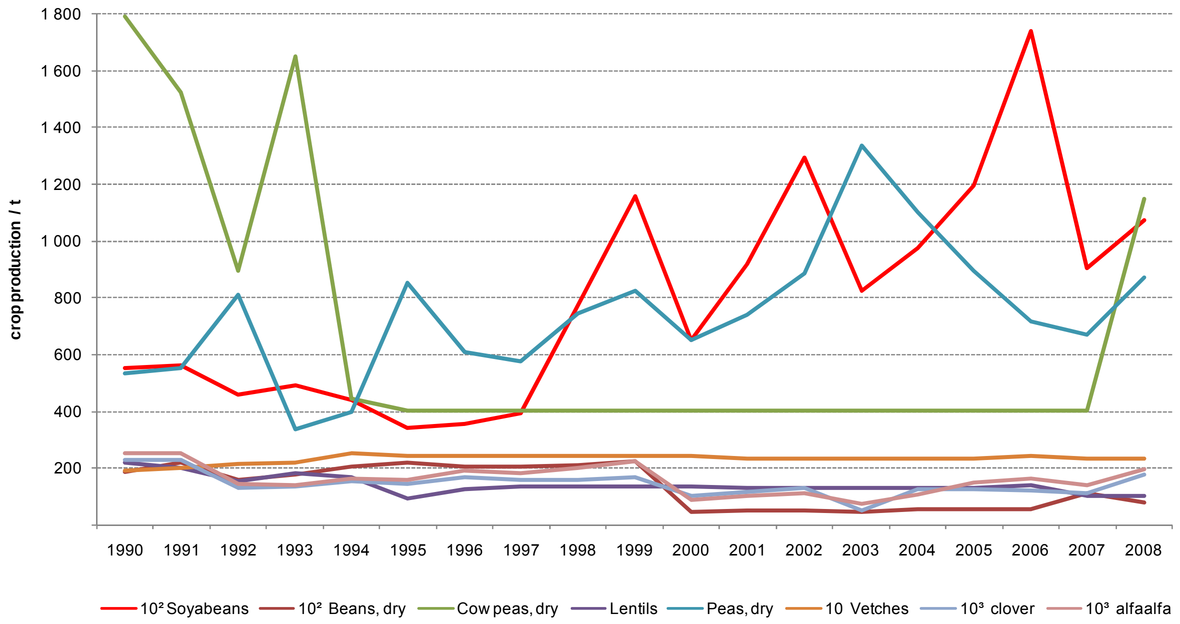


Figure 6.5-4: Production of N-fixing crops in the period from 1990 - 2008

Data on dry matter fraction, residue/crop ratio and N fraction used in emission calculation are as follows:

Table 6.5-3: Dry matter fraction, residue/crop ratio and N fraction for N-fixing crops

	dry matter fraction	residue/crop ratio	N fraction
Soyabeans	0.86	2.1	0.023
Beans, dry	0.895	2.1	0.03
Cow peas, dry	0.85	1.5	0.014
Lentils	0.85	1	0.03
Peas, dry	0.87	1.5	0.0142
Vetches	0.85	1	0.03
Clover	0.85	0	0.03
Alfaalfa	0.85	0	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). Since new (revised) data on crop production were used, N_2O emissions from N fixing crops needed to be recalculated for the period 2000-2007.

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). This includes crop specific data on the ratio of aboveground biomass to crop product mass (residue/crop ratio), dry matter fraction and N fraction (see Table 6.5-3 and 6.5-4). 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 6.5-4: Dry matter fraction, residue/crop ratio and N fraction for non N-fixing crops

	dry matter fraction	residue/crop ratio	N fraction
Wheat	0.86	1.3	0.0028
Maize	0.86	1	0.0081
Potatoes	0.3	0.4	0.011
Sugar beets	0.25	1.4	0.015
Tobacco	0.89	1	0.015
Sunflowers	0.92	1.3	0.015
Rape seed	0.9	1	0.015
Tomatoes	0.063	1	0.015
Barley	0.86	1.2	0.0043
Oats	0.92	1.3	0.007

Data on the production of non N-fixing crops were obtained from the Central Bureau of Statistics and/or FAO database (see Table 6.5-5). 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 burned is set as NO.

Table 6.5-5: Data sources regarding non N-fixing crop production

	CBS	FAO
Wheat	1990-2008	
Maize	1990-2008	
Potatoes	1990-2008	
Sugar beets	1990-2008	
Tobacco	1990-2008	
Sunflowers	1990-2008	
Rape seed	1990-2008	
Tomatoes	1990-2008	
Barley	1990-2008	
Oats	1991; 2000-2008	1992-1999

Activity data related to production of non N-fixing crops is presented in Figure 6.5-5. 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.

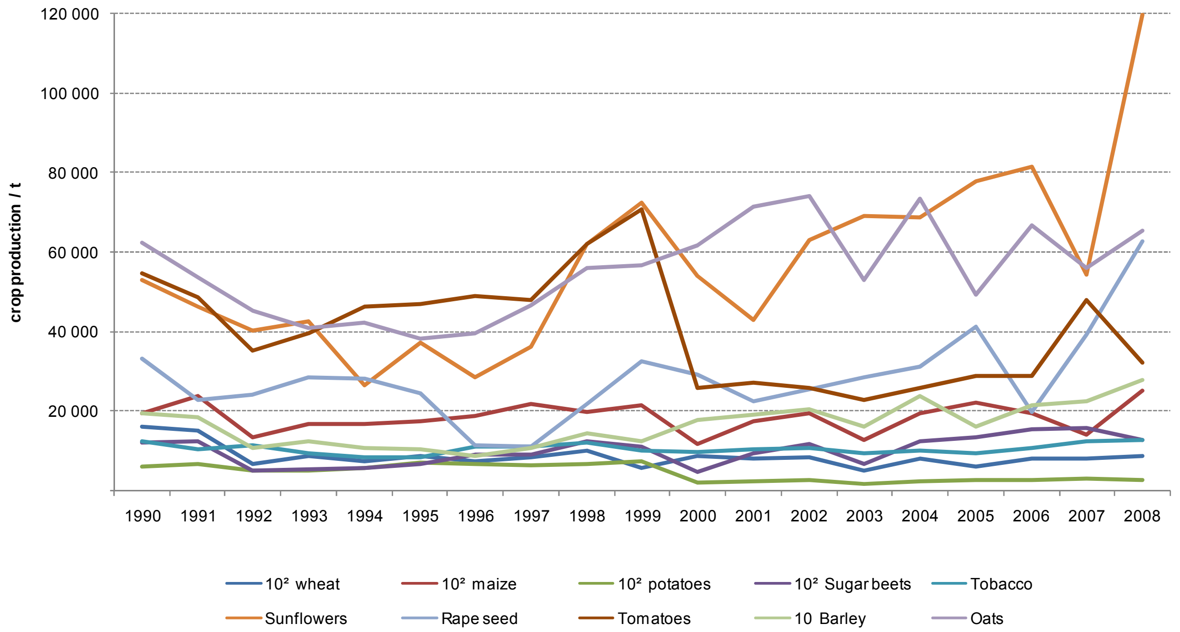


Figure 6.5-5: Production of non N-fixing crops in the period from 1990 - 2008

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. The area of organic soil in the Republic of Croatia has been obtained by expert judgment. 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

Uncertainty estimates are based on expert judgement. Uncertainty of activity data amounts 30%. Uncertainty of emission factors amounts 30%.
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

Nitrous oxide emissions from mineral fertilisers were recalculated only for the year 2007 due to an error noticed in regard to the amount of ammonium nitrate applied to soils. Previously used amount was 7.19 tonnes instead of 7190 tonnes. The latter was corrected.

Nitrous oxide emissions from animal manure and liquid/slurry were recalculated for the entire period from 1990-2007 for the same reasons as for N_2O emissions from Manure management.

Aiming to methodologically harmonise data and methods of estimation, the Central Bureau of Statistics (CBS) performed data revision for the period 2000-2007 in regard to crop production. In particular, in 2005 the CBS has, for the first time, gathered crop production statistic data concerning private family farms by using the interview method on a selected sample with the help of interviewers. This meant abandoning a long lasting method of collecting data by using the estimation method done by agricultural estimators on the basis of cadastre data. Subsequently, a revision of crop production data series for 2000-2004 was conducted while 2005-2008 data were collected through regular surveys applying a sampling method and it mostly remained the same.
The abovementioned revision resulted in changes in the following activity data:

- oproduction of soyabeans in 2004
- oproduction of dry beans for the period from 2000-2007
- oproduction of dry peas in 2007
- oproduction of clover for the period from 2000-2004
- oproduction of alfalafa for the period from 2000-2004

Changes in the production of N-fixing crops required recalculation of N_2O emission due to biological N fixation.

Emissions of nitrous oxide from crop residue were also recalculated for the same reasons as for the N-fixing crops. Mentioned data revision of crop production refers not only to N-fixing crops but also to those crops that do not fixate N. Changes regarding the latter are as follows:

- ochange in the production of wheat for the period from 2000-2004
- ochange in the production of maize for the period from 2000-2004

ochange in the production of potatoes for the period from 2000-2004
ochange in the production of sugarbeets in 2004
ochange in the production of tobacco in 2004
ochange in the production of sunflowers in 2004
ochange in the production of tomatoes for the period from 2000-2004
ochange in the production of barley for the period from 2000-2004
ochange in the production of oats for the period from 2000-2004

Changes in the production of N-fixing crops and non N-fixing crops required recalculation of N_2O emission originating from crop residue.

There were no recalculations of N_2O emission due to cultivation of organic soils.

6.5.2. DIRECT N_2O EMISSION FROM PASTURE, RANGE AND PADDOCK MANURE (CRF 4.D.2.)

6.5.2.1. Methodological issues

Estimates of N_2O emissions from animals were based on animal waste deposited directly on soils by animals on pasture, range and paddock. N_2O emissions from animals can be calculated as follows:

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

where

$N_2O_{animals}$	stands for	N_2O emissions from animal production (kg N/yr)
$N_2O_{(AWMS)}$	stands for	N_2O emissions from Animal Waste Management Systems (kg N/yr)
$N_{(T)}$	stands for	number of animals of type T
$Nex_{(T)}$	stands for	N excretion of animals of type T (kg N/animal/yr)
$AWMS_{(T)}$	stands for	fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems for animals of type T
$EF_{3(AWMS)}$	stands for	emission factor

The same emission factor (0.02 kg N_2O-N/kg of emitted N), recommended by the Revised 1996 IPCC Guidelines, was used for all grazing animals regardless of their species and climatic conditions. Direct N_2O emissions from Pasture, range and paddock manure for the period from 1990 to 2008 are shown in the Figure 6.5-6.

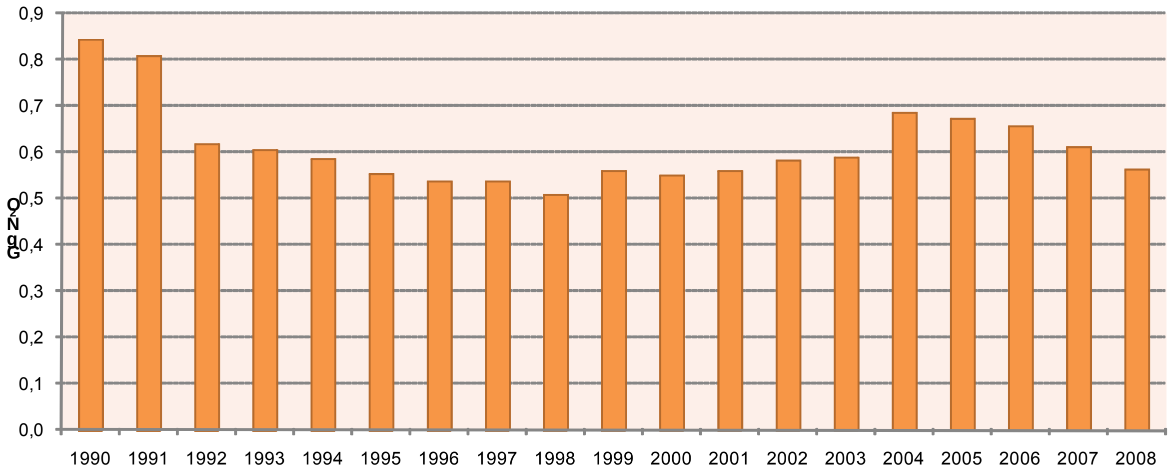


Figure 6.5-6: Direct N_2O emissions from animal production (Gg)

6.5.2.2. Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgement. Uncertainty of activity data amounts 30%. Uncertainty of emission factors amounts 40%.
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

Recalculation of N_2O emissions from pasture, range and paddock manure was performed for the entire period from 1990-2007 for the same reasons presented and explained in enteric fermentation subsector.

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 2008 is shown in Figure 6.5-7.

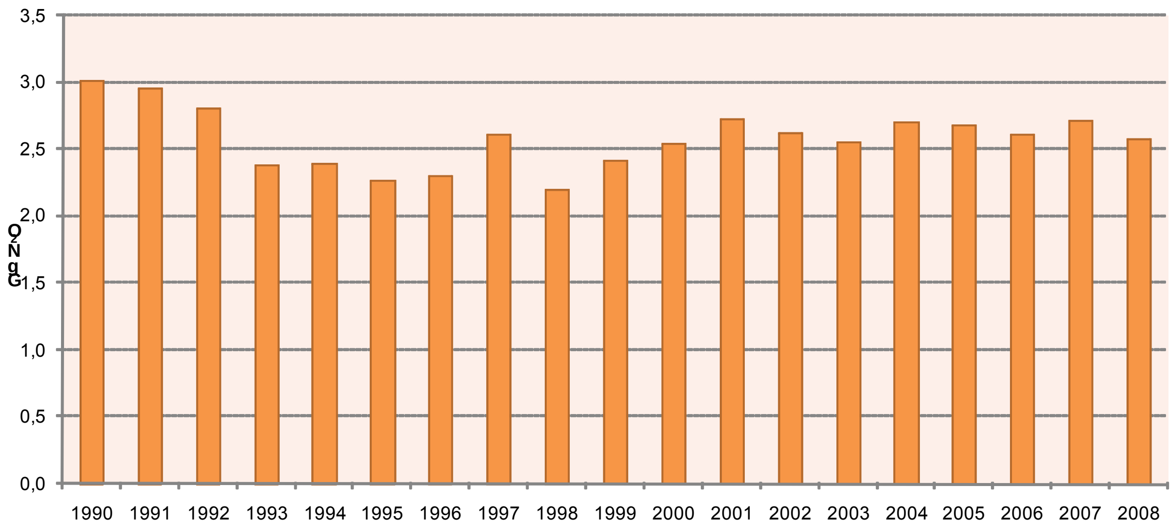


Figure 6.5-7: Indirect N_2O emissions from Agriculture (Gg)

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 6.5-1). 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). Recalculation was performed only for the year 2007.

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). Recalculation was performed for the entire period from 1990-2007.

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). Recalculation was performed only for the year 2007.

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). Recalculation was performed for the entire period from 1990-2007.

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. Uncertainty of activity data is 30%. Uncertainty of emission factors is 60%.
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

Recalculations of N_2O emissions due to volatilization of ammonia (NH_3) and nitrogen oxides (NO_x) and N_2O emissions from nitrogen leaching and runoff was perfomed for the entire period from 1990-2007 for the following reasons:

- ocorrection of the amount of mineral fertilizer (ammonium nitrate) for 2007
- onew and updated data on cattle number which enabled related reclassification for the entire period from 1990-2007
- onew and updated data on other livestock number for the period from 2000-2007
- ocorrection of the solid storage usage (MS/%) for dairy cattle for the entire period from 1990-2007

6.6. SOURCE SPECIFIC QA/QC AND VERIFICATION

During the preparation of inventory submission, activities related to quality control were mainly focused on completeness and consistency of emission estimates and 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.

Due to revision of agricultural data for the 2000-2007 period, performed by the Central Bureau of Statistics, activity data for all livestock were again compared with FAO database. Results of this comparison showed that there are significant differences between these two sets of data for the period from 2006-2008 in regard to certain animal categories and minor differences in the period from 2000-2005. The latter was investigated furthermore and, according to available information, the activity data were most likely submitted to FAO before the final revision; thus the data on animal number used for calculation of GHG emission from Agriculture are final and most accurate.

Regarding Tier 2 activities, emission factors and activity data were checked for key source categories. In Agriculture six source categories represent key source category regardless of LULUCF (detailed in Table 6.6-1):

- CH_4 Emissions from Enteric Fermentation in Domestic Livestock
- CH_4 Emissions from Manure Management
- N_2O Emissions from Manure Management
- Direct N_2O Emissions from Agricultural Soils
- N_2O Emissions from Pasture, Range and Paddock Manure
- Indirect N_2O Emissions from Nitrogen Used in Agriculture

Table 6.6-1: Key categories in agriculture sector based on the level and trend assessment in 2008[8]

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	Yes	Yes	Yes	Yes
CH_4 Emissions from Manure Management	CH_4	Yes		Yes	Yes
N_2O Emissions from Manure Management	N_2O			Yes	Yes
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Yes		
N_2O Emissions from Pasture, Range and Paddock Manure	N_2O			Yes	Yes
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	Yes	Yes	Yes

6.7. SOURCE SPECIFIC PLANNED IMPROVEMENT

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.

[8] Data on key categories are taken from Annex 1 Key Categories

6.8. REFERENCES

Bašić, F., O. Nestroy, I. Kisić, A. Butorac, M. Mesić (1988*) Protection from erosion – the key role of soil cultivation in present and changed climate conditions*, Croatian Academy of Sciences and Arts – Scientific conference with international participation "The adjustment of agriculture and forestry to climate and its changes", pages 115-125, Zagreb

Bogunović, M., Vidaček, Ž., Racz, Z., Husnjak, S., Sraka, M., (1997) *Pedological map of the Republic of Croatia and its usage*, Agricultural Gazette 5-6, pages 369-399, Zagreb

Butorac, A., (1963) *Thermal condition of soil and the most characteristic temperature thresholds for certain sites in main agricultural regions of Croatia*, Agricultural Gazette 12/63
Central Bureau of Statistics, Statistical Yearbooks (1990-2009), Zagreb

Central Bureau of Statistics, First releases (2008), Zagreb

Croatian Environment Agency (2009) *Republic of Croatia Informative Inventory Report for LRTAP Convention for the Year 2007 Submission to the Convention on Long-range Transboundary Air Pollution*, EKONERG Ltd., Zagreb

FCC/IRR/2008/HRV *Report of the review of the initial report of Croatia*, 26 August 2009

FCC/ARR/2008/HRV *Report of the initial review of the greenhouse gas inventories of Croatia submitted in 2007 and 2008*, 5 November 2009 (advance version)

FCCC/ARR/2009/HRV *Report of the individual review of the individual review of the annual submission of Croatia submitted in 2009* (advance version)

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Workbook, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 2, United Kingdom

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Reference Manual, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 3, United Kingdom

FAO database www.fao.org

Ministry of Environmental Protection, Physical Planning and Construction (2009) *National Inventory Report 2009, Croatian greenhouse gas inventory for the period 1990 – 2007*, EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2010) *Fifth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)*, Zagreb

Report of the individual review of the annual submission of Croatia submitted in 2009

Response of Croatia to Potential Problems and Further Questions from the ERT formulated in the course of the in-country review of Croatia's Initial Report under the Kyoto Protocol and 2008 Inventory Submission (2008)

Znaor, D. and Karoglan Todorović, S.,(2005) *Analysis of yields, nitrogen content and N-fixation of Croatian agricultural production in 2002-2003*, University of Essex, Colchester. Unpublished

7. LAND-USE, LAND USE CHANGE AND FORESTRY (CRF sector 5)

7.1. OVERVIEW OF SECTOR

Forests and other wooded land in the Republic of Croatia are goods of a general interest and are under special protection of the state. The Forestry Act (OG 140/05, 82/06, 129/08) 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. It prohibits the renewal of forests by clear cutting, thus natural rejuvenation is the principal method for renewal of all natural forests. 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.

Based on the Forest Management Area Plan of the Republic of Croatia for the period 2006-2015, forests and forest land cover 47.5% of Croatia's mainland area. By its origin, approximately 95% of forests in Croatia were formed by natural regeneration and 5% are grown artificially. 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. Moreover, 78% is owned by the state and managed by the Croatian Forests Ltd. while the remaining 22% are privately owned.
The Plan determines growing stock of about 398 millions of m^3 while its yearly increment amounts around 10.5 millions of m^3. The increment is an increase in the forest timber stock over a specific period and it is calculated as an annual, periodical and average increment. The check method or the method of bore-spills is most often used in Croatia to identify the increment. The quality and quantity of increment can be improved by different methods of forest cultivation. The annual cut is a part of the forest timber stock planned for commercial harvesting for a certain period (1 year, 10 years, 20 years) expressed in timber stock (m^3) or timber stock per area (m^3/ha). To satisfy the basic principles of sustainable forest management, the annual cut must not be larger than the increment value.

Ministry of Regional Development, Forestry and Water Management is authorized institution for collecting data about state of forest land. Moreover, Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official Gazette 1/07), which came into force in January 2007 and first Inventory Submission stipulated by the Regulation is 2008, prescribes obligation and procedure for emissions monitoring. Among others, the regulation prescribes monitoring of areas within different land use categories, such as forest land, agricultural land, grasslands, wetlands, settlements and other land.

According to the methodology proposed by *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

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

7.2. SOURCE CATEGORY

7.2.1. SOURCE CATEGORY DESCRIPTION

Carbon in forests is bound in trees, underbrush, soil and dead wood. As a result of biological processes in forests and anthropogenic activities, carbon is in a constant cycling process. Deforestation, among all anthropogenic activities, has the greatest impact on the change of carbon stock in existing forests. The problem of deforestation in Croatia does not exist. According to the current data, total forest area in Croatia has not decreased over the last 100 years.

7.2.2. METHODOLOGICAL ISSUES

The IPCC methodology (GPG 2003) has been used for calculation of CO_2 emissions and removals from LULUCF sector. In GHG inventory, the land-use category Forest land remaining forest land (FF) is reported using Tier 1 method. Tier 2 could not be applied due to lack of required data. All emission factors were used according to GPG 2003. The main data sources in regard to area of forest land, annual increment, fellings, fuelwood and fires are presented in Table 7.2-1. The criteria in choosing data were continuity, quality, comparability as well as accessibility of sources.

Finalization of the Croatian National Forest Inventory (CRONFI) was delayed and is currently expected to be completed in the second half of 2010.

7.2.2.1. Forest Land Remaining Forest Land

GHG emissions for Forest Land Remaining Forest Land (FF) are estimated only for aboveground and belowground biomass using Tier 1 method (GPG 2003). Other carbon pools are not included due to a lack of activity data.

Change in carbon stocks in living biomass is calculated by multiplying the difference in oven dry weight of biomass increments and losses with appropriate carbon fraction. Tier 1 method (default method) is applied for estimating carbon stock changes in biomass. Tier 1 method requires the biomass carbon loss ($\Delta CFFL$) to be subtracted from the biomass carbon increment ($\Delta CFFG$) for the reporting year (GPG 2003, Equation 3.2.2.)

Annual increase in carbon stock due to biomass increment (ΔC_{FFG}) in FF is estimated according to Equation 3.2.4 (GPG 2003). Estimation of annual increase in carbon stock due to biomass increment requires estimation of area and annual increment of total biomass for each forest type (coniferous, deciduous) (G_{TOTAL}) and climatic zone (temperate) in Croatia. The annual increase in carbon stock is calculated only for areas under forest vegetation. Stratification of forest area by dominant species was not performed due to data unavailability. The latter was indeed addressed in Statistical Yearbooks but up to 2005. With the purpose of harmonization with the EU recommendations, in 2006 the Central Bureau of Statistics did not continue with the former presentation of forest areas. The new distribution of forest areas for the period from 2006-2009 is harmonized with the national Forestry Act (adopted in 2005) and can not be compared with numbers representing previously stratified areas. Areas with degraded forest vegetation are not included because annual increment for these vegetation types could still not be obtained. In previous inventories (prior to NIR 2008) the area data used in calculation referred to both forest vegetation plus degraded forest but the annual increment referred only to forest vegetation. Since this approach is clearly inaccurate and since data on annual increment for degraded forest could not be obtained, it was decided to use a different approach – that is to use data (area and annual increment) which refer only to forest vegetation. These results were considered more correct and more accurate than the previous calculation.

G_{TOTAL} is the expansion of annual increment rate of aboveground biomass (Gw) to include belowground part involving multiplication by the ratio of belowground biomass to aboveground biomass (root to shoot ratio) that applies to increments. Since Gw data are not available directly, the increment in volume (Iv) was used with biomass expansion factor for conversion of annual net increment to aboveground increment. For 2007 and 2008, more accurate data on Iv was attained.
Average annual increment in biomass (Gw) is calculated according to Equation 3.2.5 (GPG 2003) using data on:

- Iv = average annual net increment in volume suitable for industrial processing, $m^3\ ha^{-1}\ yr^{-1}$ (Forestry Management Plans 2006-2015)
- D = basic wood density , tonnes d.m. m^{-3}, (GPG 2003)
- BEF1 = biomass expansion factor for conversion of annual net increment (including bark) to aboveground tree biomass, dimensionless (GPG 2003)
- R = root to shoot ratio, dimensionless; GPG 2003, Table 3A.1.8
- CF = carbon fraction of dry matter (default = 0.5), tonnes C $(\text{tonne d. m.})^{-1}$

Average increment in biomass (G_{TOTAL}) is calculated by multiplying average increment in biomass (Gw) per root to shoot ratio (R) appropriate to increment, dimensionless (GPG 2003, Table 3A.1.8.)

Annual decrease in carbon stock due to biomass loss in FF (ΔC_{FFL}) is calculated as a sum of losses from commercial roundwood feelings ($L_{fellings}$), fuelwood gathering ($L_{fuelwood}$) and other losses ($L_{other\ losses}$)(GPG 2003, Equation 3.2.6.).

Annual carbon loss due to commercial fellings ($L_{fellings}$) is calculated according to Equation 3.2.7, GPG 2003, using input data on:

- H = annual extracted volume, roundwood, m^3 yr^{-1}
- D = basic wood density , tonnes d.m. m^{-3}, (GPG 2003)
- BEF2 = biomass expansion factor for conversion volumes of extracted roundwood to total aboveground (including bark) biomass, dimensionless (GPG 2003)
- f_{BL} = fraction of biomass left to decay in forest
- CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d. m.)$^{-1}$

In applying the abovementioned equation, f_{BL} is set to 0 according to assumption that total biomass, associated with the volume of extracted roundwood, is considered as an immediate emission.

Annual carbon loss due to fuelwood gathering is estimated according to Equation 3.2.8, GPG 2003, using input data on:

- FG = annual volume of fuelwood gathering, tonnes C yr^{-1}. D = basic wood density , tonnes d.m. m^{-3}, (GPG 2003)
- BEF2 = biomass expansion factor for conversion volumes of extracted roundwood to total aboveground (including bark) biomass, dimensionless (GPG 2003)
- CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d. m.)$^{-1}$

Annual Carbon Loss due to Other losses includes only data on forest fires and is estimated according to Equation 3.2.9, GPG 2003, using input data on:

- $A_{disturbance}$ = forest areas affected by fires, ha yr^{-1}.
- Bw = average biomass stock of forest areas, tonnes d.m. ha^{-1}, (GPG 2003, Table 3A.1.4)
- CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d. m.)$^{-1}$

In applying abovementioned equation, f_{bl} is set to 0 according to assumption that all aboveground biomass carbon is lost upon disturbance.

Table 7.2-1 provides information on factors used.

Table 7.2-1: Emission factors used in estimations

Forest type	D	BEF1	R	BEF2	CF	Bw
Coniferous	0.4	1.15	0.23	1.3	0.5	107
Deciduous	0.588	1.2	0.24	1.4	0.5	107

Moreover, non-CO_2 greenhouse gas emissions released in wildfires for CH_4, CO, N_2O and NO_x are estimated according to 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.)$^{-1}$

Products of B and C are estimated using GPG 2003, Table 3.A.1.13.

Table 7.2-2 provides information on annual change in carbon stock in living biomass in Forest land remaining forest land. Trend of CO_2 removals by sinks for the period from 1990-2008 is presented in Figure 7.2-1.

Table 7.2-2: Annual change in Carbon Stock in living biomass in Forest Land Remaining Forest Land (Gg CO_2)

Year	Annual increase in carbon stocks	Annual decrease in carbon stocks due to carbon loss	Annual change in carbon stock in living biomass
1990	13505.18	9320.24	4184.93
1991	13505.18	4805.53	8699.64
1992	13505.18	4210.85	9294.33
1993	13505.18	5468.52	8036.66
1994	13505.18	4846.84	8658.34
1995	13505.18	4350.93	9154.24
1996	14876.47	5386.51	9489.96
1997	14876.47	6673.53	8202.94
1998	14876.47	8035.32	6841.15
1999	14876.47	6723.39	8153.08
2000	14876.47	9595.73	5280.74
2001	14876.47	6662.68	8213.80
2002	14876.47	6670.86	8205.61
2003	14876.47	7959.00	6917.48
2004	14876.47	6368.44	8508.04
2005	14876.47	6649.07	8227.41
2006	16333.04	7315.20	9017.83
2007	16254.26	8264.66	7989.60
2008	15021.29	8542.57	6478.72

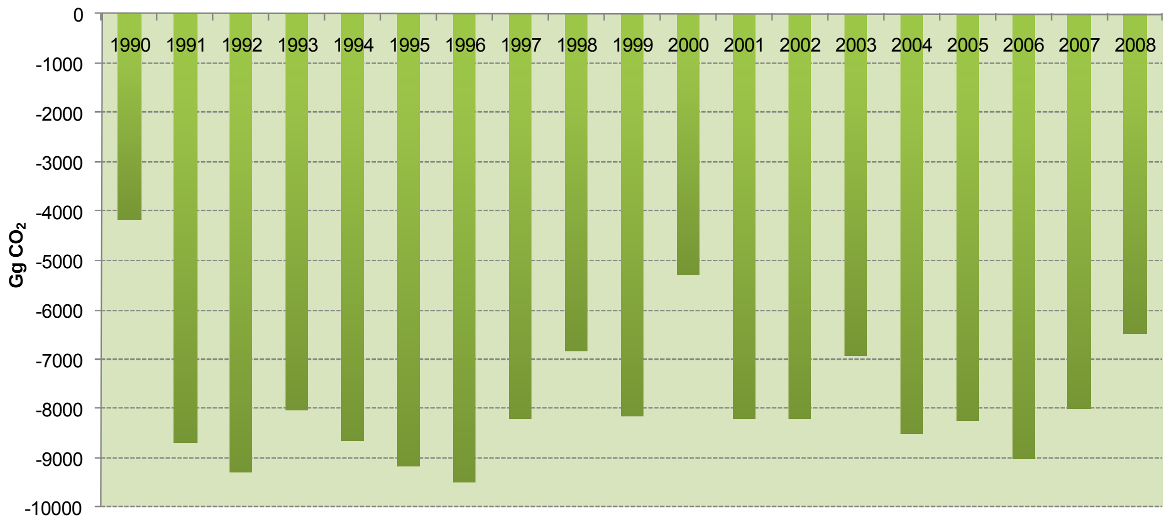


Figure 7.2-1: Trend of CO_2 removals by sinks in Croatia

As presented in Figure 7.2-1, there had been certain fluctuations within the 1990-2008 period in regard to CO_2 sinks from Forest land remaining forest land (FF) which can be explained with the following:

- The period from 1991-1995 represents the war period in Croatia during which commercial fellings significantly decreased. Decreased fellings are the major reason for the 1990/1991 fluctuation. In 1990, fellings were approximately 5 mil. m^3 and in the later period, approximately 2 mil. m^3 which makes a significant difference. This continued in 1996, too. Consequently, increased CO_2 sinks can be noticed in the period from 1991-1996. After the war, Croatia slowly began to recover in terms of forest management. During these years, commercial fellings significantly increased (more or less stable). From 1996 to 1997, fellings increased by almost one third and the area caught with fire increased almost double because the year 1997 was very dry and with high temperatures. The amount of fuelwood also increased. Therefore, this condition/situation resulted in 1996/1997 fluctuation. Increase in fellings resulted with a decrease of CO_2 sinks in Croatia. Years 1998, 2000 and 2003 were very warm and with low precipitation which lead to an increase in the area burnt. For example, in 1998 and 2003, about 8000 ha were burnt and in 2000 more than 14000 ha. The latter caused large carbon losses and consequently low CO_2 sinks. Lower sink in 2008 is caused by a decrease in biomass increment and an increase in area caught with fire.

7.2.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Determination of uncertainties was based on expert judgment. The uncertainty of the input data for CO_2 emissions was estimated at 40 to 50%, while uncertainty of using wood density and BEFs was estimated at 30%. The uncertainty of activity data for non-CO_2 emissions from fires was estimated at 25%, while for emission factors at 70%.
Emissions from sub-sector Forest land remaining forest land have been calculated using the same data source for every year in the time series except for data on fellings and fuelwood.

7.2.4. 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. 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.

7.2.5. SOURCE-SPECIFIC RECALCULATIONS

Recalculations were performed for the period from 2003-2007. Regarding 2003-2005, recalculations were necessary due to an error noticed in regard to felling and fuelwood. According to data sources for these activities in the related period (JFSQ for reporting to FAO/ITTO/UNECE), it was concluded that fuelwood was double counted and that the numbers were not corrected to represent overbark volume. Thus, the inventory team revised the data, excluded double counting and made required corrections for volume overbark by using the 1,15 factor as stated in the FAO Guidelines for FRA. As for the 2006 and 2007, double counting was also noticed but it did not require further data revision related to overbark volume.

7.2.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

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. In line with the latter, the inventory team finds preparation of the CRONFI (Croatian National Forest Inventory) as a significant activity that will in the future enable and facilitate emission/removal calculation from LULUCF with more detailed and more accurate data. Since the CRONFI was not finalized and the data/information was not available within the time scope for NIR preparation, further improvements are expected in the next NIR.

7.2.7. SUPPLEMENTARY INFORMATION ON LULUCF ACTIVITIES UNDER ARTICLE 3, PARAGRAPH 3 AND 4 OF THE KYOTO PROTOCOL

The Republic of Croatia was not able to report supplementary information on LULUCF activities under Article 3, paragraph 3 and 4 of the Kyoto Protocol.

7.3. REFERENCES

Central Bureau of Statistics, *Statistical Yearbooks (1986-2007),* Zagreb

Croatian Forests (2006) *Forest Management Area Plan of the Republic of Croatia 2006-2015,* Public company "Croatian Forests", Zagreb

IPCC (2003) *Good Practice Guidelines for Land Use, Land-Use Change and Forestry*, IGES, Japan

Croatian Forests (1996) *Forest Management Area Plan of the Republic of Croatia*, Public company "Croatian Forests", Zagreb

FCC/IRR/2008/HRV *Report of the review of the initial report of Croatia*, 26 August 2009

FCC/ARR/2008/HRV *Report of the initial review of the greenhouse gas inventories of Croatia submitted in 2007 and 2008*, 5 November 2009 (advance version)

FCCC/ARR/2009/HRV *Report of the individual review of the individual review of the annual submission of Croatia submitted in 2009* (advance version)

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Workbook,* Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, United Kingdom

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Reference Manual,* Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, United Kingdom

Klepac D. (1998) *Croatian Forestry in XIX and XX century,* University forestry education in Croatia 1898-1998, Book II, Forestry Faculty – University of Zagreb, pages 9-31, Zagreb

Matić S. (1999) *The forests of Croatia – country report, Virgin forests and forest reserves in Central and East European countries,* Development of Forestry and Renewable Forest Resources – Biotechnical faculty, 17-24, Ljubljana

Matić S., Meštrović Š., Vukelić J. (1997) *Forest and Forest Land Management of Zagreb city and Zagreb county*, Forestry Faculty – University of Zagreb, page 213, Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2008) *Initial Report of the Republic of Croatia under the Kyoto Protocol,* EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2009) *National Inventory Report 2008, Croatian greenhouse gas inventory for the period 1990 – 2007,* EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2010) *Fifth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)*, Zagreb

Response of Croatia to Potential Problems and Further Questions from the ERT formulated in the course of the in-country review of Croatia's Initial Report under the Kyoto Protocol and 2008 Inventory Submission (2008)

Sabadi, R. (1994) *An overview of forestry and wood processing sector in the Republic of Croatia*, Ministry of Agriculture and Forestry and "Croatian Forests" Zagreb, page 120, Zagreb

UNECE database; www.unece.com

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 generally inadequately organized and implemented 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.

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.

The total annual emissions of GHGs, expressed in Gg CO_2-eq, from waste management in the period 1990-2008 are presented in the Figure 8.1-1.

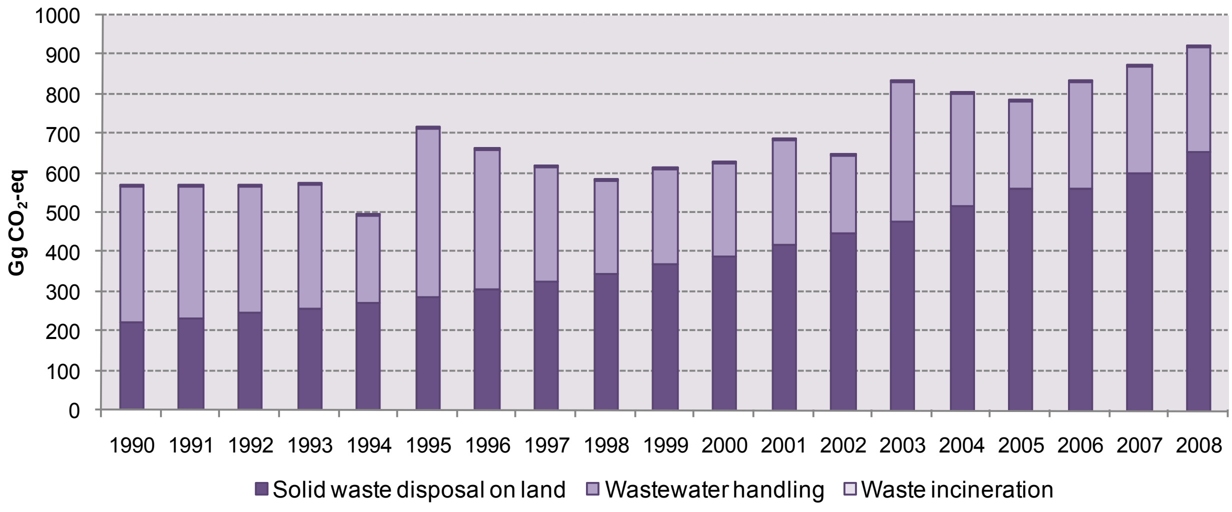


Figure 8.1-1: Emissions of GHGs from Waste (1990-2008)

8.2. SOLID WASTE DISPOSAL ON LAND (CRF 6.A.)

8.2.1. SOURCE CATEGORY DESCRIPTION

Landfill gas consists of approximately 50 percent CO_2 and 50 percent CH_4 by volume. Anaerobic decomposition of organic matter in Solid Waste Disposal Sites (SWDSs) results in the release of CH_4 to the atmosphere. The composition of waste is one of the main factors influencing the amount and the extent of CH_4 production within SWDSs. Temperature, moisture content and pH are important physical factors influencing fermentation of degradable organic substances and gas production.

8.2.2. METHODOLOGICAL ISSUES

A method used to calculate CH_4 emissions according to *Revised 1996 IPCC Guidelines* is First Order Decay (FOD) method. The quantity of CH_4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste. DOC was estimated by using country-specific data on waste composition and quantities based on compiled data from Potočnik, V. (2000), *Report: The basis for methane emissions estimation in Croatia 1990-1998, B. Data on Municipal Solid Waste in Croatia 1990-1998*. Country-specific composition of waste is presented in the Table 8.2-1.

Table 8.2-1: Country-specific composition of waste

Waste stream	Percent in the MSW	Percent DOC
Paper and textiles	21 - 22	40
Garden and park waste	18 - 19	17
Food waste	23 - 24	15
Wood and straw waste	3	30

The country-specific fraction of DOC in municipal solid waste (MSW), according to data from Table 8.2-1, was estimated to be 0.17 in the period 1990-2004 and 0.16 in the period 2005-2008. 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[9] 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.

The methodology provides a classification of SWDSs into “managed” and “unmanaged” sites through knowledge of site activities carried out. Unmanaged sites are further divided as deep ($\geq$5m depth) or shallow (<5m depth). The classification is used to apply a methane correction factor (MCF) to account for the methane generation potential of the site.

[9] 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.

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 1970-1990 have been estimated based on national rate for waste generation and fraction of MSW disposed at different types of SWDSs. Extrapolation/interpolation methods 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 2006-2008 were obtained from *Cadastre of Waste - Municipal Solid Waste,* Croatian Environment Agency. Recovered CH_4 in the period 2005-2008 have been obtained. Information on CH_4 that is recovered and burned in a flare or energy recovery device in the period 2005-2008 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 and 2.19 Gg CH_4 in 2008).

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 1990-2008 and related MCF are reported in the Table 8.2-2.

Table 8.2-2: Total annual MSW disposed to SWDSs and related MCF (1990-2008)

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

Table 8.2-2: Total annual MSW disposed to SWDSs and related MCF (1990-2008), cont.

Year	Managed SWDS (Gg)	Unmanaged SWDS (≥5m) (Gg)	Unmanaged SWDS (<5m) (Gg)	MCF (fraction)
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

* 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 the *Waste Management Strategy* and *Waste Management Plan* 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 2005-2008 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 1990-2008 are presented in the Figure 8.2-1.

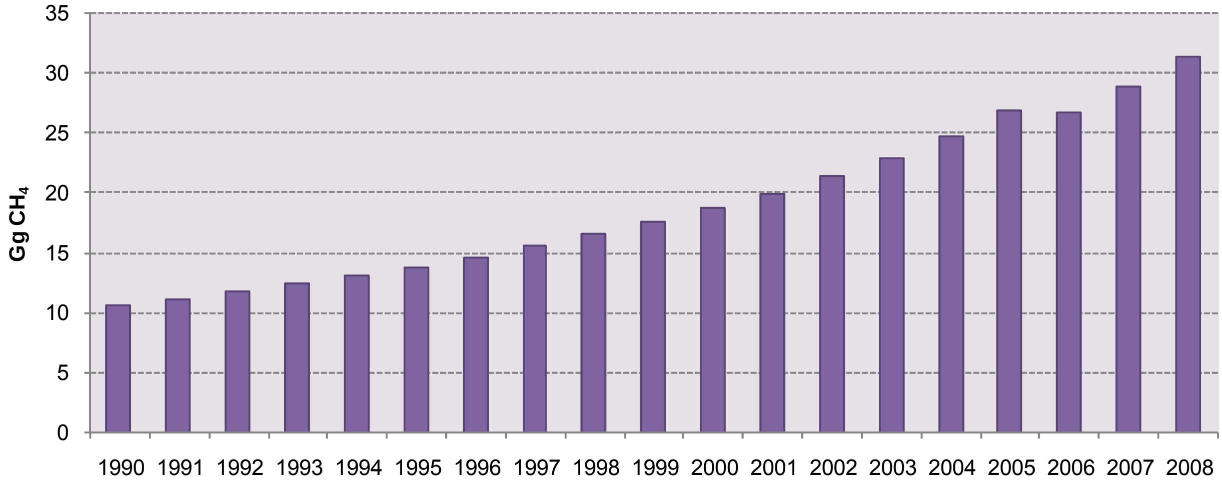


Figure 8.2-1: Emissions of CH_4 from Solid Waste Disposal on Land (1990-2008)

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. Municipal solid waste which is disposed to “Official” SWDSs is in most cases collected in an organized manner by registered companies. “Official” SWDSs do not necessarily fall under managed SWDSs category as defined by IPCC (site management activities carried out in “Official” SWDSs in most 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 only few sorting of waste in Croatia, and in consequence of that these results were compared and adjust to relevant data in similar countries.

Uncertainty estimate associated with emission factor amounts 50 percent, according to the provided uncertainty assessment in *Good Practice Guidance*. Uncertainty estimate associated with activity data amounts 50 percent, based on expert judgements.

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

There are no source-specific recalculations in this report.

8.2.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

According to National Environmental Action Plan (NEAP) (Official Gazette No. 46/02), Croatian Waste Management Strategy (Official Gazette No. 130/05) and *Waste Management Plan in the Republic of Croatia (2007-2015)* (Official Gazette No. 85/07), infrastructure development for integral system of waste management has been emphasized, respectively, conditions for effectively waste management activities are created. Consequently, more accurate data for CH_4 emission calculations should be available.

8.2.6.1. Activity data improvement

By-law on Cadastre of Emission to Environment (Official Gazette No. 36/96) and The Waste Law (Official Gazette No. 178/04, 111/06) define administration commitments of manufacturers and all entities which contributed in waste management. 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.

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, extrapolation method has been applied for estimation of waste and landfills characteristics over a long period of time. For the purposes of emission inventory improvement 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.

By-law on Conditions for Waste Treatment (Official Gazette No. 123/97, 112/01) as well as By-low on Waste Management (Official Gazette No. 23/07) defines priority for improvement and organization of disposal sites and waste disposal on managed disposal sites.

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 1990-2008.

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 2003-2008. Insufficient data have been assessed by interpolation method. Data for CH_4 emission calculation for the period 1990-2008 are presented in the Table 8.3.1.

There are no available data on sludge.

Table 8.3-1: Data for CH_4 emission calculation from Domestic and Commercial Wastewater (1990-2008)

Year	DOC (kg BOD/1000persons/yr)	Population*
1990	21899.86	2866000
1991	21899.55	2842800
1992	21899.58	2819600
1993	21899.60	2796400
1994	21899.63	2773200
1995	21900.00	2750000
1996	21900.00	2732000
1997	21900.00	2714000
1998	21900.00	2696000

Table 8.3-1: Data for CH_4 emission calculation from Domestic and Commercial Wastewater (1990-2008), cont.

Year	DOC (kg BOD/1000persons/yr)	Population*
1999	21900.00	2678000
2000	21900.00	2660000
2001	21899.65	2630333
2002	21899.70	2601666
2003	21900.16	2574000
2004	21900.00	2560000
2005	21900.01	2541460
2006	21900.17	2525460
2007	21899.89	2514488
2008	21900.13	2478889

* data for population with individual system of drainage

The resulting annual emissions of CH_4 from Domestic and Commercial Wastewater in the period 1990-2008 are presented in the Figure 8.3-1.

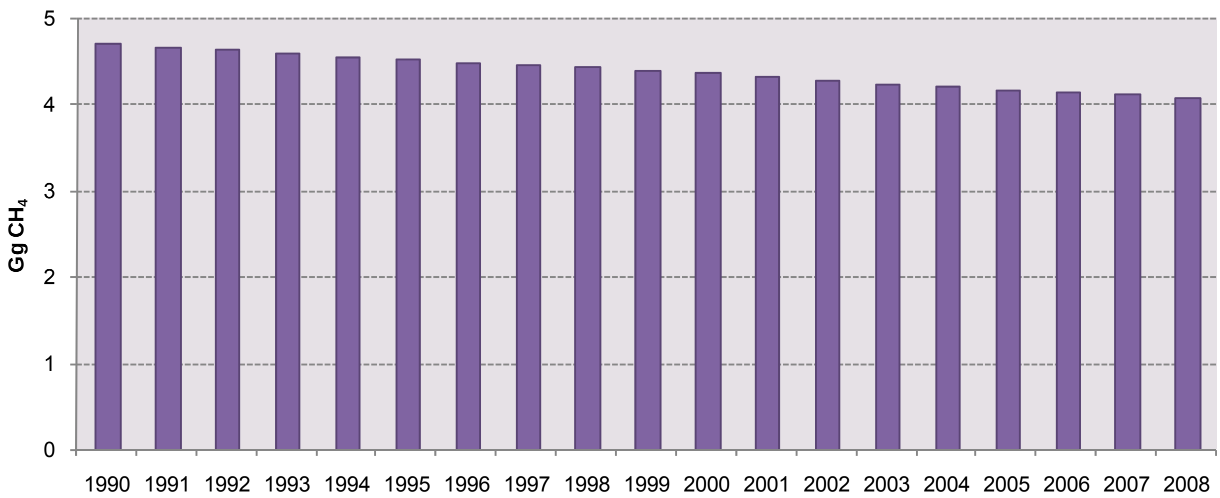


Figure 8.3-1: Emissions of CH_4 from Domestic and Commercial Wastewater (1990-2008)

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.

Data for CH_4 emission calculation for the period 1990-2008 are presented in the Table 8.3.2.

Table 8.3-2: Data for CH_4 emission calculation from Industrial Wastewater (1990-2008)

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	7237	1502	3208	2875	6010.94
1991	7128	1393	3079	2883	5800.55
1992	7018	1284	2951	2891	5590.15
1993	6909	1175	2822	2899	5379.76
1994	5911	1213	679	2115	2030.79
1995	6157	1234	5224	1806	8616.35
1996	5274	967	3817	6896	7482.78
1997	6471	738	2309	2930	4538.19
1998	9348	25	1130	1571	2643.92
1999	9759	350	1065	2371	2790.01
2000	4914	393	1169	2189	2560.97
2001	4715	316	1808	1577	3343.29
2002	5630	44	132	3619	1334.26
2003	5037	41	3695	4936	6750.44
2004	4767	151	2213	3519	4302.35
2005	6440	83	681	1864	1846.63
2006	5045	40	1692	3375	3516.73
2007	4941	46	1646	1624	3091.11
2008	2570	63	1574	1007	2693.10

The resulting annual emissions of CH_4 from Industrial Wastewater in the period 1990-2008 are presented in the Figure 8.3-2.

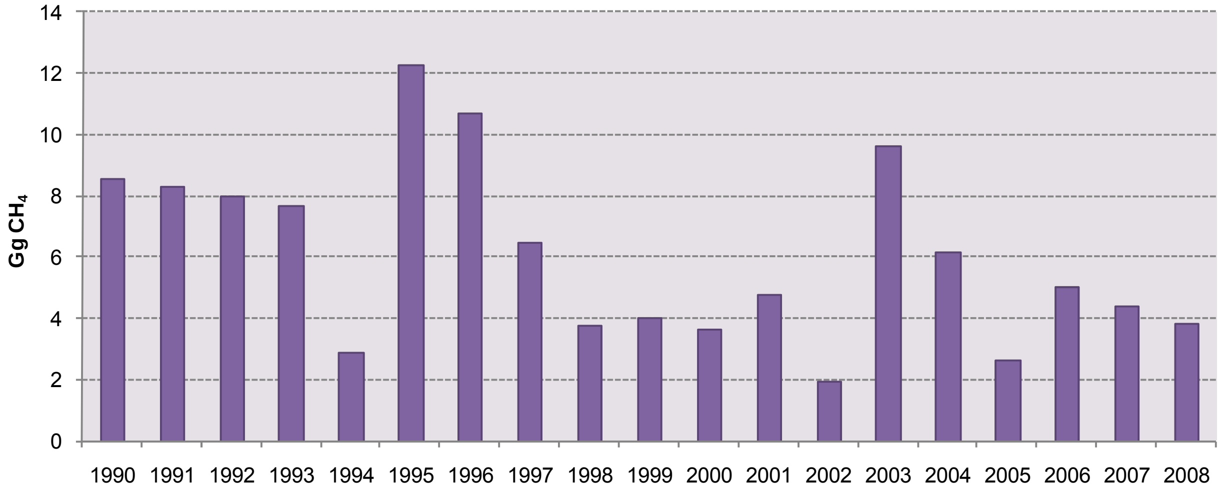


Figure 8.3-2: Emissions of CH_4 from Industrial Wastewater (1990-2008)

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 1990-2008 were taken from Statistical Yearbook. Croatian data on the annual per capita Protein intake value (PIV), for the period 1992-2005, 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 over three year from 2001 and 2003 have been used as the pattern for data calculation in the period 2006-2008.

Data for N_2O emission calculation from Human Sewage for the period 1990-2008 are presented in the Table 8.3.3.

Table 8.3-3: Data for N_2O emission calculation from Human Sewage (1990-2008)

Year	Protein intake (kg/person/yr)	Population
1990	24.23	4778000
1991	23.96	4513000
1992	22.48	4470000
1993	21.46	4641000
1994	21.94	4649000
1995	23.54	4669000
1996	23.21	4494000
1997	22.92	4572000
1998	22.74	4501000
1999	24.13	4554000
2000	24.09	4426000

Table 8.3-3: Data for N_2O emission calculation from Human Sewage (1990-2008), cont.

Year	Protein intake (kg/person/yr)	Population
2001	25.33	4440000
2002	27.19	4440000
2003	27.16	4440000
2004	26.94	4439000
2005	27.05	4442000
2006	29.47	4440000
2007	30.38	4436000
2008	31.30	4434000

The resulting annual emissions of N_2O from Human Sewage in the period 1990-2008 are presented in the Figure 8.3-3.

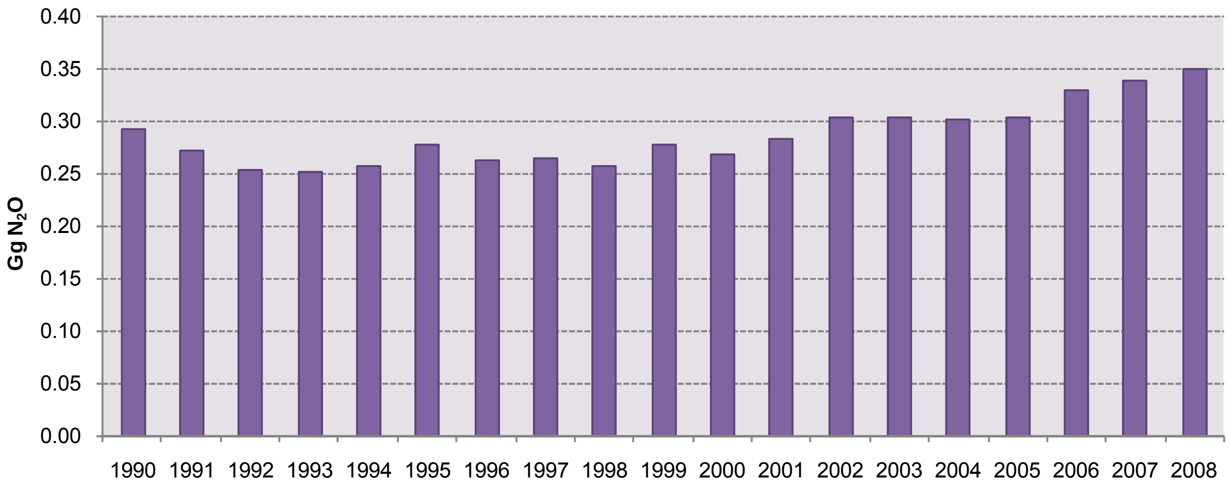


Figure 8.3-3: Emissions of N_2O from Human Sewage (1990-2008)

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.

Uncertainty estimate associated with CH_4 and N_2O emission factor amounts 30 percent, accordingly to provided uncertainty assessment in *Good Practice Guidance*. Uncertainty estimate associated with activity data amounts 50 percent, based on expert judgements.

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

8.3.5. SOURCE SPECIFIC RECALCULATIONS

Domestic and commercial wastewater
New data for BOD for 2007 were provided by state company Croatian Water (Hrvatske vode) and CH_4 emission has been recalculated for this year.

Human Sewage
New data for PIV were provided by FAOSTAT database for the period 1992-2005. Taking into account the PIV trend, the pattern over three years from 1992 to 1994 has been used for recalculation of data in 1990 and 1991. Also, data over three year from 2001 and 2003 have been used as the pattern for data recalculation for the 2006 and 2007. New population data for the period 2000-2003 were provided by Statistical Yearbook 2009. CH_4 emission has been recalculated for the period 1990-2007.

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 accurate calculation of N_2O emissions from Human Sewage, Croatia planned to analyze the influence of tourism on the population influx due to summer months, as well as fact that nearly 25 percent of the Croatian population lives close to the sea, which has influence on the emission factor.

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 1990-2008. CO_2 emissions from incineration of hazardous waste have not been estimated 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 available for 2007 and 2008.

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 2004-2008 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 for CO_2 emission calculation for the period 1990-2008 are presented in the Table 8.3.4.

Table 8.3-4: Incinerated waste (1990-2008)

Year	Incinerated waste (tonnes)
1990	51.70
1991	48.83
1992	48.37
1993	50.22
1994	50.31
1995	50.52
1996	48.63
1997	49.47
1998	48.71
1999	49.28
2000	47.41
2001	48.01

Table 8.3-4: Incinerated waste (1990-2008), cont.

Year	Incinerated waste (tonnes)
2002	48.08
2003	48.07
2004	49.20
2005	40.23
2006	48.05
2007	54.75
2008	238.50

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, hospital waste was incinerated with energy recovery.

The resulting annual emissions of CO_2 from Waste Incineration in the period 1990-2008 are presented in the Figure 8.3-4.

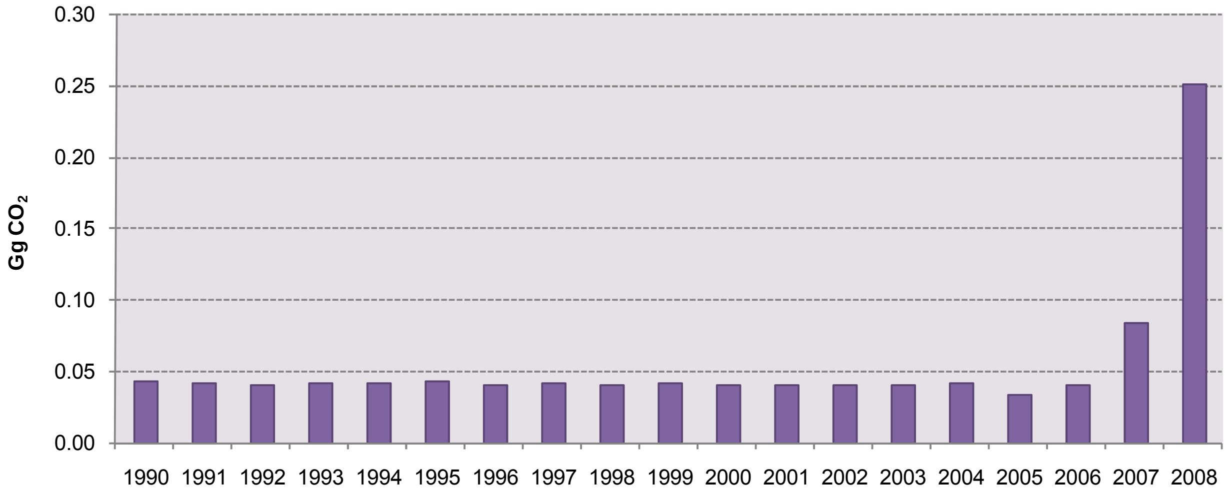


Figure 8.3-4: Emissions of CO_2 from Waste Incineration (1990-2008)

8.4.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainties contained in CO_2 emissions estimates from incineration of waste are related primarily to applied default emission factor and assessed activity data.

Uncertainty estimate associated with emission factor amounts 30 percent, according to the provided uncertainty assessment in *Good Practice Guidance*. Uncertainty estimate associated with activity data amounts 50 percent, based on expert judgements.

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

In NIR 2009 wrong data have been included for sewage sludge - water sludge which contains glues and tightening agents which belong to hazardous waste. Consequently, data have been corrected and CO_2 emissions have been recalculated for 2007 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	10.53	21	221.21	37.48	0.70
	1991		11.12		233.57	39.62	0.94
	1992		11.71		245.85	41.76	1.06
	1993		12.32		258.72	43.57	1.12
	1994		12.98		272.60	53.60	1.23
	1995		13.74		288.58	39.69	1.26
	1996		14.57		305.93	43.37	1.30
	1997		15.49		325.21	51.11	1.31
	1998		16.45		345.39	57.82	1.38
	1999		17.53		368.18	58.47	1.41
	2000		18.62		391.12	60.86	1.51
	2001		19.88		417.47	59.99	1.54
	2002		21.29		447.14	66.64	1.59
	2003		22.86		479.97	55.50	1.61
	2004		24.56		515.76	62.44	1.73
	2005		26.81		563.07	70.41	1.85
	2006		26.68		560.32	65.56	1.82
	2007		28.70		602.71	67.94	1.87
	2008		31.19		655.00	70.47	2.12
Domestic and Commercial Wastewater	1990	CH_4	4.71	21	98.85	16.75	0.31
	1991		4.67		98.05	16.63	0.39
	1992		4.63		97.25	16.52	0.42
	1993		4.59		96.45	16.24	0.42
	1994		4.55		95.65	18.81	0.43
	1995		4.52		94.85	13.05	0.41
	1996		4.49		94.23	13.36	0.40
	1997		4.46		93.61	14.71	0.38
	1998		4.43		92.99	15.57	0.37
	1999		4.40		92.37	14.67	0.35
	2000		4.37		91.75	14.28	0.35
	2001		4.32		90.73	13.04	0.33
	2002		4.27		89.74	13.37	0.32
	2003		4.23		88.78	10.27	0.30
	2004		4.20		88.30	10.69	0.30
	2005		4.17		87.66	10.96	0.29
	2006		4.15		87.11	10.19	0.28
	2007		4.13		86.73	9.78	0.27
	2008		4.07		85.50	9.20	0.28

Table 8.5-1: Emissions from Waste (1990-2008), 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	30.48	0.57
	1991		8.27		173.58	29.44	0.70
	1992		7.97		167.29	28.41	0.72
	1993		7.67		160.99	27.11	0.70
	1994		2.89		60.77	11.95	0.27
	1995		12.28		257.84	35.47	1.12
	1996		10.66		223.92	31.74	0.95
	1997		6.47		135.81	21.34	0.55
	1998		3.77		79.12	13.25	0.32
	1999		3.98		83.49	13.26	0.32
	2000		3.65		76.64	11.93	0.30
	2001		4.76		100.05	14.38	0.37
	2002		1.90		39.93	5.95	0.14
	2003		9.62		202.01	23.36	0.68
	2004		6.13		128.75	15.59	0.43
	2005		2.63		55.26	6.91	0.18
	2006		5.01		105.24	12.31	0.34
	2007		4.40		92.50	10.43	0.29
	2008		3.84		80.59	8.67	0.26
Human Sewage	1990	N_2O	0.29	310	90.24	15.29	0.29
	1991		0.27		84.27	14.29	0.34
	1992		0.25		78.34	13.30	0.34
	1993		0.25		77.64	13.07	0.34
	1994		0.26		79.49	15.63	0.36
	1995		0.28		85.67	11.78	0.37
	1996		0.26		81.31	11.53	0.35
	1997		0.26		81.68	12.84	0.33
	1998		0.26		79.77	13.36	0.32
	1999		0.28		85.64	13.60	0.33
	2000		0.27		83.10	12.93	0.32
	2001		0.28		87.66	12.60	0.32
	2002		0.30		94.10	14.03	0.33
	2003		0.30		93.98	10.87	0.32
	2004		0.30		93.20	11.28	0.31
	2005		0.30		93.64	11.71	0.31
	2006		0.33		101.99	11.93	0.33
	2007		0.34		105.05	11.84	0.33
	2008		0.35		108.16	11.64	0.35

Table 8.5-1: Emissions from Waste (1990-2008), 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	0.007	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

8.6. REFERENCES

Central Bureau of Statistics, *Statistical Yearbooks (1990-2008)*

Croatian Environment Agency (2006) *Cadastre of Emission to Environment (KEO) Reporting Forms - regarding to hazardous waste*, Zagreb

Croatian Environment Agency,*Cadastre of Waste - Municipal Solid Waste, Report 2006, Report 2007, Report 2008,* Zagreb

Croatian Environment Agency (2010) Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2008* Submission to the Convention on Long-range Transboundary Air Pollution, EKONERG Ltd., Zagreb

Croatian Water Ltd. (2010) *Report: Data for methane emission calculations from domestic and commercial wastewater,* Zagreb

Diaz, L.F. et al. (1996) *Solid Waste Management for Economically Developing Countries, ISWA*

Government of the Republic of Croatia (2005) *Croatian Waste Management Strategy*

FAOSTAT: Statistical Database, http://www.fao.org

FCC/IRR/2008/HRV *Report of the review of the initial report of Croatia*, 26 August 2009

FCC/ARR/2008/HRV *Report of the initial review of the greenhouse gas inventories of Croatia submitted in 2007 and 2008*, 5 November 2009 (advance version)

FCCC/ARR/2009/HRV *Report of the individual review of the individual review of the annual submission of Croatia submitted in 2009* (advance version)

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

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, Japan

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Workbook,* Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, United Kingdom

IPCC/UNEP/OECD/IEA (1997) *Greenhouse Gas Inventory Reference Manual,* Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, United Kingdom

Ministry of Environmental Protection, Physical Planning and Construction: *Report of Environment Condition,* http://www.mzopu.hr/okolis

Ministry of Environmental Protection, Physical Planning and Construction (2006) *Guidelines Development for starting implementation of Waste Management Plan in the Republic of Croatia*, LIFE04 TCY/CRO/000028, EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2009) *National Inventory Report 2009, Croatian greenhouse gas inventory for the period 1990 – 2007,* EKONERG Ltd., Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2010) *Fifth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)*, Zagreb

Ministry of Environmental Protection, Physical Planning and Construction (2007) *Waste Management Plan in the Republic of Croatia (2007-2015),* Zagreb

Potočnik, V. (2000) *Report: The basis for methane emission estimation in Croatia 1990-1998, B. Data on Municipal Solid Waste in Croatia 1990-1998, Zagreb*

9. 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).

9.1. 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[10]

Recalculations are performed in the following sectors:

- Energy
  - Public Electricity and Heat Production, Manufacturing Industries and Construction, Road Transport, Other Sectors and Aviation Bunkers
- Industrial Processes
  - Cement Production, Limestone and Dolomite Use, Production of Other Chemicals, 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, direct N_2O emissions from Agricultural soils and indirect N_2O emissions from nitrogen used in agriculture
- LULUCF
  - Emissions/sinks from Forest land remaining forest land
- Waste
  - Wastewater Handling (Domestic and Commercial Wastewater; Human sewage), Waste Incineration

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 9.1.1.)
- Correction of errors (Chapter 9.1.2.)

9.1.1. 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] Suggestions reported in “Report of the individual review of the greenhouse gas inventory of Croatia submitted in 2006”

9.1.1.1. Changes in available data

Industrial processes

Mineral products (2.A.); Cement Production (2.A.1.)

In NIR 2009, activity data for the year 2007 have been estimated due to the insufficient data (data from one plant have not been collected). Since those data were subsequently obtained, recalculations were made accordingly.

Mineral products (2.A.); Limestone and Dolomite Use (2.A.3.)

According to ERT recommendation during the in-country review, data for the period from 2000-2008 were updated by adding the limestone use in desulphurization process in TPP Plomin 2 (previously included in the energy sector). Emissions of CO_2 have been recalculated according to the corrected activity data.

Chemical Industry (2.B.); Production of Other Chemicals (2.B.5.)

Activity data and emissions for the whole time period of the previous report (1990-2007) were rechecked and some of the data were corrected according to the emission inventory report 'Republic of Croatia *Informative Inventory Report to LRTAP Convention for the Year 2008* 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).

Consumption of Halocarbons and SF_6 (2.F.); Electrical Equipment (2.F.8.)

In this report, additional data provided by one operator have been included for the period 1995-2008. Accordingly, SF_6 emissions have been recalculated for the period 1995-2007.

Solvent and Other Product Use

Solvent and Other Product Use (3.A.B.C.D.)

Emissions of NMVOC 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'. NMVOC emissions have been changed for some years. Therefore, CO_2 emissions have been recalculated for the period 1990-2007 in this report.

Agriculture

CH_4 Emissions from Enteric Fermentation in Domestic Livestock (4.A.)

Recalculations regarding emissions from enteric fermentation subsector are the result, among other reasons, of the revision of statistical data performed by the Central Bureau of Statistics (CBS) for the period 2000-2007. The latter refers to the revision of livestock number which resulted in certain, mostly not significant, changes of the following activity data:

- number of cattle,
- number of sheep,
- number of goats,
- number of horses,
- number of swine and
- number of poultry.

Another novelty is that the number of goats for the period from 2000-2008 was provided by the CBS; thus FAO database was used only for the 1990-1999 period.

Manure management (4.B.)

Recalculation of CH_4 emissions originating from Manure management was performed for the entire period from 1990-2007 for the same reasons presented and explained in enteric fermentation subsector.

Recalculation of N_2O emissions originating from Manure management was performed for the entire period from 1990-2007 due to the same reasons presented and explained in enteric fermentation subsector (valid also for manure management CH_4 emissions).

Agricultural soils (4.D.)

Direct emission from Agricultural soils

CBS performed revision of data related to crop production for the period from 2000-2007 which resulted in recalculations of direct emission, N_2O emission due to biological N fixation and N_2O emission originating from crop residue. Revision refers to changes of both N-fixing and non N-fixing crops as follows:

- N-fixing crops
  - production of soyabeans in 2004
  - production of dry beans for the period from 2000-2007
  - production of dry peas in 2007
  - production of clover for the period from 2000-2004
  - production of alfalafa for the period from 2000-2004
- non N-fixing crops
  - change in the production of wheat for the period from 2000-2004
  - change in the production of maize for the period from 2000-2004
  - change in the production of potatoes for the period from 2000-2004
  - change in the production of sugarbeets in 2004

o change in the production of tobacco in 2004
o change in the production of sunflowers in 2004
o change in the production of tomatoes for the period from 2000-2004
o change in the production of barley for the period from 2000-2004
o change in the production of oats for the period from 2000-2004

Direct N_2O emission from pasture, range and paddock manure

Recalculation of N_2O emissions from pasture, range and paddock manure was performed for the entire period from 1990-2007 for the same reasons presented and explained in enteric fermentation subsector.

Indirect N_2O emissions from nitrogen used in agriculture

Recalculations of N_2O emissions due to volatilization of ammonia (NH_3) and nitrogen oxides (NO_x) and N_2O emissions from nitrogen leaching and runoff was performed for the entire period from 1990-2007 for the following reasons[11]:

o new and updated data on cattle number which enabled related reclassification for the entire period from 1990-2007
o new and updated data on other livestock number for the period from 2000-2007

Waste

Wastewater Handling (6.B.); Domestic and Commercial Wastewater (6.B.2)

New data for BOD for 2007 were provided by state company Croatian Water (Hrvatske vode) and CH_4 emission has been recalculated for this year.

Wastewater Handling (6.B.); Human Sewage

New data for PIV were provided by FAOSTAT database for the period 1992-2005. Taking into account the PIV trend, the pattern over three years from 1992 to 1994 has been used for recalculation of data in 1990 and 1991. Also, data over three year from 2001 and 2003 have been used as the pattern for data recalculation for the 2006 and 2007. New population data for the period 2000-2003 were provided by Statistical Yearbook 2009. CH_4 emission has been recalculated for the period 1990-2007.

9.1.1.2. Consistency with good practice guidance

Energy

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

In this sector three recalculations were performed as follows:

a) CO_2 emission from SO_2 scrubbing in TPP Plomin 2 was relocated from Energy to Industrial processes sector (Limestone and dolomite use) as ERT recommended. Recalculations were performed for the period from 2000-2007.

[11] There are another 2 reasons for this recalculation presented in subchapter Correction of errors.

b) For the period from 1990-1994 in TPP Rijeka gas coke was used as a fuel for electricity production. Consumption of gas coke as well as emissions were located under the solid fuels. This explains the fact that implied emission factor for solid fuels were below the IPCC default range. Mistake is corrected by relocating gas coke from solid to gaseous fuels for the whole period of time.

c) Some inconsistencies in data occurred because two different approaches were used for emission calculation (bottom up for large point sources and top down for the rest of the sector). Recalculations are carried out to reconcile these two approaches for emission calculation. Fuel consumption from CHP and TPP plants (tier 2) were compared to same subsector in national energy balance. The differences which occurred were added to consumption of PHP plants. In such way total consumption of this sector is equal to total consumption in national energy balance. This approach assures that neither double-counting nor omissions occur. Recalculation was performed for the whole period of time (1990-2007).

9.1.1.4. New methods

Energy

Manufacturing industry and construction (1.A.2.)

During the QC proceeding (comparison of activity data from national energy balance and data from balance for industry) was observed that the fuel consumed in industrial cogeneration plants was not included in so called ‘Industry analysis balance’. Recalculations are carried out to add fuel consumption in industrial cogenerations to industry sector. Recalculations were performed for the period from 2001 to 2007.

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

Recalculations were performed because new COPERT version for calculating the pollutant emissions from the road traffic implemented (COPERT IV). The use of this version of COPERT is recommended by ERT after centralized review of 2009 annual submission. Usage of these COPERT tool for calculating road transport emissions provides transparent and standardized, and thus consistent and comparable reporting of emissions in accordance with the requirements of international conventions and protocols and EU legislation. In addition to the methodology changes, in this report is generated a model, which automatically count the number of vehicles carried by a COPERT requirements, which until now was not the case. The model is built on the Access database. This step is a reduced likelihood of human error and increased accuracy. The result of application of this model are revised population certain categories of vehicles which is one of the key input parameters for calculation of emissions from road transport with COPERT IV. Further, the new value for the minimum and maximum average month temperatures observed were input in COPERT. That is because earlier values of the minimum and maximum average monthly temperature in Croatia were input. In accordance with the recommendations of the team responsible for developing COPERT model (training organized by the EEA and ETC / ACC in June of 2009) to take values of the minimum and maximum average months temperature for the largest cities in Croatia, mentioned was done for the purposes of this report. Emissions of this sector have been recalculated for the whole period (1990-2007).

Industrial Processes

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

In NIR 2009 emissions of CO_2 have been calculated by multiplying annual steel production with related emission factor provided by *Revised 1996 IPCC Guidelines*.

In this report a higher tier method based on annual steel consumption of carbon donors in EAFs has been used for CO_2 emission calculation. New activity data have been provided by steel manufacturers. Thereupon, CO_2 emissions have been recalculated for the period 1990-2007.

Agriculture

CH_4 Emissions from Enteric Fermentation in Domestic Livestock (4.A.)

In accordance with the ERT recommendations regarding cattle characterisation, due to mentioned CBS data revision, reclassification based on Tier 2 methodology was enabled. This specifically refers to the period from 2000-2007. Furthermore, CBS provided more detailed data for the previous period too, thus emission recalculation was performed for the entire period from 1990-2007.

Manure management (4.B.)

Recalculation of CH_4 emissions originating from Manure management was performed for the entire period from 1990-2007 for the same reasons presented and explained in enteric fermentation subsector.
Recalculation of N_2O emissions originating from Manure management was performed for the entire period from 1990-2007 due to the same reasons presented and explained in enteric fermentation subsector (valid also for manure management CH_4 emissions).

Agricultural soils (4.D.)
Direct N_2O emission from pasture, range and paddock manure

Recalculation of N_2O emissions from pasture, range and paddock manure was performed for the entire period from 1990-2007 for the same reasons presented and explained in enteric fermentation subsector.

9.1.2. 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

Other sectors (1.A.3.b.)

For CH_4 emission calculation wrong emission factor for gas works gas was used (107.6 Gg/TJ was used instead if 47.4 Gg/TJ). Emission factor was corrected for the whole period (1990-2007).

Aviation bunkers (1.C.)

In 2007 wrong Net calorific value was used to calculate consumption of jet kerosene (44.96 TJ/Gg was used instead if 43.96 TJ/Gg). As ERT recommended, this error is corrected.

Agriculture

Manure management (4.B.)

Recalculation of N_2O emissions originating from Manure management was performed for the entire period from 1990-2007 due to an error noticed in regard to manure management system usage of dairy cattle – previously used MS (Eastern Europe) for solid storage was 67% instead of 68%. The latter was corrected for the entire period.

Agricultural soils (4.D.)

Direct emission from Agricultural soils
Nitrous oxide emissions from mineral fertilisers were recalculated only for the year 2007 due to an error noticed in regard to the amount of ammonium nitrate applied to soils. Previously used amount was 7.19 tonnes instead of 7190 tonnes. The latter was corrected.

Nitrous oxide emissions from animal manure and liquid/slurry were recalculated for the entire period from 1990-2007 for the same reasons as for N_2O emissions from Manure management.

Indirect N_2O emissions from nitrogen used in agriculture
Recalculations of N_2O emissions due to volatilization of ammonia (NH_3) and nitrogen oxides (NO_x) and N_2O emissions from nitrogen leaching and runoff was performed for the entire period from 1990-2007 for the following reasons:

- ocorrection of the amount of mineral fertilizer (ammonium nitrate) for 2007
- ocorrection of the solid storage usage (MS/%) for dairy cattle for the entire period from 1990-2007

LULUCF

Recalculations were performed for the period from 2003-2007. The latter was necessary due to an error noticed in regard to fellings and fuelwood which refers to double counting of fuelwood. For 2003-2005, apart from excluding double-counted fuelwood, additional correction was required for the data to represent overbark volume. For 2006 and 2007, this additional task was not necessary.

Waste

Waste Incineration (6.C.)

In NIR 2009 wrong data have been included for sewage sludge - water sludge which contains glues and tightening agents which belong to hazardous waste. Consequently, data have been corrected and CO_2 emissions have been recalculated for 2007 in this report.

9.2. 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 9.2-1 shows the differences between the last submission (NIR 2009) and current submission (NIR 2010), on the level of the different greenhouse gases.

Table 9.2-1: Differences between NIR 2000 and NIR 2010, for 1990-2007 due to recalculations

	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998
CO_2 (Tg) Incl. LULUCF	NIR 2009	18.9	8.5	7.3	8.9	7.7	7.8	8.1	10.4	12.6
	NIR 2010	18.9	8.5	7.3	8.9	7.6	7.8	8.1	10.4	12.6
	Difference %	***0.0***	***0.0***	***0.1***	***1.0***	***-0.8***	***0.9***	***-0.1***	***0.1***	***0.0***
CO_2 (Tg) Excl. LULUCF	NIR 2009	23.1	17.2	16.6	16.9	16.3	16.9	17.6	18.6	19.5
	NIR 2010	23.1	17.2	16.6	17.0	16.3	17.0	17.5	18.6	19.4
	Difference %	***0.0***	***0.0***	***0.0***	***0.5***	***-0.4***	***0.4***	***-0.1***	***0.0***	***0.0***
CH_4 (CO_2-eq Gg)	NIR 2009	3419	3174	2859	2984	2675	2853	2812	2796	2581
	NIR 2010	3442	3269	2886	2998	2693	2867	2825	2812	2601
	Difference %	***0.7***	***3.0***	***0.9***	***0.5***	***0.7***	***0.5***	***0.4***	***0.6***	***0.8***
N_2O (CO_2-eq Gg)	NIR 2009	3903	3740	3635	3116	3174	3063	3042	3334	2903
	NIR 2010	3918	3740	3640	3100	3166	3047	3025	3315	2878
	Difference %	***0.4***	***0.0***	***0.1***	***-0.5***	***-0.3***	***-0.5***	***-0.6***	***-0.6***	***-0.9***
HFCs (CO_2-eq Gg)	NIR 2009	NO	NO	NO	NO	NO	7.8	60.3	91.3	17.6
	NIR 2010	NO	NO	NO	NO	NO	7.8	60.3	91.3	17.6
	Difference %	NO	NO	NO	NO	NO	***0.0***	***0.0***	***0.0***	***0.0***
PFCs (CO_2-eq Gg)	NIR 2009	936.6	642.4	NO	NO	NO	NO	NO	NO	NO
	NIR 2010	936.6	642.4	NO	NO	NO	NO	NO	NO	NO
	Difference %	***0.0***	***0.0***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***
SF_6 (CO_2-eq Gg)	NIR 2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NIR 2010	0.0	0.0	0.0	0.0	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***
Total (Tg CO_2-eq) Incl. LULUCF	NIR 2009	27.2	16.1	13.8	15.0	13.5	13.7	14.0	16.6	18.1
	NIR 2010	27.2	16.2	13.8	15.1	13.5	13.8	14.0	16.6	18.1
	Difference %	***0.2***	***0.6***	***0.3***	***0.6***	***-0.4***	***0.5***	***-0.1***	***0.0***	***-0.1***
Total (Tg CO_2-eq) Excl. LULUCF	NIR 2009	31.4	24.8	23.1	23.0	22.2	22.9	23.5	24.8	25.0
	NIR 2010	31.4	24.9	23.1	23.1	22.2	22.9	23.5	24.8	25.0
	Difference %	***0.1***	***0.4***	***0.2***	***0.4***	***-0.2***	***0.3***	***-0.1***	***0.0***	***0.0***

Table 9.2-1: Differences between NIR 2009 and NIR 2010 for 1990-2007 due to recalculations (cont.)

Source		1999	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 (Tg) Incl. LULUCF	NIR 2009	12.1	14.7	12.7	13.6	17.2	15.1	15.7	16.0	18.6
	NIR 2010	12.1	14.6	12.7	13.7	16.5	14.5	15.2	14.5	16.8
	Difference %	***0.1***	***-0.2***	***0.0***	***0.4***	***-3.9***	***-4.3***	***-3.5***	***-9.6***	***-9.4***
CO_2 (Tg) Excl. LULUCF	NIR 2009	20.3	20.0	20.9	21.9	23.5	23.0	23.4	23.5	24.9
	NIR 2010	20.3	19.9	20.9	21.9	23.4	23.0	23.4	23.5	24.8
	Difference %	***0.1***	***-0.1***	***0.0***	***0.3***	***-0.1***	***-0.2***	***-0.2***	***0.0***	***-0.2***
CH_4 (CO_2-eq Gg)	NIR 2009	2596	2658	2833	2844	3111	3133	3124	3338	3481
	NIR 2010	2614	2674	2846	2858	3123	3151	3129	3357	3475
	Difference %	***0.7***	***0.6***	***0.4***	***0.5***	***0.4***	***0.6***	***0.1***	***0.6***	***-0.2***
N_2O (CO_2-eq Gg)	NIR 2009	3196	3307	3388	3375	3185	3477	3520	3456	3557
	NIR 2010	3171	3237	3354	3263	3084	3506	3519	3501	3495
	Difference %	***-0.8***	***-2.1***	***-1.0***	***-3.3***	***-3.1***	***0.8***	***0.0***	***1.3***	***-1.8***
HFCs (CO_2-eq Gg)	NIR 2009	9.2	23.2	49.0	49.3	163.7	188.9	349.2	430.7	465.1
	NIR 2010	9.2	23.2	49.0	49.3	163.7	188.9	349.2	430.7	465.1
	Difference %	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***
PFCs (CO_2-eq Gg)	NIR 2009	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO
	NIR 2010	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO
	Difference %	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***	***NO***
SF_6 (CO_2-eq Gg)	NIR 2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NIR 2010	0.0	0.0	0.0	0.0	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***
Total (Tg CO_2-eq) Incl. LULUCF	NIR 2009	17.9	20.7	18.9	19.9	23.6	21.9	22.7	23.3	26.1
	NIR 2010	18.0	20.6	18.9	19.9	22.9	21.3	22.2	21.8	24.3
	Difference %	***0.0***	***-0.4***	***-0.1***	***-0.2***	***-3.2***	***-2.8***	***-2.4***	***-6.3***	***-6.9***
Total (Tg CO_2-eq) Excl.LULUCF	NIR 2009	26.1	26.0	27.2	28.1	29.9	29.8	30.4	30.8	32.4
	NIR 2010	26.1	25.9	27.1	28.1	29.8	29.8	30.4	30.8	32.3
	Difference %	***0.0***	***-0.3***	***-0.1***	***-0.1***	***-0.4***	***0.0***	***-0.1***	***0.2***	***-0.4***

The change in the 1990-2007 trend for the greenhouse gas emissions compared to the previous submission is presented in Table 9.2-2. It can be concluded that the trend in the total national emissions decreased by 2.63 percent including LULUCF and 2.74 percent excluding LULUCF comparing NIR 2008 with Resubmission and decreased by 10.94 percent including LULUCF and 5.64 percent excluding LULUCF comparing Resubmission 2008 with NIR 2008. The largest absolute changes in emission trends are recorded for CO_2, HFCs and total CO_2-eq, described in Table 9.2-2.

Table 9.2-2: Differences between NIR 2009 and NIR 2010 for the emission trends 1990-2007

Gas	Trend (absolute)		
CO_2-eq (Gg)	**NIR 2009**	**NIR 2010**	***Difference***
CO_2 emissions including net CO_2 from LULUCF	-2881.75	-4421.04	*1539.29*
CO_2 emissions excluding net CO_2 from LULUCF	423.62	411.87	*11.75*
CH_4	-80.99	-85.38	*4.39*
N_2O	-446.65	-417.48	*-29.17*
HFCs	430.68	0.00	*430.68*
PFCs	0.00	0.00	*0.00*
SF6	0.00	5.48	*-5.48*
Total (including LULUCF)	**-3909.86**	**-5424.32**	***1514.46***
Total (excluding LULUCF)	**-604.49**	**-591.41**	***-13.08***

Table 9.2-2: Differences between NIR 2009 and NIR 2010 for the emission trends 1990-2008 (cont)

Gas	Trend (percent)		
CO_2-eq (Gg)	**NIR 2009**	**NIR 2010**	***Difference***
CO_2 emissions including net CO_2 from LULUCF	-1.89	6.20	*-8.10*
CO_2 emissions excluding net CO_2 from LULUCF	7.62	1.77	*5.85*
CH_4	1.83	-1.97	*3.81*
N_2O	-8.86	-11.42	*2.56*
HFCs	100.00	100.00	*0.00*
PFCs	-100.00	-100.00	*0.00*
SF6	51.58	52.03	*-0.46*
Total (including LULUCF)	**-4.07**	**1.15**	***-5.22***
Total (excluding LULUCF)	**3.22**	**-1.44**	***4.66***

9.3. 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 1990-2008, in 2008 Resubmission of Croatia's 2008 Inventory Submission, in 2009 for period 1990-2007 and this latest submission in April 2010.

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[12]. 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.

[12] 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

Short-term goals (< 1 years)

Generally, 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.

Long-term goals (> 1 years)

The extensive use of plant-specific data which will be collected in the newly established Register of Environmental Pollution is highly recommended ("bottom up" approach). In addition, usage of more source-specific QA/QC procedures will improve the quality of GHG inventory in Energy sector.

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 Manual. 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 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.

For implementation of rigorous source-specific evaluations approach (Tier 3) is necessary additional technical and financial resources.

INDUSTRIAL PROCESSES AND SOLVENT AND OTHER PRODUCT USE

Short-term goals (< 1 years)

Uncertainty of emission estimation is mainly caused by implementation of default IPCC emission factors. Consequently, wider use of well documented country-specific (technology-specific and plant-specific) emission factors, in sectors Industrial Processes and Solvent and Other Product Use, is an important short-term goal. The use of country-specific EFs, where available, as a way to minimize uncertainty, is recommended.

Short-term goals are also improvements of halocarbons and SF_6 emission estimations. According to requirement of Regulation on the Greenhouse Gases Emissions Monitoring in the

Republic of Croatia (Official Gazette No. 1/07) each sources of HFCs and SF_6 emissions should report required activity data for more accurate emissions estimation (Tier 2 method).

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.

Long-term goals (> 1 years)

As a small country with a small number of plants and good-quality production statistics, Croatia has often adopted higher-tier methodologies for Industrial Processes, based on plant-level information. Croatia considers 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.

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. In line with the latter, the inventory team finds preparation of the CRONFI (Croatian National Forest Inventory) as a significant activity that will in the future enable and facilitate emission/removal calculation from LULUCF with more detailed and more accurate data. Since the CRONFI was not finalized and the data/information was not available within the time scope for NIR preparation, further improvements are expected in the next NIR.

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.

By-law on Cadastre of Emission to Environment (Official Gazette No. 36/96) and The Waste Law (Official Gazette No. 178/04, 111/06) define administration commitments of manufacturers and all entities which contributed in waste management. 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.

By-law on Conditions for Waste Treatment (Official Gazette No. 123/97, 112/01) as well as By-low on Waste Management (Official Gazette No. 23/07) defines priority for improvement and organization of disposal sites and waste disposal on managed disposal sites.

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.

In order to accurate calculation of N_2O emissions from Human Sewage, Croatia planned to analyze the influence of tourism on the population influx due to summer months, as well as fact that nearly 25 percent of the Croatian population lives close to the sea, which has influence on the emission factor.

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.

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% 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 approches:

- excluding LULUCF
- including LULUCF

Following the *Good Practice Guidelines*, Croatia undertook a key category analysis using Tier 1 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. Additionaly, other sources of direct greenhouse gas emissions not listed in above mentioned guidances were added to the list, e.g. CO_2 Emissions from Natural Gas Scrubbing, CO_2 Emissions from Solvent and Other Product Use, CO_2 Emissions from Non energy-use in Industrial Processes reported under 2.G Other non-specified NEU in CRF Reporter.

Table A1-1: 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	
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	
Mobile 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	

Table A1-1: Categories Assessed in Key Category Analysis (cont.)

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	
CO_2 Emissions from Non energy-use in Industrial Processes	CO_2	
SOLVENT AND OTHER PRODUCT USE	CO_2	
AGRICULTURE SECTOR		
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	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	
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 2005 in CRF tables is the Excel file HRV-2007-2005-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*.

A1.2. TABLES 7.A1-7.A3 OF THE IPCC GOOD PRACTICE GUIDANCE

Table A1-2: 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 (%)
CO_2 Emissions from Stationary Combustion - Oil	CO_2	8497.04	0.270	27%
CO_2 Emissions from Stationary Combustion - Gas	CO_2	4062.92	0.129	40%
Mobile Combustion - Road Vehicles	CO_2	3559.96	0.113	51%
CO_2 Emissions from Stationary Combustion - Coal	CO_2	2780.45	0.089	60%
Direct N_2O Emissions from Agricultural Soils	N_2O	1298.53	0.041	64%
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	1235.80	0.039	68%
Fugitive Emissions from Oil and Gas Operations	CH_4	1201.18	0.038	72%
CO_2 Emissions from Cement Production	CO_2	1085.79	0.035	76%
PFC Emissions from Aluminium production	PFC	936.56	0.030	78%
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	932.49	0.030	81%
CO_2 Emissions from Ammonia Production	CO_2	870.99	0.028	84%
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.19	0.027	87%
Nitric Acid Production	N_2O	804.08	0.026	89%
CO_2 Emissions from Natural Gas Scrubbing*	CO_2	415.95	0.013	91%
N_2O Emissions from Manure Management	N_2O	380.04	0.012	92%
Emissions from Waste Water Handling	CH_4	278.73	0.009	93%
N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.13	0.008	94%
CH_4 Emissions from Manure Management	CH_4	228.05	0.007	94%
Solid Waste Disposal Sites	CH_4	221.21	0.007	95%
Fuel Combustion - Stationary Sources	CH_4	167.89	0.005	96%
CO_2 Emissions from Lime Production	CO_2	160.63	0.005	96%
Mobile Combustion: Aircraft	CO_2	154.72	0.005	97%
Mobile Combustion: Railways	CO_2	138.14	0.004	97%
Mobile Combustion: Water-borne Navigation	CO_2	132.98	0.004	98%
CO_2 Emissions from Ferroalloys Production	CO_2	118.84	0.004	98%
Aluminium Production	CO_2	111.37	0.004	98%
Total Solvent and Other Product Use	CO_2	96.23	0.003	99%
Emissions from Waste Water Handling	N_2O	90.24	0.003	99%
Fuel Combustion - Stationary Sources	N_2O	62.14	0.002	99%
CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.49	0.002	99%
Mobile Combustion - Road Vehicles	N_2O	50.57	0.002	99%
Fugitive Emissions from Coal Mining and Handling	CH_4	48.76	0.002	100%
Mobile Combustion - Road Vehicles	CH_4	42.63	0.001	100%
Total Solvent and Other Product Use	N_2O	34.72	0.001	100%
CO_2 Emissions from Soda Ash Production and Use	CO_2	25.74	0.001	100%
Production of Chemicals	CH_4	16.45	0.001	100%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	11.01	0.000	100%
CO_2 Emissions from Iron and Steel Production	CO_2	5.46	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.04	0.000	100%
Mobile Combustion: Aircraft	N_2O	1.36	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.30	0.000	100%
Mobile Combustion: Railways	N_2O	0.39	0.000	100%
Mobile Combustion: Water-borne Navigation	N_2O	0.34	0.000	100%
Mobile Combustion: Railways	CH_4	0.21	0.000	100%
Mobile Combustion: Water-borne Navigation	CH_4	0.19	0.000	100%
Emissions from Waste Incineration	CO_2	0.04	0.000	100%
Mobile Combustion: Aircraft	CH_4	0.02	0.000	100%
Other non-specified NEU	CO_2	0.00	0.000	100%
TOTAL		**31,415.981**		

Table A1-3: Key categories analysis – Level Assessment - Tier 1(Including 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 (%)**
CO_2 Emissions from Stationary Combustion - Oil	CO_2	8497.044	0.239	24%
Forest land remaining forest land	CO_2	4184.932	0.118	36%
CO_2 Emissions from Stationary Combustion - Gas	CO_2	4062.918	0.114	47%
Mobile Combustion - Road Vehicles	CO_2	3559.958	0.100	57%
CO_2 Emissions from Stationary Combustion - Coal	CO_2	2780.447	0.078	65%
Direct N_2O Emissions from Agricultural Soils	N_2O	1298.533	0.036	68%
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	1235.797	0.035	72%
Fugitive Emissions from Oil and Gas Operations	CH_4	1201.180	0.034	75%
CO_2 Emissions from Cement Production	CO_2	1085.790	0.030	78%
PFC Emissions from Aluminium production	PFC	936.564	0.026	81%
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	932.495	0.026	84%
CO_2 Emissions from Ammonia Production	CO_2	870.990	0.024	86%
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.186	0.024	88%
Nitric Acid Production	N_2O	804.078	0.023	91%
CO_2 Emissions from Natural Gas Scrubbing*	CO_2	415.949	0.012	92%
N_2O Emissions from Manure Management	N_2O	380.038	0.011	93%
Emissions from Waste Water Handling	CH_4	278.732	0.008	94%
N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.130	0.007	94%
CH_4 Emissions from Manure Management	CH_4	228.053	0.006	95%
Solid Waste Disposal Sites	CH_4	221.208	0.006	96%
Fuel Combustion - Stationary Sources	CH_4	167.887	0.005	96%
CO_2 Emissions from Lime Production	CO_2	160.629	0.005	97%
Mobile Combustion: Aircraft	CO_2	154.724	0.004	97%
Mobile Combustion: Railways	CO_2	138.142	0.004	97%
Mobile Combustion: Water-borne Navigation	CO_2	132.980	0.004	98%
CO_2 Emissions from Ferroalloys Production	CO_2	118.836	0.003	98%
Aluminium Production	CO_2	111.372	0.003	98%
Total Solvent and Other Product Use	CO_2	96.229	0.003	99%
Emissions from Waste Water Handling	N_2O	90.235	0.003	99%
Fuel Combustion - Stationary Sources	N_2O	62.143	0.002	99%
CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.487	0.001	99%
Mobile Combustion - Road Vehicles	N_2O	50.567	0.001	99%
Fugitive Emissions from Coal Mining and Handling	CH_4	48.757	0.001	100%
Mobile Combustion - Road Vehicles	CH_4	42.633	0.001	100%
Total Solvent and Other Product Use	N_2O	34.720	0.001	100%
CO_2 Emissions from Soda Ash Production and Use	CO_2	25.740	0.001	100%
Production of Other Chemicals	CH_4	16.450	0.000	100%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	11.013	0.000	100%
CO_2 Emissions from Iron and Steel Production	CO_2	5.457	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.038	0.000	100%
Mobile Combustion: Aircraft	N_2O	1.355	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.299	0.000	100%
Mobile Combustion: Railways	N_2O	0.392	0.000	100%
Mobile Combustion: Water-borne Navigation	N_2O	0.337	0.000	100%
Mobile Combustion: Railways	CH_4	0.214	0.000	100%
Mobile Combustion: Water-borne Navigation	CH_4	0.190	0.000	100%
Emissions from Waste Incineration	CO_2	0.043	0.000	100%
Mobile Combustion: Aircraft	CH_4	0.023	0.000	100%
Forest land remaining forest land	CH_4	0.011	0.000	100%
Forest land remaining forest land	N_2O	0.003	0.000	100%
Other non-specified NEU	CO_2	0.00	0.000	100%
TOTAL		**35,600.927**		

Table A1-4: Key categories analysis – Level Assessment - Tier 1(Excluding LULUCF)-2008

Tier 1 Analysis - Level Assessment – Excluding LULUCF						
IPCC Source Categories	Direct GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Current Year (2007) Estimate (Gg eq-CO_2)	Level Assessment	Cumulative Total (%)
Mobile Combustion - Road Vehicles	CO_2	3559.96	5813.63	0.188	19%
CO_2 Emissions from Stationary Combustion - Oil	CO_2	8497.04	5480.72	0.177	36%
CO_2 Emissions from Stationary Combustion - Gas	CO_2	4062.92	4909.89	0.159	52%
CO_2 Emissions from Stationary Combustion - Coal	CO_2	2780.45	2728.85	0.088	61%
CO_2 Emissions from Cement Production	CO_2	1085.79	1526.87	0.049	66%
Fugitive Emissions from Oil and Gas Operations	CH_4	1201.18	1526.58	0.049	71%
Direct N_2O Emissions from Agricultural Soils	N_2O	1298.53	1253.53	0.040	75%
CO_2 Emissions from Ammonia Production	CO_2	870.99	942.51	0.030	78%
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	932.49	799.70	0.026	81%
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.19	783.60	0.025	83%
CH_4 Emissions from Enteric Fermentation in Domestic	CH_4	1235.80	767.96	0.025	86%
Nitric Acid Production	N_2O	804.08	756.86	0.024	88%
CO_2 Emissions from Natural Gas Scrubbing*	CO_2	415.95	666.00	0.022	90%
Solid Waste Disposal Sites	CH_4	221.21	655.00	0.021	92%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	11.01	601.73	0.019	94%
CO_2 Emissions from Lime Production	CO_2	160.63	251.36	0.008	95%
N_2O Emissions from Manure Management	N_2O	380.04	209.80	0.007	96%
N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.13	174.01	0.006	96%
Emissions from Waste Water Handling	CH_4	278.73	166.09	0.005	97%
CH_4 Emissions from Manure Management	CH_4	228.05	144.24	0.005	97%
Mobile Combustion: Water-borne Navigation	CO_2	132.98	130.83	0.004	98%
Emissions from Waste Water Handling	N_2O	90.24	108.16	0.003	98%
Mobile Combustion: Railways	CO_2	138.14	101.16	0.003	99%
Mobile Combustion: Aircraft	CO_2	154.72	88.23	0.003	99%
Fuel Combustion - Stationary Sources	CH_4	167.89	87.33	0.003	99%
Mobile Combustion - Road Vehicles	N_2O	50.57	86.02	0.003	99%
Total Solvent and Other Product Use	CO_2	96.23	46.81	0.002	100%
Fuel Combustion - Stationary Sources	N_2O	62.14	44.68	0.001	100%
Total Solvent and Other Product Use	N_2O	34.72	34.72	0.001	100%
CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.49	21.49	0.001	100%
Mobile Combustion - Road Vehicles	CH_4	42.63	20.27	0.001	100%
CO_2 Emissions from Soda Ash Production and Use	CO_2	25.74	13.42	0.000	100%
CO_2 Emissions from Iron and Steel Production	CO_2	5.46	8.61	0.000	100%
Production of Chemicals	CH_4	16.45	5.49	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.04	1.92	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.30	1.18	0.000	100%
Mobile Combustion: Aircraft	N_2O	1.36	0.77	0.000	100%
Mobile Combustion: Water-borne Navigation	N_2O	0.34	0.33	0.000	100%
Mobile Combustion: Railways	N_2O	0.39	0.26	0.000	100%
Emissions from Waste Incineration	CO_2	0.04	0.25	0.000	100%
Mobile Combustion: Water-borne Navigation	CH_4	0.19	0.19	0.000	100%
Mobile Combustion: Railways	CH_4	0.21	0.14	0.000	100%
Mobile Combustion: Aircraft	CH_4	0.02	0.01	0.000	100%
CO_2 Emissions from Ferroalloys Production	CO_2	118.84	0.00	0.000	100%
Aluminium Production	CO_2	111.37	0.00	0.000	100%
Other non-specified NEU	CO_2	0.00	0.00	0.000	100%
Fugitive Emissions from Coal Mining and Handling	CH_4	48.76	0.00	0.000	100%
PFC Emissions from Aluminium production	PFC	936.56	0.00	0.000	100%
TOTAL		**31,415.981**	**30,961.208**		

Table A1-5: Key categories analysis – Level Assessment - Tier 1 (Including LULUCF)-2008

Tier 1 Analysis - Level Assessment – Including LULUCF					
IPCC Source Categories	Direct GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Current Year (2007) Estimate (Gg eq-CO_2)	Level Assessment	Cumulative Total (%)
Forest land remaining forest land	CO_2	4184.932	6478.715	0.173	17%
Mobile Combustion - Road Vehicles	CO_2	3559.958	5813.629	0.155	33%
CO2 Emissions from Stationary Combustion - Oil	CO_2	8497.044	5480.722	0.146	47%
CO2 Emissions from Stationary Combustion - Gas	CO_2	4062.918	4909.893	0.131	61%
CO2 Emissions from Stationary Combustion - Coal	CO_2	2780.447	2728.851	0.073	68%
CO2 Emissions from Cement Production	CO_2	1085.790	1526.867	0.041	72%
Fugitive Emissions from Oil and Gas Operations	CH_4	1201.180	1526.584	0.041	76%
Direct N2O Emissions from Agricultural Soils	N_2O	1298.533	1253.532	0.033	79%
CO2 Emissions from Ammonia Production	CO_2	870.990	942.508	0.025	82%
Indirect N2O Emissions from Nitrogen Used in Agriculture	N_2O	932.495	799.705	0.021	84%
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.186	783.600	0.021	86%
CH4 Emissions from Enteric Fermentation in Domestic	CH_4	1235.797	767.960	0.021	88%
Nitric Acid Production	N_2O	804.078	756.863	0.020	90%
CO2 Emissions from Natural Gas Scrubbing*	CO_2	415.949	666.000	0.018	92%
Solid Waste Disposal Sites	CH_4	221.208	654.998	0.017	94%
HFC Emissions from Consumption of HFCs, PFCs and SF6	HFC	11.013	601.729	0.016	95%
CO_2 Emissions from Lime Production	CO_2	160.629	251.362	0.007	96%
N_2O Emissions from Manure Management	N_2O	380.038	209.799	0.006	97%
N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.130	174.006	0.005	97%
Emissions from Waste Water Handling	CH_4	278.732	166.095	0.004	97%
CH_4 Emissions from Manure Management	CH_4	228.053	144.243	0.004	98%
Mobile Combustion: Water-borne Navigation	CO_2	132.980	130.828	0.003	98%
Emissions from Waste Water Handling	N_2O	90.235	108.159	0.003	98%
Mobile Combustion: Railways	CO_2	138.142	101.156	0.003	99%
Mobile Combustion: Aircraft	CO_2	154.724	88.228	0.002	99%
Fuel Combustion - Stationary Sources	CH_4	167.887	87.327	0.002	99%
Mobile Combustion - Road Vehicles	N_2O	50.567	86.025	0.002	99%
Total Solvent and Other Product Use	CO_2	96.229	46.813	0.001	100%
Fuel Combustion - Stationary Sources	N_2O	62.143	44.676	0.001	100%
Total Solvent and Other Product Use	N_2O	34.720	34.720	0.001	100%
CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.487	21.490	0.001	100%
Mobile Combustion - Road Vehicles	CH_4	42.633	20.271	0.001	100%
CO_2 Emissions from Soda Ash Production and Use	CO_2	25.740	13.416	0.000	100%
CO_2 Emissions from Iron and Steel Production	CO_2	5.457	8.613	0.000	100%
Production of Other Chemicals	CH_4	16.450	5.492	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.038	1.916	0.000	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.299	1.177	0.000	100%
Mobile Combustion: Aircraft	N_2O	1.355	0.774	0.000	100%
Mobile Combustion: Water-borne Navigation	N_2O	0.337	0.331	0.000	100%
Mobile Combustion: Railways	N_2O	0.392	0.257	0.000	100%
Emissions from Waste Incineration	CO_2	0.043	0.250	0.000	100%
Mobile Combustion: Water-borne Navigation	CH_4	0.190	0.187	0.000	100%
Mobile Combustion: Railways	CH_4	0.214	0.145	0.000	100%
Forest land remaining forest land	CH_4	0.011	0.014	0.000	100%
Mobile Combustion: Aircraft	CH_4	0.023	0.013	0.000	100%
Forest land remaining forest land	N_2O	0.003	0.003	0.000	100%
CO_2 Emissions from Ferroalloys Production	CO_2	118.836	0.000	0.000	100%
Aluminium Production	CO_2	111.372	0.000	0.000	100%
Other non-specified NEU	CO_2	0.000	0.000	0.000	100%
Fugitive Emissions from Coal Mining and Handling	CH_4	48.757	0.000	0.000	100%
PFC Emissions from Aluminium production	PFC	936.56	0.000	0.000	100%
TOTAL		**35,600.927**	**37,439.941**		

Table A1-6: Key categories analysis – Trend Assessment - Tier 1 (Excluding LULUCF)-2008

Tier 1 Analysis - Trend Assessment – Excluding LULUCF							
IPCC Source Categories	**Dir. GHG**	**Base Year (1990) Estimate (Gg eq-CO_2)**	**Last Year (2006) Estimate (Gg eq-CO_2)**	**Trend Assess**	**% Contrib. on to trend**	**Cumulative Total of Column F**
CO_2 Emissions from Stationary Combustion - Oil	CO_2	8497.04	5480.72	0.095	26.16%	26%
Mobile Combustion - Road Vehicles	CO_2	3559.96	5813.63	0.076	20.84%	47%
PFC Emissions from Aluminium production	PFC	936.56	0.00	0.030	8.34%	55%
CO_2 Emissions from Stationary Combustion - Gas	CO_2	4062.92	4909.89	0.030	8.19%	64%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	11.01	601.73	0.019	5.34%	69%
CO_2 Emissions from Cement Production	CO_2	1085.79	1526.87	0.015	4.13%	73%
CH_4 Emissions from Enteric Fermentation in Domestic	CH_4	1235.80	767.96	0.015	4.07%	77%
Solid Waste Disposal Sites	CH_4	221.21	655.00	0.014	3.95%	81%
Fugitive Emissions from Oil and Gas Operations	CH_4	1201.18	1526.58	0.011	3.10%	84%
CO_2 Emissions from Natural Gas Scrubbing*	CO_2	415.95	666.00	0.008	2.31%	86%
N_2O Emissions from Manure Management	N_2O	380.04	209.80	0.005	1.49%	88%
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	932.49	799.70	0.004	1.08%	89%
CO_2 Emissions from Ferroalloys Production	CO_2	118.84	0.00	0.004	1.06%	90%
Aluminium Production	CO_2	111.37	0.00	0.004	0.99%	91%
Emissions from Waste Water Handling	CH_4	278.73	166.09	0.004	0.98%	92%
CO_2 Emissions from Lime Production	CO_2	160.63	251.36	0.003	0.84%	93%
CO_2 Emissions from Ammonia Production	CO_2	870.99	942.51	0.003	0.76%	94%
N_2O Emissions from Pasture, Range and Paddock	N_2O	261.13	174.01	0.003	0.75%	94%
CH_4 Emissions from Manure Management	CH_4	228.05	144.24	0.003	0.73%	95%
Fuel Combustion - Stationary Sources	CH_4	167.89	87.33	0.003	0.71%	96%
Mobile Combustion: Aircraft	CO_2	154.72	88.23	0.002	0.58%	96%
Fugitive Emissions from Coal Mining and Handling	CH_4	48.76	0.00	0.002	0.43%	97%
Total Solvent and Other Product Use	CO_2	96.23	46.81	0.002	0.43%	97%
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.19	783.60	0.001	0.39%	98%
Mobile Combustion - Road Vehicles	N_2O	50.57	86.02	0.001	0.33%	98%
Nitric Acid Production	N_2O	804.08	756.86	0.001	0.32%	98%
Mobile Combustion: Railways	CO_2	138.14	101.16	0.0011	0.32%	99%
CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.49	21.49	0.0010	0.26%	99%
Direct N_2O Emissions from Agricultural Soils	N_2O	1298.53	1253.53	0.0009	0.24%	99%
Mobile Combustion - Road Vehicles	CH_4	42.63	20.27	0.0007	0.20%	99%
Emissions from Waste Water Handling	N_2O	90.24	108.16	0.0006	0.17%	99%
Fuel Combustion - Stationary Sources	N_2O	62.14	44.68	0.0005	0.15%	100%
CO_2 Emissions from Soda Ash Production and Use	CO_2	25.74	13.42	0.0004	0.11%	100%
CO_2 Emissions from Stationary Combustion - Coal	CO_2	2780.45	2728.85	0.0004	0.10%	100%
Production of Chemicals	CH_4	16.45	5.49	0.0003	0.10%	100%
CO_2 Emissions from Iron and Steel Production	CO_2	5.46	8.61	0.0001	0.03%	100%
Mobile Combustion: Aircraft	N_2O	1.36	0.77	0.0000	0.01%	100%
Total Solvent and Other Product Use	N_2O	34.72	34.72	0.0000	0.00%	100%
Mobile Combustion: Water-borne Navigation	CO_2	132.98	130.83	0.0000	0.00%	100%
Emissions from Waste Incineration	CO_2	0.04	0.25	0.0000	0.00%	100%
Mobile Combustion: Railways	N_2O	0.39	0.26	0.0000	0.00%	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.30	1.18	0.0000	0.00%	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.04	1.92	0.0000	0.00%	100%
Mobile Combustion: Railways	CH_4	0.21	0.00	0.0000	0.00%	100%
Mobile Combustion: Aircraft	CH_4	0.02	0.00	0.0000	0.00%	100%
Mobile Combustion: Water-borne Navigation	N_2O	0.34	0.00	0.0000	0.00%	100%
Mobile Combustion: Water-borne Navigation	CH_4	0.19	0.00	0.0000	0.00%	100%
Other non-specified NEU	CO_2	0	0	0.0000	0.00%	100%
TOTAL		**31,415.98**	**30,961.21**			

Table A1-7: Key categories analysis – Trend Assessment - Tier 1 (Including LULUCF)-2008

Tier 1 Analysis - Trend Assessment – Including LULUCF							
IPCC Source Categories	Dir. GHG	Base Year (1990) Estimate (Gg eq-CO_2)	Last Year (2007) Estimate (Gg eq-CO_2)	Trend Assess	% Contrib. on to trend	Cumulative Total of Column F
CO_2 Emissions from Stationary Combustion - Oil	CO_2	8497.044	5480.722	0.088	25.29%	25%
Forest land remaining forest land	CO_2	4184.932	6478.715	0.053	15.20%	40%
Mobile Combustion - Road Vehicles	CO_2	3559.958	5813.629	0.053	15.15%	56%
PFC Emissions from Aluminium production	PFC	936.564	0.000	0.025	7.21%	63%
CO_2 Emissions from Stationary Combustion - Gas	CO_2	4062.918	4909.893	0.016	4.66%	68%
HFC Emissions from Consumption of HFCs, PFCs and	HFC	11.013	601.729	0.015	4.32%	72%
CH_4 Emissions from Enteric Fermentation in Domestic	CH_4	1235.797	767.960	0.014	3.89%	76%
Solid Waste Disposal Sites	CH_4	221.208	654.998	0.011	3.09%	79%
CO_2 Emissions from Cement Production	CO_2	1085.790	1526.867	0.010	2.82%	82%
Fugitive Emissions from Oil and Gas Operations	CH_4	1201.180	1526.584	0.007	1.93%	84%
CO_2 Emissions from Natural Gas Scrubbing*	CO_2	415.949	666.000	0.006	1.67%	85%
CO_2 Emissions from Stationary Combustion - Coal	CO_2	2780.447	2728.851	0.005	1.43%	87%
N_2O Emissions from Manure Management	N_2O	380.038	209.799	0.005	1.39%	88%
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	932.495	799.705	0.005	1.32%	89%
Emissions from Waste Water Handling	CH_4	278.732	166.095	0.003	0.93%	90%
CO_2 Emissions from Ferroalloys Production	CO_2	118.836	0.000	0.003	0.91%	91%
Aluminium Production	CO_2	111.372	0.000	0.003	0.86%	92%
Direct N_2O Emissions from Agricultural Soils	N_2O	1298.533	1253.532	0.003	0.82%	93%
N_2O Emissions from Pasture, Range and Paddock	N_2O	261.130	174.006	0.003	0.74%	94%
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.186	783.600	0.003	0.72%	94%
CH_4 Emissions from Manure Management	CH_4	228.053	144.243	0.002	0.70%	95%
Fuel Combustion - Stationary Sources	CH_4	167.887	87.327	0.002	0.65%	96%
Nitric Acid Production	N_2O	804.078	756.863	0.002	0.65%	96%
CO_2 Emissions from Lime Production	CO_2	160.629	251.362	0.002	0.60%	97%
Mobile Combustion: Aircraft	CO_2	154.724	88.228	0.002	0.55%	98%
Total Solvent and Other Product Use	CO_2	96.229	46.813	0.0014	0.40%	98%
Fugitive Emissions from Coal Mining and Handling	CH_4	48.757	0.000	0.0013	0.38%	98%
Mobile Combustion: Railways	CO_2	138.142	101.156	0.0011	0.32%	99%
Mobile Combustion - Road Vehicles	N_2O	50.567	86.025	0.0008	0.24%	99%
CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.487	21.490	0.0008	0.24%	99%
CO_2 Emissions from Ammonia Production	CO_2	870.990	942.508	0.0007	0.19%	99%
Mobile Combustion - Road Vehicles	CH_4	42.633	20.271	0.0006	0.18%	99%
Fuel Combustion - Stationary Sources	N_2O	62.143	44.676	0.0005	0.15%	100%
CO_2 Emissions from Soda Ash Production and Use	CO_2	25.740	13.416	0.0003	0.10%	100%
Emissions from Waste Water Handling	N_2O	90.235	108.159	0.0003	0.10%	100%
Production of Other Chemicals	CH_4	16.450	5.492	0.0003	0.09%	100%
Mobile Combustion: Water-borne Navigation	CO_2	132.980	130.828	0.0002	0.07%	100%
CO_2 Emissions from Iron and Steel Production	CO_2	5.457	8.613	0.0000	0.02%	100%
Total Solvent and Other Product Use	N_2O	34.720	34.720	0.0000	0.01%	100%
Mobile Combustion: Aircraft	N_2O	1.355	0.774	0.0000	0.00%	100%
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.038	1.916	0.0000	0.00%	100%
Emissions from Waste Incineration	CO_2	0.043	0.250	0.0000	0.00%	100%
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.299	1.177	0.0000	0.00%	100%
Mobile Combustion: Railways	N_2O	0.392	0.257	0.0000	0.00%	100%
Mobile Combustion: Railways	CH_4	0.214	0.145	0.0000	0.00%	100%
Mobile Combustion: Water-borne Navigation	N_2O	0.337	0.331	0.0000	0.00%	100%
Mobile Combustion: Water-borne Navigation	CH_4	0.190	0.000	0.0000	0.00%	100%
Mobile Combustion: Aircraft	CH_4	0.023	0.000	0.0000	0.00%	100%
Forest land remaining forest land	CH_4	0.01	0.000	0.0000	0.00%	100%
Forest land remaining forest land	N_2O	0.00	0.000	0.0000	0.00%	100%
Other non-specified NEU	CO_2	0.00	0.000	0.0000	0.00%	100%
TOTAL		**35,600.93**	**37,439.941**			

Table A1-8: Key categories for Croatia – summary (Excluding LULUCF)-1990

Tier 1 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	Level
CO_2 Emissions from Stationary Combustion: Oil	CO_2	Yes	Level
CO_2 Emissions from Stationary Combustion: Gas	CO_2	Yes	Level
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	Level
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	Level
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	No	
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	Level
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	Level
INDUSTRIAL SECTOR			
CO_2 Emissions from Cement Production	CO_2	Yes	Level
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	Level
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	Level
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	No	
PFC Emissions from Aluminium production	PFC	Yes	Level
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	Level
CH_4 Emissions from Manure Management	CH_4	Yes	Level
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	Level
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Level
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	Level
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	Level
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	Level
CH_4 Emissions from Waste Water Handling	CH_4	Yes	Level
N_2O Emissions from Human Sewage	N_2O	No	

Table A1-9: Key categories for Croatia – summary (Including LULUCF)-1990

Tier 1 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	Level
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	Level
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	Level
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	Level
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	Level
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	No	
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	Level
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	Level
SOLVENT AND OTHER PRODUCT USE			
CO_2 Emissions from solvent and other product use	CO_2	Yes	Level
N_2O Emissions from solvent and other product use	N_2O	No	
INDUSTRIAL SECTOR		No	
CO_2 Emissions from Cement Production	CO_2	No	
CO_2 Emissions from Lime Production	CO_2	Yes	Level
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	No	
CO_2 Emissions from Iron and Steel Production	CO_2	No	
CO_2 Emissions from Ferroalloys Production	CO_2	Yes	Level
CO_2 Emissions from Aluminium Production	CO_2	No	
CH_4 Emissions from Production of Other Chemicals	CH_4	Yes	Level
N_2O Emissions from Nitric Acid Production	N_2O	No	
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC		
PFC Emissions from Aluminium production	PFC	No	
CO_2 Emissions from Other non-specified NEU	CO_2	No	
AGRICULTURE SECTOR			
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	Level
CH_4 Emissions from Manure Management	CH_4	Yes	Level
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	Level
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Level
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	Level
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	Level
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	Level
CH_4 Emissions from Forest land remaining forest land	CH_4	No	
N_2O Emissions from Forest land remaining forest land	N_2O	No	
WASTE SECTOR			
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	No	
CH_4 Emissions from Waste Water Handling N_2O Emissions from Human Sewage	CH_4 N_2O	Yes No	Level

Table A1-10: Key categories for Croatia – summary (Excluding LULUCF)-2008

Tier 1 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	Level
CO_2 Emissions from Stationary Combustion: Oil	CO_2	Yes	Level, Trend
CO_2 Emissions from Stationary Combustion: Gas	CO_2	Yes	Level, Trend
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	Level, Trend
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	Level
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	No	
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	Level, Trend
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	Level, Trend
INDUSTRIAL SECTOR			
CO_2 Emissions from Cement Production	CO_2	Yes	Level, Trend
CO_2 Emissions from Lime Production	CO_2	Yes	Level, Trend
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	Level, Trend
CO_2 Emissions from Iron and Steel Production	CO_2	No	
CO_2 Emissions from Ferroalloys Production	CO_2	Yes	Trend
CO_2 Emissions from Aluminium Production	CO_2	Yes	Trend
CH_4 Emissions from Production of Other Chemicals	CH_4	No	
N_2O Emissions from Nitric Acid Production	N_2O	Yes	Level
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	Yes	Level, Trend
PFC Emissions from Aluminium production	PFC	Yes	Trend
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	Level, Trend
CH_4 Emissions from Manure Management	CH_4	Yes	Level, Trend
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	Trend
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Level
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	Trend
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	Level, Trend
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	Level, Trend
CH_4 Emissions from Waste Water Handling	CH_4	Yes	Trend
N_2O Emissions from Human Sewage	N_2O	No	

Table A1-11: Key categories for Croatia – summary (Including LULUCF)-2008

Tier 1 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	Level, Trend
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	Level, Trend
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	Level, Trend
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	Level, Trend
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	Level, Trend
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	No	
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	Level, Trend
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Yes	Level, Trend
INDUSTRIAL SECTOR			
CO_2 Emissions from Cement Production	CO_2	Yes	Level, Trend
CO_2 Emissions from Lime Production	CO_2	Yes	Trend
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	Level, Trend
CO_2 Emissions from Iron and Steel Production	CO_2	No	
CO_2 Emissions from Ferroalloys Production	CO_2	Yes	Trend
CO_2 Emissions from Aluminium Production	CO_2	Yes	Trend
CH_4 Emissions from Production of Other Chemicals	CH_4	No	
N_2O Emissions from Nitric Acid Production	N_2O	Yes	Level
HFC Emissions from Consumption of HFCs, PFCs, SF_6	HFC	Yes	Level, Trend
PFC Emissions from Aluminium production	PFC	Yes	Trend
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	Level, Trend
CH_4 Emissions from Manure Management	CH_4	Yes	Trend
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No	
N_2O Emissions from Manure Management	N_2O	Yes	Trend
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Level
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	Trend
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	Level, Trend
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	Level
CH_4 Emissions from Forest land remaining forest land	CH_4	No	
N_2O Emissions from Forest land remaining forest land	N_2O	No	
WASTE SECTOR			
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	Level, Trend
CH_4 Emissions from Waste Water Handling	CH_4	Yes	Trend
N_2O Emissions from Human Sewage	N_2O	No	

Table A1-12: 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	
		2007	2008	2007	2008
ENERGY SECTOR					
CO_2 Emissions from Stationary Combustion: Coal	CO_2	Yes	Yes	Yes	Yes/No*
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/*No
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	Yes	Yes/No*	Yes/No*
CO_2 Emissions from Ammonia Production	CO_2	Yes	Yes	Yes	Yes
N_2O Emissions from Nitric Acid Production	N_2O	Yes	Yes	Yes	No
CO_2 Emissions from Ferroalloys Production	CO_2	No	No	No	Yes
CO_2 Emissions from Aluminium Production	CO_2	No	No	No	Yes
HFC Emissions from Consumption of HFCs	HFC	Yes	Yes	No	Yes
PFC Emissions from Aluminium production	PFC	No	No	No	Yes
SOLVENT AND OTHER PRODUCT USE					
CO_2 Emissions from solvent and other product use	CO_2	No	No	No	No
AGRICULTURE SECTOR					
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	Yes	Yes	Yes
CH_4 Emissions from Manure Management	CH_4	No	Yes/No**	No	Yes
N_2O Emissions from Manure Management	N_2O	No/Yes*	No	No	Yes
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Yes	Yes	No
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*
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	No	Yes

*Not Key category for excluding LULUCF

**Not Key category for including LULUCF

Table A1-13: Table 7.A3 for 1990

Table 7.A3					
Tier 1 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	L-ex. LUL.	L-in. LUL.	
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	L-ex. LUL.	L-in. LUL.	
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	L-ex. LUL.	L-in. LUL.	
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	L-ex. LUL.	L-in. LUL.	
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			
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	Yes	L-ex. LUL.	L-in. LUL.	
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	No			
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	No			
Fugitive Emissions from Coal Mining and Handling	CH_4	No			
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L-ex. LUL.	L-in. LUL.	
CO2 Emissions from Natural Gas Scrubbing*	CO_2	Yes	L-ex. LUL.	L-in. LUL.	
TOTAL SOLVENT AND OTHER PRODUCTS USE	CO_2				
INDUSTRIAL SECTOR					
Emissions from Cement Production	CO_2	Yes	L-ex. LUL.	L-in. LUL.	
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	No		L-in. LUL.	
Emissions from Iron and Steel Production	CO_2	No			
Emissions from Ferroalloys Production	CO_2	Yes	L-ex. LUL.		
Emissions from Aluminium Production	CO_2	No			
Emissions from Production of Other Chemicals	CH_4	No			
Emissions from Nitric Acid Production	N_2O	Yes	L-ex. LUL.	L-in. LUL.	
Emissions from Consumption of HFCs, PFCs, SF_6	HFC	No			
Emissions from Aluminium production	PFC	Yes	L-ex. LUL.	L-in. LUL.	
Emissions from Other non-specified NEU	CO_2	No			
LULUCF					
Forest land remaining forest land	CO_2	No		L-in. LUL.	
Forest land remaining forest land	CH_4	No			
Forest land remaining forest land	N_2O	No			
AGRICULTURE SECTOR					
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L-ex. LUL.	L-in. LUL.	
CH_4 Emissions from Manure Management	CH_4	Yes	L-ex. LUL.	L-in. LUL.	
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	No			
N_2O Emissions from Manure Management	N_2O	Yes	L-ex. LUL.	L-in. LUL.	
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L-ex. LUL.	L-in. LUL.	
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	L-ex. LUL.	L-in. LUL.	
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L-ex. LUL.		
CH_4 and N_2O Emissions from Agricultural Residue Burning	N_2O	Yes	L-ex. LUL.		
WASTE SECTOR					
CH4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	L-ex. LUL.		
Emissions from Waste Water Handling	CH_4	Yes	L-ex. LUL.	L-in. LUL.	
Emissions from Waste Water Handling	N_2O	No			
Emissions from Waste Incineration	CO_2	No			
Emissions from Waste Incineration	N_2O	No			

L-ex. LUL. – Level excluding LULUCF
L-in. LUL. – Level including LULUCF

Table A1-14: Table 7.A3 for 2008

Table 7.A3							
Tier 1 Analysis - Source Analysis Summary (Croatian Inventory, 2008)							
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	L-ex. LUL.		L-in. LUL.	T-in. LUL.	
CO_2 Emissions from Stationary Combustion - Oil	CO_2	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
CO_2 Emissions from Stationary Combustion - Gas	CO_2	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
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	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
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					
Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	Yes	L-ex. LUL.		L-in. LUL.	T-in. LUL.	
Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	No					
Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	No					
Fugitive Emissions from Coal Mining and Handling	CH_4	No					
Fugitive Emissions from Oil and Gas Operations	CH_4	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
CO_2 Emissions from Natural Gas Scrubbing*	CO_2	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
TOTAL SOLVENT AND OTHER PROD. USE	CO_2						
INDUSTRIAL SECTOR							
Emissions from Cement Production	CO_2	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
Emissions from Lime Production	CO_2	Yes	L-ex. LUL.	T-ex. LUL.		T-in. LUL.	
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	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
Emissions from Iron and Steel Production	CO_2	No					
Emissions from Ferroalloys Production	CO_2	No		T-ex. LUL.		T-in. LUL.	
Emissions from Aluminium Production	CO_2	No		T-ex. LUL.		T-in. LUL.	
Emissions from Production of Other Chemicals	CH_4	No					
Emissions from Nitric Acid Production	N_2O	Yes	L-ex. LUL.		L-in. LUL.		
Emissions from Consumption of HFCs, PFCs, SF_6	HFC	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
Emissions from Aluminium production	PFC	No		T-ex. LUL.		T-in. LUL.	
Emissions from Other non-specified NEU	CO_2	No					
LULUCF							
Forest land remaining forest land	CO_2	Yes			L-in. LUL.	T-in. LUL.	
Forest land remaining forest land	CH_4	No					
Forest land remaining forest land	N_2O	No					
AGRICULTURE SECTOR							
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
CH_4 Emissions from Manure Management	CH_4	Yes	L-ex. LUL.	T-ex. LUL.		T-in. LUL.	
CH_4 and N_2O Emissions from Agricultural Residue Burning	CH_4	Yes		T-ex. LUL.			
N_2O Emissions from Manure Management	N_2O	Yes		T-ex. LUL.		T-in. LUL.	
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	L-ex. LUL.		L-in. LUL.		
N_2O Emissions from Pasture Range and Paddock Manure	N_2O	Yes	L-ex. LUL.	T-ex. LUL.		T-in. LUL.	
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
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	L-ex. LUL.	T-ex. LUL.	L-in. LUL.	T-in. LUL.	
Emissions from Waste Water Handling	CH_4	Yes		T-ex. LUL.		T-in. LUL.	
Emissions from Waste Water Handling	N_2O	No					
Emissions from Waste Incineration	CO_2	No					
Emissions from Waste Incineration	N_2O	No					

L-ex. LUL. – Level excluding LULUCF T-ex. LUL. – Trend excluding LULUCF
L-in. LUL. – Level including LULUCF T-in. LUL. – Trend including LULUCF

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
Fuel consumption							
Hard coal (1000 t)	253.7	96.2	569.9	915.0	835.9	895.8	925.0
NCV for hard coal (MJ/kg)	25.1	25.7	26.2	24.2	24.6	24.5	24.5
Fuel oil (1000 t)	570.4	325.4	283.4	284.0	311.4	423.9	331.6
NCV for fuel oil (MJ/kg)	40.4	40.8	40.5	40.3	40.4	40.2	40.2
Extra light oil (1000 t)	0.7	2.6	7.5	3.0	1.0	1.4	1.2
NCV for ex. light oil (MJ/kg)	42.3	42.0	42.0	42.3	42.3	42.3	42.3
Natural gas (1000000 m^3)	194.6	114.5	155.7	48.2	128.4	296.8	166.4
NCV for nat. gas (MJ/m^3)	33.4	33.4	33.4	33.4	33.4	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
Emissions							
EF CO_2 – hard coal (t/TJ)	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
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
EF CO_2 – coke gas (t/TJ)	47.4						
CO_2 emission (Gg)	2739	1464	2577	3030	3113	3896	3435
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	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
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
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

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

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Fuel oil (1000 t)	117.7	336.2	108.6	162.0	156.1	93.8	124.9
NCV for fuel oil (MJ/kg)	40.5	40.5	40.7	40.7	38.4	40.2	40.2
Extra light oil (1000 t)	0.0	1.0	0.9	0.0	0.0	0.0	0.2
NCV for extra light oil (MJ/kg)	0.0	21.3	21.4	21.4	0.0	0.0	21.4
Natural gas (1000000 m^3)	312.7	103.3	357.7	479.0	458.8	550.6	541.9
NCV for natural gas (MJ/m^3)	33.3	33.4	33.4	33.4	33.6	33.3	33.3
Total fuel consumption (TJ)	15196	17170	16399	22567	21411	22124	23091
Emissions							
EF CO_2 – fuel oil (t/TJ)	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
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)	2739	1240	1005	1397	1322	1313	1393

Table A2-2: The GHG emissions from Public Cogeneration Plants (cont.)

	1990	1995	2000	2005	2006	2007	2008
EF CH_4 – fuel oil (kg/TJ)	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
EF CH_4 – nat. gas (kg/TJ)	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
EF N_2O – fuel oil (kg/TJ)	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
EF N_2O – nat. gas (kg/TJ)	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

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

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Fuel oil (1000 t)	0.0	38.8	37.0	39.0	33.4	36.9	20.8
NCV for fuel oil (MJ/kg)	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
NCV for light heating oil (MJ/kg)	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
NCV for natural gas (MJ/m^3)	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
Landfill Gas (1000000 m^3)						3.9	2.2
NCV for landfill gas (MJ/m^3)						17.0	17.0
Total fuel cunsumption (TJ)	0.0	4026.8	3359.8	3969.7	3384.2	4467.0	3109.7
Emissions							
EF CO_2 - fuel oil (t/TJ)	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
EF CO_2 - natural gas (t/TJ)	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
EF CO_2 - gas work gas (t/TJ)	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
CO_2 Emission (Gg)	0.0	278.2	216.2	260.0	220.3	282.9	195.0
EF CH_4 - fuel oil (kg/TJ)	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
EF CH_4 - natural gas (kg/TJ)	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
EF CH_4 - gas work gas (t/TJ)	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
CH_4 Emission (Mg)	0.0	10.1	6.1	7.8	6.5	7.8	5.3
EF N_2O - fuel oil (kg/TJ)	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
EF N_2O - natural gas (kg/TJ)	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
EF N_2O - gas work gas (t/TJ)	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
N_2O Emission (Mg)	0.0	1.8	1.0	1.4	1.1	1.3	0.8

The GHG emissions from thermal power plants and public cogeneration plants, for the whole period (1990-2008), 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 two years, on aggregated level. The GHG emissions on plant level, for the year 2008, are given in the Table A2-5.

Table A2-4: The GHG emissions from TPPs and PCPs (Tier 2), year 2008

	TE Plomin	TE Rijeka	TE Sisak	TE-TO Zagreb	EL-TO Zagreb	TE-TO Osijek	KTE Jertovec
Fuel consumption							
Hard coal (1000 t)	925.0						
NCV for hard coal (MJ/kg)	24.50						
Fuel oil (1000 t)		242.0	89.56	80.752	25.945	18.167	
NCV for fuel oil (MJ/kg)		40.2	40.2	40.2	40.2	40.2	
Extra light oil (1000 t)	0.842	0.2819		0.192			0.0386
NCV for ELLU (MJ/kg)	42.7	42.1		42.7			42.2
Natural gas (1000000 m^3)			151.3	344.6	148.6	48.658	15.088
NCV for nat. gas (MJ/m^3)			33.3	33.3	33.3	33.3	33.3
Total fuel consumption (TJ)	22698.5	9738.1	8644.2	14742.4	5996.0	2352.3	504.6
Emissions							
EF CO_2 – hard coal (t/TJ)	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
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)	2103.6	745.8	557.3	890.5	356.4	146.5	28.2
EF CH_4 – hard coal (kg/TJ)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
EF CH_4 – fuel oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – extra light oil (kg/TJ)	0.9	0.9	0.9	0.9	0.9	0.9	0.9
EF CH_4 – natural gas (kg/TJ)	0.1	0.1	0.1	5.2	4.7	1.6	6.0
CH_4 emission (Mg)	15.9	8.8	3.7	62.6	24.4	3.3	3.0
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)	36.3	2.9	1.6	2.1	0.8	0.4	0.1

Table A2-5: The GHG emissions from Petroleum refining

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Fuel oil (1000 t)	227.2	199.5	193.4	254.0	249.9	288.0	194.2
NCV for fuel oil (MJ/kg)	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
NCV for LPG (MJ/kg)	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
NCV for petroleum coke (MJ/kg)	33.6	29.3	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
NCV for refinery gas (MJ/kg)	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
NCV for natural gas (MJ/m^3)	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**
Emissions							
EF CO_2 – fuel oil (t/TJ)	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
EF CO_2 – petroleum coke (t/TJ)	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
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)	**900.6**	**716.5**	**726.3**	**1804.4**	**1665.1**	**1861.7**	**1437.3**
EF CH_4 – fuel oil (kg/TJ)	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
EF CH_4 – petroleum coke (kg/TJ)	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
EF CH_4 – natural gas (kg/TJ)	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**
EF N_2O – fuel oil (kg/TJ)	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
EF N_2O – petroleum coke (kg/TJ)	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
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)	**7.2**	**5.6**	**5.9**	**14.7**	**13.6**	**14.9**	**10.6**

Table A2-6: The GHG emissions from manufacturing of solid fuels and other energy industries

	1990	1995	2000	2005	2006	2007	2008
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
NCV for nat. gas (MJ/m^3)	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
Emissions							
EF CO_2 – LPG (t/TJ)	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
EF CO_2 – ex.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)	874.4	394.3	293.1	350.3	308.4	361.4	245.4
EF CH_4 – hard coal (kg/TJ)	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
EF CH_4 – ex.ligh oil (kg/TJ)	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
CH_4 emission (Mg)	16.0	7.2	5.8	6.7	5.7	6.5	4.4
EF N_2O – hard coal (kg/TJ)	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
EF N_2O – ex.ligh oil (kg/TJ)	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
N_2O emission (Mg)	2.3	0.7	0.7	0.7	0.6	0.6	0.4

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

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Gasoline (1000 t)	0.2	8.5	7.6	6.9	7.3	7.6	7.9
NCV for gasoline (MJ/kg)	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	222.0
NCV for gas/diesel o.(MJ/kg)	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
NCV for fuel oil (MJ/kg)	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
NCV for LPG (MJ/kg)	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
NCV for petroleum coke (MJ/kg)	29.3			31.0	31.0	31.0	31.0
Total fuel consumpt. (TJ)	28498	16383	19056	21602	23719	21151	21012

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

	1990	1995	2000	2005	2006	2007	2008
Emissions							
EF CO_2 – gasoline (t/TJ)	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
EF CO_2 – gas/diesel oil (t/TJ)	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
EF CO_2 – LPG (t/TJ)	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
EF CO_2 – petroleum coke (t/TJ)	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
EF CH_4 – gasoline (kg/TJ)	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
EF CH_4 – gas/diesel oil (kg/TJ)	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
EF CH_4 – LPG (kg/TJ)	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
EF CH_4 – petroleum coke (kg/TJ)	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
EF N_2O – gasoline (kg/TJ)	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
EF N_2O – gas/diesel oil (kg/TJ)	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
EF N_2O – LPG (kg/TJ)	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
EF N_2O – petroleum coke (kg/TJ)	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

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

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Anthracite (1000 t)	107.2	5.0		0.3	0.1	0.3	0.0
NCV for anthracite (MJ/kg)	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
NCV for hard coal (MJ/kg)	25.1	28.1	26.2	25.1	24.9	24.9	24.9
Brown Coal (1000 t)	261.2	95.8	28.2	56.9	61.3	53.2	47.1
NCV for brown coal (MJ/kg)	16.7	17.8	17.8	18.5	17.7	17.7	18.0
Lignite (1000 t)	73.2	56.3	14.4	0.2	0.2	0.4	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
NCV for coke oven coke (MJ/kg)	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

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

	1990	1995	2000	2005	2006	2007	2008
Emissions							
EF CO_2 – anthracite (t/TJ)	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
EF CO_2 – brown coal (t/TJ)	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
EF CO_2 – briquettes (t/TJ)	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
CO_2 emission (Gg)	1676.8	448.4	310.5	564.4	514.7	603.3	608.9
EF CH_4 – anthracite (kg/TJ)	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
EF CH_4 – brown coal (kg/TJ)	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
EF CH_4 – briquettes (kg/TJ)	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
CH_4 emission (Mg)	0.168	0.046	0.032	0.060	0.054	0.064	0.065
EF N_2O – anthracite (kg/TJ)	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
EF N_2O – brown coal (kg/TJ)	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
EF N_2O – briquettes (kg/TJ)	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
N_2O emission (Mg)	0.003	0.002	0.002	0.008	0.008	0.009	0.009

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

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Natural gas (1000000 m3)	845.7	656.8	703.8	712.3	703.3	757.3	769.6
NCV for natural gas (MJ/m3)	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
NCV for gas work gas (MJ/kg)	15.8	15.8	15.8	21.5	30.4	27.8	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)	30895	22487	24054	24294	24004	25825	26495.1
Emissions							
EF CO_2 - natural gas (t/TJ)	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
EF CO_2 - coke oven gas (t/TJ)	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
CO_2 Emission (Gg)	1992.5	1253.8	1341.6	1355.5	1339.1	1440.9	1461.9
EF CH_4 - natural gas (kg/TJ)	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
EF CH_4- coke ov. gas (kg/TJ)	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
CH_4 Emission (Mg)	0.1652	0.1132	0.1209	0.121	0.120	0.129	0.131

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

	1990	1995	2000	2005	2006	2007	2008
Emissions							
EF N_2O - natural gas (kg/TJ)	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
EF N_2O-coke ov. gas (kg/TJ)	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
N_2O Emission (Mg)	0.003	0.002	0.002	0.002	0.002	0.003	0.003

Table A2-10: The number of road motor vehicles in Croatia

	1990	1995	2000	2005	2006	2007	2008
Mopeds	18,025	20,738	44,218	73,906	75,657	76,641	82,469
Motorcycles	12,456	16,600	28,346	58,807	72,204	87,024	107,658
Passenger Cars	1,120,030	817,211	1,144,970	1,394,585	1,443,168	1,474,726	1,532,317
Buses	6,482	4,479	4,724	4,927	4,941	5,001	5,104
Light and Heavy Duty Vehicles	80,017	87,709	127,329	165,824	171,180	174,505	178,888
Total	1,237,010	946,737	1,349,587	1,698,049	1,767,150	1,817,897	1,906,436

Table A2-11: GHG emissions from Road Transport

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Gasoline (1000 t)	759.7	558.8	764.5	694.2	695.0	708.2	678.6
NCV for gasoline (MJ/kg)	44.59	44.59	44.59	44.59	44.59	44.59	44.59
Diesel (1000 t)	365.9	405.8	558.0	955.6	1048.9	1152.1	1106.9
NCV for diesel (MJ/kg)	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
NCV for LPG (MJ/kg)	46.89	46.89	46.89	46.89	46.89	46.89	46.89
Biodiesel TJ						122.1	51.8
Total fuel consumption (TJ)	49503.1	42892.8	58382	72805.2	77521.2	83191.2	80753.8
Emissions							
CO_2 emission (Gg)	3560.0	3093.7	4197.4	5249.5	5595.9	6010.0	5813.6
CH_4 emission (Gg)	2.030	1.529	1.732	1.156	1.129	1.081	0.965
N_2O emission (Gg)	0.163	0.138	0.220	0.484	0.503	0.288	0.277

Table A2-12: The GHG emissions from Domestic Air Transport

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Gasoline (1000 t)	0.0	0.3	0.1	1.1	1.1	1.1	1.0
NCV for gasoline (MJ/kg)		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
NCV for jet kerosene (MJ/kg)	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Total fuel consumption (TJ)	2186	1112	776	943	1036	1075	1248
Emissions							
EF CO_2 – gasoline (t/TJ)	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
CO_2 emission (Gg)	154.7	78.7	55.0	66.6	73.2	76.0	88.2
EF CH_4 – gasoline (kg/TJ)	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
CH_4 emission (Mg)	1.1	0.6	0.4	0.5	0.5	0.5	0.6
EF N_2O – gasoline (kg/TJ)	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
N_2O emission (Mg)	4.4	2.2	1.6	1.9	2.1	2.2	2.5

Table A2-13: The GHG emissions from National Navigation

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Gasoline (1000 t)	0.1	0.6	0.3				
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
NCV for diesel (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Fuel oil (1000 t)	2.1	6.2	1.4				1.5
NCV for fuel oil (MJ/kg)	40.2	40.2	40.2				40.2
Light heating oil (1000 t)	1.6	1.5					
NCV for light heating oil (MJ/kg)	42.7	42.7					
Total fuel cunsumption (TJ)	1810.1	1330.9	1167.3	1358.2	1413.7	1469.2	1781.5
Emissions							
EF CO_2 - gasoline (t/TJ)	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
EF CO_2 - fuel oil (t/TJ)	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
CO_2 Emission (Gg)	133.0	98.3	85.7	99.6	103.7	107.7	130.8
EF CH_4 - gasoline (kg/TJ)	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
EF CH_4 - fuel oil (kg/TJ)	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
CH_4 Emission (Mg)	9.1	6.7	5.8	6.8	7.1	7.3	8.9
EF N_2O - gasoline (kg/TJ)	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
EF N_2O - fuel oil (kg/TJ)	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
N_2O Emission (Mg)	1.0	0.8	0.7	0.8	0.8	0.9	1.1

Table A2-14: The GHG emissions from Railways

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Gasoline (1000 t)	0.1		0.1				
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
NCV for diesel (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	42.7
Fuel oil (1000 t)	0.2	1.5					
NCV for fuel oil (MJ/kg)	40.2	40.2					
Light heating oil (1000 t)	1.1	1.7					
NCV for light heating oil (MJ/kg)	42.7	42.7					
Brown coal (1000 t)	10.0						
NCV for brown coal (MJ/kg)	16.7						
Lignite (1000 t)	4.3						
NCV for lignite (MJ/kg)	10.9						
Jet Kerosene (1000 t)	0.1						
NCV for jet kerosene (MJ/m3)	43.9						
Petroleum (1000 t)		0.1					
NCV for petroleum (MJ/m3)		44.0					
Total fuel cunsumption (TJ)	1819.97	1448.49	1166.17	1302.66	1379.53	1392.35	1379.5
Emissions							
EF CO_2 - gasoline (t/TJ)	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
EF CO_2 - fuel oil (t/TJ)	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
EF CO_2 - brown coal (t/TJ)	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
EF CO_2 - jet kerosene (t/TJ)	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
CO_2 Emission (Gg)	138.1	106.4	85.5	95.5	101.2	102.1	101.2
EF CH_4 - gasoline (kg/TJ)	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
EF CH_4 - fuel oil (kg/TJ)	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
EF CH_4 - brown coal (kg/TJ)	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
EF CH_4 - jet kerosene (t/TJ)	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
CH_4 Emission (Mg)	10.2	7.2	5.8	6.5	6.9	7.0	6.9
EF N_2O - gasoline (kg/TJ)	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
EF N_2O - fuel oil (kg/TJ)	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
EF N_2O - brown coal (kg/TJ)	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
EF N_2O - jet kerosene (t/TJ)	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
N_2O Emission (Mg)	1.3	0.9	0.7	0.8	0.8	0.8	0.8

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

	1990	1995	2000	2005	2006	2007	2008
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
NCV for light heating oil (MJ/kg)	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
NCV for fuel oil (MJ/kg)	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
NCV for LPG (MJ/kg)	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
NCV for brown coal (MJ/kg)	16.74	17.30	17.80	18.50	17.73	19.03	18.0
Lignite (1000 t)	40.0	1.6	1.2	0.6	0.2	0.1	0.1
NCV for lignite (MJ/kg)	10.9	10.1	12.0	12.1	12.3	11.7	11.8
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
NCV for gas work gas (MJ/m3)	15.8	15.9	19.5	21.5	30.4	27.8	19.6
Natural gas (1000000 m3)	82.0	132.6	98.2	151.2	147.0	144.2	160.4
NCV for natural gas (MJ/m3)	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
Bio gass (TJ)							170.9
Total fuel cunsumption (TJ)	10819	9969	9507	12054	11157	9617	10125
Emissions							
EF CO_2 - petroleum (t/TJ)	73.3	73.3	73.3	73.3	73.3	74.3	74.3
EF CO_2 - diesel (t/TJ)	73.3	73.3	73.3	73.3	73.3	73.3	73.3
EF CO_2 - fuel oil (t/TJ)	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
EF CO_2 - anthracite (t/TJ)	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
EF CO_2 - lignite (t/TJ)	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
EF CO_2 - gas work gas (t/TJ)	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
EF CO_2 - gasoline (t/TJ)	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
EF CO2 - solid biomass wood (t/TJ)	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
CO_2 Emission (Gg)	771.2	649.3	635.2	782.8	719.5	617.0	641.0

Table A2-15: The GHG emissions from Commercial/Institutional (cont.)

	1990	1995	2000	2005	2006	2007	2008
EF CH_4 - petroleum (kg/TJ)	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
EF CH_4 - fuel oil (kg/TJ)	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
EF CH_4 - anthracite (kg/TJ)	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
EF CH_4 - lignite (kg/TJ)	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
EF CH_4 - gas work gas (kg/TJ)	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
EF CH_4 - gasoline (kg/TJ)	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
EF CH4 -solid biomass wood	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
CH_4 Emission (Mg)	93.6	77.0	78.2	94.5	86.1	97.4	95.5
EF N_2O - petroleum (kg/TJ)	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
EF N_2O - fuel oil (kg/TJ)	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
EF N_2O - anthracite (kg/TJ)	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
EF N_2O - lignite (kg/TJ)	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
EF N_2O - gas work gas (kg/TJ)	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
EF N_2O - gasoline (kg/TJ)	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
EF N2O - solid biomass wood	4.0	4.0	4.0	4.0	4.0	4.0	4.0
EF N2O - landfill gas (t/TJ)	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

Table A2-16: The GHG emissions from Residential sector

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Petroleum (1000 t)		7.9	1.6	1	0.9	1.2	1.1
NCV for petroleum (MJ/kg)		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
NCV for light heating oil (MJ/kg)	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
NCV for fuel oil (MJ/kg)	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
NCV for LPG (MJ/kg)	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
NCV for brown coal (MJ/kg)	16.7	17.3	17.8	18.5	17.7	19.0	18.0
Lignite (1000 t)	207.3	10.8	15.0	11.7	10.6	5	8.1
NCV for lignite (MJ/kg)	10.9	10.1	12.0	12.1	12.3	11.7	11.8
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	8.979	7.693	6.4091
NCV for gas work gas (MJ/m^3)	15.8	15.9	19.5	21.5	30.4	27.8	19.6
Natural gas (1000000 m^3)	230.0	381.3	496.6	687.8	651.7	622.5	682.7
NCV for natural gas (MJ/m^3)	34.0	34.0	34.0	34.0	34.0	34.0	34.0

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

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Biomass (TJ)	19080	11070	13410	12510	12600	10620	1055
Total fuel consumption (TJ)	47477	36301	43598	50831	48069	43019	44705
Emissions							
EF CO_2 - petroleum (t/TJ)	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
EF CO_2 - fuel oil (t/TJ)	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
EF CO_2 - brown coal (t/TJ)	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
EF CO_2 - briquettes (t/TJ)	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
EF CO_2 - natural gas (t/TJ)	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
CO_2 Emission (Gg)	4045.3	2785.3	3337.3	3718.8	3534.7	3113.2	3212.2
EF CH_4 - petroleum (k/TJ)	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
EF CH_4 - fuel oil (kg/TJ)	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
EF CH_4 - brown coal (kg/TJ)	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
EF CH_4 - briquettes (kg/TJ)	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
EF CH_4 - natural gas (kg/TJ)	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
CH_4 Emission (Mg)	7249.4	3594.9	4353.6	4134.4	4099.0	3442.2	3584.0
EF N_2O - petroleum (k/TJ)	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
EF N_2O - fuel oil (kg/TJ)	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
EF N_2O - brown coal (kg/TJ)	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
EF N_2O - briquettes (kg/TJ)	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
EF N_2O - natural gas (kg/TJ)	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
N_2O Emission (Mg)	92.8	53.1	63.5	61.6	60.7	51.3	52.9

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

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Gasoline (1000 t)	4.0	7.8	12.1	8.1	11.2	8.4	8.9
NCV for gasoline (MJ/kg)	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
NCV for extra light oil (MJ/kg)	42.7	42.7	42.7	42.7	42.7	42.7	43.7
Fuel consumption - mobile (TJ)	10117	7147	10687	8792	9191	9109	9869

Table A2-17: The GHG emissions from Agriculture/Forestry/Fishing (cont.)

	1990	1995	2000	2005	2006	2007	2008
Fuel consumption							
Fuel oil (1000 t)	12.3	6.2	13.4	4.7	4.5	4.5	4.6
NCV for fuel oil (MJ/kg)	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
NCV for LPG (MJ/kg)	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
NCV for natural gas (MJ/m3)	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
Total fuel consumption (TJ)	11668	8074	11841	9896	10146	10025	10892
Emissions							
EF CO_2 - gasoline (t/TJ)	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
EF CO_2 - diesel (t/TJ)	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
EF CO_2 - fuel oil (t/TJ)	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
EF CO_2 - gas work gas (t/TJ)	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
CO_2 emission (Gg) - stationary	98.2	57.9	76.4	66.4	57.9	55.7	61.8
Total CO_2 emission (Gg)	839.2	580.3	857.5	709.4	729.5	721.9	783.6
EF CH_4 - gasoline (kg/TJ)	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
EF CH_4 - diesel (kg/TJ)	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
EF CH_4 - fuel oil (kg/TJ)	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
EF CH_4 - gas work gas (kg/TJ)	1.0	1.0	1.0	1.0	1.0	1.0	5.0
EF CH_4 - natural gas (kg/TJ)	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
Total CH_4 emission (Mg)	61.8	42.4	62.5	51.1	52.3	51.7	56.0
EF N_2O - gasoline (kg/TJ)	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
EF N_2O - diesel (kg/TJ)	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
EF N_2O - fuel oil (kg/TJ)	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
EF N_2O - gas work gas (kg/TJ)	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
N_2O emission (Mg) - stationary	0.5	0.3	0.4	0.3	0.3	0.2	0.3
Total N_2O emission (Mg)	6.6	4.6	6.9	5.5	5.8	5.7	6.2

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
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 ºC and pressure 1 atm.

Table A2-19: Methane emissions from Oil and Gas Activities. years 1990, 1995, 2000, 2008

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
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 2008					
1B 2a	Oil			**0.37**	
		Production	35.42	0.09	2650
		Transport	147.27	0.11	745
		Refining	187.55	0.03	135
		Storage	187.55	0.14	135
1B 2b	Natural Gas			**70.63**	
		Prod./Process./Trans./Distrib.	110.22	43.07 [1)]	458000
		Other Leakage(non-residential)	87.01	24.32 [2)]	279500
		Other Leakage (residential)	23.21	3.24 [3)]	139500
1B 2c	Venting and Flaring			**1.69**	
		Gas	110.22	1.69	18000

[1)] – Methane emissions from Processing. Transmission and Distribution
[2)] – Other Leakage at Industrial Plants and Power Stations
[3)] – Other Leakage in Residential and Commercial Sectors

ANNEX 3

CO_2 REFERENCE APPROACH AND COMPARISON WITH SECTORAL APPROACH, AND RELEVANT INFORMATION ON THE NATIONAL ENERGY BALANCE

Table A3-1: Fuel combustion CO_2 emissions (Reference and Sectoral Approach)

YEAR	FUEL TYPES	Reference approach		Sectoral approach		Difference	
		Energy Consump. excluding non-energy (PJ)	CO_2 emissions (Gg)	Energy Consump. (PJ)	CO_2 emission (Gg)	Energy Consump. (%)	CO_2 emission (%)
1990	Liquid Fuels	182.19	12,845.26	181.26	13,254.18	0.51	-3.09
	Solid Fuels	34.27	3,102.87	28.67	2,800.86	19.54	10.78
	Gaseous Fuels	76.47	4,393.99	75.66	4,110.36	1.06	6.90
	Total	***292.93***	***20,342.13***	***285.59***	***20,165.40***	***2.57***	***0.88***
1991	Liquid Fuels	125.85	9,007.48	129.24	9,460.61	-2.62	-4.79
	Solid Fuels	21.07	1,850.52	17.41	1,692.68	21.06	9.32
	Gaseous Fuels	69.29	3,966.70	63.10	3,465.41	9.81	14.47
	Total	***216.21***	***14,824.71***	***209.74***	***14,618.71***	***3.09***	***1.41***
1992	Liquid Fuels	119.35	8,509.32	122.57	9,015.98	-2.62	-5.62
	Solid Fuels	17.25	1,476.32	13.47	1,284.85	28.08	14.90
	Gaseous Fuels	67.53	3,867.87	63.22	3,502.71	6.81	10.42
	Total	***204.14***	***13,853.52***	***199.26***	***13,803.55***	***2.45***	***0.36***
1993	Liquid Fuels	117.56	8,510.98	126.93	9,318.93	-7.38	-8.67
	Solid Fuels	14.71	1,225.37	10.98	1,043.62	33.97	17.41
	Gaseous Fuels	83.90	4,780.15	73.56	4,082.30	14.05	17.09
	Total	***216.18***	***14,516.50***	***211.47***	***14,444.85***	***2.22***	***0.50***
1994	Liquid Fuels	121.93	9,050.93	126.17	9,230.82	-3.37	-1.95
	Solid Fuels	9.20	771.63	6.83	660.54	34.72	16.82
	Gaseous Fuels	70.00	3,971.21	67.23	3,736.96	4.11	6.27
	Total	***201.12***	***13,793.77***	***200.23***	***13,628.31***	***0.44***	***1.21***
1995	Liquid Fuels	136.27	9,987.52	143.47	10,516.91	-5.02	-5.03
	Solid Fuels	7.71	735.29	7.63	728.68	1.04	0.91
	Gaseous Fuels	62.06	3,453.51	56.45	3,147.74	9.94	9.71
	Total	***206.04***	***14,176.32***	***207.55***	***14,393.33***	***-0.73***	***-1.51***
1996	Liquid Fuels	147.34	10,575.61	147.34	146.15	10,711.03	0.81
	Solid Fuels	6.21	591.97	6.21	6.18	589.91	0.42
	Gaseous Fuels	72.48	4,035.19	72.48	65.52	3,654.13	10.62
	Total	***226.03***	***15,202.76***	***217.86***	***14,955.07***	***3.75***	***1.66***
1997	Liquid Fuels	147.43	10,562.81	151.39	11,077.34	-2.61	-4.64
	Solid Fuels	10.17	960.12	10.19	962.07	-0.17	-0.20
	Gaseous Fuels	74.01	4,120.66	68.45	3,817.94	8.12	7.93
	Total	***231.62***	***15,643.60***	***230.04***	***15,857.36***	***0.69***	***-1.35***
1998	Liquid Fuels	163.14	11,767.02	164.48	12,070.31	-0.81	-2.51
	Solid Fuels	9.87	929.44	9.86	928.38	0.11	0.11
	Gaseous Fuels	74.70	4,158.70	69.67	3,885.88	7.21	7.02
	Total	***247.71***	***16,855.16***	***244.02***	***16,884.56***	***1.51***	***-0.17***
1999	Liquid Fuels	171.92	12,728.11	174.00	12,795.24	-1.20	-0.52
	Solid Fuels	8.63	810.25	8.52	800.49	1.23	1.22
	Gaseous Fuels	72.95	4,060.89	67.97	3,790.33	7.33	7.14
	Total	***253.49***	***17,599.25***	***250.48***	***17,386.07***	***1.20***	***1.23***
2000	Liquid Fuels	148.90	11,068.00	153.04	11,172.89	-2.70	-0.94
	Solid Fuels	18.65	1,747.47	18.68	1,750.18	-0.16	-0.16
	Gaseous Fuels	73.77	4,107.09	68.92	3,844.00	7.04	6.84
	Total	***241.32***	***16,922.55***	***240.64***	***16,767.07***	***0.28***	***0.93***
2001	Liquid Fuels	155.14	11,533.06	158.22	11,587.47	-1.95	-0.47
	Solid Fuels	19.83	1,849.61	19.69	1,836.17	0.74	0.73
	Gaseous Fuels	81.58	4,543.01	75.46	4,209.33	8.10	7.93
	Total	***256.54***	***17,925.69***	***253.37***	***17,632.97***	***1.25***	***1.66***

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 (%)
2002	Liquid Fuels	169.08	12,533.70	164.88	12,077.93	2.55	3.77
	Solid Fuels	24.43	2,277.22	24.04	2,239.90	1.64	1.67
	Gaseous Fuels	85.37	4,753.96	79.71	4,445.29	7.11	6.94
	Total	***278.89***	***19,564.88***	***268.63***	***18,763.12***	***3.82***	***4.27***
2003	Liquid Fuels	179.28	13,302.49	181.10	13,263.57	-1.01	0.29
	Solid Fuels	27.20	2,532.94	27.03	2,516.83	0.64	0.64
	Gaseous Fuels	82.90	4,615.81	77.73	4,335.05	6.65	6.48
	Total	***289.38***	***20,451.24***	***285.86***	***20,115.45***	***1.23***	***1.67***
2004	Liquid Fuels	166.44	12,383.85	166.93	12,226.63	-0.29	1.29
	Solid Fuels	28.88	2,687.52	29.01	2,699.99	-0.46	-0.46
	Gaseous Fuels	86.27	4,804.49	81.96	4,571.71	5.25	5.09
	Total	***281.59***	***19,875.86***	***277.90***	***19,498.33***	***1.33***	***1.94***
2005	Liquid Fuels	173.51	12,962.09	173.13	12,782.43	0.22	1.41
	Solid Fuels	28.64	2,667.30	28.55	2,658.30	0.34	0.34
	Gaseous Fuels	83.10	4,627.87	79.55	4,436.80	4.47	4.31
	Total	***285.25***	***20,257.25***	***281.22***	***19,877.53***	***1.43***	***1.91***
2006	Liquid Fuels	174.83	13,053.17	176.33	13,051.17	-0.85	0.02
	Solid Fuels	26.56	2,472.98	26.39	2,457.31	0.64	0.64
	Gaseous Fuels	82.65	4,601.66	78.99	4,404.60	4.64	4.47
	Total	***284.04***	***20,127.81***	***281.71***	***19,913.09***	***0.83***	***1.08***
2007	Liquid Fuels	179.52	13,421.81	180.36	13,346.24	-0.47	0.57
	Solid Fuels	28.96	2,695.65	28.50	2,655.36	1.59	1.52
	Gaseous Fuels	95.58	5,324.32	91.34	5,095.26	4.64	4.50
	Total	***304.05***	***21,441.79***	***300.21***	***21,096.86***	***1.28***	***1.63***
2008	Liquid Fuels	169.62	12,549.53	167.42	12,358.69	1.31	1.54
	Solid Fuels	29.69	2,722.73	29.31	2,728.85	1.30	-0.22
	Gaseous Fuels	90.30	5,031.54	88.70	4,949.37	1.81	1.66
	Total	***289.61***	***20,303.79***	***285.43***	***20,036.91***	***1.46***	***1.33***

Table A3-2: Net calorific values for different fossil fuels from 1990 to 2008

			Net calorific values 1990- 2008 MJ/kg(m^3)
Liquid Fossil	Primary Fuel	Crude Oil	41.87-42.4
	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	33.5
		Lubricants	33.5
		Refinery Gas	48.57
		Petroleum Coke	29.31-31
		Ethane	47.31
Solid Fossil	Primary Fuel	Anthracite	29.29-29.31
		Other Bituminous Coal	24.3-26.9
		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/Mm^3
Natural Gas		Natural Gas	34
Biomass		Solid Biomass Fuel Wood	9

Table A3-3: National energy balance for 2008

ENERGY BALANCE 2008 ***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					835,4	2729,4
Import		1266,8	52,6	8,2	3473,3	1226,8
Export						695,9
Import-processing						
Export-processing						
Stock change		-145,6			114,7	-55,2
Bunkers						
Energy supplied		**1121,2**	**52,6**	**8,2**	**4423,4**	**3205,1**
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		925,5				151,3
public cogeneration plants						540,3
public heating plants						75,5
industrial cogeneration plants			46,1			340,6
– in rafineries						32,8
– in gas production						68,0
Industrial heating plants						86,2
Petroleum refineries					4305,3	16,3
NGL-plant					118,1	16,9
Coke plant						
Gas works						
Total transformation sector		**925,5**	**46,1**		**4423,4**	**1227,1**
Energy sector own use						
Oil and gas extraction						55,3
Coal production						
Electric energy supply industry						
hydro power plants						
thermal power plants						
public cogeneration plants						
industrial cogeneration plants						
Industrial heating plants						
Petroleum refineries						54,0
NGL-plant						6,0
Gas works						
Total energy sector own use						**115,3**
Losses						**49,5**
Final energy demand		**195,7**	**6,5**	**8,2**	**0,0**	**1813,2**
Energy consumption		**195,7**	**6,5**	**8,2**	**0,0**	**1307,4**
Industry		**195,7**	**1,0**			**447,7**
Iron and steel						33,5
Non-ferrous metals						1,2
Non-metallic minerals						49,3
Chemical						67,6
Construction materials		195,7	1,0			138,3
Pulp and paper						5,7
Food production						104,4
Not elsewhere specified						47,7
Transport						
Rail						
Road						
Air						
– international						
– domestic						
Sea and River						
Public transport						
Not elsewhere specified						
Other sectors			**5,5**	**8,2**		**859,7**
Households			3,8	8,1		682,7
Services			1,7	0,1		156,2
Agriculture						20,8
Construction						

Table A3-3: National energy balance for 2008 (continue)

ENERGY BALANCE 2008 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	50191,8	1505,1	376,0	183,9	134,0	10757,3	3,5	3037,0
Import		2,0						87,0
Export		243,7					1,7	1119,0
Import-processing								
Export-processing								
Stock change								
Bunkers								
Energy supplied	**50191,8**	**1263,4**	**376,0**	**183,9**	**134,0**	**10757,3**	**1,8**	**2005,0**
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	50191,8							
– small HPP	893,4							
Wind power plants			376,0					
Solar power plants				0,9				
Geothermal power plants								
thermal power plants						2215,0		
public cogeneration plants								
public heating plants								
industrial cogeneration plants						8542,3		70,0
– in rafineries								
– in gas production								
Industrial heating plants								1738,0
Petroleum refineries								
NGL-plant								
Coke plant								
Gas works								
Total transformation sector	**50191,8**		**376,0**	**0,9**		**10757,3**		**1808,0**
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		**1263,4**		**183,0**	**134,0**		**1,8**	**197,0**
Energy consumption		**1263,4**		**183,0**	**134,0**		**1,8**	**197,0**
Industry		**55,7**						
Iron and steel		3,6						
Non-ferrous metals		0,8						
Non-metallic minerals								
Chemical		0,1						
Construction materials		1,2						
Pulp and paper								
Food production		0,3						
Not elsewhere specified		49,7						
Transport							**1,4**	
Rail								
Road							0,9	
Air								
– international								
– domestic								
Sea and River								
Public transport							0,5	
Not elsewhere specified								
Other sectors		**1207,7**		**183,0**	**134,0**		**0,4**	**197,0**
Households		1200,0		183,0				186,0
Services		7,7			134,0			11,0
Agriculture								
Construction							0,4	

Table A3-3: National energy balance for 2008 (continue)

ENERGY BALANCE 2008 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		316,9	849,0	151,9	0,1	97,0	1047,2	349,6	37,2	1091,4
Import	24,9	9,4	287,2	1,0	1,0	19,5	1005,7	57,7	68,5	4,7
Export		133,6	466,9	116,9		0,6	431,6	101,6		176,2
Import-processing										
Export-processing										
Stock change		-1,7	26,0	-35,0		-3,2	-64,5	1,0	-1,0	-193,4
Bunkers										21,7
Energy supplied	**24,9**	**191,0**	**695,3**	**1,0**	**1,1**	**112,7**	**1556,8**	**306,7**	**104,7**	**704,8**
Production										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants										
public cogeneration plants										
public heating plants										
industrial cogeneration plants										
– in rafineries										
– in gas production										
Industrial heating plants										
Petroleum refineries		254,3	849,0	151,9	0,1	97,0	1047,2	349,6	37,2	1091,4
NGL-plant		62,6								
Coke plant										
Gas works										
Total production		**316,9**	**849,0**	**151,9**	**0,1**	**97,0**	**1047,2**	**349,6**	**37,2**	**1091,4**
Transformation sector										
hydro power plants										
– small HPP										
Wind power plants										
Solar power plants										
Geothermal power plants										
thermal power plants								1,1		331,6
public cogeneration plants								0,2	59,7	65,7
public heating plants								5,6	20,2	
industrial cogeneration plants										186,9
– in rafineries										161,2
– in gas production										
Industrial heating plants		0,3						1,9	3,9	25,0
Petroleum refineries										
NGL-plant										
Coke plant										
Gas works		4,7								
Total transformation sector		**5,0**						**8,8**	**83,8**	**609,2**
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										33,0
NGL-plant										
Gas works										
Total energy sector own use										**33,0**
Losses										
Final energy demand	**24,9**	**186,0**	**695,3**	**1,0**	**1,1**	**112,7**	**1556,8**	**297,9**	**20,9**	**62,6**
Energy consumption	**24,9**	**186,0**	**695,3**	**1,0**	**1,1**	**112,7**	**1556,8**	**297,9**	**20,9**	**62,6**
Industry	**24,9**	**26,3**	**0,1**				**27,7**	**28,5**	**13,2**	**56,5**
Iron and steel	2,7	6,7						0,8	0,2	0,1
Non-ferrous metals		2,9						0,4	2,9	
Non-metallic minerals		0,8					0,1		0,2	
Chemical								0,6		27,7
Construction materials	14,1	9,1	0,1				27,6	7,1	1,0	17,3
Pulp and paper		0,1						0,1		1,8
Food production	7,5	1,5						13,1	5,5	7,8
Not elsewhere specified	0,6	5,2						6,4	3,4	1,8
Transport		**68,7**	**678,4**	**1,0**		**112,7**	**1179,7**			**1,5**
Rail							32,3			
Road		68,7	678,4				1080,0			
Air				1,0		112,7				
– international						49,8				
– domestic				1,0		62,9				
Sea and River							40,3			1,5
Public transport							27,1			
Not elsewhere specified										
Other sectors		**91,0**	**16,8**		**1,1**		**349,4**	**269,4**	**7,7**	**4,6**
Households		74,0			1,1			151,0	4,5	
Services		10,4						87,0	3,2	
Agriculture		2,8	8,9				200,2	16,5		4,6
Construction		3,8	7,9				149,2	14,9		

Table A3-3: National energy balance for 2008 (continue)

ENERGY BALANCE 2008 *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	155,6		169,1	36,9	5,9	89,5	57,2	40,7	154,5		
Import		3,9	150,7	30,9	4,9	191,6				197,8	39,8
Export	129,6	0,1	73,3	32,1	2,1	34,8		36,3			
Import-processing											
Export-processing											
Stock change	0,7		-5,4	3,2	0,8	3,2		-0,5		-34,8	3,4
Bunkers											
Energy supplied	**26,7**	**3,8**	**241,1**	**38,9**	**9,5**	**249,5**	**57,2**	**3,9**	**154,5**	**163,0**	**43,2**
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	129,0		169,1	36,9	5,9	89,5		40,7	154,5		
NGL-plant	26,6						57,2				
Coke plant											
Gas works											
Total production	**155,6**		**169,1**	**36,9**	**5,9**	**89,5**	**57,2**	**40,7**	**154,5**		
Transformation sector											
hydro power plants											
– small HPP											
Wind power plants											
Solar power plants											
Geothermal power plants											
thermal power plants											
public cogeneration plants											
public heating plants											
industrial cogeneration plants						4,9			22,1		
– in rafineries						4,9			22,1		
– in gas production											
Industrial heating plants											
Petroleum refineries	26,7									163,0	43,2
NGL-plant											
Coke plant											
Gas works											
Total transformation sector	**26,7**					**4,9**			**22,1**	**163,0**	**43,2**
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						53,0			132,4		
NGL-plant											
Gas works											
Total energy sector own use						**53,0**			**132,4**		
Losses											
Final energy demand		**3,8**	**241,1**	**38,9**	**9,5**	**191,6**	**57,2**	**3,9**			
Energy consumption						**191,6**					
Industry						**191,6**					
Iron and steel											
Non-ferrous metals											
Non-metallic minerals											
Chemical											
Construction materials						191,6					
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 2008 (continue)

ENERGY BALANCE 2008 natural units	Gas works gas	Electricity	Steam and hot water
	10^3 m^3	GWh	TJ
Production	10574,4	12325,6	32160,6
Import		8163,8	
Export		1586,9	
Import-processing			
Export-processing			
Stock change			
Bunkers			
Energy supplied	**10574,4**	**18902,5**	**32160,6**
Production			
hydro power plants		5325,9	
– small HPP		94,8	
Wind power plants		39,9	
Solar power plants		0,1	
Geothermal power plants			
thermal power plants		4414,3	
public cogeneration plants		2085,7	8986,4
public heating plants			2964,0
industrial cogeneration plants		459,7	15359,4
– in rafineries		117,2	7072,8
– in gas production		62,7	1250,0
Industrial heating plants			4850,8
Petroleum refineries			
NGL-plant			
Coke plant			
Gas works	10574,4		
Total production	**10574,4**	**12325,6**	**32160,6**
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		111,3	848,0
Coal production			
Electric energy supply industry		31,4	
hydro power plants		194,6	
thermal power plants		348,8	
public cogeneration plants		107,9	859,9
industrial cogeneration plants			
Industrial heating plants			
Petroleum refineries		273,7	7072,8
NGL-plant		9,9	402,0
Gas works			
Total energy sector own use		**1077,6**	**9182,7**
Losses	**264,3**	**1706,3**	**1595,6**
Final energy demand	**10310,1**	**16118,6**	**21382,3**
Energy consumption	**10310,1**	**16118,6**	**21382,3**
Industry	**1462,4**	**3685,7**	**13727,4**
Iron and steel		398,1	35,9
Non-ferrous metals		77,5	
Non-metallic minerals	989,3	118,8	187,4
Chemical		494,6	5012,0
Construction materials		675,3	9,4
Pulp and paper		249,1	1544,6
Food production	45,7	632,1	4588,2
Not elsewhere specified	427,4	1040,2	2349,9
Transport		**323,6**	
Rail		188,6	
Road			
Air		20,4	
– international			
– domestic		20,4	
Sea and River		27,3	
Public transport		63,2	
Not elsewhere specified		24,1	
Other sectors	**8847,7**	**12109,3**	**7654,9**
Households	6409,1	6711,4	5997,5
Services	2438,6	5033,3	1657,4
Agriculture		70,0	
Construction		294,6	

Table A3-3: National energy balance for 2008 (continue)

PJ	Anthracite	Hard coal	Brown coal	Lignite	Crude oil	Natural gas
PRIMARNA BILANCA						
Production	-	-	-	-	35,42	94,050
Import	-	31,54	0,95	0,10	147,27	41,711
Export	-	-	-	-	-	23,661
Import-processing	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-
Stock change	-	- 3,63	-	-	4,86	- 1,877
Bunkers	-	-	-	-	-	-
Energy supplied	**-**	**27,92**	**0,95**	**0,10**	**187,55**	**110,22**
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	**-**	**27,92**	**0,95**	**0,10**	**187,55**	**110,22**
Transformation sector						
hydro power plants	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-
thermal power plants	-	23,04	-	-	-	5,14
public cogeneration plants	-	-	-	-	-	18,37
public heating plants	-	-	-	-	-	2,57
industrial cogeneration plants	-	-	0,83	-	-	11,58
– in rafineries	-	-	-	-	-	1,12
– in gas production	-	-	-	-	-	2,31
Industrial heating plants	-	-	-	-	-	2,93
Petroleum refineries	-	-	-	-	182,54	0,55
NGL-plant	-	-	-	-	5,01	1,83
Coke plant	-	-	-	-	-	-
Gas works	-	-	-	-	-	-
Total transformation sector	**-**	**23,04**	**0,83**	**-**	**187,55**	**42,97**
Energy sector own use						
Oil and gas extraction	-	-	-	-	-	1,88
Coal production	-	-	-	-	-	-
Electric energy supply industry	-	-	-	-	-	-
hydro power plants	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	1,84
NGL-plant	-	-	-	-	-	0,20
Gas works	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**3,92**
Losses	-	-	-	-	-	1,68
Final energy demand	**-**	**4,87**	**0,12**	**0,10**	**-**	**61,65**
Energy consumption	**-**	**4,87**	**0,12**	**0,10**	**-**	**44,45**
Industry	**-**	**4,87**	**0,02**	**-**	**-**	**15,22**
Iron and steel	-	-	-	-	-	1,14
Non-ferrous metals	-	-	-	-	-	0,04
Non-metallic minerals	-	-	-	-	-	1,68
Chemical	-	-	-	-	-	2,30
Construction materials	-	4,87	0,02	-	-	4,70
Pulp and paper	-	-	-	-	-	0,19
Food production	-	-	-	-	-	3,55
Not elsewhere specified	-	-	-	-	-	1,62
Transport	**-**	**-**	**-**	**-**	**-**	**-**
Rail	-	-	-	-	-	-
Road	-	-	-	-	-	-
Air	-	-	-	-	-	-
– international	-	-	-	-	-	-
– domestic	-	-	-	-	-	-
Sea and River	-	-	-	-	-	-
Public transport	-	-	-	-	-	-
Not elsewhere specified	-	-	-	-	-	-
Other sectors	**-**	**-**	**0,10**	**0,10**	**-**	**29,23**
Households	-	-	0,07	0,10	-	23,21
Services	-	-	0,03	0,00	-	5,31
Agriculture	-	-	-	-	-	0,71
Construction	-	-	-	-	-	-

Table A3-3: National energy balance for 2008 (continue)

PJ	Hydro energy	Fuel wood	Wind energy	Solar energy	Geothermal energy	Landfill gas	Biofuels	Other biomass
PRIMARNA BILANCA								
Production	50,19	13,546	0,376	0,184	0,134	0,2085	0,130	3,037
Import	-	0,02	-	-	-	-	-	0,09
Export	-	2,19	-	-	-	-	0,06	1,12
Import-processing	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-
Stock change	-	-	-	-	-	-	-	-
Bunkers	-	-	-	-	-	-	-	-
Energy supplied	**50,19**	**11,37**	**0,38**	**0,18**	**0,13**	**0,2085**	**0,07**	**2,01**
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	**50,19**	**11,37**	**0,38**	**0,18**	**0,13**	**0,2085**	**0,07**	**2,01**
Transformation sector								
hydro power plants	50,19	-	-	-	-	-	-	-
– small HPP	0,89	-	-	-	-	-	-	-
Wind power plants	-	-	0,38	-	-	-	-	-
Solar power plants	-	-	-	0,00	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	0,0377	-	-
public cogeneration plants	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	0,1708	-	0,07
– in rafineries	-	-	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	1,74
Petroleum refineries	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-
Total transformation sector	**50,19**	**-**	**0,38**	**0,00**	**-**	**0,2085**	**-**	**1,81**
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	**-**	**11,37**	**-**	**0,18**	**0,13**	**0,0000**	**0,07**	**0,20**
Energy consumption	**-**	**11,37**	**-**	**0,18**	**0,13**	**0,0000**	**0,07**	**0,20**
Industry	**-**	**0,50**	**-**	**-**	**-**	**-**	**-**	**-**
Iron and steel	-	0,03	-	-	-	-	-	-
Non-ferrous metals	-	0,01	-	-	-	-	-	-
Non-metallic minerals	-	-	-	-	-	-	-	-
Chemical	-	0,00	-	-	-	-	-	-
Construction materials	-	0,01	-	-	-	-	-	-
Pulp and paper	-	-	-	-	-	-	-	-
Food production	-	0,00	-	-	-	-	-	-
Not elsewhere specified	-	0,45	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**	**0,05**	**-**
Rail	-	-	-	-	-	-	-	-
Road	-	-	-	-	-	-	0,03	-
Air	-	-	-	-	-	-	-	-
– international	-	-	-	-	-	-	-	-
– domestic	-	-	-	-	-	-	-	-
Sea and River	-	-	-	-	-	-	-	-
Public transport	-	-	-	-	-	-	0,02	-
Not elsewhere specified	-	-	-	-	-	-	-	-
Other sectors	**-**	**10,87**	**-**	**0,18**	**0,13**	**-**	**0,01**	**0,20**
Households	-	10,80	-	0,18	-	-	-	0,19
Services	-	0,07	-	-	0,13	-	-	0,01
Agriculture	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	0,01	-

Table A3-3: National energy balance for 2008 (continue)

PJ	Coke oven coke	Liquefied petroleum gases	Unleaded motor gasoline	Standard motor gasoline	Petroleum	Jet fuel	Diesel oil	Light heating oil	Low sulphur fuel oil	Standard fuel oil
PRIMARNA BILANCA										
Production	-	-	-	-	-	-	-	-	-	-
Import	0,73	0,44	12,81	0,04	0,04	0,86	42,95	2,46	2,75	0,19
Export	-	6,26	20,82	5,21	-	0,03	18,43	4,34	-	7,08
Import-processing	-	-	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-	-	-
Stock change	-	-0,08	1,16	-1,56	-	-0,14	-2,75	0,04	-0,04	-7,77
Bunkers	-	-	-	-	-	-	-	-	-	0,87
Energy supplied	**0,73**	**-5,90**	**-6,85**	**-6,73**	**0,04**	**0,69**	**21,77**	**-1,83**	**2,71**	**-15,54**
Production										
hydro power plants	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	-
– in rafineries	-	-	-	-	-	-	-	-	-	-
– in gas production	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	-	11,92	37,86	6,77	0,00	4,26	44,73	14,93	1,50	43,86
NGL-plant	-	2,94	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-
Total production	**-**	**14,86**	**37,86**	**6,77**	**0,00**	**4,26**	**44,73**	**14,93**	**1,50**	**43,86**
Gross production	**0,73**	**8,96**	**31,00**	**0,04**	**0,05**	**4,95**	**66,49**	**13,10**	**4,21**	**28,33**
Transformation sector										
hydro power plants	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	0,05	-	13,33
public cogeneration plants	-	-	-	-	-	-	-	0,01	2,40	2,64
public heating plants	-	-	-	-	-	-	-	0,24	0,81	-
industrial cogeneration plants	-	-	-	-	-	-	-	-	-	7,51
– in rafineries	-	-	-	-	-	-	-	-	-	6,48
– in gas production	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	0,01	-	-	-	-	-	0,08	0,16	1,00
Petroleum refineries	-	-	-	-	-	-	-	-	-	-
NGL-plant	-	-	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	0,22	-	-	-	-	-	-	-	-
Total transformation sector	**-**	**0,23**	**-**	**-**	**-**	**-**	**-**	**0,38**	**3,37**	**24,48**
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	-	-	-	-	-	-	-	-	-	1,33
NGL-plant	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,33**
Losses	-	-	-	-	-	-	-	-	-	-
Final energy demand	**0,73**	**8,72**	**31,00**	**0,04**	**0,05**	**4,95**	**66,49**	**12,72**	**0,84**	**2,52**
Energy consumption	**0,73**	**8,72**	**31,00**	**0,04**	**0,05**	**4,95**	**66,49**	**12,72**	**0,84**	**2,52**
Industry	**0,73**	**1,23**	**0,00**	**-**	**-**	**-**	**1,18**	**1,22**	**0,53**	**2,27**
Iron and steel	0,08	0,31	-	-	-	-	-	0,03	0,01	0,00
Non-ferrous metals	-	0,14	-	-	-	-	-	0,02	0,12	-
Non-metallic minerals	-	0,04	-	-	-	-	0,00	-	0,01	-
Chemical	-	-	-	-	-	-	-	0,03	-	1,11
Construction materials	0,41	0,43	0,00	-	-	-	1,18	0,30	0,04	0,70
Pulp and paper	-	0,00	-	-	-	-	-	0,00	-	0,07
Food production	0,22	0,07	-	-	-	-	-	0,56	0,22	0,31
Not elsewhere specified	0,02	0,24	-	-	-	-	-	0,27	0,14	0,07
Transport	**-**	**3,22**	**30,25**	**0,04**	**-**	**4,95**	**50,38**	**-**	**-**	**0,06**
Rail	-	-	-	-	-	-	1,38	-	-	-
Road	-	3,22	30,25	-	-	-	46,13	-	-	-
Air	-	-	-	0,04	-	4,95	-	-	-	-
– international	-	-	-	-	-	2,19	-	-	-	-
– domestic	-	-	-	0,04	-	2,77	-	-	-	-
Sea and River	-	-	-	-	-	-	1,72	-	-	0,06
Public transport	-	-	-	-	-	-	1,16	-	-	-
Not elsewhere specified	-	-	-	-	-	-	-	-	-	-
Other sectors	**-**	**4,27**	**0,75**	**-**	**0,05**	**-**	**14,92**	**11,51**	**0,31**	**0,18**
Households	-	3,47	-	-	0,05	-	-	6,45	0,18	-
Services	-	0,49	-	-	-	-	-	3,72	0,13	-
Agriculture	-	0,13	0,40	-	-	-	8,55	0,70	-	0,18
Construction	-	0,18	0,35	-	-	-	6,37	0,64	-	-

Table A3-3: National energy balance for 2008 (continue)

PJ	Naphta	White spirit	Bitumen	Other oils	Lubricants	Petroleum coke	Etan	Other derivates	Refinery gas	Refinery semiproducts	Aditives
PRIMARNA BILANCA											
Production	-	-	-	-	-	-	-	-	-	-	-
Import	-	0,13	5,05	1,04	0,16	5,94	-	-	-	8,39	1,69
Export	5,78	0,00	2,46	1,08	0,07	1,08	-	1,46	-	-	-
Import-processing	-	-	-	-	-	-	-	-	-	-	-
Export-processing	-	-	-	-	-	-	-	-	-	-	-
Stock change	0,03	-	- 0,18	0,11	0,03	0,10	-	- 0,02	-	- 1,48	0,14
Bunkers	-	-	-	-	-	-	-	-	-	-	-
Energy supplied	**- 5,75**	**0,13**	**2,41**	**0,07**	**0,12**	**4,96**	**-**	**- 1,48**	**-**	**6,91**	**1,83**
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	5,75	-	5,66	1,24	0,20	2,77	-	1,64	7,50	-	-
NGL-plant	1,19	-	-	-	-	-	2,71	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total production	**6,94**	**-**	**5,66**	**1,24**	**0,20**	**2,77**	**2,71**	**1,64**	**7,50**	**-**	**-**
Gross production	**1,19**	**0,13**	**8,08**	**1,30**	**0,32**	**7,73**	**2,71**	**0,16**	**7,50**	**6,91**	**1,83**
Transformation sector											
hydro power plants	-	-	-	-	-	-	-	-	-	-	-
– small HPP	-	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-	-
Solar power plants	-	-	-	-	-	-	-	-	-	-	-
Geothermal power plants	-	-	-	-	-	-	-	-	-	-	-
thermal power plants	-	-	-	-	-	-	-	-	-	-	-
public cogeneration plants	-	-	-	-	-	-	-	-	-	-	-
public heating plants	-	-	-	-	-	-	-	-	-	-	-
industrial cogeneration plants	-	-	-	-	-	0,15	-	-	1,07	-	-
– in rafineries	-	-	-	-	-	0,15	-	-	1,07	-	-
– in gas production	-	-	-	-	-	-	-	-	-	-	-
Industrial heating plants	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	1,19	-	-	-	-	-	-	-	-	6,91	1,83
NGL-plant	-	-	-	-	-	-	-	-	-	-	-
Coke plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total transformation sector	**1,19**	**-**	**-**	**-**	**-**	**0,15**	**-**	**-**	**1,07**	**6,91**	**1,83**
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	-	-	-	-	-	1,64	-	-	6,43	-	-
NGL-plant	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Total energy sector own use	**-**	**-**	**-**	**-**	**-**	**1,64**	**-**	**-**	**6,43**	**-**	**-**
Losses	-	-	-	-	-	-	-	-	-	-	-
Final energy demand	**0,00**	**0,13**	**8,08**	**1,30**	**0,32**	**5,94**	**2,71**	**0,16**	**- 0,00**	**- 0,00**	**- 0,00**
Energy consumption	**0,00**	**-**	**-**	**-**	**-**	**5,94**	**-**	**0,00**	**- 0,00**	**- 0,00**	**- 0,00**
Industry	**-**	**-**	**-**	**-**	**-**	**5,94**	**-**	**-**	**-**	**-**	**-**
Iron and steel	-	-	-	-	-	-	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-	-	-	-	-	-
Non-metallic minerals	-	-	-	-	-	-	-	-	-	-	-
Chemical	-	-	-	-	-	-	-	-	-	-	-
Construction materials	-	-	-	-	-	5,94	-	-	-	-	-
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 2008 (continue)

PJ	Gas works gas	Electricity	Steam and hot water
PRIMARNA BILANCA			
Production	-	-	-
Import	-	29,39	-
Export	-	5,71	-
Import-processing	-	-	-
Export-processing	-	-	-
Stock change	-	-	-
Bunkers	-	-	-
Energy supplied	**-**	**23,68**	**-**
Production			
hydro power plants	-	19,17	-
– small HPP	-	0,34	-
Wind power plants	-	0,14	-
Solar power plants	-	0,00	-
Geothermal power plants	-	-	-
thermal power plants	-	15,89	-
public cogeneration plants	-	7,51	8,99
public heating plants	-	-	2,96
industrial cogeneration plants	-	1,65	15,36
– in rafineries	-	0,42	7,07
– in gas production	-	0,23	1,25
Industrial heating plants	-	-	4,85
Petroleum refineries	-	-	-
NGL-plant	-	-	-
Coke plant	-	-	-
Gas works	0,21	-	-
Total production	**0,21**	**44,37**	**32,16**
Gross production	**0,21**	**68,05**	**32,16**
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	-	0,40	0,85
Coal production	-	-	-
Electric energy supply industry	-	0,11	-
hydro power plants	-	0,70	-
thermal power plants	-	1,26	-
public cogeneration plants	-	0,39	0,86
industrial cogeneration plants	-	-	-
Industrial heating plants	-	-	-
Petroleum refineries	-	0,99	7,07
NGL-plant	-	0,04	0,40
Gas works	-	-	-
Total energy sector own use	**-**	**3,88**	**9,18**
Losses	0,01	6,14	1,60
Final energy demand	**0,20**	**58,03**	**21,38**
Energy consumption	**0,20**	**58,03**	**21,38**
Industry	**0,03**	**13,27**	**13,73**
Iron and steel	-	1,43	0,04
Non-ferrous metals	-	0,28	-
Non-metallic minerals	0,02	0,43	0,19
Chemical	-	1,78	5,01
Construction materials	-	2,43	0,01
Pulp and paper	-	0,90	1,54
Food production	0,00	2,28	4,59
Not elsewhere specified	0,01	3,74	2,35
Transport	**-**	**1,16**	**-**
Rail	-	0,68	-
Road	-	-	-
Air	-	0,07	-
– international	-	-	-
– domestic	-	0,07	-
Sea and River	-	0,10	-
Public transport	-	0,23	-
Not elsewhere specified	-	0,09	-
Other sectors	**0,17**	**43,59**	**7,65**
Households	0,13	24,16	6,00
Services	0,05	18,12	1,66
Agriculture	-	0,25	-
Construction	-	1,06	-

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 Table9s1.

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	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.1 Forest Land converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.2 Cropland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.1 Forest Land converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Difficulties 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.2.3 Grassland converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.1 Forest Land converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.2 Cropland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.1 Forest Land converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Difficulties 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.2.3 Grassland converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	no data available
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.1 Forest Land converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.2 Cropland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Difficulties 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	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.3 Grassland converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.1 5.E.1 Settlements remaining Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.1 Forest Land converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.2 Cropland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.3 Grassland converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.4 Wetlands converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.E.2.5 Other Land converted to Settlements	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.1 Forest Land converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.2 Cropland converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.3 Grassland converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.4 Wetlands converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.F.2.5 Settlements converted to Other Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	no data available
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Difficulties 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.2.3 Wetlands converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	no data available
Carbon	5 LULUCF	5.A.2.2 Grassland converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.A.2.5 Other Land converted to Forest Land	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.1 Forest Land converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.2 Cropland converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.3 Wetlands converted to Grassland	Difficulties in collecting adequate activity data.
Carbon	5 LULUCF	5.C.2.5 Other Land converted to Grassland	Difficulties in collecting adequate activity data.
CH_4	1 Energy	1.B.2.A.1 Exploration	Activity data and emission factors were not available
CH_4	1 Energy	1.B.2.B.1 Exploration	Activity data and emission factors were not available
CH_4	2 Industrial Processes	2.A.7.1 Glass Production	The IPCC Guidelines do not provide methodologies for calculation of CH_4 emission

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

GHG	Sector	Source/sink category	Explanation
CH_4	2 Industrial Processes	2.C.1.1 Steel	The IPCC Guidelines do not provide methodologies for calculation of CH_4 emission
CH_4	2 Industrial Processes	2.B.5 Propylene	The IPCC Guidelines do not provide methodologies for calculation of CH_4 emission
CH_4	2 Industrial Processes	2.B.5 Polyvinilchloride	The IPCC Guidelines do not provide methodologies for calculation of CH_4 emission
CH_4	2 Industrial Processes	2.B.5 Polystyrene	The IPCC Guidelines do not provide methodologies for calculation of CH_4 emission
CH_4	2 Industrial Processes	2.B.5 Sulphuric acid production	The IPCC Guidelines do not provide methodologies for calculation of CH_4 emission
CH_4	2 Industrial Processes	2.B.5 Polyethene low density	The IPCC Guidelines do not provide methodologies for calculation of CH_4 emission
CH_4	4 Agriculture	4.A 4.A Enteric Fermentation	No data available
CH_4	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.E.1 Settlements remaining Settlements	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.E.2 Land converted to Settlements	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.F.2 Land converted to Other Land	Difficulties in collecting adequate activity data.
CH_4	5 LULUCF	5.G Harvested Wood Products	Difficulties in collecting adequate activity data.
CH_4	6 Waste	6.B.1 6.B.1 Industrial Wastewater	CH_4 emission has not been estimated because activity data are not available.
CH_4	6 Waste	6.B.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage)	CH_4 emission has not been estimated because activity data are not available.
CH_4	6 Waste	6.C.2 Incineration of hospital wastes	IPCC Guidelines do not provide default emission factor for CH_4 emission calculation from Incineration of clinical waste. There is no national information on these data. Information about type of incineration/technology is lacking.
CH_4	6 Waste	6.C.2 Incineration of hazardous waste	IPCC Guidelines do not provide default emission factor for CH_4 emission calculation from Incineration of clinical waste. There is no national information on these data. Information about type of incineration/technology is lacking.
CH_4	6 Waste	6.C.2 Incineration of sewage sludge	CH_4 emission has not been estimated because activity data are not available. Guidelines do not provide default emission factor for CH_4 emission calculation from incineration of sewage sludge
CH_4	6 Waste	6.C.2 Incineration of plastics	CH_4 emission has not been estimated because activity data are not available. IPCC do not provide default emission factor for CH_4 emission calculation from incineration of plastics

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

GHG	Sector	Source/sink category	Explanation
CO_2	2 Industrial Processes	2.A.5 Asphalt Roofing	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.A.6 Road Paving with Asphalt	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.A.7.1 Glass Production	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.B.5.2 Ethylene	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.D.2 Food and Drink	CO_2 from Food and Drink Production (e.g. gasification of water) can be of biogenic or non-biogenic origin. Only information on CO_2 emissions of non-biogenic origin should be reported.
CO_2	2 Industrial Processes	2.B.5 Propylene	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.B.5 Polyvinilchloride	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.B.5 Polystyrene	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.B.5 Sulphuric acid production	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	2 Industrial Processes	2.B.5 Polyethene low density	The IPCC Guidelines do not provide methodologies for calculation of CO_2 emission
CO_2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
CO_2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
CO_2	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
CO_2	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
CO_2	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
CO_2	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
CO_2	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Difficulties in collecting adequate activity data.
CO_2	5 LULUCF	5.G Harvested Wood Products	Difficulties in collecting adequate activity data.
CO_2	6 Waste	6.A.1 Managed Waste Disposal on Land	IPCC Guidelines do not provide methodology for the calculation of CO_2 emissions from Solid Waste Disposal on Land.
CO_2	6 Waste	6.C.2 Incineration of sewage sludge	CO_2 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.
HFCs	2 Industrial Processes	2.F.4 Aerosols/ Metered Dose Inhalers	The total potential emission from consumption of HFCs has not been estimated because the input data for emission calculation are not available.
HFCs	2 Industrial Processes	2.F.5 Solvents	The total potential emission from consumption of HFCs has not been estimated because the input data for emission calculation are not available.

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

GHG	Sector	Source/sink category	Explanation
N_2O	2 Industrial Processes	2.A.7.1 Glass Production	The IPCC Guidelines do not provide methodologies for calculation of N_2O emission
N_2O	2 Industrial Processes	2.B.5.2 Ethylene	The IPCC Guidelines do not provide methodologies for calculation of N_2O emission
N_2O	2 Industrial Processes	2.B.5 Propylene	The IPCC Guidelines do not provide methodologies for calculation of N_2O emission
N_2O	2 Industrial Processes	2.B.5 Polyvinilchloride	The IPCC Guidelines do not provide methodologies for calculation of N_2O emission
N_2O	2 Industrial Processes	2.B.5 Polystyrene	The IPCC Guidelines do not provide methodologies for calculation of N_2O emission
N_2O	2 Industrial Processes	2.B.5 Sulphuric acid production	The IPCC Guidelines do not provide methodologies for calculation of N_2O emission
N_2O	2 Industrial Processes	2.B.5 Polyethene low density	The IPCC Guidelines do not provide methodologies for calculation of N_2O emission
N_2O	3 Solvent and Other Product Use	3.B Degreasing and Dry Cleaning	Activity data for emission calculation are presented by means of population.The IPCC guidelines do not provide methodologies for the calculation of emissions of N_2O from Solvent and Other Product Use.
N_2O	3 Solvent and Other Product Use	3.D.2 Fire Extinguishers	N_2O emissions are not estimated because activity data are not available. IPCC Guidelines do not provide methodology for the calculation of N_2O emission.
N_2O	3 Solvent and Other Product Use	3.D.4 Other Use of N_2O	N_2O emissions are not estimated because activity data are not available. IPCC Guidelines do not provide methodology for the calculation of N_2O emission.
N_2O	3 Solvent and Other Product Use	3.D.5 Other Solvent Use (SNAP 0604)	IPCC Guidelines do not provide methodology for the calculation of N_2O emission.
N_2O	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.A.1 5.A.1 Forest Land remaining Forest Land	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.1 5.B.1 Cropland remaining Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.2.1 Forest Land converted to Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.2.2 Grassland converted to Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.2.3 Wetlands converted to Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Difficulties 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
N_2O	5 LULUCF	5.B.2.5 Other Land converted to Cropland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.C.1 5.C.1 Grassland remaining Grassland	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.D.1 5.D.1 Wetlands remaining Wetlands	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.E.1 Settlements remaining Settlements	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.E.2 Land converted to Settlements	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.F.2 Land converted to Other Land	Difficulties in collecting adequate activity data.
N_2O	5 LULUCF	5.G Harvested Wood Products	Difficulties in collecting adequate activity data.
N_2O	6 Waste	6.B.1 6.B.1 Industrial Wastewater	IPCC Guidelines do not provide methodology for the calculation of N_2O emission from Industrial Wastewater.
N_2O	6 Waste	6.B.1 6.B.1 Industrial Wastewater	IPCC Guidelines do not provide methodology for the calculation of N_2O emission from Industrial Wastewater - Sludge.
N_2O	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 N_2O emission from Domestic Wastewater
N_2O	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 N_2O emission from Domestic Sludge.
N_2O	6 Waste	6.C.2 Incineration of hospital wastes	IPCC Guidelines do not provide default emission factor for N_2O emission calculation from Incineration of clinical waste. There is no national information on these data. Information about type of incineration/technology is lacking.
N_2O	6 Waste	6.C.2 Incineration of hazardous waste	IPCC Guidelines do not provide default emission factor for N_2O 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.
N_2O	6 Waste	6.C.2 Incineration of sewage sludge	N_2O emission has not been estimated because activity data are not available. IPCC Guidelines do not provide default emission factor for N_2O emission calculation from incineration of sewage sludge.
N_2O	6 Waste	6.C.2 Incineration of plastics	N_2O emission has not been estimated because activity data are not available. IPCC Guidelines do not provide default emission factor for N_2O emission calculation from incineration of plastics.
SF_6	2 Industrial Processes	2.F.8 Electrical Equipment	The total potential emission from consumption of SF_6 has not been estimated because the input data for emission calculation are not available.
SF_6	2 Industrial Processes	2.F.P2.1 In bulk	Data are not available.
SF_6	2 Industrial Processes	2.F.P3.1 In bulk	Data are not available.

ANNEX 5

TABLE 6.1 OF THE IPCC GOOD PRACTICE GUIDANCE

Table A5-1: 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 2006	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	CO_2 Emissions from Stationary Combustion - Coal	CO_2	2,780.4	2.728.9	5	5	7.07	0.62	0.00	0.09	0.00	0.43	0.43
1A	CO_2 Emissions from Stationary Combustion - Oil	CO_2	8,497.0	5.480.7	5	5	7.07	1.2517	-0.0918	0.1745	-0.4592	0.8723	0.9858
1A	CO_2 Emissions from Stationary Combustion - Gas	CO_2	4,062.9	4.909.9	5	5	7.07	1.1213	0.0288	0.1563	0.1440	0.7814	0.7946
1A	Mobile Combustion - Road Vehicles	CO_2	3,560.0	5.813.6	5	5	7.07	1.3277	0.0733	0.1851	0.3665	0.9253	0.9952
1A	Mobile Combustion: Water-borne Navigation	CO_2	133.0	130.8	5	5	7.07	0.0299	0.0000	0.0042	0.0000	0.0208	0.0208
1A	Mobile Combustion: Aircraft	CO_2	154.7	88.2	5	5	7.07	0.0201	-0.0020	0.0028	-0.0102	0.0140	0.0174
1A	Mobile Combustion: Railways	CO_2	138.1	101.2	5	5	7.07	0.0231	-0.0011	0.0032	-0.0056	0.0161	0.0170
1A	Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.2	783.6	5	5	7.07	0.1790	-0.0014	0.0249	-0.0069	0.1247	0.1249
1B	CO_2 Emissions from Natural Gas Scrubbing*	CO_2	415.9	666.0	10	3	10.44	0.2246	0.0081	0.0212	0.0244	0.2120	0.2134
2A	CO_2 Emissions from Cement Production	CO_2	1,085.8	1.526.9	3	3	4.24	0.2092	0.0145	0.0486	0.0436	0.1458	0.1522
2A	CO_2 Emissions from Lime Production	CO_2	160.6	251.4	3	3	4.24	0.0344	0.0030	0.0080	0.0089	0.0240	0.0256
2A	CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.5	21.5	7.5	30	30.92	0.0215	-0.0009	0.0007	-0.0279	0.0051	0.0284
2A	CO_2 Emissions from Soda Ash Production and Use	CO_2	25.7	13.4	7.5	30	30.92	0.0134	-0.0004	0.0004	-0.0114	0.0032	0.0119
2C	CO_2 Emissions from Iron and Steel Production	CO_2	5.5	8.6	7.5	30	30.92	0.0086	0.0001	0.0003	0.0031	0.0021	0.0037
2B	CO_2 Emissions from Ammonia Production	CO_2	871.0	942.5	3	5	5.83	0.1775	0.0027	0.0300	0.0134	0.0900	0.0910
2C	CO_2 Emissions from Ferroalloys Production	CO_2	118.8	0.0	7.5	30	30.92	0.0000	-0.0037	0.0000	-0.1118	0.0000	0.1118
2C	Aluminium Production	CO_2	111.4	0.0	3	30	30.15	0.0000	-0.0035	0.0000	-0.1048	0.0000	0.1048
2G	Emissions from Waste Incineration	CO_2	0.0	0.3	50	30	58.31	0.0005	0.0000	0.0000	0.0002	0.0004	0.0004
3	Total Solvent and Other Product Use	CO_2	96.2	46.8	50	50	70.71	0.1069	-0.0015	0.0015	-0.0764	0.0745	0.1067
6C	Other non-specified NEU	CO_2			5	50	50.25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	CO_2 Total		**35558.7**	**38687.6**									

Table A5-1: 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	CH_4	167.9	87.3	5	50	50.25	0.1417	-0.0025	0.0028	-0.1243	0.0139	0.1251
1A	Mobile Combustion - Road Vehicles	CH_4	42.6	20.3	5	40	40.31	0.0264	-0.0007	0.0006	-0.0277	0.0032	0.0279
1A	Mobile Combustion: Water-borne Navigation	CH_4	0.2	0.2	5	40	40.31	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
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	0.0002	0.0000	0.0000	-0.0001	0.0000	0.0001
1A	Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.3	1.2	5	40	40.31	0.0015	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	-0.0015	0.0000	-0.3824	0.0000	0.3824
1B	Fugitive Emissions from Oil and Gas Operations	CH_4	1,201.2	1.526.6	5	300	300.04	14.7940	0.0109	0.0486	3.2722	0.2430	3.2812
2B	Production of Chemicals	CH_4	16.5	5.5	7.5	30	30.92	0.0055	-0.0003	0.0002	-0.0102	0.0013	0.0103
4A	CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	1,235.8	768.0	30	40	50.00	1.2402	-0.0143	0.0244	-0.5727	0.7333	0.9305
4B	CH_4 Emissions from Manure Management	CH_4	228.1	144.2	30	40	50.00	0.2329	-0.0026	0.0046	-0.1025	0.1377	0.1717
6A	Solid Waste Disposal Sites	CH_4	221.2	655.0	50	50	70.71	1.4959	0.0139	0.0208	0.6954	1.0425	1.2531
6B	Emissions from Waste Water Handling	CH_4	278.7	166.1	50	30	58.31	0.3128	-0.0035	0.0053	-0.1037	0.2643	0.2840
	CH_4 Total		**3,442.4**	**3,374.5**									

Table A5-1: 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	62.1	44.7	5	200	200.06	0.2887	-0.0005	0.0014	-0.1055	0.0071	0.1057
1A	Mobile Combustion - Road Vehicles	N_2O	50.6	86.0	5	200	200.06	0.5559	0.0012	0.0027	0.2304	0.0137	0.2308
1A	Mobile Combustion: Water-borne Navigation	N_2O	0.3	0.3	5	200	200.06	0.0021	0.0000	0.0000	0.0000	0.0001	0.0001
1A	Mobile Combustion: Aircraft	N_2O	1.4	0.8	5	200	200.06	0.0050	0.0000	0.0000	-0.0036	0.0001	0.0036
1A	Mobile Combustion: Railways	N_2O	0.4	0.3	5	200	200.06	0.0017	0.0000	0.0000	-0.0008	0.0000	0.0008
1A	Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.0	1.9	5	200	200.06	0.0124	0.0000	0.0001	-0.0006	0.0003	0.0007
2B	Nitric Acid Production	N_2O	804.1	756.9	3	30	30.15	0.7370	-0.0011	0.0241	-0.0340	0.0723	0.0799
C	Total Solvent and Other Product Use	N_2O	34.7	34.7	50	50	70.71	0.079295	0.000016	0.001105	0.000800	0.055259	0.055264
4B	N_2O Emissions from Manure Management	N_2O	380.0	209.8	30	60	67.08	0.4546	-0.0052	0.0067	-0.3146	0.2003	0.3730
4B	Direct N_2O Emissions from Agricultural Soils	N_2O	1,298.5	1,253.5	30	40	50.00	2.0244	-0.0008	0.0399	-0.0333	1.1970	1.1975
4D	N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.1	174.0	30	40	50.00	0.2810	-0.0027	0.0055	-0.1061	0.1662	0.1972
4F	Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	932.5	799.7	30	60	67.08	1.7327	-0.0038	0.0255	-0.2278	0.7637	0.7969
6B	Emissions from Waste Water Handling	N_2O	90.2	108.2	10	30	31.62	0.1105	0.0006	0.0034	0.0184	0.0344	0.0390
	N_2O Total		**3,918.1**	**3,470.8**									
2F	HFC Emiss. from Consumption of HFCs, PFCs and SF_6	HFC	11.0	601.7	70	70	98.99	1.9240	0.0188	0.0192	1.3166	1.3408	1.8791
2C	PFC Emissions from Aluminium production	PFC	936.6	0.0	30	50	58.31	0.0000	-0.0294	0.0000	-1.4686	0.0000	1.4686
	HFC/PFC/SF_6 Total		**947.,6**	**601.7**									
	Total GHG Emissions	CO_2-eq	**31,415.98**	**30,961.2**									
	Total Uncertainties (Level/Trend)							**15.49**					**4.94**

Table A5-2: 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 2006	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	CO_2 Emissions from Stationary Combustion - Coal	CO_2	2,780.4	2,728.9	5	5	7.07	0.5154	-0.0055	0.0767	-0.0274	0.3833	0.3842
1A	CO_2 Emissions from Stationary Combustion - Oil	CO_2	8,497.0	5,480.7	5	5	7.07	1.0351	-0.0968	0.1539	-0.4841	0.7697	0.9093
1A	CO_2 Emissions from Stationary Combustion - Gas	CO_2	4,062.9	4,909.9	5	5	7.07	0.9273	0.0179	0.1379	0.0894	0.6896	0.6953
1A	Mobile Combustion - Road Vehicles	CO_2	3,560.0	5,813.6	5	5	7.07	1.0980	0.0581	0.1633	0.2904	0.8165	0.8666
1A	Mobile Combustion: Water-borne Navigation	CO_2	133.0	130.8	5	5	7.07	0.0247	-0.0003	0.0037	-0.0013	0.0184	0.0184
1A	Mobile Combustion: Aircraft	CO_2	154.7	88.2	5	5	7.07	0.0167	-0.0021	0.0025	-0.0105	0.0124	0.0162
1A	Mobile Combustion: Railways	CO_2	138.1	101.2	5	5	7.07	0.0191	-0.0012	0.0028	-0.0062	0.0142	0.0155
1A	Mobile Combustion - Agriculture/Forestry/Fishing	CO_2	839.2	783.6	5	5	7.07	0.1480	-0.0028	0.0220	-0.0139	0.1101	0.1109
1B	CO_2 Emissions from Natural Gas Scrubbing*	CO_2	415.9	666.0	10	3	10.44	0.1857	0.0064	0.0187	0.0193	0.1871	0.1881
2A	CO_2 Emissions from Cement Production	CO_2	1,085.8	1,526.9	3	3	4.24	0.1730	0.0108	0.0429	0.0324	0.1287	0.1327
2A	CO_2 Emissions from Lime Production	CO_2	160.6	251.4	3	3	4.24	0.0285	0.0023	0.0071	0.0069	0.0212	0.0223
2A	CO_2 Emissions from Limestone and Dolomite Use	CO_2	51.5	21.5	7.5	30	30.92	0.0177	-0.0009	0.0006	-0.0275	0.0045	0.0279
2A	CO_2 Emissions from Soda Ash Production and Use	CO_2	25.7	13.4	7.5	30	30.92	0.0111	-0.0004	0.0004	-0.0115	0.0028	0.0118
2C	CO_2 Emissions from Iron and Steel Production	CO_2	5.5	8.6	7.5	30	30.92	0.0071	0.0001	0.0002	0.0024	0.0018	0.0030
2B	CO_2 Emissions from Ammonia Production	CO_2	871.0	942.5	3	5	5.83	0.1468	0.0007	0.0265	0.0037	0.0794	0.0795
2C	CO_2 Emissions from Ferroalloys Production	CO_2	118.8		7.5	30	30.92	0.0000	-0.0035	0.0000	-0.1053	0.0000	0.1053
2C	Aluminium Production	CO_2	111.4		3	30	30.15	0.0000	-0.0033	0.0000	-0.0987	0.0000	0.0987
5A	Forest land remaining forest land	CO_2	4,184.9	6,478.7	45	30	54.08	9.3587	0.0583	0.1820	1.7487	8.1892	8.3738
2G	Emissions from Waste Incineration	CO_2	0.0	0.3	50	30	58.31	0.0004	0.0000	0.0000	0.0002	0.0004	0.0004
3	Total Solvent and Other Product Use	CO_2	96.2	46.8	50	50	70.71	0.0884	-0.0015	0.0013	-0.0764	0.0657	0.1008
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
	CO_2 Total		**27,292.9**	**29,992.9**									

Table A5-2: 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 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	CH_4	167.9	87.3	5	50	50.25	0.1276	-0.0021	0.0025	-0.1051	0.0123	0.1058
1A	Mobile Combustion - Road Vehicles	CH_4	42.6	20.3	5	40	40.31	0.0238	-0.0006	0.0006	-0.0235	0.0028	0.0237
1A	Mobile Combustion: Water-borne Navigation	CH_4	0.2	0.2	5	40	40.31	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
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	0.0002	0.0000	0.0000	-0.0001	0.0000	0.0001
1A	Mobile Combustion - Agriculture/Forestry/Fishing	CH_4	1.3	1.2	5	40	40.31	0.0014	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	-0.0013	0.0000	-0.3306	0.0000	0.3306
1B	Fugitive Emissions from Oil and Gas Operations	CH_4	1,201.2	1,526.6	5	300	300.04	13.3227	0.0103	0.0429	3.0881	0.2144	3.0955
2B	Production of Other Chemicals	CH_4	16.5	5.5	7.5	30	30.92	0.0049	-0.0003	0.0002	-0.0088	0.0012	0.0088
4A	CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	1,235.8	768.0	30	40	50.00	1.1169	-0.0119	0.0216	-0.4779	0.6471	0.8045
4B	CH_4 Emissions from Manure Management	CH_4	228.1	144.2	30	40	50.00	0.2098	-0.0021	0.0041	-0.0854	0.1216	0.1485
5A	Forest land remaining forest land	CH_4	0.0	0.0	45	30	54.08	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6A	Solid Waste Disposal Sites	CH_4	221.2	655.0	50	50	70.71	1.3471	0.0124	0.0184	0.6199	0.9199	1.1093
6B	Emissions from Waste Water Handling	CH_4	278.7	166.1	50	30	58.31	0.2817	-0.0029	0.0047	-0.0869	0.2333	0.2489
		CH_4 Total	**3,442.4**	**3,374.5**									

Table A5-2: 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 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	62.1	44.7	5	200	200.06	0.2600	-0.0004	0.0013	-0.0862	0.0063	0.0864
1A	Mobile Combustion - Road Vehicles	N_2O	50.6	86.0	5	200	200.06	0.5006	0.0010	0.0024	0.2089	0.0121	0.2093
1A	Mobile Combustion: Water-borne Navigation	N_2O	0.3	0.3	5	200	200.06	0.0019	0.0000	0.0000	0.0000	0.0000	0.0001
1A	Mobile Combustion: Aircraft	N_2O	1.4	0.8	5	200	200.06	0.0045	0.0000	0.0000	-0.0030	0.0001	0.0030
1A	Mobile Combustion: Railways	N_2O	0.4	0.3	5	200	200.06	0.0015	0.0000	0.0000	-0.0007	0.0000	0.0007
1A	Mobile Combustion - Agriculture/Forestry/Fishing	N_2O	2.0	1.9	5	200	200.06	0.0112	0.0000	0.0001	-0.0003	0.0003	0.0004
2B	Nitric Acid Production	N_2O	804.1	756.9	3	30	30.15	0.6637	-0.0006	0.0213	-0.0166	0.0638	0.0659
C	Total Solvent and Other Product Use	N_2O	34.7	34.7	50	50	70.71	0.0714	0.0000	0.0010	0.0017	0.0488	0.0488
4B	N_2O Emissions from Manure Management	N_2O	380.0	209.8	30	60	67.08	0.4094	-0.0044	0.0059	-0.2649	0.1768	0.3185
4B	Direct N_2O Emissions from Agricultural Soils	N_2O	1,298.5	1,253.5	30	40	50.00	1.8230	0.0000	0.0352	-0.0005	1.0563	1.0563
4D	N_2O Emissions from Pasture, Range and Paddock Manure	N_2O	261.1	174.0	30	40	50.00	0.2531	-0.0022	0.0049	-0.0878	0.1466	0.1709
4F	Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	932.5	799.7	30	60	67.08	1.5604	-0.0028	0.0225	-0.1699	0.6739	0.6950
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	108.2	10	30	31.62	0.0995	0.0006	0.0030	0.0177	0.0304	0.0352
	N_2O Total		**3,918.1**	**3,470.8**									
2F	HFC Emiss. from Consumption of HFCs, PFCs and SF_6	HFC	11.0	601.7	70	70	98.99	1.7326	0.0166	0.0169	1.1622	1.1831	1.6585
2C	PFC Emissions from Aluminium production	PFC	936.6		30	50	58.31	0.0000	-0.0254	0.0000	-1.2699	0.0000	1.2699
	HFC/PFC/SF_6 Total		**947.6**	**601.7**									
	Total GHG Emissions	CO_2-eq	**35,600.9**	**37,439.9**									
	Total Uncertainties (Level/Trend)							**15.81**					**9.28**

ANNEX 6

INVENTORY DATA RECORD SHEET

Table A6-1: An example of Inventory Data Record Sheet for 2008 in Waste

INVENTORY DATA RECORD SHEET

Year: 2008

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 2008, 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: 825.00 Gg

Unmamaged – deep: 763.37 Gg

Unmanaged – shallow: 142.63 Gg

Country-specific methane correction factor (MCF): 0.862

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

Recovered methane: 2.19 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.

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.

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
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: Andrea Hublin, M.Sc. EKONERG address: Koranska 5, 10000 Zagreb tel.: +385 1 6000 134 fax.: +385 1 6171 560 e-mail: andrea.hublin@ekonerg.hr	

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	**20581.35**	**69.63**	**1462.18**	**0.38**	**116.83**	**NO**	**22160.36**	**70.54**
A. Fuel Comb (Sectoral Appr.)	20165.40	10.11	212.24	0.56	116.83	NO	20494.48	65.24
1. Energy Industries	7126.54	0.17	3.61	0.06	13.63	NO	7143.78	22.74
2. Man. Ind. and Constr.	5447.30	0.48	10.08	0.09	17.96	NO	5475.33	17.43
3. Transport	3985.80	2.05	43.06	0.25	52.65	NO	4081.51	12.99
4. Comm./Inst, Resid., Agric.	3605.76	7.40	155.50	0.16	32.59	NO	3793.85	12.08
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	5.15
2. Industrial Processes	**2430.30**	**0.78**	**16.45**	**2.59**	**804.08**	**947.58**	**4198.41**	**13.36**
A. Mineral Products	1323.65	NE,NO	NE,NO	NE,NO	NE,NO	NO	1323.65	4.21
B. Chemical Industry	870.99	16.45	16.45	2.59	804.08	NO	1691.52	5.38
C. Metal Production	235.67	NE,NO	NE,NO	NO	NO	936.56	1172.23	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	**96.23**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**130.95**	**0.42**
4. Agriculture	**NO**	**69.71**	**1463.85**	**9.27**	**2872.20**	**NO**	**4336.05**	**13.80**
A. Enteric Fermentation	NO	58.85	1235.80	0.00	0.00	NO	1235.80	3.93
B. Manure Management	NO	10.86	228.05	1.23	380.04	NO	608.09	1.94
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	8.04	2492.16	NO	2492.16	7.93
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,N O
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**	**-13.32**
A. Forest Land	-4184.93	0.00	0.01	0.00	0.00	NO	-4184.92	-13.32
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	**0.04**	**23.81**	**499.94**	**0.29**	**90.24**	**NO**	**590.22**	**1.88**
A. Solid Waste Disp. on Land	NE,NO	10.53	221.21	0.00	0.00	NO	221.21	0.70
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	**18922.99**	**163.93**	**3442.43**	**12.53**	**3883.34**	**947.58**	**27231.06**	**86.68**
Total Emissions without LUCF	**23107.92**	**163.92**	**3442.43**	**12.53**	**3883.34**	**947.58**	**31415.98**	**100.0**
Share of Gases in Total Em./Rem.	**69.49**		**12.64**		**14.26**		**100.00**	
Share of Gases in Total Emissions	**73.55**		**10.96**		**12.36**		**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	**15074.54**	**62.41**	**1310.67**	**0.27**	**83.54**	**NO**	**16468.74**	**66.26**
A. Fuel Comb (Sectoral Appr.)	14618.71	6.69	140.48	0.40	83.54	NO	14842.72	59.72
1. Energy Industries	4768.18	0.11	2.27	0.04	9.03	NO	4779.47	19.23
2. Man. Ind. and Constr.	3882.52	0.37	7.70	0.06	13.10	NO	3903.32	15.70
3. Transport	2932.15	1.55	32.62	0.19	39.64	NO	3004.40	12.09
4. Comm./Inst, Resid., Agric.	3035.86	4.66	97.89	0.10	21.77	NO	3155.53	12.70
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	6.54
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	6.37
2. Industrial Processes	**2024.14**	**0.58**	**12.26**	**2.28**	**706.28**	**653.29**	**3395.96**	**13.66**
A. Mineral Products	870.62	NE,NO	NE,NO	NE,NO	NE,NO	NO	870.62	3.50
B. Chemical Industry	928.55	12.26	12.26	2.28	706.28	NO	1647.08	6.63
C. Metal Production	224.97	NE,NO	NE,NO	NO	NO	642.44	867.41	3.49
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	10.85	10.85	0.04
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**93.82**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**128.54**	**0.52**
4. Agriculture	**NO**	**68.60**	**1440.50**	**9.13**	**2830.76**	**NO**	**4271.26**	**17.19**
A. Enteric Fermentation	NO	57.90	1215.98	0.00	0.00	NO	1215.98	4.89
B. Manure Management	NO	10.69	224.52	1.14	354.83	NO	579.35	2.33
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.99	2475.93	NO	2475.93	9.96
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	**-8699.64**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8699.63**	**-35.00**
A. Forest Land	-8699.64	0.00	0.01	0.00	0.00	NO	-8699.63	-35.00
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	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	**0.04**	**24.06**	**505.21**	**0.27**	**84.27**	**NO**	**589.52**	**2.37**
A. Solid Waste Disp. on Land	NE,NO	11.12	233.57	0.00	0.00	NO	233.57	0.94
B. Waste-water Handling	0.00	12.93	271.63	0.27	84.27	NO	355.90	1.43
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	**8492.89**	**155.65**	**3268.64**	**11.95**	**3704.84**	**653.29**	**16154.38**	**65.00**
Total Emissions without LUCF	**17192.54**	**155.65**	**3268.64**	**11.95**	**3704.84**	**653.29**	**24854.02**	**100.0**
Share of Gases in Total Em./Rem.	**52.57**		**20.23**		**22.93**		**100.00**	
Share of Gases in Total Emissions	**69.17**		**13.15**		**14.91**		**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	**14280.88**	**61.13**	**1283.75**	**0.24**	**73.31**	**NO**	**15637.95**	**67.70**
A. Fuel Comb (Sectoral Appr.)	13803.55	5.47	114.81	0.35	73.31	NO	13991.67	60.58
1. Energy Industries	5338.81	0.11	2.35	0.05	9.79	NO	5350.95	23.17
2. Man. Ind. and Constr.	3087.45	0.30	6.26	0.05	9.97	NO	3103.68	13.44
3. Transport	2828.14	1.37	28.70	0.17	35.13	NO	2891.97	12.52
4. Comm./Inst, Resid., Agric.	2549.15	3.69	77.50	0.09	18.43	NO	2645.07	11.45
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	477.33	55.66	1168.94	NO	NO	NO	1646.27	7.13
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	6.98
2. Industrial Processes	**2204.00**	**0.51**	**10.71**	**2.98**	**923.47**	**10.85**	**3149.03**	**13.63**
A. Mineral Products	930.19	NE,NO	NE,NO	NE,NO	NE,NO	NO	930.19	4.03
B. Chemical Industry	1182.05	10.71	10.71	2.98	923.47	NO	2116.23	9.16
C. Metal Production	91.76	NE,NO	NE,NO	NO	NO	NO	91.76	0.40
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	10.85	10.85	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**76.73**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**111.45**	**0.48**
4. Agriculture	**NO**	**51.47**	**1080.89**	**8.16**	**2529.72**	**NO**	**3610.61**	**15.63**
A. Enteric Fermentation	NO	43.37	910.73	0.00	0.00	NO	910.73	3.94
B. Manure Management	NO	8.10	170.16	0.91	283.63	NO	453.79	1.96
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.25	2246.08	NO	2246.08	9.72
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	**-9294.33**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-9294.32**	**-40.24**
A. Forest Land	-9294.33	0.00	0.00	0.00	0.00	NO	-9294.32	-40.24
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	**0.04**	**24.30**	**510.38**	**0.25**	**78.34**	**NO**	**588.76**	**2.55**
A. Solid Waste Disp. on Land	NE,NO	11.71	245.84	0.00	0.00	NO	245.84	1.06
B. Waste-water Handling	0.00	12.60	264.54	0.25	78.34	NO	342.87	1.48
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**7267.32**	**137.42**	**2885.74**	**11.63**	**3604.84**	**10.85**	**13803.47**	**59.76**
Total Emissions without LUCF	**16561.65**	**137.42**	**2885.74**	**11.63**	**3604.84**	**10.85**	**23097.79**	**100.0**
Share of Gases in Total Em./Rem.	**52.65**		**20.91**		**26.12**		**100.00**	
Share of Gases in Total Emissions	**71.70**		**12.49**		**15.61**		**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	**15120.96**	**67.34**	**1414.11**	**0.24**	**75.42**	**NO**	**16610.49**	**71.94**
A. Fuel Comb (Sectoral Appr.)	14444.85	5.21	109.45	0.36	75.42	NO	14629.71	63.36
1. Energy Industries	5918.93	0.14	2.93	0.05	10.07	NO	5931.93	25.69
2. Man. Ind. and Constr.	3005.87	0.29	6.09	0.05	9.54	NO	3021.50	13.09
3. Transport	2988.84	1.35	28.36	0.18	38.41	NO	3055.61	13.23
4. Comm./Inst, Resid., Agric.	2531.21	3.43	72.06	0.08	17.40	NO	2620.67	11.35
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	8.58
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	8.44
2. Industrial Processes	**1776.66**	**0.54**	**11.30**	**2.25**	**696.15**	**10.92**	**2495.04**	**10.81**
A. Mineral Products	797.98	NE,NO	NE,NO	NE,NO	NE,NO	NO	797.98	3.46
B. Chemical Industry	945.15	11.30	11.30	2.25	696.15	NO	1652.61	7.16
C. Metal Production	33.53	NE,NO	NE,NO	NO	NO	NO	33.53	0.15
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	**81.68**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**116.40**	**0.50**
4. Agriculture	**NO**	**50.30**	**1056.40**	**7.15**	**2216.40**	**NO**	**3272.79**	**14.17**
A. Enteric Fermentation	NO	41.98	881.67	0.00	0.00	NO	881.67	3.82
B. Manure Management	NO	8.32	174.73	0.89	276.38	NO	451.11	1.95
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.26	1940.02	NO	1940.02	8.40
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	**-8036.66**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-8036.63**	**-34.81**
A. Forest Land	-8036.66	0.00	0.02	0.00	0.01	NO	-8036.63	-34.81
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	**0.04**	**24.58**	**516.16**	**0.25**	**77.64**	**NO**	**593.84**	**2.57**
A. Solid Waste Disp. on Land	NE,NO	12.32	258.72	0.00	0.00	NO	258.72	1.12
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	**8942.69**	**142.76**	**2998.00**	**9.89**	**3065.61**	**10.92**	**15051.94**	**65.19**
Total Emissions without LUCF	**16979.35**	**142.76**	**2998.00**	**9.89**	**3065.61**	**10.92**	**23088.57**	**100.0**
Share of Gases in Total Em./Rem.	**59.41**		**19.92**		**20.37**		**100.00**	
Share of Gases in Total Emissions	**73.54**		**12.98**		**13.28**		**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	**14233.18**	**60.99**	**1280.82**	**0.25**	**76.68**	**NO**	**15590.69**	**70.38**
A. Fuel Comb (Sectoral Appr.)	13628.31	5.49	115.32	0.37	76.68	NO	13820.32	62.39
1. Energy Industries	4670.54	0.12	2.48	0.04	7.45	NO	4680.47	21.13
2. Man. Ind. and Constr.	3175.64	0.28	5.90	0.04	8.96	NO	3190.50	14.40
3. Transport	3166.34	1.47	30.83	0.20	41.69	NO	3238.86	14.62
4. Comm./Inst, Resid., Agric.	2615.80	3.62	76.11	0.09	18.58	NO	2710.49	12.24
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	7.99
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	7.86
2. Industrial Processes	**1960.62**	**0.52**	**10.90**	**2.43**	**752.82**	**11.20**	**2735.54**	**12.35**
A. Mineral Products	963.54	NE,NO	NE,NO	NE,NO	NE,NO	NO	963.54	4.35
B. Chemical Industry	964.02	10.90	10.90	2.43	752.82	NO	1727.74	7.80
C. Metal Production	33.06	NE,NO	NE,NO	NO	NO	NO	33.06	0.15
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	11.20	11.20	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**89.23**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**123.95**	**0.56**
4. Agriculture	**NO**	**46.29**	**972.14**	**7.17**	**2221.86**	**NO**	**3194.00**	**14.42**
A. Enteric Fermentation	NO	37.94	796.75	0.00	0.00	NO	796.75	3.60
B. Manure Management	NO	8.35	175.39	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	6.34	1964.42	NO	1964.42	8.87
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	**-8658.34**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8658.32**	**-39.08**
A. Forest Land	-8658.34	0.00	0.01	0.00	0.00	NO	-8658.32	-39.08
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	**0.04**	**20.43**	**429.02**	**0.26**	**79.49**	**NO**	**508.55**	**2.30**
A. Solid Waste Disp. on Land	NE,NO	12.98	272.60	0.00	0.00	NO	272.60	1.23
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	**7624.73**	**128.23**	**2692.90**	**10.10**	**3130.85**	**11.20**	**13494.40**	**60.92**
Total Emissions without LUCF	**16283.07**	**128.23**	**2692.90**	**10.10**	**3130.85**	**11.20**	**22152.73**	**100.0**
Share of Gases in Total Em./Rem.	**56.50**		**19.96**		**23.20**		**100.00**	
Share of Gases in Total Emissions	**73.50**		**12.16**		**14.13**		**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	**15090.25**	**61.47**	**1290.81**	**0.26**	**81.57**	**NO**	**16462.64**	**71.78**
A. Fuel Comb (Sectoral Appr.)	14393.33	5.66	118.90	0.39	81.57	NO	14593.79	63.63
1. Energy Industries	5262.46	0.14	2.93	0.05	9.58	NO	5274.96	23.00
2. Man. Ind. and Constr.	2928.27	0.26	5.56	0.04	8.79	NO	2942.63	12.83
3. Transport	3377.05	1.54	32.40	0.21	44.12	NO	3453.57	15.06
4. Comm./Inst, Resid., Agric.	2825.55	3.71	78.00	0.09	19.09	NO	2922.64	12.74
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	8.15
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	8.05
2. Industrial Processes	**1821.56**	**0.45**	**9.40**	**2.34**	**723.99**	**19.50**	**2574.45**	**11.23**
A. Mineral Products	743.86	NE,NO	NE,NO	NE,NO	NE,NO	NO	743.86	3.24
B. Chemical Industry	1044.28	9.40	9.40	2.34	723.99	NO	1777.67	7.75
C. Metal Production	33.42	NE,NO	NE,NO	NO	NO	NO	33.42	0.15
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	19.50	19.50	0.09
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**89.07**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**123.79**	**0.54**
4. Agriculture	**NO**	**44.05**	**925.05**	**6.84**	**2121.04**	**NO**	**3046.09**	**13.28**
A. Enteric Fermentation	NO	36.53	767.19	0.00	0.00	NO	767.19	3.35
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	6.06	1878.98	NO	1878.98	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	**-9154.24**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-9154.24**	**-39.92**
A. Forest Land	-9154.24	0.00	0.00	0.00	0.00	NO	-9154.24	-39.92
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	**0.04**	**30.54**	**641.28**	**0.28**	**85.67**	**NO**	**727.00**	**3.17**
A. Solid Waste Disp. on Land	NE,NO	13.74	288.59	0.00	0.00	NO	288.59	1.26
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	**7846.68**	**136.50**	**2866.55**	**9.72**	**3012.28**	**19.50**	**13779.73**	**60.08**
Total Emissions without LUCF	**17000.92**	**136.50**	**2866.55**	**9.72**	**3012.28**	**19.50**	**22933.97**	**100.0**
Share of Gases in Total Em./Rem.	**56.94**		**20.80**		**21.86**		**100.00**	
Share of Gases in Total Emissions	**74.13**		**12.50**		**13.13**		**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	**15599.11**	**62.14**	**1304.87**	**0.29**	**90.95**	**NO**	**16994.9**	**72.43**
A. Fuel Comb (Sectoral Appr.)	14955.07	6.60	138.57	0.43	90.95	NO	15184.6	64.72
1. Energy Industries	5110.55	0.13	2.80	0.04	8.83	NO	5122.2	21.83
2. Man. Ind. and Constr.	2972.45	0.27	5.58	0.04	8.76	NO	2986.8	12.73
3. Transport	3643.03	1.66	34.76	0.24	50.33	NO	3728.1	15.89
4. Comm./Inst, Resid., Agric.	3229.05	4.54	95.42	0.11	23.03	NO	3347.5	14.27
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	7.72
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	7.64
2. Industrial Processes	**1843.60**	**0.42**	**8.81**	**2.17**	**674.11**	**72.27**	**2598.8**	**11.08**
A. Mineral Products	827.84	NE,NO	NE,NO	NE,NO	NE,NO	NO	827.8	3.53
B. Chemical Industry	1000.20	8.81	8.81	2.17	674.11	NO	1683.1	7.17
C. Metal Production	15.55	NE,NO	NE,NO	NO	NO	NO	15.6	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	72.27	72.3	0.31
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**97.80**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**132.5**	**0.56**
4. Agriculture	**NO**	**42.23**	**886.91**	**6.92**	**2143.88**	**NO**	**3030.8**	**12.92**
A. Enteric Fermentation	NO	34.82	731.23	0.00	0.00	NO	731.2	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	6.18	1916.24	NO	1916.2	8.17
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	**-9489.96**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-9490.0**	**-40.45**
A. Forest Land	-9489.96	0.00	0.01	0.00	0.00	NO	-9490.0	-40.45
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	**0.04**	**29.72**	**624.08**	**0.26**	**81.31**	**NO**	**705.4**	**3.01**
A. Solid Waste Disp. on Land	NE,NO	14.57	305.92	0.00	0.00	NO	305.9	1.30
B. Waste-water Handling	0.00	15.15	318.16	0.26	81.31	NO	399.5	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	**8050.58**	**134.51**	**2824.67**	**9.65**	**2990.26**	**72.27**	**13972.5**	**59.55**
Total Emissions without LUCF	**17540.55**	**134.51**	**2824.67**	**9.65**	**2990.26**	**72.27**	**23462.5**	**100.0**
Share of Gases in Total Em./Rem.	**57.62**		**20.22**		**21.40**		**100.0**	
Share of Gases in Total Emissions	**74.76**		**12.04**		**12.74**		**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	**16457.13**	**65.22**	**1369.67**	**0.32**	**99.58**	**NO**	**17926.39**	**72.15**
A. Fuel Comb (Sectoral Appr.)	15857.36	6.67	139.99	0.47	99.58	NO	16096.93	64.78
1. Energy Industries	5593.10	0.12	2.62	0.05	10.65	NO	5606.36	22.56
2. Man. Ind. and Constr.	3000.47	0.29	6.13	0.04	9.41	NO	3016.02	12.14
3. Transport	3983.55	1.74	36.57	0.27	56.57	NO	4076.69	16.41
4. Comm./Inst, Resid., Agric.	3280.24	4.51	94.67	0.11	22.95	NO	3397.86	13.68
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	**2073.36**	**0.39**	**8.10**	**2.29**	**708.49**	**103.16**	**2893.12**	**11.64**
A. Mineral Products	934.42	NE,NO	NE,NO	NE,NO	NE,NO	NO	934.42	3.76
B. Chemical Industry	1094.24	8.10	8.10	2.29	708.49	NO	1810.84	7.29
C. Metal Production	44.70	NE,NO	NE,NO	NO	NO	NO	44.70	0.18
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	103.16	103.16	0.42
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**85.89**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**120.61**	**0.49**
4. Agriculture	**NO**	**41.90**	**879.99**	**7.71**	**2390.45**	**NO**	**3270.43**	**13.16**
A. Enteric Fermentation	NO	34.63	727.21	0.00	0.00	NO	727.21	2.93
B. Manure Management	NO	7.27	152.77	0.72	223.74	NO	376.51	1.52
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.99	2166.71	NO	2166.71	8.72
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	**-8202.94**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8202.93**	**-33.01**
A. Forest Land	-8202.94	0.00	0.01	0.00	0.00	NO	-8202.93	-33.01
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	**0.04**	**26.41**	**554.59**	**0.26**	**81.68**	**NO**	**636.32**	**2.56**
A. Solid Waste Disp. on Land	NE,NO	15.48	325.17	0.00	0.00	NO	325.17	1.31
B. Waste-water Handling	0.00	10.92	229.42	0.26	81.68	NO	311.10	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	**10413.48**	**133.92**	**2812.37**	**10.58**	**3280.21**	**103.16**	**16643.94**	**66.99**
Total Emissions without LUCF	**18616.43**	**133.92**	**2812.37**	**10.58**	**3280.21**	**103.16**	**24846.87**	**100.0**
Share of Gases in Total Em./Rem.	**62.57**		**16.90**		**19.71**		**100.00**	
Share of Gases in Total Emissions	**74.92**		**11.32**		**13.20**		**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	**17473.73**	**57.55**	**1208.45**	**0.34**	**104.35**	**NO**	**18786.53**	**75.27**
A. Fuel Comb (Sectoral Appr.)	16884.56	6.46	135.63	0.50	104.35	NO	17124.54	68.61
1. Energy Industries	6271.37	0.14	2.88	0.06	11.67	NO	6285.91	25.19
2. Man. Ind. and Constr.	3286.89	0.30	6.20	0.05	9.59	NO	3302.68	13.23
3. Transport	4185.10	1.79	37.51	0.29	61.64	NO	4284.26	17.17
4. Comm./Inst, Resid., Agric.	3141.20	4.24	89.03	0.10	21.45	NO	3251.69	13.03
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	6.66
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	6.60
2. Industrial Processes	**1884.15**	**0.35**	**7.42**	**1.72**	**533.42**	**30.11**	**2455.11**	**9.84**
A. Mineral Products	1003.08	NE,NO	NE,NO	NE,NO	NE,NO	NO	1003.08	4.02
B. Chemical Industry	858.38	7.42	7.42	1.72	533.42	NO	1399.23	5.61
C. Metal Production	22.69	NE,NO	NE,NO	NO	NO	NO	22.69	0.09
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	30.11	30.11	0.12
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**91.48**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**126.20**	**0.51**
4. Agriculture	**NO**	**41.30**	**867.37**	**6.86**	**2125.49**	**NO**	**2992.86**	**11.99**
A. Enteric Fermentation	NO	34.14	716.85	0.00	0.00	NO	716.85	2.87
B. Manure Management	NO	7.17	150.52	0.70	217.94	NO	368.46	1.48
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.15	1907.55	NO	1907.55	7.64
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	**-6841.15**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-6841.12**	**-27.41**
A. Forest Land	-6841.15	0.00	0.02	0.00	0.01	NO	-6841.12	-27.41
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	**0.04**	**24.64**	**517.49**	**0.26**	**79.77**	**NO**	**597.30**	**2.39**
A. Solid Waste Disp. on Land	NE,NO	16.45	345.37	0.00	0.00	NO	345.37	1.38
B. Waste-water Handling	0.00	8.20	172.11	0.26	79.77	NO	251.89	1.01
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	**12608.25**	**123.85**	**2600.75**	**9.17**	**2843.04**	**30.11**	**18116.88**	**72.59**
Total Emissions without LUCF	**19449.40**	**123.84**	**2600.75**	**9.17**	**2843.04**	**30.11**	**24958.00**	**100.0**
Share of Gases in Total Em./Rem.	**69.59**		**14.36**		**15.69**		**100.00**	
Share of Gases in Total Emissions	**77.93**		**10.42**		**11.39**		**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	**17911.31**	**56.31**	**1182.58**	**0.35**	**109.18**	**NO**	**19203.08**	**73.57**
A. Fuel Comb (Sectoral Appr.)	17386.07	6.21	130.40	0.52	109.18	NO	17625.65	67.52
1. Energy Industries	6467.55	0.14	2.94	0.06	11.81	NO	6482.31	24.83
2. Man. Ind. and Constr.	2956.89	0.25	5.24	0.04	8.07	NO	2970.20	11.38
3. Transport	4412.45	1.81	38.03	0.33	68.31	NO	4518.78	17.31
4. Comm./Inst, Resid., Agric.	3549.17	4.01	84.19	0.10	20.99	NO	3654.36	14.00
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	6.04
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	6.03
2. Industrial Processes	**2303.80**	**0.31**	**6.61**	**2.03**	**629.42**	**21.68**	**2961.51**	**11.35**
A. Mineral Products	1251.83	NE,NO	NE,NO	NE,NO	NE,NO	NO	1251.83	4.80
B. Chemical Industry	1027.84	6.61	6.61	2.03	629.42	NO	1663.87	6.37
C. Metal Production	24.14	NE,NO	NE,NO	NO	NO	NO	24.14	0.09
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	21.68	21.68	0.08
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**82.10**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**116.82**	**0.45**
4. Agriculture	**NO**	**41.92**	**880.33**	**7.46**	**2311.94**	**NO**	**3192.27**	**12.23**
A. Enteric Fermentation	NO	33.98	713.52	0.00	0.00	NO	713.52	2.73
B. Manure Management	NO	7.94	166.81	0.72	222.83	NO	389.64	1.49
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.74	2089.11	NO	2089.11	8.00
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	**-8153.08**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-8153.08**	**-31.23**
A. Forest Land	-8153.08	0.00	0.00	0.00	0.00	NO	-8153.08	-31.23
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	**0.04**	**25.91**	**544.02**	**0.28**	**85.64**	**NO**	**629.70**	**2.41**
A. Solid Waste Disp. on Land	NE,NO	17.53	368.16	0.00	0.00	NO	368.16	1.41
B. Waste-water Handling	0.00	8.37	175.86	0.28	85.64	NO	261.50	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	**12144.17**	**124.45**	**2613.55**	**10.12**	**3136.18**	**21.68**	**17950.30**	**68.77**
Total Emissions without LUCF	**20297.25**	**124.45**	**2613.55**	**10.12**	**3136.18**	**21.68**	**26103.38**	**100.0**
Share of Gases in Total Em./Rem.	**67.65**		**14.56**		**17.47**		**100.00**	
Share of Gases in Total Emissions	**77.76**		**10.01**		**12.01**		**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	**17400.09**	**59.55**	**1250.50**	**0.37**	**115.25**	**NO**	**18765.84**	**72.53**
A. Fuel Comb (Sectoral Appr.)	16767.07	6.64	139.39	0.55	115.25	NO	17021.71	65.79
1. Energy Industries	5877.59	0.14	3.00	0.07	14.56	NO	5895.15	22.78
2. Man. Ind. and Constr.	3076.76	0.26	5.40	0.04	8.43	NO	3090.59	11.95
3. Transport	4423.56	1.74	36.62	0.33	69.15	NO	4529.33	17.51
4. Comm./Inst, Resid., Agric.	3389.15	4.49	94.38	0.11	23.11	NO	3506.65	13.55
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	6.74
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	6.74
2. Industrial Processes	**2446.22**	**0.33**	**6.91**	**2.39**	**740.65**	**35.49**	**3229.26**	**12.48**
A. Mineral Products	1408.89	NE,NO	NE,NO	NE,NO	NE,NO	NO	1408.89	5.45
B. Chemical Industry	1022.14	6.91	6.91	2.39	740.65	NO	1769.70	6.84
C. Metal Production	15.18	NE,NO	NE,NO	NO	NO	NO	15.18	0.06
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	35.49	35.49	0.14
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**80.47**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**115.19**	**0.45**
4. Agriculture	**NO**	**40.79**	**856.63**	**7.30**	**2263.47**	**NO**	**3120.10**	**12.06**
A. Enteric Fermentation	NO	33.42	701.73	0.00	0.00	NO	701.73	2.71
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	6.60	2047.39	NO	2047.39	7.91
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	**-5280.74**	**0.00**	**0.04**	**0.00**	**0.01**	**NO**	**-5280.69**	**-20.41**
A. Forest Land	-5280.74	0.00	0.04	0.00	0.01	NO	-5280.69	-20.41
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	**0.04**	**26.64**	**559.48**	**0.27**	**83.10**	**NO**	**642.63**	**2.48**
A. Solid Waste Disp. on Land	NE,NO	18.62	391.10	0.00	0.00	NO	391.10	1.51
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	**14646.06**	**127.31**	**2673.57**	**10.33**	**3202.48**	**35.49**	**20592.32**	**79.59**
Total Emissions without LUCF	**19926.81**	**127.31**	**2673.57**	**10.33**	**3202.48**	**35.49**	**25873.02**	**100.0**
Share of Gases in Total Em./Rem.	**71.12**		**12.98**		**15.55**		**100.00**	
Share of Gases in Total Emissions	**77.02**		**10.33**		**12.38**		**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	**18320.60**	**64.55**	**1355.48**	**0.56**	**173.78**	**NO**	**19849.86**	**73.15**
A. Fuel Comb (Sectoral Appr.)	17632.97	5.42	113.89	0.83	173.78	NO	17920.63	66.04
1. Energy Industries	6376.31	0.16	3.42	0.07	15.23	NO	6394.96	23.57
2. Man. Ind. and Constr.	3169.25	0.25	5.27	0.04	8.42	NO	3182.94	11.73
3. Transport	4481.72	1.50	31.44	0.62	130.83	NO	4643.99	17.11
4. Comm./Inst, Resid., Agric.	3605.68	3.51	73.76	0.09	19.30	NO	3698.74	13.63
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	7.11
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	7.11
2. Industrial Processes	**2465.67**	**0.34**	**7.13**	**2.01**	**622.93**	**61.89**	**3157.62**	**11.64**
A. Mineral Products	1617.54	NE,NO	NE,NO	NE,NO	NE,NO	NO	1617.54	5.96
B. Chemical Industry	841.32	7.13	7.13	2.01	622.93	NO	1471.38	5.42
C. Metal Production	6.81	NE,NO	NE,NO	NO	NO	NO	6.81	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	61.89	61.89	0.23
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**86.94**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**121.66**	**0.45**
4. Agriculture	**NO**	**41.67**	**875.01**	**7.85**	**2434.63**	**NO**	**3309.64**	**12.20**
A. Enteric Fermentation	NO	34.25	719.27	0.00	0.00	NO	719.27	2.65
B. Manure Management	NO	7.42	155.74	0.70	218.31	NO	374.05	1.38
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.15	2216.32	NO	2216.32	8.17
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	**-8213.80**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8213.78**	**-30.27**
A. Forest Land	-8213.80	0.00	0.01	0.00	0.00	NO	-8213.78	-30.27
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	**0.04**	**28.96**	**608.24**	**0.28**	**87.66**	**NO**	**695.95**	**2.56**
A. Solid Waste Disp. on Land	NE,NO	19.88	417.47	0.00	0.00	NO	417.47	1.54
B. Waste-water Handling	0.00	9.08	190.77	0.28	87.66	NO	278.44	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	**12659.46**	**135.52**	**2845.88**	**10.71**	**3319.00**	**61.89**	**18920.95**	**69.73**
Total Emissions without LUCF	**20873.26**	**135.52**	**2845.88**	**10.71**	**3319.00**	**61.89**	**27134.73**	**100.0**
Share of Gases in Total Em./Rem.	**66.91**		**15.04**		**17.54**		**100.00**	
Share of Gases in Total Emissions	**76.92**		**10.49**		**12.23**		**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	**19428.44**	**67.02**	**1407.41**	**0.38**	**116.69**	**NO**	**20952.55**	**74.58**
A. Fuel Comb (Sectoral Appr.)	18763.12	5.47	114.79	0.56	116.69	NO	18994.60	67.61
1. Energy Industries	7261.63	0.19	3.94	0.09	17.91	NO	7283.48	25.93
2. Man. Ind. and Constr.	3031.35	0.24	5.11	0.04	8.29	NO	3044.74	10.84
3. Transport	4778.34	1.45	30.42	0.34	70.73	NO	4879.49	17.37
4. Comm./Inst, Resid., Agric.	3691.81	3.59	75.33	0.09	19.75	NO	3786.89	13.48
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	6.97
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	6.97
2. Industrial Processes	**2371.62**	**0.29**	**6.05**	**1.95**	**604.67**	**63.07**	**3045.42**	**10.84**
A. Mineral Products	1606.25	NE,NO	NE,NO	NE,NO	NE,NO	NO	1606.25	5.72
B. Chemical Industry	763.57	6.05	6.05	1.95	604.67	NO	1374.29	4.89
C. Metal Production	1.81	NE,NO	NE,NO	NO	NO	NO	1.81	0.01
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	63.07	63.07	0.22
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**110.21**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**144.93**	**0.52**
4. Agriculture	**NO**	**41.32**	**867.78**	**7.78**	**2412.45**	**NO**	**3280.23**	**11.68**
A. Enteric Fermentation	NO	33.79	709.67	0.00	0.00	NO	709.67	2.53
B. Manure Management	NO	7.53	158.11	0.69	212.85	NO	370.96	1.32
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.10	2199.60	NO	2199.60	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	**-8205.61**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8205.61**	**-29.21**
A. Forest Land	-8205.61	0.00	0.01	0.00	0.00	NO	-8205.61	-29.21
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	**0.04**	**27.47**	**576.81**	**0.30**	**94.10**	**NO**	**670.95**	**2.39**
A. Solid Waste Disp. on Land	NE,NO	21.29	447.14	0.00	0.00	NO	447.14	1.59
B. Waste-water Handling	0.00	6.17	129.66	0.30	94.10	NO	223.77	0.80
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	**13704.71**	**136.10**	**2858.05**	**10.41**	**3227.92**	**63.07**	**19888.47**	**70.79**
Total Emissions without LUCF	**21910.32**	**136.10**	**2858.05**	**10.41**	**3227.92**	**63.07**	**28094.08**	**100.0**
Share of Gases in Total Em./Rem.	**68.91**		**14.37**		**16.23**		**100.00**	
Share of Gases in Total Emissions	**77.99**		**10.17**		**11.49**		**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
Year 2003	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20799.49**	**68.47**	**1437.92**	**0.41**	**128.08**	**NO**	**22365.49**	**75.04**
A. Fuel Comb (Sectoral Appr.)	20115.45	6.42	134.84	0.61	128.08	NO	20378.37	68.37
1. Energy Industries	7926.94	0.22	4.55	0.09	19.73	NO	7951.22	26.68
2. Man. Ind. and Constr.	3108.34	0.27	5.67	0.04	9.30	NO	3123.31	10.48
3. Transport	5160.08	1.37	28.77	0.36	75.18	NO	5264.03	17.66
4. Comm./Inst, Resid., Agric.	3920.10	4.56	95.85	0.11	23.86	NO	4039.81	13.55
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	6.67
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	6.67
2. Industrial Processes	**2501.41**	**0.31**	**6.59**	**1.84**	**570.01**	**178.14**	**3256.15**	**10.92**
A. Mineral Products	1601.30	NE,NO	NE,NO	NE,NO	NE,NO	NO	1601.30	5.37
B. Chemical Industry	871.96	6.59	6.59	1.84	570.01	NO	1448.56	4.86
C. Metal Production	28.14	NE,NO	NE,NO	NO	NO	NO	28.14	0.09
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	178.14	178.14	0.60
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**118.80**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**153.52**	**0.52**
4. Agriculture	**NO**	**43.23**	**907.78**	**7.28**	**2257.52**	**NO**	**3165.30**	**10.62**
A. Enteric Fermentation	NO	35.34	742.09	0.00	0.00	NO	742.09	2.49
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	6.56	2034.74	NO	2034.74	6.83
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	**-6917.48**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-6917.45**	**-23.21**
A. Forest Land	-6917.48	0.00	0.02	0.00	0.01	NO	-6917.45	-23.21
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	**0.04**	**36.70**	**770.76**	**0.30**	**93.98**	**NO**	**864.78**	**2.90**
A. Solid Waste Disp. on Land	NE,NO	22.86	479.97	0.00	0.00	NO	479.97	1.61
B. Waste-water Handling	0.00	13.85	290.79	0.30	93.98	NO	384.77	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	**16502.26**	**148.72**	**3123.08**	**9.84**	**3049.59**	**178.14**	**22887.79**	**76.79**
Total Emissions without LUCF	**23419.74**	**148.72**	**3123.08**	**9.84**	**3049.59**	**178.14**	**29805.24**	**100.0**
Share of Gases in Total Em./Rem.	**72.10**		**13.65**		**13.32**		**100.00**	
Share of Gases in Total Emissions	**78.58**		**10.48**		**10.23**		**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	**20208.33**	**69.61**	**1461.89**	**0.64**	**197.05**	**NO**	**21867.27**	**73.31**
A. Fuel Comb (Sectoral Appr.)	19498.33	6.23	130.80	0.94	197.05	NO	19826.18	66.47
1. Energy Industries	6813.84	0.21	4.40	0.08	17.75	NO	6835.99	22.92
2. Man. Ind. and Constr.	3552.43	0.32	6.76	0.05	11.12	NO	3570.31	11.97
3. Transport	5298.55	1.27	26.72	0.69	144.98	NO	5470.24	18.34
4. Comm./Inst, Resid., Agric.	3833.52	4.42	92.92	0.11	23.20	NO	3949.64	13.24
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	6.84
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	6.84
2. Industrial Processes	**2613.06**	**0.31**	**6.41**	**2.24**	**695.54**	**203.87**	**3518.87**	**11.80**
A. Mineral Products	1698.92	NE,NO	NE,NO	NE,NO	NE,NO	NO	1698.92	5.70
B. Chemical Industry	908.33	6.41	6.41	2.24	695.54	NO	1610.28	5.40
C. Metal Production	5.81	NE,NO	NE,NO	NO	NO	NO	5.81	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	203.87	203.87	0.68
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**143.40**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**178.12**	**0.60**
4. Agriculture	**NO**	**45.25**	**950.32**	**8.02**	**2485.90**	**NO**	**3436.22**	**11.52**
A. Enteric Fermentation	NO	36.75	771.66	0.00	0.00	NO	771.66	2.59
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	7.28	2258.17	NO	2258.17	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	**-8508.04**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-8508.04**	**-28.53**
A. Forest Land	-8508.04	0.00	0.00	0.00	0.00	NO	-8508.04	-28.53
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	**0.04**	**34.90**	**732.80**	**0.30**	**93.20**	**NO**	**826.04**	**2.77**
A. Solid Waste Disp. on Land	NE,NO	24.56	515.76	0.00	0.00	NO	515.76	1.73
B. Waste-water Handling	0.00	10.34	217.05	0.30	93.20	NO	310.25	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	**14456.79**	**150.07**	**3151.43**	**11.20**	**3471.68**	**203.87**	**21318.49**	**71.47**
Total Emissions without LUCF	**22964.83**	**150.07**	**3151.43**	**11.20**	**3471.68**	**203.87**	**29826.53**	**100.0**
Share of Gases in Total Em./Rem.	**67.81**		**14.78**		**16.28**		**100.00**	
Share of Gases in Total Emissions	**76.99**		**10.57**		**11.64**		**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	**20568.53**	**69.30**	**1455.36**	**0.65**	**202.02**	**NO**	**22225.91**	**73.13**
A. Fuel Comb (Sectoral Appr.)	19877.53	5.94	124.84	0.96	202.02	NO	20204.40	66.48
1. Energy Industries	6841.09	0.20	4.26	0.09	18.45	NO	6863.80	22.59
2. Man. Ind. and Constr.	3658.32	0.29	6.13	0.05	10.16	NO	3674.61	12.09
3. Transport	5511.17	1.17	24.57	0.72	151.18	NO	5686.92	18.71
4. Comm./Inst, Resid., Agric.	3866.95	4.28	89.88	0.11	22.24	NO	3979.06	13.09
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	6.65
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	6.65
2. Industrial Processes	**2640.79**	**0.29**	**6.01**	**2.19**	**679.04**	**365.02**	**3690.86**	**12.14**
A. Mineral Products	1741.91	NE,NO	NE,NO	NE,NO	NE,NO	NO	1741.91	5.73
B. Chemical Industry	894.63	6.01	6.01	2.19	679.04	NO	1579.67	5.20
C. Metal Production	4.26	NE,NO	NE,NO	NO	NO	NO	4.26	0.01
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	365.02	365.02	1.20
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**168.66**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**203.38**	**0.67**
4. Agriculture	**NO**	**45.78**	**961.34**	**8.09**	**2509.13**	**NO**	**3470.47**	**11.42**
A. Enteric Fermentation	NO	38.37	805.76	0.00	0.00	NO	805.76	2.65
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	7.37	2285.10	NO	2285.10	7.52
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	**-8227.41**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-8227.40**	**-27.07**
A. Forest Land	-8227.41	0.00	0.00	0.00	0.00	NO	-8227.40	-27.07
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	**0.03**	**33.62**	**705.99**	**0.30**	**93.64**	**NO**	**799.67**	**2.63**
A. Solid Waste Disp. on Land	NE,NO	26.81	563.07	0.00	0.00	NO	563.07	1.85
B. Waste-water Handling	0.00	6.81	142.92	0.30	93.64	NO	236.56	0.78
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	**15150.61**	**148.99**	**3128.70**	**11.24**	**3483.84**	**365.02**	**22162.89**	**72.93**
Total Emissions without LUCF	**23378.01**	**148.99**	**3128.70**	**11.24**	**3483.84**	**365.02**	**30390.29**	**100.0**
Share of Gases in Total Em./Rem.	**68.36**		**14.12**		**15.72**		**100.00**	
Share of Gases in Total Emissions	**76.93**		**10.30**		**11.46**		**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	**20576.09**	**75.96**	**1595.13**	**0.67**	**207.11**	**NO**	**22378.33**	**72.60**
A. Fuel Comb (Sectoral Appr.)	19913.09	5.88	123.39	0.99	207.11	NO	20243.59	65.67
1. Energy Industries	6629.02	0.19	4.05	0.08	17.31	NO	6650.38	21.57
2. Man. Ind. and Constr.	3780.30	0.30	6.35	0.05	10.85	NO	3797.50	12.32
3. Transport	5873.88	1.14	24.00	0.75	157.05	NO	6054.94	19.64
4. Comm./Inst, Resid., Agric.	3629.88	4.24	88.99	0.10	21.90	NO	3740.77	12.14
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	6.93
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	6.93
2. Industrial Processes	**2747.09**	**0.37**	**7.74**	**2.17**	**671.40**	**447.17**	**3873.40**	**12.57**
A. Mineral Products	1871.63	NE,NO	NE,NO	NE,NO	NE,NO	NO	1871.63	6.07
B. Chemical Industry	870.40	7.74	7.74	2.17	671.40	NO	1549.55	5.03
C. Metal Production	5.05	NE,NO	NE,NO	NO	NO	NO	5.05	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	447.17	447.17	1.45
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**196.57**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**231.29**	**0.75**
4. Agriculture	**NO**	**47.69**	**1001.51**	**8.02**	**2485.35**	**NO**	**3486.86**	**11.31**
A. Enteric Fermentation	NO	39.12	821.59	0.00	0.00	NO	821.59	2.67
B. Manure Management	NO	8.57	179.91	0.75	231.80	NO	411.72	1.34
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.27	2253.55	NO	2253.55	7.31
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	**-9017.83**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-9017.83**	**-29.26**
A. Forest Land	-9017.83	0.00	0.00	0.00	0.00	NO	-9017.83	-29.26
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	**0.04**	**35.84**	**752.66**	**0.33**	**101.99**	**NO**	**854.70**	**2.77**
A. Solid Waste Disp. on Land	NE,NO	26.68	560.32	0.00	0.00	NO	560.32	1.82
B. Waste-water Handling	0.00	9.16	192.35	0.33	101.99	NO	294.34	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	**14501.95**	**159.86**	**3357.04**	**11.18**	**3465.86**	**447.17**	**21806.74**	**70.74**
Total Emissions without LUCF	**23519.79**	**159.86**	**3357.04**	**11.18**	**3465.86**	**447.17**	**30824.58**	**100.0**
Share of Gases in Total Em./Rem.	**66.50**		**15.39**		**15.89**		**100.00**	
Share of Gases in Total Emissions	**76.30**		**10.89**		**11.24**		**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	**21761.86**	**82.26**	**1727.50**	**0.45**	**139.00**	**NO**	**23628.36**	**73.23**
A. Fuel Comb (Sectoral Appr.)	21096.86	5.22	109.70	0.66	139.00	NO	21345.56	66.16
1. Energy Industries	7737.32	0.22	4.69	0.09	18.94	NO	7760.95	24.05
2. Man. Ind. and Constr.	3762.30	0.31	6.58	0.05	10.73	NO	3779.61	11.71
3. Transport	6295.82	1.10	23.01	0.43	90.53	NO	6409.36	19.86
4. Comm./Inst, Resid., Agric.	3301.42	3.59	75.41	0.09	18.81	NO	3395.64	10.52
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	7.08
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	7.08
2. Industrial Processes	**2851.37**	**0.34**	**7.14**	**2.39**	**741.61**	**481.86**	**4081.99**	**12.65**
A. Mineral Products	1901.24	NE,NO	NE,NO	NE,NO	NE,NO	NO	1901.24	5.89
B. Chemical Industry	945.00	7.14	7.14	2.39	741.61	NO	1693.75	5.25
C. Metal Production	5.13	NE,NO	NE,NO	NO	NO	NO	5.13	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	481.86	481.86	1.49
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NO
3. Solvent and Other Product Use	**201.00**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**235.72**	**0.73**
4. Agriculture	**NO**	**45.62**	**958.09**	**7.98**	**2474.12**	**NO**	**3432.21**	**10.64**
A. Enteric Fermentation	NO	37.70	791.66	0.00	0.00	NO	791.66	2.45
B. Manure Management	NO	7.93	166.44	0.72	222.15	NO	388.59	1.20
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.26	2251.96	NO	2251.96	6.98
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	**-7989.60**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-7989.59**	**-24.76**
A. Forest Land	-7989.60	0.00	0.01	0.00	0.00	NO	-7989.59	-24.76
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	**0.08**	**37.24**	**781.95**	**0.34**	**105.05**	**NO**	**887.08**	**2.75**
A. Solid Waste Disp. on Land	NE,NO	28.70	602.71	0.00	0.00	NO	602.71	1.87
B. Waste-water Handling	0.00	8.53	179.23	0.34	105.05	NO	284.29	0.88
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	**16824.72**	**165.46**	**3474.69**	**11.16**	**3459.79**	**481.86**	**24275.78**	**75.24**
Total Emissions without LUCF	**24814.32**	**165.46**	**3474.69**	**11.16**	**3459.79**	**481.86**	**32265.37**	**100.0**
Share of Gases in Total Em./Rem.	**69.31**		**14.31**		**14.25**		**100.00**	
Share of Gases in Total Emissions	**76.91**		**10.77**		**10.72**		**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	**20702.91**	**77.89**	**1635.70**	**0.43**	**133.98**	**NO**	**22472.59**	**72.58**
A. Fuel Comb (Sectoral Appr.)	20036.91	5.20	109.12	0.64	133.98	NO	20280.01	65.50
1. Energy Industries	6703.90	0.19	3.90	0.08	17.36	NO	6725.15	21.72
2. Man. Ind. and Constr.	3768.11	0.29	6.16	0.05	9.83	NO	3784.11	12.22
3. Transport	6133.84	0.98	20.62	0.42	87.39	NO	6241.84	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	666.00	72.69	1526.58	NO	NO	NO	2192.58	7.08
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	666.00	72.69	1526.58	NO	NO	NO	2192.58	7.08
2. Industrial Processes	**2766.29**	**0.26**	**5.49**	**2.44**	**756.86**	**601.73**	**4130.37**	**13.34**
A. Mineral Products	1815.17	NE,NO	NE,NO	NE,NO	NE,NO	NO	1815.17	5.86
B. Chemical Industry	942.51	5.49	5.49	2.44	756.86	NO	1704.86	5.51
C. Metal Production	8.61	NE,NO	NE,NO	NO	NO	NO	8.61	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	NA,NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	601.73	601.73	1.94
G. Other	NO	NO	NO	NO	NO	NO	NA,NO	NO
3. Solvent and Other Product Use	**46.81**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**81.53**	**0.26**
4. Agriculture	**NO**	**43.44**	**912.20**	**7.86**	**2437.04**	**NO**	**3349.24**	**10.82**
A. Enteric Fermentation	NO	36.57	767.96	0.00	0.00	NO	767.96	2.48
B. Manure Management	NO	6.87	144.24	0.68	209.80	NO	354.04	1.14
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.18	2227.24	NO	2227.24	7.19
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	**-6478.72**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-6478.70**	**-20.92**
A. Forest Land	-6478.72	0.00	0.01	0.00	0.00	NO	-6478.70	-20.92
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	**0.25**	**39.10**	**821.09**	**0.35**	**108.16**	**NO**	**929.50**	**3.00**
A. Solid Waste Disp. on Land	NE,NO	31.19	655.00	0.00	0.00	NO	655.00	2.12
B. Waste-water Handling	0.00	7.91	166.09	0.35	108.16	NO	274.25	0.89
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	**17037.54**	**160.69**	**3374.51**	**11.08**	**3436.04**	**601.73**	**24484.54**	**79.08**
Total Emissions without LUCF	**23516.26**	**160.69**	**3374.51**	**11.08**	**3436.04**	**601.73**	**30963.24**	**100.0**
Share of Gases in Total Em./Rem.	**69.58**		**13.78**		**14.03**		**100.00**	
Share of Gases in Total Emissions	**75.95**		**10.90**		**11.10**		**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	

ANNEX 8

CO_2 EMISSION FACTORS, OXIDATION FACTORS AND NATIONAL NET CALORIFIC VALUES (needed for CO_2 monitoring plan preparation)

Table A8-1: National net calorific values, CO_2 emission factors and oxidation factors for 1990 and 2008

Fuel	Net Caloric Value			Carbon emission factor[13] (t C/TJ)	CO_2 emission factor (t CO_2/TJ) (with OF=1.0)	Real oxidation factor (OF)
	Unit	1990	2008			
SOLID FUELS						
Anthracite	TJ/Gg	29.29	-	26.8	98.27	0.98
Other Bituminous Coal	TJ/Gg	25.14	24.90	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	11.80	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	-	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	19.62	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

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