**Republic of Croatia**

**Ministry of Environmental Protection,**
**Physical Planning and Construction**

# NATIONAL INVENTORY REPORT 2009

**Submission to the UNFCCC and the Kyoto Protocol**

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

Ordered by: Croatian Environment Agency

Contract No.: 10-08-653/01

Title:

# NATIONAL INVENTORY REPORT 2009

**Croatian greenhouse gas inventory**
**for the period 1990-2007**

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Zagreb, May 2009

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# LIST OF ABBREVIATIONS

*CBS - Central Bureau of Statistics*
*CFC - Chlorofluorocarbons*
*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*
*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*
*NMVOC - Non-methane Volatile organic Compounds*
*UNECE - United Nations Economic Commission for Europe*
UNFCCC - United Nations Framework Convention on Climate Change
*ZGOS - Zagreb's Environmental Protection and Waste Management Company*

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# EXECUTIVE SUMMARY

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

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

The Republic of Croatia signed the Kyoto Protocol on 11 March 1999. At the session of the Conference of Parties (COP 7) held in Marrakesh in 2001 the Republic of Croatia submitted a request for recognition of specific circumstances under Article 4, paragraph 6 of the Convention. The request was related to the increase of emissions level by 4.46 Mt $CO_2$-eq in the base year, i.e. 1990, based on the specific circumstance that Croatia has been integrated into the common economic, energy and infrastructural system of the former Yugoslavia in that year.

At the session of the COP 11 held in Montreal in 2005 the Decision 10/CP.11 was adopted allowing Croatia a certain degree of flexibility in determining the reference value of greenhouse gas emission levels compared to the historical level. At the session of the COP 12 held in Nairobi in 2006 the Decision 7/CP.12 was adopted allowing Croatia to add 3.5 Mt $CO_2$-eq to its 1990 level of greenhouse gas emissions for the purpose of establishing the level of emissions for the base year for implementation of its commitments under Article 4, paragraph 2, of 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

[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.

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 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 2007. 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 four reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005 and 2006. The latest in-country review in conjunction with the review of Croatia's Initial Report was held from 20th to 25th October 2008 during which the ERT formulated a review of Croatia's 2008 Inventory Submission. According to their recommendations, certain recalculations for the whole period from 1990 to 2006 were carried out. These recalculations are presented in the following documents:

- 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 (hereinafter: 'Resubmission of Croatia's 2008 Inventory Submission')
- CFR tables 'Official Resubmission 2008'
- National Inventory Report 2009

After the resubmission, additional corrections and recalculations were necessary due to either observed errors or because new and more accurate data were attained. These recalculations are presented and explained only within this report.

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 2009 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 2006. 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 1990-2007 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 1990-2007 (Gg $CO_2$-eq)*

| Source | Emissions and removals of GHG (Gg $CO_2$-eq) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base year[2] | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
| Energy | | 22149 | 16391 | 18822 | 22289 | 22416 | 23803 |
| Industrial Processes | | 4194 | 2573 | 3224 | 3682 | 3864 | 4073 |
| Solvent and Other Product Use | | 131 | 124 | 115 | 203 | 231 | 233 |
| Agriculture | | 4321 | 3045 | 3151 | 3464 | 3418 | 3410 |
| Waste | | 579 | 732 | 644 | 795 | 840 | 868 |
| **Total emission (excluding net $CO_2$ from LULUCF)** | **34845[3]** | **31374** | **22865** | **25955** | **30433** | **30769** | **32385** |
| Removals (LULUCF) | | -4185 | -9154 | -5281 | -7726 | -7490 | -6303 |
| **Total emission (including LULUCF)** | | **27189** | **13711** | **20675** | **22707** | **23279** | **26082** |

*Table ES.3-2: Emissions/removals of GHG by gases for the period 1990-2007 (Gg $CO_2$-eq)*

| Source | Emissions and removals of GHG (Gg $CO_2$-eq) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base year[2] | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
| Carbon dioxide ($CO_2$) | | 23105 | 16930 | 19955 | 23424 | 23528 | 24865 |
| Methane ($CH_4$) | | 3419 | 2853 | 2658 | 3124 | 3338 | 3481 |
| Nitrous oxide ($N_2O$) | | 3903 | 3063 | 3308 | 3519 | 3457 | 3556 |
| HFCs, PFCs and $SF_6$ | | 948 | 19 | 35 | 365 | 447 | 482 |
| **Total emission (excluding net $CO_2$ from LULUCF)** | **34845[3]** | **31374** | **22865** | **25955** | **30433** | **30769** | **32385** |
| Removals (LULUCF) | | -4185 | -9154 | -5281 | -7726 | -7490 | -6303 |
| **Total emission (including LULUCF)** | | **27189** | **13711** | **20675** | **22707** | **23279** | **26082** |

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 2007 has the Energy Sector with 73.5 percent, followed by Industrial Processes with 12.6 percent, Agriculture with 10.5 percent, Waste with 2.7 percent and Solvent and Other product

[2] See Annex 8: Decision 7/CP.12 Level of emissions for the base year of Croatia
[3] According to recalculated assigned amount reported to the ERT during the course of Initial Report review

Use with 0.7 percent. This structure is with minor changes consistent through all the observed period from 1990 to 2007. In the year 2007, the amount of removed emissions of the greenhouse gases by $CO_2$ from the forestry sector was 19.5 percent.

Energy sector is the largest contributor to greenhouse gas emissions. In this sector, in the year 2007, the total energy consumption was 6.5 percent higher than in the former year 2006, whereat the total largest increase was in consumption of gaseous fuels (14.3 percent) from the Energy Industries sector (27.5 percent). Increase in total energy consumption is mostly due to unfavourable hydrological conditions which leaded to decrease in hydro power utilisation by 27.4%. The $CO_2$ emission from Energy industries sector was 7662 Gg in 2007, representing 23.6 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 retained until 2006. However, in 2007, the number of cattle decreased by 3.5 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 2007. 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 1997-2007 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 2007, 3.2 millions of tons of clinker was produced. The ammonia production in 2007 was 8.6 percent higher in comparison to the previous year. Also, the nitric acid production in 2007 was 10.1 percent higher in comparison to 2006. 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 2007 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 2005-2007 have been included in emission estimation. It should be emphasized that Solid Waste Disposal on Land contributes with 69.5 percent in total sectoral emission in 2007. Waste sector contributes to total greenhouse gas emissions with 2.7 percent in 2007.

## 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 1990-2007 (Gg $CO_2$)*

| Sector | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Energy | 20583 | 15021 | 17434 | 20624 | 20594 | 21825 |
| Industrial processes | 2426 | 1820 | 2441 | 2632 | 2737 | 2842 |
| Solvent and Other Product Use | 96 | 89 | 80 | 169 | 197 | 198 |
| LULUCF | -4185 | -9154 | -5281 | -7726 | -7490 | -6303 |
| **Total $CO_2$ emission** | **23105** | **16930** | **19955** | **23424** | **23528** | **24865** |
| **Net $CO_2$ emission** | **18920** | **7776** | **14674** | **15698** | **16038** | **18562** |

### 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 73.5 percent in total greenhouse gas emission. $CO_2$ emission from fuel combustion makes the largest part of it (89 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 1990-2007 (Gg $CO_2$)*

| Source | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Energy Industries | 20483 | 14522 | 17078 | 20267 | 20281 | 7662 |
| Manufacturing Industries & Constr. | 7144 | 5198 | 5907 | 6889 | 6663 | 3892 |
| Transport (Road & Off-Road) | 5475 | 2943 | 3,091 | 3666 | 3762 | 6570 |
| Comm./Inst., Resid., Agr /For./Fish.) | 4070 | 3459 | 4573 | 5732 | 6116 | 3396 |
| Fugitive emissions | 1666 | 1869 | 1744 | 2021 | 2135 | 2283 |
| **Total $CO_2$ emission** | **22149** | **16391** | **18822** | **22289** | **22416** | **23803** |

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 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 |
|---|---|---|---|---|---|---|
| Reference appr. | 21204 | 15228 | 17948 | 21165 | 20923 | 22402 |
| Sectoral appr. | 20167 | 14324 | 16800 | 19933 | 19931 | 21160 |
| **Relative Diff (%)** | **5.1** | **6.3** | **6.8** | **6.2** | **5.0** | **5.9** |

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 2007, emission from Transport sector contributed with 20.3 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 1990-2007 (Gg $CO_2$)*

| ***Source*** | **1990** | **1995** | **2000** | **2005** | **2006** | **2007** |
|---|---|---|---|---|---|---|
| Cement production | 1085.8 | 628.7 | 1243.6 | 1499.9 | 1588.0 | 1612.0 |
| Lime production | 160.6 | 83.4 | 137.9 | 198.4 | 244.5 | 254.5 |
| Limestone and dolomite use | 51.5 | 17.4 | 13.4 | 21.4 | 18.9 | 16.8 |
| Soda ash production and use | 25.7 | 14.4 | 11.3 | 17.2 | 15.1 | 13.4 |
| Ammonia production | 871 | 1044.3 | 1022.1 | 894.6 | 870.4 | 945.0 |
| Ferroalloys production | 118.8 | 31.88 | 12.2 | 0.0 | 0.0 | 0.0 |
| Aluminum production | 113.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Iron and steel production | 0.8 | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 |
| ***Total $CO_2$ emission*** | **2425.6** | **1820.1** | **2440.9** | **2631.8** | **2737.3** | **2842.1** |

The most significant $CO_2$ industrial processes emission sources are production of cement, ammonia and lime. In 2007, 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 1996-2007 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 tones of $CO_2$ released per tone 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 42 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 total growing stock in the Croatian forests is around 398 million $m^3$. The most frequent species are Beech (*Fagus sylvatica*), Common Oak (*Quercus robur*), Sessile Oak (*Quercus petrea*), European Hornbeam (*Carpinus betulus*), Common Fir (*Abies alba*) and other types of deciduous and evergreen trees. The average growing stock in the state-owned forests is 190 $m^3$/ha and in the privately owned forests 80 $m^3$/ha. The annual increment in Croatian forests is around 10.5 million $m^3$ of wood. 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 ($m^3$, $m^3$/ha) or by the surface area. 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 1990-2007 (Gg $CO_2$)*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| ***Removals*** | 4185 | 9154 | 5281 | 7726 | 7490 | 6303 |

## 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 1990-2007 (Gg $CH_4$)*

| Source | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Energy | 69.1 | 61.1 | 59.3 | 69.7 | 76.3 | 82.7 |
| Industrial Processes | 0.8 | 0.5 | 0.3 | 0.3 | 0.4 | 0.3 |
| Agriculture | 69.1 | 43.8 | 40.3 | 45.2 | 46.4 | 45.5 |
| Waste | 23.8 | 30.5 | 26.6 | 33.6 | 35.8 | 37.3 |
| ***Total $CH_4$ emission*** | 162.8 | 135.9 | 126.6 | 148.8 | 159.0 | 165.8 |

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 accounts with about 0.6 percent; venting and flaring of gas/oil production accounts with approximately 2.3 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 1.5 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 1990-2007 (Gg $N_2O$)*

| Source | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Energy | 0.4 | 0.3 | 0.5 | 0.7 | 0.7 | 0.8 |
| Industrial Processes | 2.6 | 2.3 | 2.4 | 2.2 | 2.2 | 2.4 |
| Agriculture | 9.3 | 6.9 | 7.4 | 8.1 | 7.9 | 7.9 |
| Waste | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| ***Total $N_2O$ emission*** | 12.6 | 9.9 | 10.7 | 11.4 | 11.2 | 11.5 |

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 1990-2007 (Gg $CO_2$-eq)*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| ***HFC, PFC and $SF_6$ emission*** | 948 | 20 | 35 | 365 | 447 | 482 |

## 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 2007* Submission to the Convention on Long-range Transboundary Air Pollution'.

The calculations of aggregated results for the emissions of indirect gases in the period 1990-2007 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 |
| **$NO_x$ Emission** | **85.91** | **60.96** | **71.73** | **75.96** | **70.82** | **73.39** |
| Energy Industries | 13.61 | 10.30 | 11.99 | 12.04 | 11.15 | 13.39 |
| Manufacturing Ind. & Construction | 17.49 | 8.92 | 9.73 | 16.60 | 12.26 | 14.07 |
| Transport | 36.79 | 31.05 | 34.56 | 31.83 | 32.00 | 32.11 |
| Other Energy (fuel combustion) | 15.03 | 8.13 | 12.85 | 13.15 | 13.24 | 12.86 |
| Fugitive Emission from Fuels | 0.64 | 0.49 | 0.47 | 0.45 | 0.43 | 0.46 |
| Industrial Processes | 2.42 | 2.23 | 2.29 | 2.05 | 1.89 | 0.66 |
| Agriculture | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| LULUCF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO Emission** | **549.87** | **378.50** | **409.91** | **343.63** | **370.50** | **357.12** |
| Energy Industries | 1.54 | 0.99 | 1.21 | 0.93 | 1.35 | 1.89 |
| Manufacturing Ind. & Construction. | 40.44 | 41.26 | 37.82 | 32.60 | 36.69 | 44.84 |
| Transport | 252.38 | 186.59 | 193.90 | 159.40 | 159.45 | 159.48 |
| Other Energy (fuel combustion) | 203.98 | 116.74 | 146.47 | 133.02 | 133.47 | 115.58 |
| Fugitive Emission from Fuels | 0.64 | 0.44 | 0.33 | 0.32 | 0.31 | 0.33 |
| Industrial Processes | 46.57 | 32.44 | 30.00 | 17.24 | 39.11 | 34.87 |
| Agriculture | 4.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| LULUCF | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 | 0.01 |
| **NMVOC Emission** | **118.47** | **86.03** | **88.42** | **102.18** | **111.99** | **113.65** |
| Energy Industries | 0.32 | 0.23 | 0.28 | 0.29 | 0.29 | 0.34 |
| Manufacturing Ind. & Construction | 1.70 | 1.37 | 1.44 | 1.76 | 3.33 | 3.61 |
| Transport | 40.90 | 31.71 | 34.12 | 18.54 | 18.56 | 18.58 |
| Other Energy (fuel combustion) | 12.15 | 6.91 | 9.01 | 8.30 | 8.37 | 7.41 |
| Fugitive Emission from Fuels | 8.23 | 7.77 | 9.73 | 9.05 | 9.03 | 9.61 |
| Industrial Processes | 22.33 | 7.64 | 6.37 | 6.69 | 5.32 | 6.61 |
| Solvent Use | 32.84 | 30.40 | 27.46 | 57.56 | 67.09 | 67.51 |
| **$SO_2$ Emission** | **172.90** | **78.15** | **67.33** | **64.77** | **62.55** | **67.62** |
| Energy Industries | 78.51 | 38.98 | 25.39 | 32.76 | 30.44 | 38.94 |
| Manufacturing Ind. & Construction | 55.84 | 24.66 | 22.59 | 10.29 | 11.59 | 8.60 |
| Transport | 5.44 | 3.52 | 6.19 | 8.60 | 8.64 | 8.66 |
| Other Energy (fuel combustion) | 23.87 | 4.65 | 6.50 | 6.63 | 5.85 | 4.89 |
| Fugitive Emission from Fuels | 6.38 | 4.96 | 4.80 | 4.60 | 4.39 | 4.70 |
| Industrial Processes | 2.85 | 1.37 | 1.85 | 1.89 | 1.65 | 1.82 |

# 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 Republic of Croatia signed the Kyoto Protocol on 11 March 1999. At the session of the Conference of Parties (COP 7) held in Marrakesh in 2001 the Republic of Croatia submitted a request for recognition of specific circumstances under Article 4, paragraph 6 of the Convention. The request was related to the increase of emissions level by 4.46 Mt $CO_2$-eq in the base year, i.e. 1990, based on the specific circumstance that Croatia has been integrated into the common economic, energy and infrastructural system of the former Yugoslavia in that year.

At the session of the COP 11 held in Montreal in 2005 the Decision 10/CP.11 was adopted allowing Croatia a certain degree of flexibility in determining the reference value of greenhouse gas emission levels compared to the historical level. At the session of the COP 12 held in Nairobi in 2006 the Decision 7/CP.12 was adopted allowing Croatia to add 3.5 Mt $CO_2$-eq to its 1990 level of greenhouse gas emissions for the purpose of establishing the level of emissions for the base year for implementation of its commitments under Article 4, paragraph 2, of 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[4] 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.

[4] 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.

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

Taking into consideration abovementioned comprehensive reporting requirements and previous experience in preparation of annual inventory submissions, Ministry of Environmental Protection, Physical Planning and Construction as a national focal point has decided to enforce regulation which shall stipulate institutional and procedural arrangements for greenhouse gas monitoring and reporting in Croatia. In this regard the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia came into force on 2 January 2007 (Official Gazette, No. 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 2007. 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 2009 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:
  - Draft of National implementation strategy and action plan
  - Regulation on greenhouse gas emissions monitoring in the Republic of Croatia

Furthermore, since the introduction of annual technical reviews of the national inventories by experts review teams (ERT), Croatia has undergone four reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005 and 2006. The latest in-country review in conjunction with the review of Croatia's Initial Report was held from 20th to 25th October 2008 during which the ERT formulated a review of Croatia's 2008 Inventory Submission. According to their recommendations, certain recalculations for the whole period from 1990 to 2007 were carried out. These recalculations are presented in the following documents:

- 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 (hereinafter: 'Resubmission of Croatia's 2008 Inventory Submission')
- CFR tables 'Official Resubmission 2008'
- National Inventory Report 2009

After the resubmission, additional corrections and recalculations were necessary due to either observed errors or because new and more accurate data were attained. These recalculations are presented and explained only within this report.

## 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 sulfate 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 3s1-3s2.

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<br>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<br>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<br>Data on cement and lime production | Survey of ammonia manufacturer (Petrokemija Fertilizer Company Kutina)<br>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;<br>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 are shown in Table A1-2 and Table A1-3 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 Table A1-4 and Table A1-5 respectively, 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 A1-6 and A1-7 respectively. The tables indicate weather the key category arises from the level assessment or the trend assessment or both level and trend assessment.

Some changes in the Key Categories occurred in NIR 2009 in relation to NIR 2008, e.g. Mobile combustion: Agriculture/Forestry/Fishing, $CO_2$ Emissions from Ammonia Production, Direct $N_2O$ Emissions from Agricultural Soils, Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture are included in Trend Assessment. Furthermore, HFC Emissions from Consumption of HFCs, $CO_2$ emissions from Solvent and Other Product Use are excluded from Trend Assessment. These changes are shown in Table A1-8.

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

### 1.6.1. QA/QC PLAN

According to Good Practice Guidance and Uncertainty Management in National GHG Inventories, QA/QC plan is an internal document to organize, plan, and implement QA/QC activities. Croatia has prepared QA/QC plan for 2009 reporting cycle following the recommendations from document 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).

QA/QC plan follows the proposed cycle of activities including:

- Development and approval of QA/QC plan (QA/QC manager and Inventory team leader);
- Data checking and inventory reviewing activities (QA/QC manager and sectorial experts);
- Compilation of findings (QA/QC manager);
- Recommendations for corrective actions (QA/QC manager);
- Implementing and reporting corrective actions (sectorial experts);
- Reporting (QA/QC manager).

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

- Activity data gathering and handling activities;
- Activity data documentation and archiving;
- Choice of emission factors and emissions estimation.

General (Tier 1) and source-specific (Tier 2) QC procedures for each QC activity outlined in *Good Practice Guidance and Uncertainty Management in National GHG Inventories* were followed. In that regard Manuals of procedures for Compiling, Archiving, Updating and Managing of GHG Inventory were prepared for all IPCC sectors[5] in order to support inventory team with comprehensive guidelines for choice of methodology, emission factors and activity data, uncertainty estimates, QA/QC activities, reporting and documentation and inventory improvement plan. These guidelines are in accordance with *IPCC Guidelines and Good Practice Guidance* but 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 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

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

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 2007 in Waste sector is presented in Annex 6, Table A6-1.

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 and the CRF.

Finally, before submitting this NIR an audit has been carried out by designated QA/QC manager. The audit covered 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. It is also important to mention that EKONERG - Energy Research and Environmental Protection Institute is certified against ISO 9001:2000 and that all activities should be conducted in line with internal quality management system procedures.

### 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 15.6 percent, while the total uncertainty including LULUCF is 15.7 percent. The uncertainty introduced into the trend in total national emissions excluding LULUCF is estimated to be 5.2 percent and including LULUCF 9.1 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 8.7 percent excluding LULUCF and 14.5 percent including LULUCF). Furthermore, LULUCF sources/sink shows quite large uncertainty of 8.1 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 1990-2007.

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 2007, excluding removals by sinks, amounted to 32.385 mil. t $CO_2$-eq (equivalent $CO_2$ emissions), which represents 3.2 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. The main reasons of GHG emission increase 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 unfavourable hydrological conditions which leaded to decrease in hydro power utilisation by 27.4%.

Lately, cement, lime, ammonia and nitric acid producers reached their highest producing capacity which has a reflect on emission levels.

Waste disposal on land, as well as Wastewater handling, have the greatest impact on emission increase in Waste sector.

## 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 2007, the shares of GHG emissions were as follows: 76.8 percent $CO_2$, 10.8 percent $CH_4$, 11.0 percent $N_2O$, 1.4 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 (1990-2007)*

| Gas | Emissions and removals of GHG (Gg $CO_2$-eq) | | | | | |
|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
| $CO_2$ | 23105 | 16930 | 19955 | 23424 | 23528 | 24865 |
| $CH_4$ as $CO_2$-eq | 3419 | 2853 | 2658 | 3124 | 3338 | 3481 |
| $N_2O$ as $CO_2$-eq | 3903 | 3063 | 3308 | 3519 | 3457 | 3556 |
| HFCs as $CO_2$-eq | NO | 8 | 23 | 349 | 431 | 465 |
| PFCs as $CO_2$-eq | 937 | NO | NO | NO | NO | NO |
| $SF_6$ as $CO_2$-eq | 11 | 12 | 12 | 16 | 16 | 17 |
| ***Total GHG emission*** | **31374** | **22865** | **25955** | **30433** | **30769** | **32385** |
| Removals ($CO_2$) | -4185 | -9154 | -5281 | -7726 | -7490 | -6303 |
| ***Total emission (including LULUCF)*** | **27189** | **13711** | **20675** | **22707** | **23279** | **26082** |

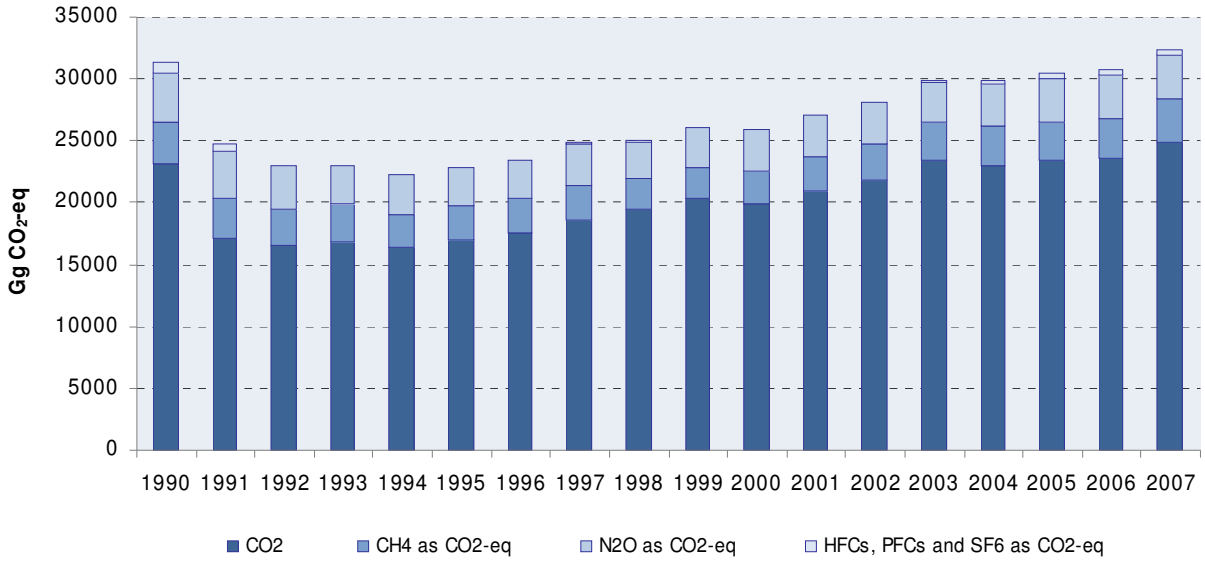


*Figure 2.2-1: Trend of GHG emissions, by gases*

### 2.2.1. CARBON DIOXIDE – $CO_2$

The most significant anthropogenic greenhouse gas is carbon dioxide ($CO_2$). In 2007, $CO_2$ emission was 7.6 percent higher than in 1990. $CO_2$ removals by sinks were almost 51 percent larger then 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 2007 was 1.8 percent above the emission in 1990, largely due to an increase in emission in the Energy and Waste sectors.

### 2.2.3. NITROUS OXIDE – $N_2O$

The $N_2O$ emission in 2007 was 8.9 percent lower than emission in 1990. Decrease of emission was in Energy sector (Manufacturing industries and construction and Other sectors), Industrial processes (Nitric acid production) and Agriculture ($N_2O$ emission from Manure management, Direct emission from agriculture soils, 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 2007 was approximately 1.4 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.

## 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 (1990-2007)*

| Source | Emissions and removals of GHG (Gg $CO_2$-eq) | | | | | |
|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
| Energy | 22149 | 16391 | 18822 | 22289 | 22416 | 23803 |
| Industrial Processes | 4194 | 2573 | 3224 | 3682 | 3864 | 4073 |
| Solvent and Other Product Use | 131 | 124 | 115 | 203 | 231 | 233 |
| Agriculture | 4321 | 3045 | 3151 | 3464 | 3418 | 3410 |
| Waste | 579 | 732 | 644 | 795 | 840 | 868 |
| ***Total GHG emission*** | **31374** | **22865** | **25955** | **30433** | **30769** | **32385** |
| Removals (LULUCF) | -4185 | -9154 | -5281 | -7726 | -7490 | -6303 |
| ***Total emission (including LULUCF)*** | **27189** | **13711** | **20675** | **22707** | **23279** | **26082** |

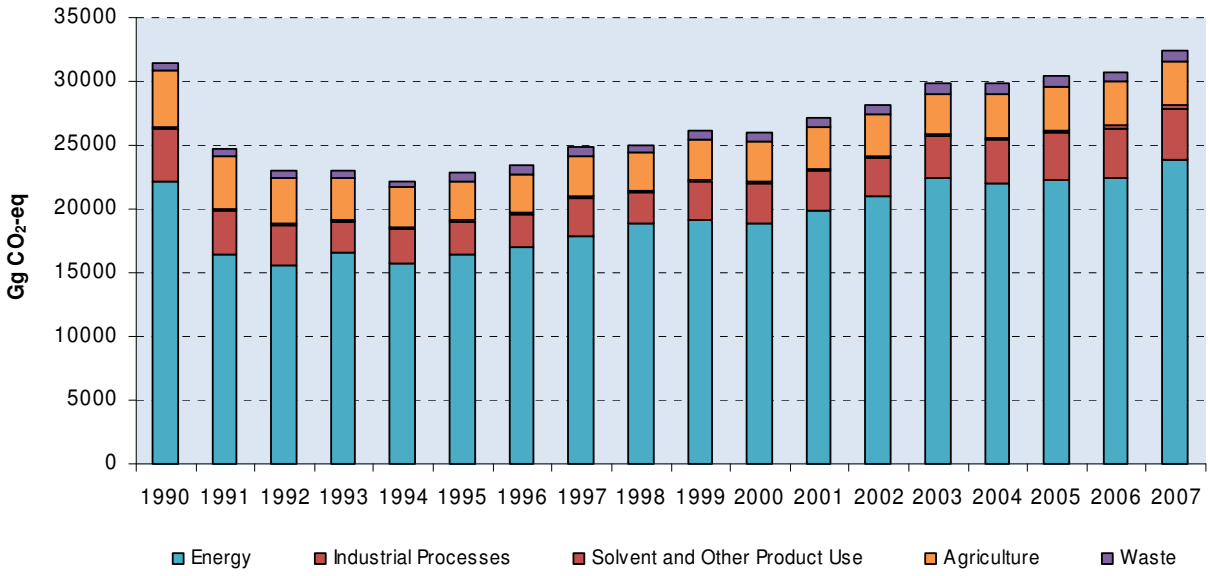


*Figure 2.3-1: Trend of GHG emissions, by sectors*

### 2.3.1. ENERGY

The most important IPCC sector in Croatia is Energy sector. The Energy sector accounted for some 73.5 percent of the total national GHG emissions (presented as equivalent emission of $CO_2$). In 2007, the GHG emission from Energy was 7.5 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 2007 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 2007 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 also a decreasing trend. The GHG emission in 2007 was 21 percent lower in comparison with 1990 emission. According to estimation of Croatian experts for agriculture, approximately 10.5 percent of total GHG emissions belong to Agriculture.

### 2.3.5. WASTE

Emissions from Waste sector have been constantly increasing in the period 1990-2007. Increasing emissions are a consequence of greater quantities of waste, activities in wastewater handling and waste incineration. The GHG emission in 2007 was 50 percent larger in comparison with 1990 emission. Contribution of waste sector to total GHG emission is approximately 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 2007* 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 |
| **$NO_x$ Emission** | **85.91** | **60.96** | **71.73** | **75.96** | **70.82** | **73.39** |
| Energy Industries | 13.61 | 10.30 | 11.99 | 12.04 | 11.15 | 13.39 |
| Manufacturing Ind. & Construction | 17.49 | 8.92 | 9.73 | 16.60 | 12.26 | 14.07 |
| Transport | 36.79 | 31.05 | 34.56 | 31.83 | 32.00 | 32.11 |
| Other Energy (fuel combustion) | 15.03 | 8.13 | 12.85 | 13.15 | 13.24 | 12.86 |
| Fugitive Emission from Fuels | 0.64 | 0.49 | 0.47 | 0.45 | 0.43 | 0.46 |
| Industrial Processes | 2.42 | 2.23 | 2.29 | 2.05 | 1.89 | 0.66 |
| Agriculture | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| LULUCF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO Emission** | **549.87** | **378.50** | **409.91** | **343.63** | **370.50** | **357.12** |
| Energy Industries | 1.54 | 0.99 | 1.21 | 0.93 | 1.35 | 1.89 |
| Manufacturing Ind. & Construction. | 40.44 | 41.26 | 37.82 | 32.60 | 36.69 | 44.84 |
| Transport | 252.38 | 186.59 | 193.90 | 159.40 | 159.45 | 159.48 |
| Other Energy (fuel combustion) | 203.98 | 116.74 | 146.47 | 133.02 | 133.47 | 115.58 |
| Fugitive Emission from Fuels | 0.64 | 0.44 | 0.33 | 0.32 | 0.31 | 0.33 |
| Industrial Processes | 46.57 | 32.44 | 30.00 | 17.24 | 39.11 | 34.87 |
| Agriculture | 4.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| LULUCF | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 | 0.01 |
| **NMVOC Emission** | **118.47** | **86.03** | **88.42** | **102.18** | **111.99** | **113.65** |
| Energy Industries | 0.32 | 0.23 | 0.28 | 0.29 | 0.29 | 0.34 |
| Manufacturing Ind. & Construction | 1.70 | 1.37 | 1.44 | 1.76 | 3.33 | 3.61 |
| Transport | 40.90 | 31.71 | 34.12 | 18.54 | 18.56 | 18.58 |
| Other Energy (fuel combustion) | 12.15 | 6.91 | 9.01 | 8.30 | 8.37 | 7.41 |
| Fugitive Emission from Fuels | 8.23 | 7.77 | 9.73 | 9.05 | 9.03 | 9.61 |
| Industrial Processes | 22.33 | 7.64 | 6.37 | 6.69 | 5.32 | 6.61 |
| Solvent Use | 32.84 | 30.40 | 27.46 | 57.56 | 67.09 | 67.51 |
| **$SO_2$ Emission** | **172.90** | **78.15** | **67.33** | **64.77** | **62.55** | **67.62** |
| Energy Industries | 78.51 | 38.98 | 25.39 | 32.76 | 30.44 | 38.94 |
| Manufacturing Ind. & Construction | 55.84 | 24.66 | 22.59 | 10.29 | 11.59 | 8.60 |
| Transport | 5.44 | 3.52 | 6.19 | 8.60 | 8.64 | 8.66 |
| Other Energy (fuel combustion) | 23.87 | 4.65 | 6.50 | 6.63 | 5.85 | 4.89 |
| Fugitive Emission from Fuels | 6.38 | 4.96 | 4.80 | 4.60 | 4.39 | 4.70 |
| Industrial Processes | 2.85 | 1.37 | 1.85 | 1.89 | 1.65 | 1.82 |

# 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 |
|---|---|---|---|---|---|---|
| Coal and coke | 4.21 | 1.96 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fuel wood | 22.68 | 13.52 | 15.64 | 14.77 | 17.18 | 15.11 |
| Crude oil | 104.54 | 62.81 | 51.35 | 40.11 | 38.9 | 37.27 |
| Natural gas | 74.27 | 69.12 | 59.4 | 79.76 | 94.27 | 100.12 |
| Hydro power | 38.55 | 51.75 | 56.93 | 62.4 | 58.18 | 42.21 |
| Renewables | 0.00 | 0.00 | 0.00 | 0.2 | 0.24 | 0.71 |
| **Total** | **244.25** | **199.16** | **183.32** | **197.24** | **208.77** | **195.42** |

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

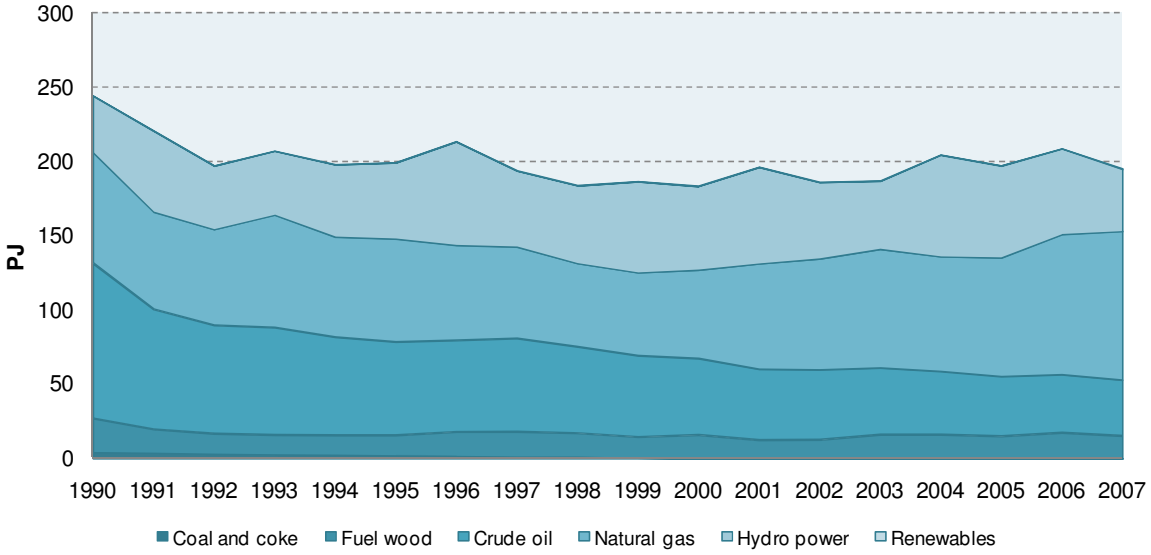


*Figure 3.1-1: Trends in primary energy production for the period from 1990 to 2007*

In 1990 primary energy production was about 244 PJ, which is 20% higher comparing to 2007. In 2007, the total primary energy production dropped by 4.5% with relation to the 2006. Comparing to 2006, the energy production from renewable sources increased three times in 2007. The production of natural gas increased 6.2% while production of fuel wood dropped by 12% and crude oil by 4.2%. Hydro power utilization also dropped by 27.4%.

While in 1990 the share of crude oil in primary energy production was the highest one with 42.8%, in 2007 its' share was only 19.1%. In 2007, the share of natural gas (51.2%) was the

highest one. It was followed by hydro power with the share of 21.6%. The comparison of shares in primary energy productions for the 1990 and 2007 are presented in figure 1.1-2.

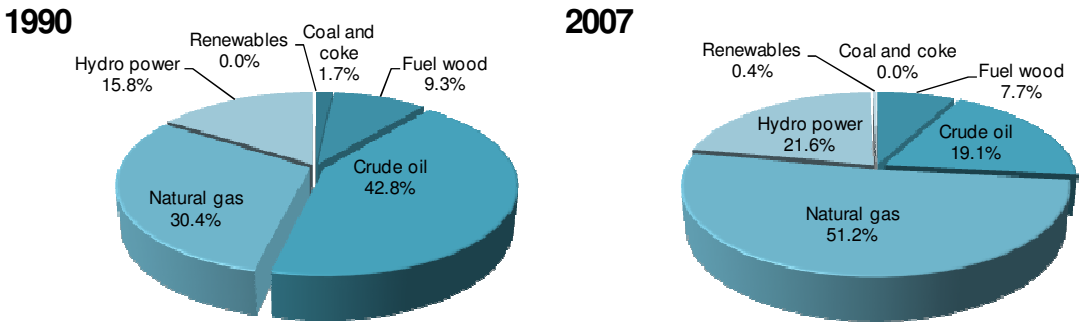


*Figure 3.1-2: Shares of individual energy forms in the total production for the 1990 and 2007*

## 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 2007 is presented in the table 3.1-2.

*Table 3.1-2: Primary energy supply*

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

Figure 3.1-3 presents the trends in the primary energy supply from 1990 to 2007.

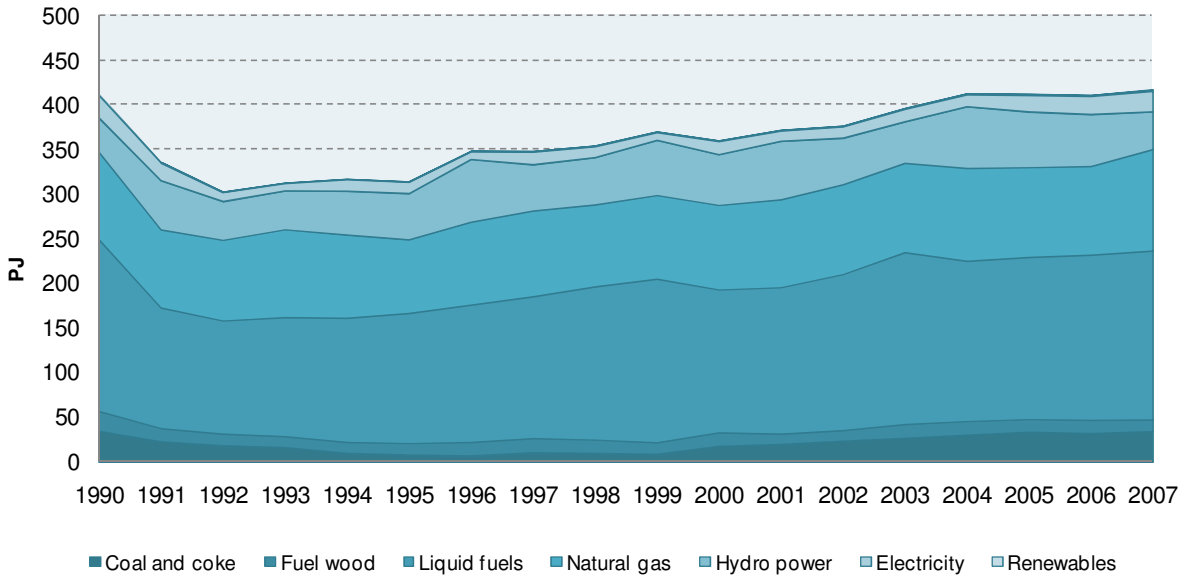


*Figure 3.1-3: Trends in primary energy supply for the period from 1990 to 2007*

In 1990 primary energy supply was about 412 PJ, which is 1% lower comparing to 2007. In 2007, the total primary energy supply increased by 1.5% with relation to the previous year. There was an increase in natural gas consumption, electricity, liquid fuels, coal and coke and renewable energy sources while consumption of fuel wood decreased. Due to poor hydrology conditions, hydro power energy supply decreased by 27.4% with relation to the 2006. Figure 1.1-4 presents comparison of the shares of individual energy forms in the total primary energy supply for the 1990 and 2007.

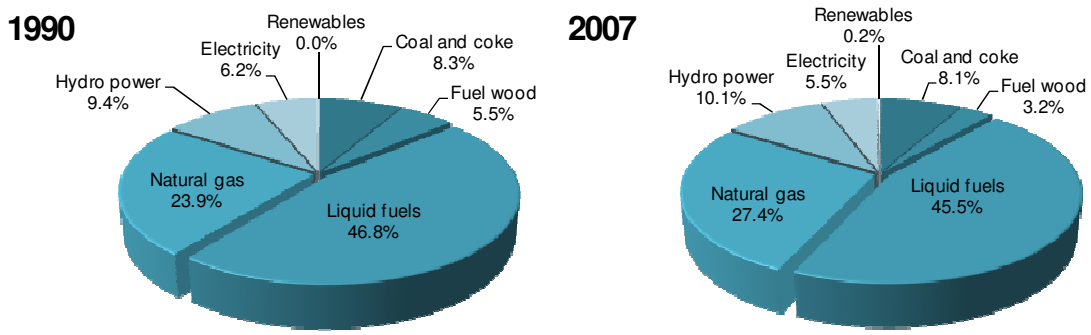


*Figure 3.1-4: Comparison of the shares of individual energy forms for the 1990 and 2007*

Liquid fuels had the largest share in total primary energy supply in 1990 as well as in 2007 (approximately 45%). It was followed by the natural gas with the share of approximately 25%. The figure 1.1-5 presents difference between total primary energy production (P) given in table 1.1-1 and total primary energy supply (S) given in table 1.1-2.

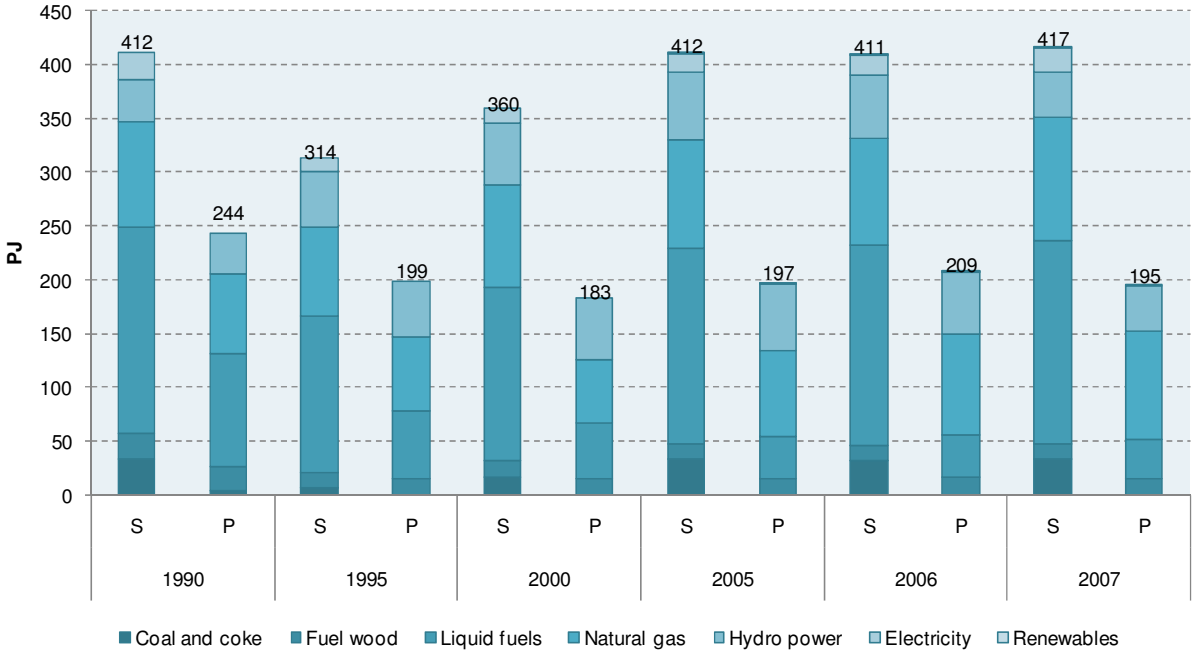


*Figure 3.1-5: Total primary energy supply (S) and production (P)*

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 2007 amounted 46.9%. Total hydro power and fuel wood supply were fully covered from the territory of Croatia. Own natural gas supply in 2007 amounted 87.7% while own oil supply amounted 19.6%. The production of solid fuels stopped in 2000, thus all needs for coke and coal were satisfied from export.

The basis for estimating the GHG emissions from Energy sector is the national energy balance. Data on production, imports, exports, stock change and consumption of fuels are reported both in natural units (kg or $m^3$) and energy units (J). National energy balance for 2007 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 2007*

| Fuel | Hd - TJ/Gg ($m^3$) | | $CO_2$ emission factor (Gg $CO_2$/PJ) | Oxidation factor |
|---|---|---|---|---|
| | 1990 | 2007 | | |
| **SOLID FUELS** | | | | |
| Anthracite | 29.29 | 29.31 | 96.3 | 0.98 |
| Other Bituminous Coal | 25.14 | 24.90 | 92.7 | 0.98 |
| Sub-Bituminous Coal | 16.74 | 19.03 | 94.1 | 0.98 |
| Lignite | 10.90 | 11.72 | 99.2 | 0.98 |
| Brown Coal Briquettes | 16.74 | - | 95.6 | 0.98 |
| Coke oven Coke | 29.31 | 29.31 | 106.0 | 0.98 |
| **LIQUID FUELS** | | | | |
| Motor gasoline | 44.60 | 44.59 | 68.6 | 0.99 |
| Aviation gasoline | 44.60 | 44.59 | 68.6 | 0.99 |
| Jet Kerosene | 44.00 | 43.96 | 70.8 | 0.99 |
| Gas/Diesel oil | 42.71 | 42.71 | 73.3 | 0.99 |
| Residual Fuel Oil | 40.19 | 40.19 | 76.6 | 0.99 |
| Liquefied Petroleum Gases | 46.89 | 46.89 | 62.4 | 0.99 |
| Petroleum Coke | 29.31 | 31.00 | 99.8 | 0.99 |
| Petroleum | 44.00 | 43.96 | 71.1 | 0.99 |
| Lubricants | 33.57 | - | 72.6 | 0.99 |
| **GASEOUS FUELS** | | | | |
| Natural Gas | 34.00 | 34.00 | 47.4 | 0.995 |
| Gas Works Gas | 15.82 | 27.76 | 47.4 | 0.995 |
| Coke Oven Gas | 17.9 | - | 47.4 | 0.995 |
| **BIOMASS FUELS** | | | | |
| Wood biomass | - | 9.00 | 107.4 | 0.98 |
| Industrial waste | - | - | 107.4 | 0.98 |

The structure of energy consumption of fossil fuels from 1990 to 2007 is shown in Figure 3.1-2.

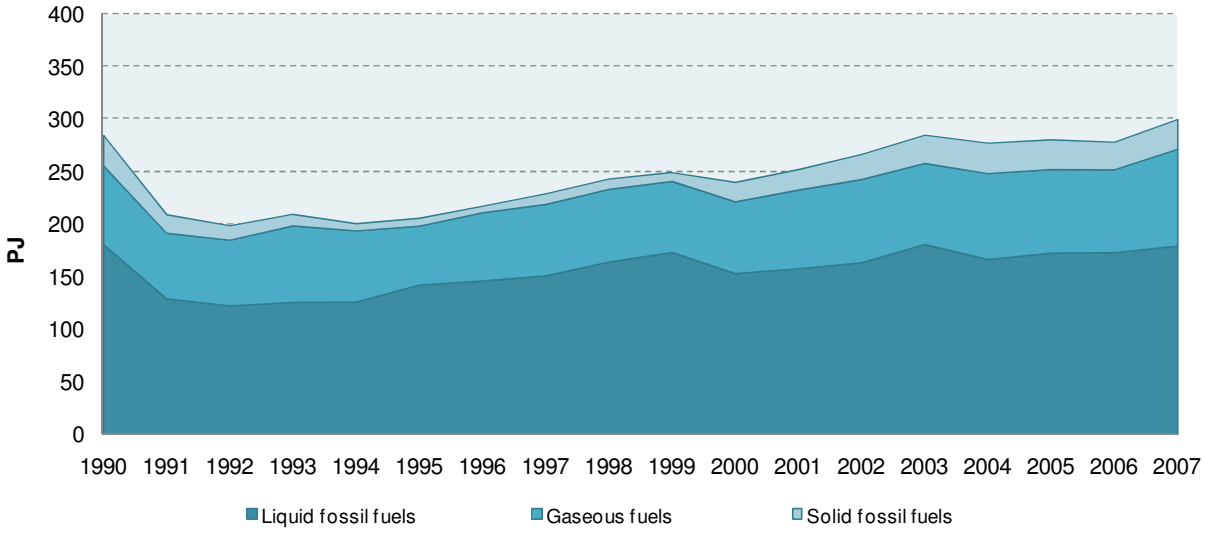


*Figure 3.1-6: Structure of energy consumption*

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 (2007), is presented in the Table 3.1-4 while contribution of individual subsectors to GHG emission for the period 1990-2007 is presented in Figure 3.1-7.

*Table 3.1-4: Contribution of individual subsectors to emission of greenhouse gases, for 2007*

| GHG categories | $CO_2$-eq (Gg) | | | Total | |
|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$-eq (Gg) | % |
| **ENERGY** | **21,824.72** | **82.72** | **0.78** | **23802.55** | |
| **A.Fuel combustion activities** | **21,159.72** | **5.68** | **0.78** | **21519.75** | **90.41** |
| 1 Energy industries | 7,638.81 | 0.22 | 0.06 | 7662.24 | 32.19 |
| a Electricity and heat production | 5,446.52 | 0.14 | 0.05 | 5463.49 | 22.95 |
| b Petroleum refining | 1,830.93 | 0.07 | 0.01 | 1837.05 | 7.72 |
| c Manufacture of solid fuels | 361.35 | 0.01 | 0.00 | 361.69 | 1.52 |
| 2 Manufacturing ind. and constr. | 3,874.22 | 0.33 | 0.03 | 3891.86 | 16.35 |
| 3 Transport | 6,345.27 | 1.55 | 0.62 | 6570.03 | 27.60 |
| a Civil aviation | 76.00 | 0.00 | 0.00 | 76.68 | 0.32 |
| b Road transport | 6,059.43 | 1.53 | 0.62 | 6282.69 | 26.40 |
| c Railways | 102.10 | 0.01 | 0.00 | 102.50 | 0.43 |
| d Navigation (domestic) | 107.73 | 0.01 | 0.00 | 108.16 | 0.45 |
| 4 Other sectors | 3,301.42 | 3.59 | 0.06 | 3395.63 | 14.27 |
| 5 Other | NO | NO | NO | 0.00 | 0.00 |
| **B.Fugitive emissions from fuels** | **665.00** | **77.04** | **NO** | **2282.80** | **9.59** |
| 1 Solid fuels | NO | NO | NO | 2282.80 | 9.59 |
| 2 Oil and natural gas | 665.00 | 77.04 | NO | 0.00 | 0.00 |

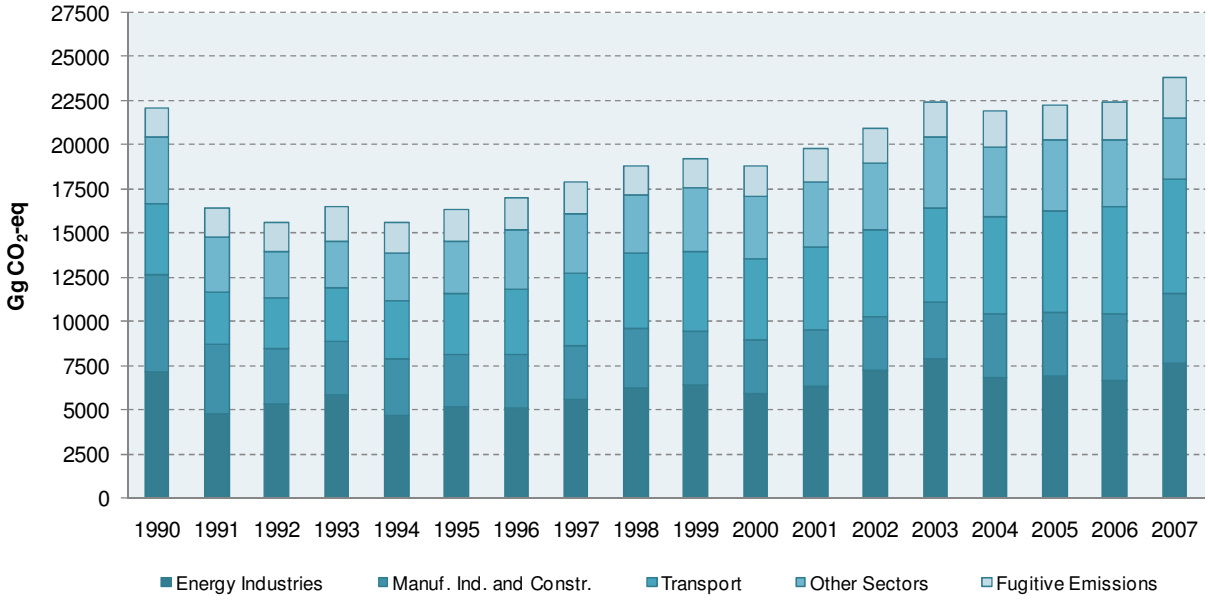


*Figure 3.1-7: $CO_2$-eq emissions from energy sector by subsectors in 1990-2007*

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; 27 percent in 2006) and the combustion in Manufacturing Industries and Construction with decreasing trend (26 percent in 1990; 17 percent in 2006). 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. SOURCE CATEGORY DESCRIPTION

### 3.2.1.1. 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 3.2-1 and Figure 3.2-1. The GHG emissions from thermal power plants and public cogeneration plants in the period from 1990-2007, were calculated using more detailed Tier 2 approach while emissions from Petroleum Refining and Other Energy Industries were calculated using Tier 1 approach.

*Table 3.2-1: The $CO_2$-eq emissions (Gg) from Energy Industries*

| $CO_2$-eq emission (Gg) | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|
| Public El. and Heat Prod. | 3719 | 2911 | 3822 | 4489 | 5160 | 5750 | 4658 | 4722 | 4694 |
| Petroleum Refining | 2575 | 1892 | 1792 | 1603 | 1800 | 1882 | 1916 | 1811 | 1654 |
| Other Energy Industries | 992 | 395 | 293 | 235 | 269 | 264 | 279 | 351 | 309 |
| **Total Energy Industries** | **7286** | **5198** | **5907** | **6327** | **7228** | **7895** | **6853** | **6884** | **6657** |

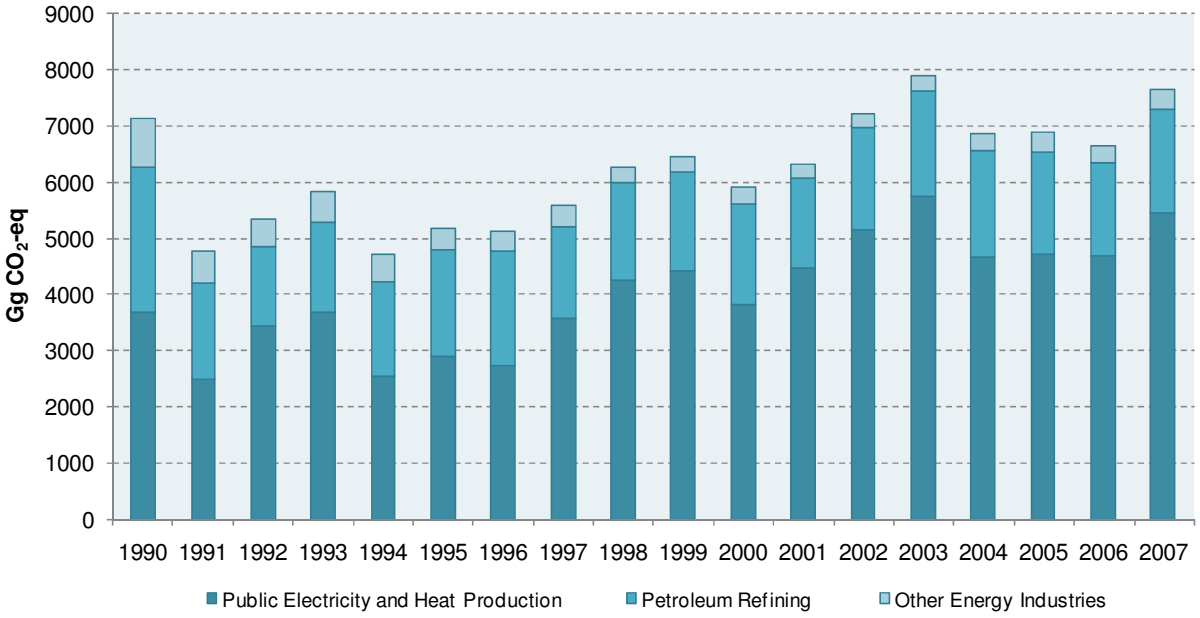


*Figure 3.2-1: The $CO_2$-eq emissions from Energy Industries*

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.

In this sector, in the year 2007, the total energy consumption was 16.8 percent higher than in the former year 2006, whereat the total largest increase was in consumption of gaseous fuels (14.3 percent) from the Energy Industries sector (27.5 percent). Increase in total energy consumption is mostly due to unfavourable hydrological conditions which leaded to decrease in hydro power utilisation by 27.4% (Table 3.2-2).

*Table 3.2-2: Differences between electricity production in 2006 and 2007*

| ENERGY BALANCE | Electricity, GWh | | Difference 2007-2006 | Difference % |
|---|---|---|---|---|
| | 2007 | 2006 | | |
| Production | 12245.1 | 12429.6 | -184.5 | -1.5 |
| Hydro power plants | 4400.2 | 6123.5 | -1723.3 | -28.1 |
| Thermal power plants | 5216.3 | 3955.2 | 1261.1 | 31.9 |
| Public cogeneration plants | 2115.5 | 1875.4 | 240.1 | 12.8 |
| Industrial cogeneration plants | 513.1 | 475.5 | 37.6 | 7.9 |
| Import | 7811.8 | 8313.1 | -501.3 | -6.0 |
| Export | 1450.7 | 2690.9 | -1240.2 | -46.1 |
| **TOTAL CONSUMPTION** | **18606.2** | **18051.8** | **554.4** | **3.1** |

## 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 3993 MW (including 50% of nuclear unit Krško in Slovenia). Out of this amount, 1397 MW is placed in thermal power plant, 2056 MW in hydro power plant and 348 MW in the nuclear unit Krško (50% of total available capacity). Generating capacities of HPPs, TPPs and NPP Krško are presented in the Table 3.2-3.

*Table 3.2-3: Generating capacities of HPPs, TPPs and NPP Krško*

| | Available Power (MW) Net Output | Fuel |
|---|---|---|
| HPPs | 2071 | 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) | 337 | 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 | 83 | natural gas / extra light oil |
| Emergency diesel (4) | 29 | D2 |
| Emergency diesel (1) | 13 | 2GT |
| **Total (HPPs+NPP+TPPs)** | **4062** | |

$UO_2$ - 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 2007 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 2007, the import of electricity was about 42 percent of total electricity consumption in Croatia. Electricity supply for the period from 1990 to 2007 is presented on Figure 3.2-2.

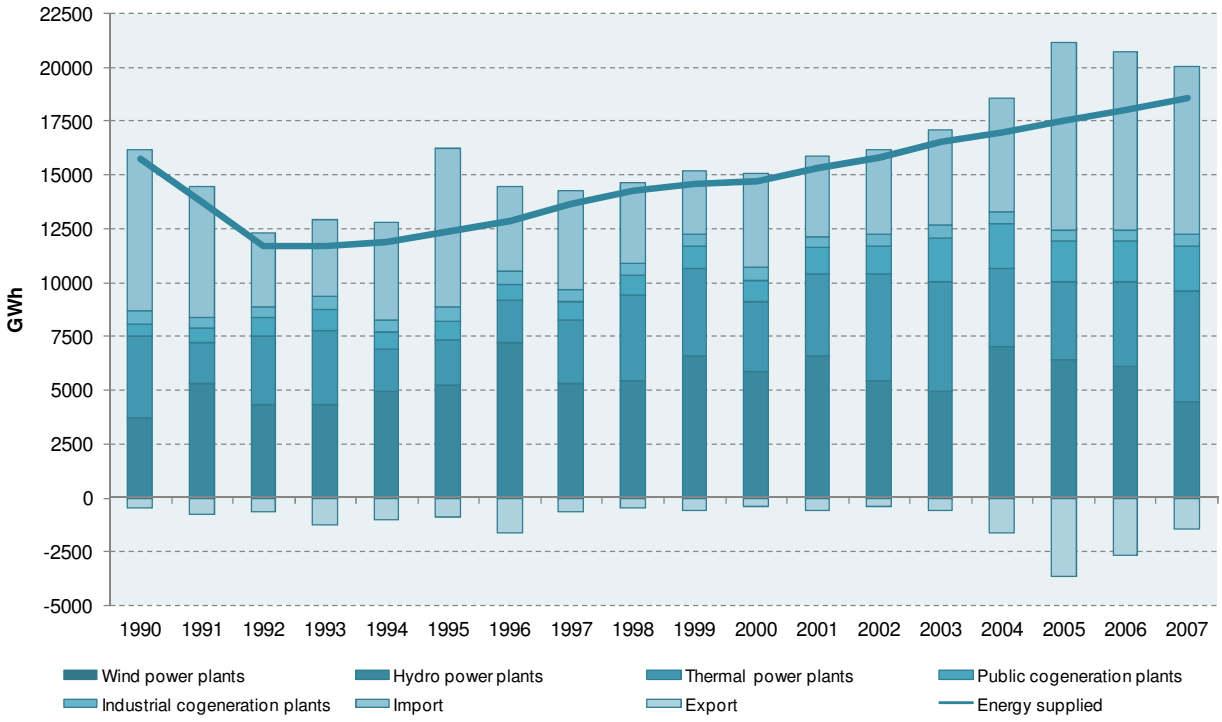


*Figure 3.2-2: Electricity supply for the period from 1990 to 2007*

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

**$CO_2$ emission from $SO_2$ scrubbing process**

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 $CaSO_4$ produced during $SO_2$ scrubbing process according to equation (4):

(1) $SO_2 + 1/2O_2 \rightarrow SO_3$

(2) $SO_3 + H_2O \rightarrow H_2SO_4$

(3) $H_2SO_4 + CaCO_3 \rightarrow CaSO_4 + CO_2 + H_2O$

---

(4) $SO_2 + 1/2O_2 + CaCO_3 + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O + CO_2$

$$n(CaSO_4) = n(CO_2)$$

$$m(CO_2) = \frac{m(CaSO_4 \cdot 2H_2O)}{M(CaSO_4 \cdot 2H_2O)} \cdot M(CO_2)$$

In Table 3.2-4 amounts of produced $CaSO_4$ as well as emitted $CO_2$ emission is presented.

*Table 3.2-4: Amounts of produced $CaSO_4$ and $CO_2$ emission for the period from 2002-2007*

| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Production of $CaSO_4$, Gg | 20483 | 24319 | 21065 | 23541 | 24272 | 19873 |
| $CO_2$ emission, Gg | 5.2 | 6.2 | 5.4 | 6.0 | 6.2 | 5.1 |

Their $CO_2$-eq emissions as well as $CO_2$ emissions from $SO_2$ scrubbing process, for the whole period from 1990 to 2007 are presented on Figure 3.2-3.

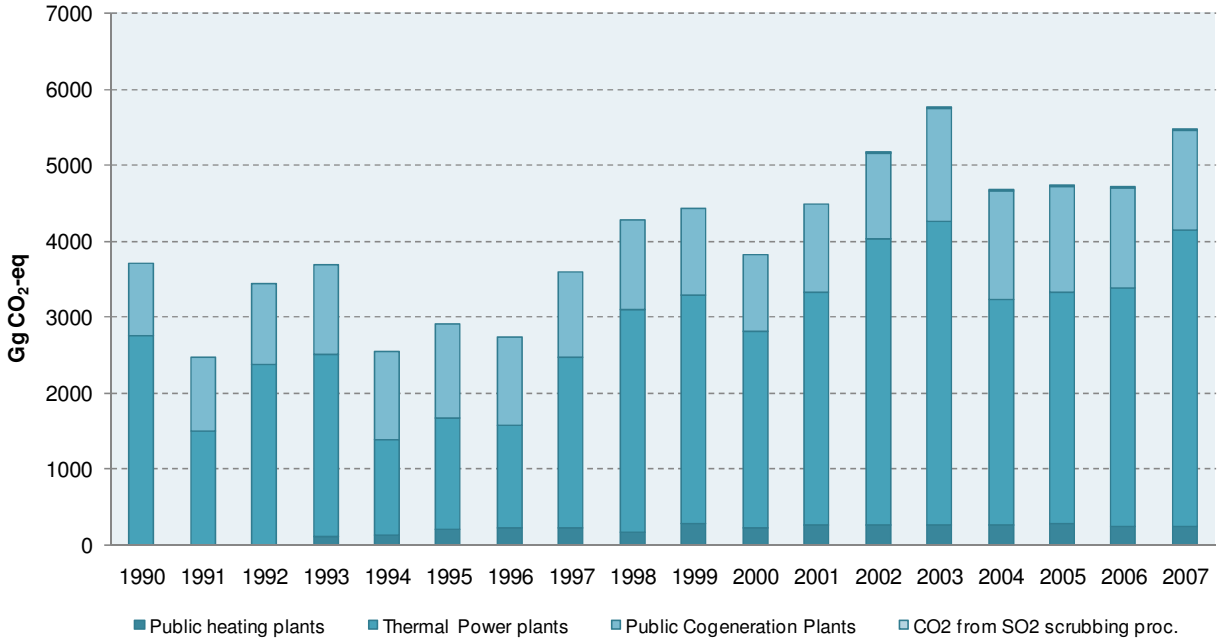


*Figure 3.2-3: Public electricity and Heat production subsector's $CO_2$-eq emissions for the period from 1990 to 2007*

Electricity and heat production, fuel consumption and GHG emissions for the years 1990, 1995 and 2000-2007 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 3.2-5.

*Table 3.2-5: 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 on Figure 3.2-4.

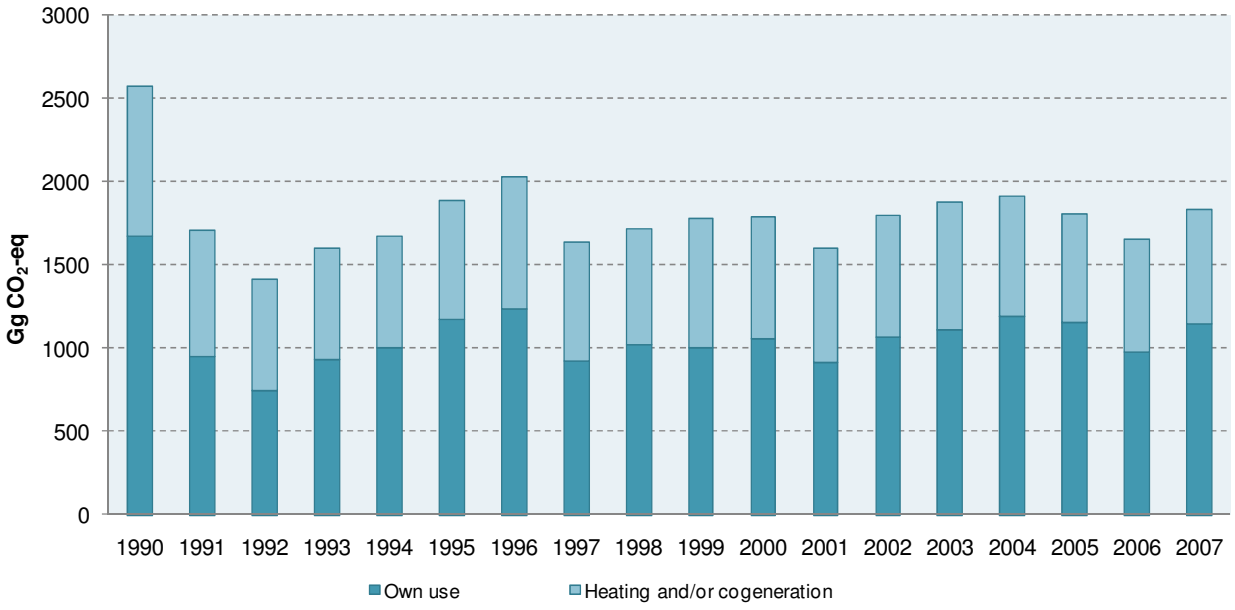


*Figure 3.2-4: $CO_2$-eq emissions from Petroleum refining subsector for the period from 1990 to 2007*

Fuel consumption and GHG emissions from petroleum refining are presented in Table A2-5 and Table A2-6 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 2007. 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 2007 are presented on Figure 3.2-5.

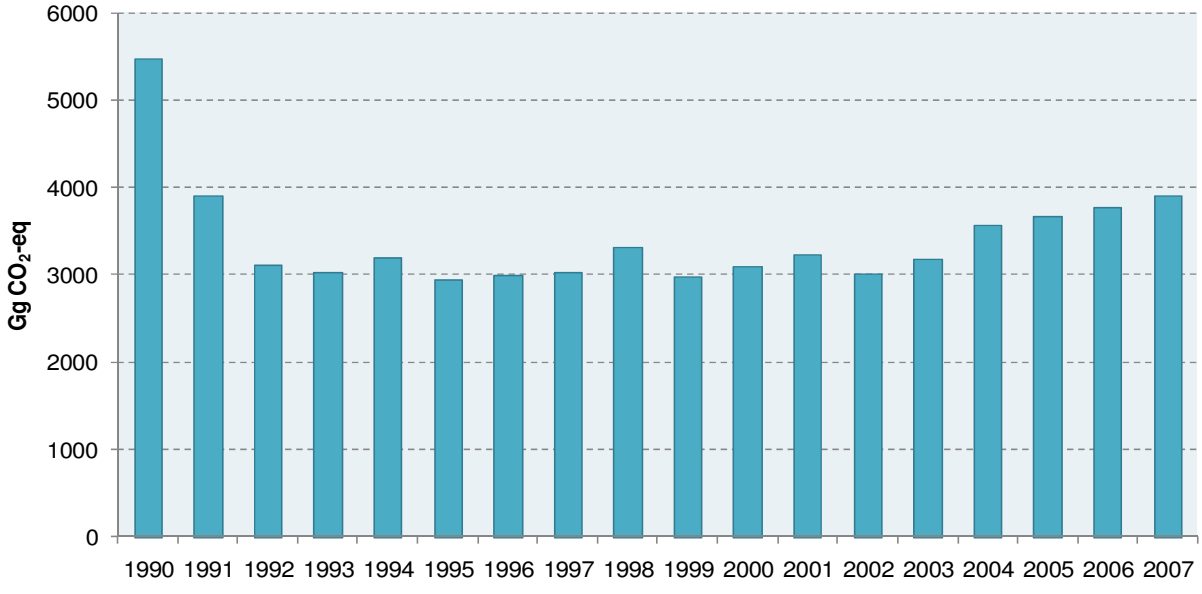


*Figure 3.2-5: $CO_2$-eq emissions from Manufacturing of Solid fuels and Other Energy Industries for the period from 1990 to 2007*

Fuel consumption and GHG emissions from manufacturing of solid fuels and other energy industries are presented in the Table A2-7 of the Annex 2.

### 3.2.1.2. 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). The total GHG emission from Manufacturing Industries and Construction is given in the Table 3.2-6 and Figure 3.2-6.

*Table 3.2-6: The $CO_2$-eq emissions (Gg) from Manufacturing Industries and Construction*

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| Iron & Steel Industry | | | | 93 | 66 | 81 | 65 | 89 | 102 | 104 |
| Non-Ferrous Metals | | | | 16 | 20 | 16 | 27 | 21 | 18 | 21 |
| Chemical | | | | 540 | 420 | 481 | 860 | 473 | 582 | 538 |
| Pulp. Paper & Print | | | | 123 | 109 | 114 | 125 | 130 | 136 | 161 |
| Food Proc. Bev. & Tab. | | | | 450 | 512 | 469 | 488 | 542 | 543 | 560 |
| Other (constr. mater…) | | | | 2009 | 1884 | 2017 | 2005 | 2413 | 2382 | 2507 |
| **Total Manuf. Ind. & Cons.** | 5475 | 2943 | 3091 | 3231 | 3012 | 3178 | 3570 | 3667 | 3762 | 3892 |

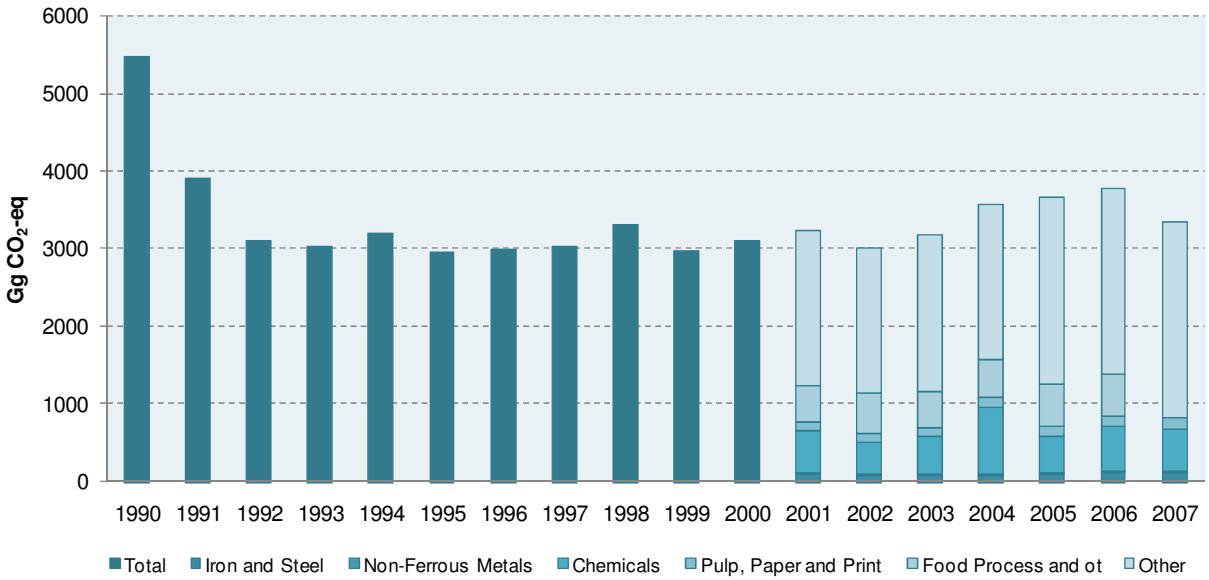


*Figure 3.2-6: The $CO_2$-eq emissions from Manufacturing Industries and Construction*

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 2001-2006. The largest contributor to emissions is fuel combustion in industry of construction materials (subsector: Other in Figure 3.2-2), 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 A2-8, A2-9 and A2-10 of the Annex 2.

### 3.2.1.3. 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 3.2-7 and Figure 3.2-7.

*Table 3.2-7: The $CO_2$-eq emissions (Gg) from Transport*

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| Civil Aviation | 156 | 79 | 55 | 56 | 52 | 51 | 59 | 67 | 74 | 77 |
| Road Transport | 3642 | 3174 | 4346 | 4408 | 4706 | 5111 | 5268 | 5469 | 5836 | 6283 |
| Railways | 139 | 107 | 86 | 88 | 87 | 88 | 92 | 96 | 102 | 103 |
| National Navigation | 134 | 99 | 86 | 92 | 111 | 112 | 91 | 100 | 104 | 108 |
| **Total Transport** | 4070 | 3459 | 4573 | 4644 | 4957 | 5362 | 5511 | 5732 | 6116 | 6570 |

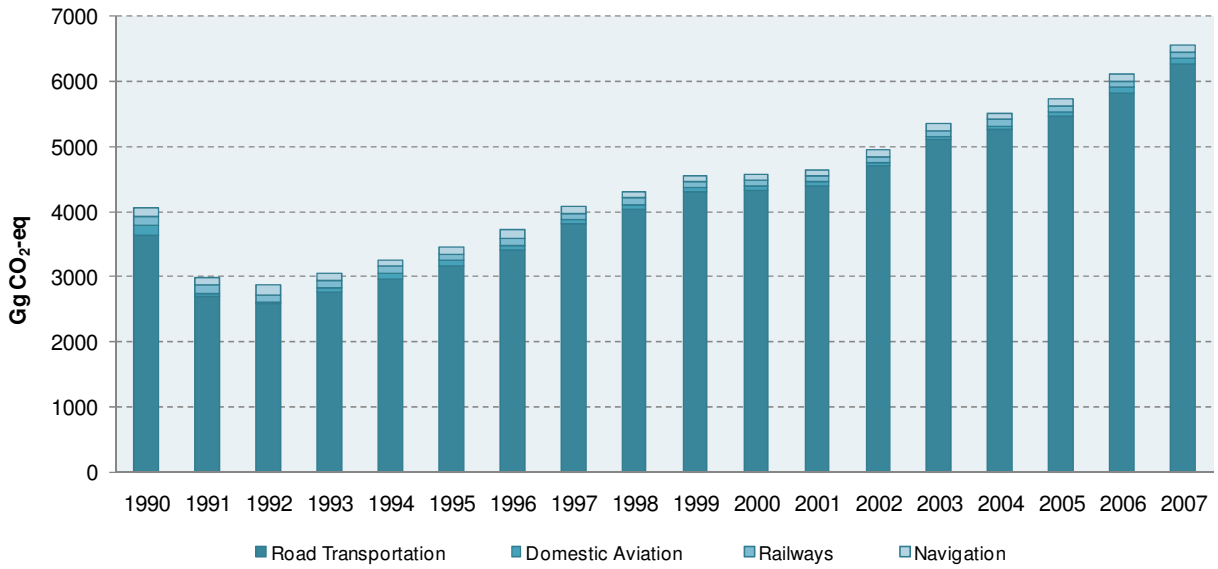


*Figure 3.2-7: The $CO_2$-eq emissions from Transport*

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 3.2-8).

*Table 3.2-8: Estimation of civil aviation drivers*

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| Total jet kerosene ($10^3$ t) | 160.0 | 32.0 | 25.0 | 63.0 | 90.0 | 85.0 | 78.0 | 82.0 |
| Passangers carried - Total ($10^3$) | | 139.0 | 238.0 | 507.0 | 661.0 | 679.0 | 824.0 | 866.0 |
| Passangers carried – inter. ($10^3$) | | 26.0 | 108.0 | 234.0 | 389.0 | 346.0 | 475.0 | 504.0 |
| Passangers carried – dom. ($10^3$) | | 113.0 | 130.0 | 273.0 | 272.0 | 333.0 | 349.0 | 362.0 |
| Passangers kilometers- total ($10^6$) | | 66.0 | 145.0 | 316.0 | 444.0 | 444.0 | 597.0 | 548.0 |
| Passangers kilometers-inter. ($10^6$) | | 22.0 | 100.0 | 214.0 | 331.0 | 317.0 | 467.0 | 440.0 |
| Passangers kilometers-dom. ($10^6$) | | 44.0 | 45.0 | 102.0 | 113.0 | 127.0 | 130.0 | 108.0 |
| Passangers dom/km | | 389.4 | 346.2 | 373.6 | 415.4 | 381.4 | 372.5 | 298.3 |
| Passangers int/km | | 846.2 | 925.9 | 914.5 | 850.9 | 916.2 | 983.2 | 873.0 |
| Passangers int+dom | | 1235.5 | 1272.1 | 1288.2 | 1266.3 | 1297.6 | 1355.7 | 1171.4 |
| share dom | 0.311 | 0.315 | 0.272 | 0.290 | 0.328 | 0.294 | 0.275 | 0.255 |
| **Jet kerosene in dom. aviation** | **49.68** | **10.08** | **6.80** | **18.27** | **29.53** | **24.98** | **21.43** | **20.89** |
| **Jet kerosene in inter.aviation** | **110.32** | **21.92** | **18.20** | **44.73** | **60.47** | **60.02** | **56.57** | **61.11** |

*Table 3.2-8: Estimation of civil aviation drivers (cont.)*

| | 1999 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| Total jet kerosene ($10^3$ t) | 85.0 | 72.0 | 69.0 | 68.0 | 78.0 | 93.0 | 96.3 | 99.6 |
| Passangers carried - Total ($10^3$) | 926.0 | 1245.0 | 1356.0 | 1582.0 | 1743.0 | 2099.0 | 2148.0 | 2288.0 |
| Passangers carried – inter. ($10^3$) | 585.0 | 863.0 | 957.0 | 1108.0 | 1269.0 | 1633.0 | 1698.0 | 1796.0 |
| Passangers carried – dom. ($10^3$) | 341.0 | 382.0 | 399.0 | 474.0 | 474.0 | 466.0 | 450.0 | 492.0 |
| Passangers kilometers- total ($10^6$) | 643.0 | 922.0 | 1027.0 | 1228.0 | 1460.0 | 1989.0 | 1959.0 | 2055.0 |
| Passangers kilometers-inter. ($10^6$) | 537.0 | 807.0 | 907.0 | 1084.0 | 1315.0 | 1842.0 | 1813.0 | 1896.0 |
| Passangers kilometers-dom. ($10^6$) | 106.0 | 115.0 | 120.0 | 144.0 | 145.0 | 147.0 | 146.0 | 159.0 |
| Passangers dom/km | 310.9 | 301.0 | 300.8 | 303.8 | 305.9 | 315.5 | 324.4 | 323.2 |
| Passangers int/km | 917.9 | 935.1 | 947.8 | 978.3 | 1036.2 | 1128.0 | 1067.7 | 1055.7 |
| Passangers int+dom | 1228.8 | 1236.2 | 1248.5 | 1282.1 | 1342.2 | 1443.4 | 1392.2 | 1378.9 |
| share dom | 0.253 | 0.244 | 0.241 | 0.237 | 0.228 | 0.219 | 0.233 | 0.234 |
| **Jet kerosene in dom. aviation** | **21.50** | **17.53** | **16.62** | **16.11** | **17.78** | **20.32** | **22.44** | **23.34** |
| **Jet kerosene in inter.aviation** | **63.50** | **54.47** | **52.38** | **51.89** | **60.22** | **72.68** | **73.86** | **76.26** |

Data for the period from 1991 to 2006 were obtained from Statistical yearbooks (1994, 1997 and 2007) 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 3.2-8).

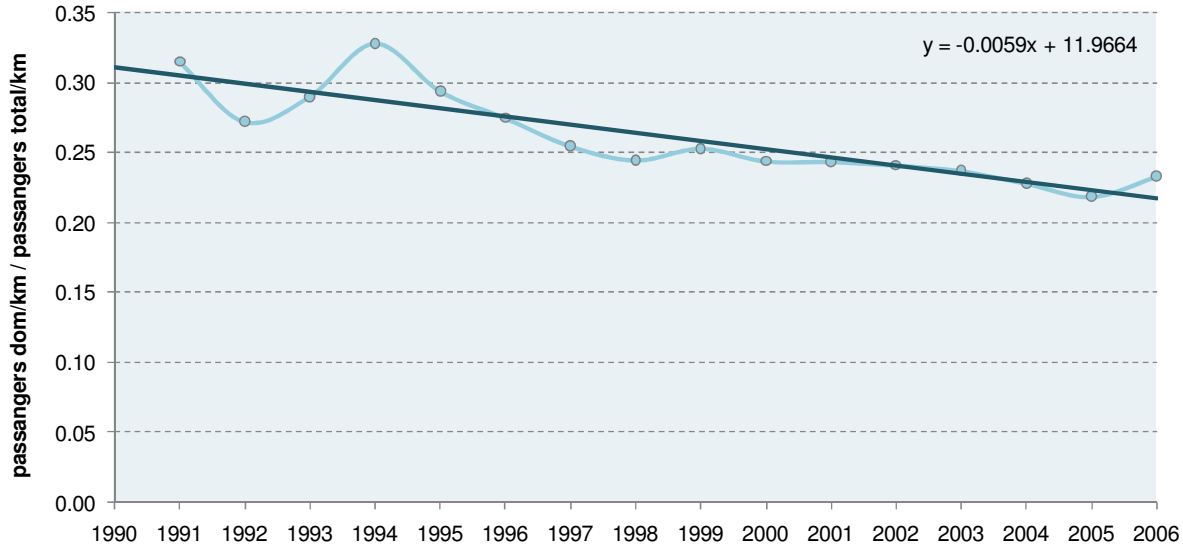


*Figure 3.2-8: The average km traveled per passenger on domestic/international routes for the period 1991-2006*

The GHG emissions were calculated using Tier 1 approach based on jet fuel consumption (calculated as explained) and aviation kerosene 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 A2-13 of the Annex 2.

**Road Transport**

The COPERT III 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 2007. For calculating emissions, COPERT III emission factors per fuel types were used. Corresponding to the COPERT III fleet classification all vehicles are grouped into vehicle classes and subclasses as is shown in Table 3.2-9.

*Table 3.2.9: 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 A2-11 of the Annex 2 while the vehicle numbers per sub-classes are shown in Figure 3.2-9.

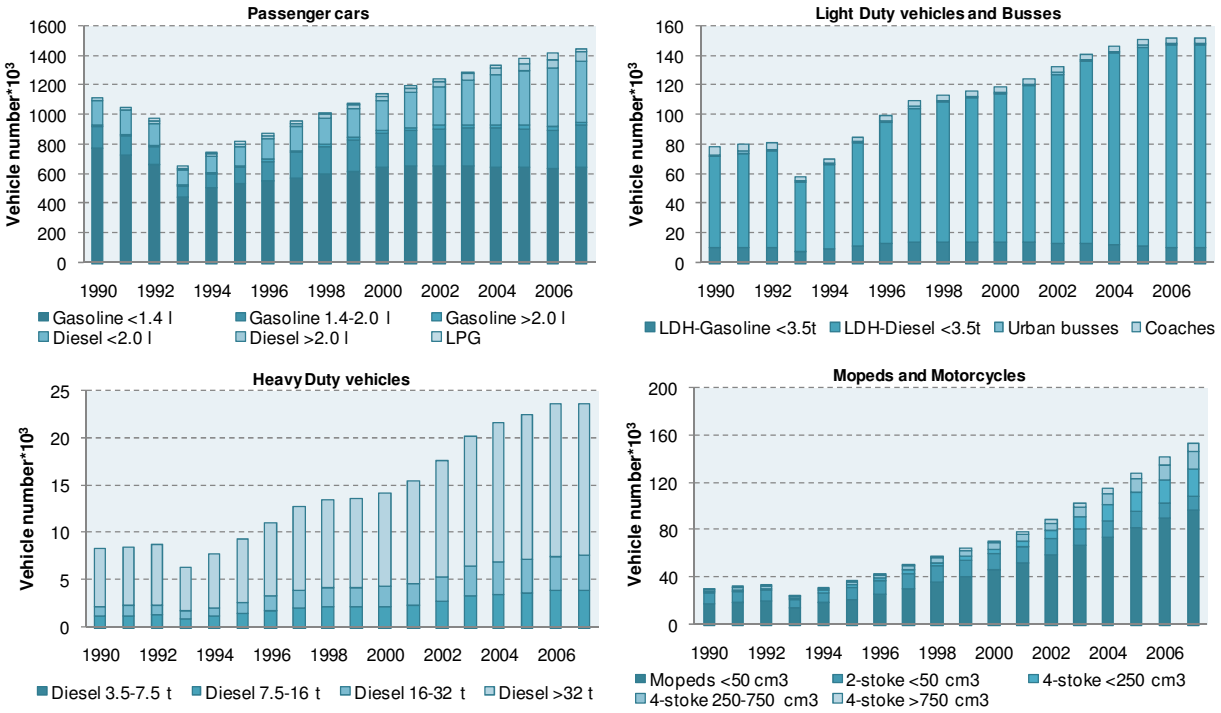


*Figure 3.2-9: Number of vehicles in sub-classes in the period from 1990 to 2007*

Total number of vehicles in 2007 increased by 30% 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 2007 amounted 82%. Comparing 2007 with 1990, the increase in total number of passenger cars is mostly due to growth in the number of diesel cars (60%) with engine size <2.0 l and gasoline cars with engine size between 1.4 - 2.0 l (50%) while number gasoline vehicles with engine smaller than 1.4 l decreased for 20%. Concerning Duty vehicles, there has been growth in the number of diesel Light duty vehicles for 48% as well as number of Heavy duty vehicles for 68%, comparing with 1990. Number of Mopeds and Motorcycles increased 5 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 3.2-10. 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.

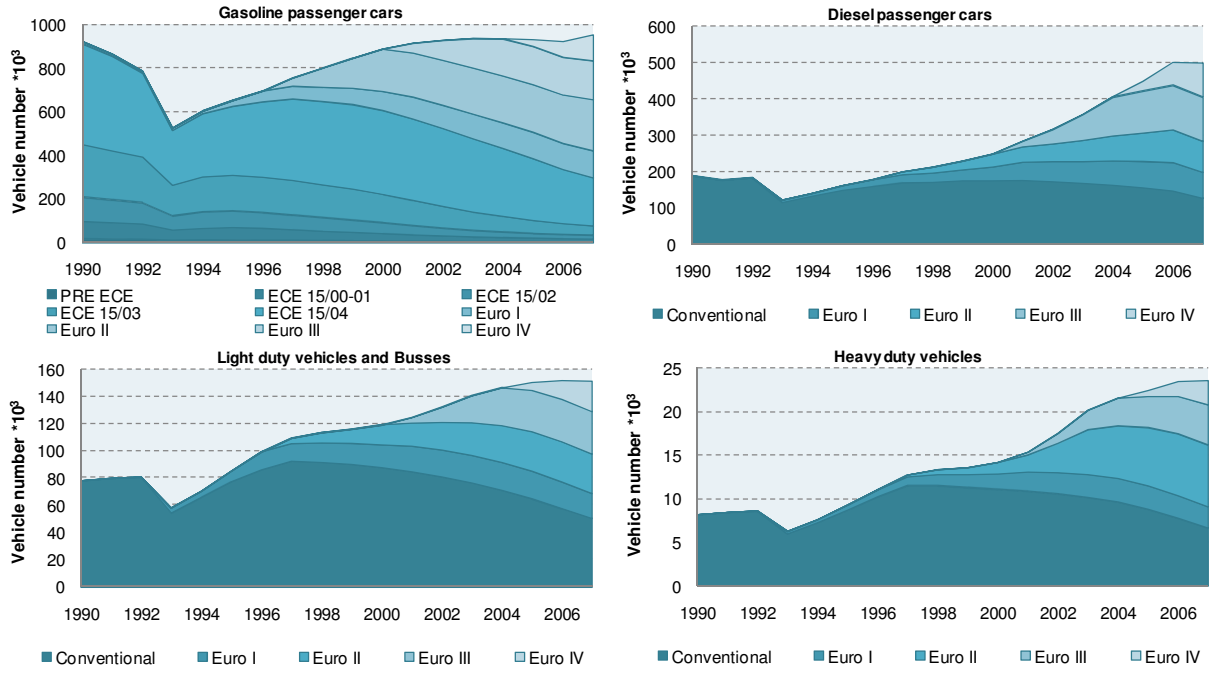


*Figure 3.2-10: Layer distribution of vehicle numbers per vehicle type for the period from 1990 to 2007*

Fuel consumption and GHG emissions from Road Transport are presented in the Table A2-12 of the Annex 2.

The GHG emissions were calculated for the whole period from 1990 to 2007 using COPERT III 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 3.2-11.

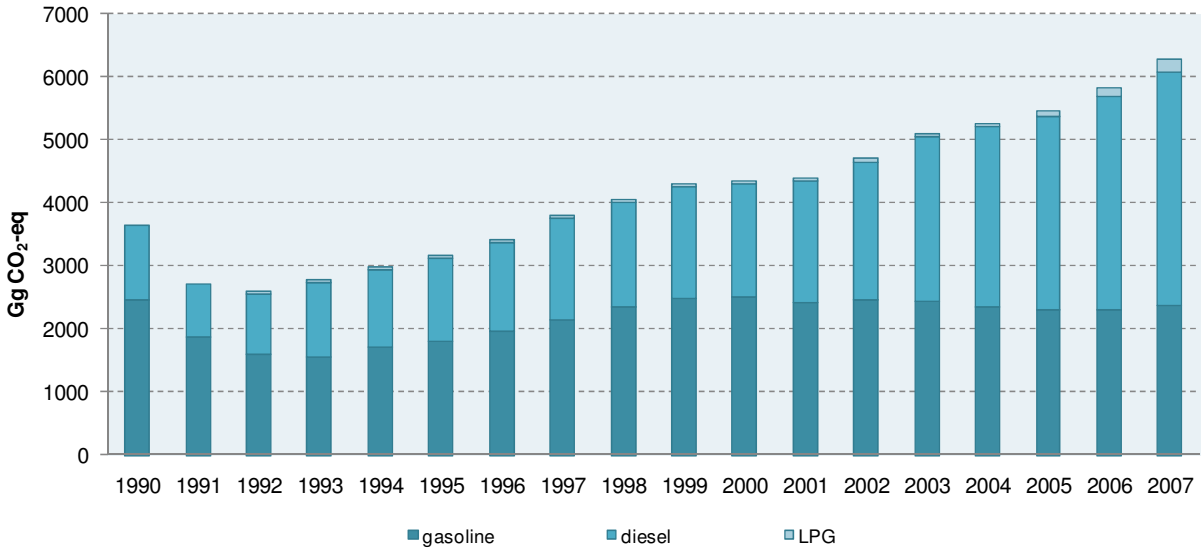


*Figure 3.2-11: $CO_2$-eq emission from Road transport sector by fuel for the period from 1990 to 2007*

**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 A2-14 and A2-15 of the Annex 2.

### 3.2.1.4. 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 3.2-10 and Figure 3.2-12.

*Table 3.2-10: The $CO_2$-eq emissions (Gg) from small stationary energy sources*

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| Commerc./Institutional | 775 | 652 | 638 | 743 | 790 | 818 | 806 | 786 | 723 | 611 |
| Residential | 2176 | 1688 | 2008 | 2155 | 2256 | 2467 | 2442 | 2481 | 2286 | 2060 |
| Agric./Forestry/Fishing | 843 | 583 | 861 | 801 | 742 | 755 | 702 | 712 | 732 | 725 |
| **Total** | **3794** | **2923** | **3507** | **3699** | **3787** | **4040** | **3950** | **3979** | **3741** | **3396** |

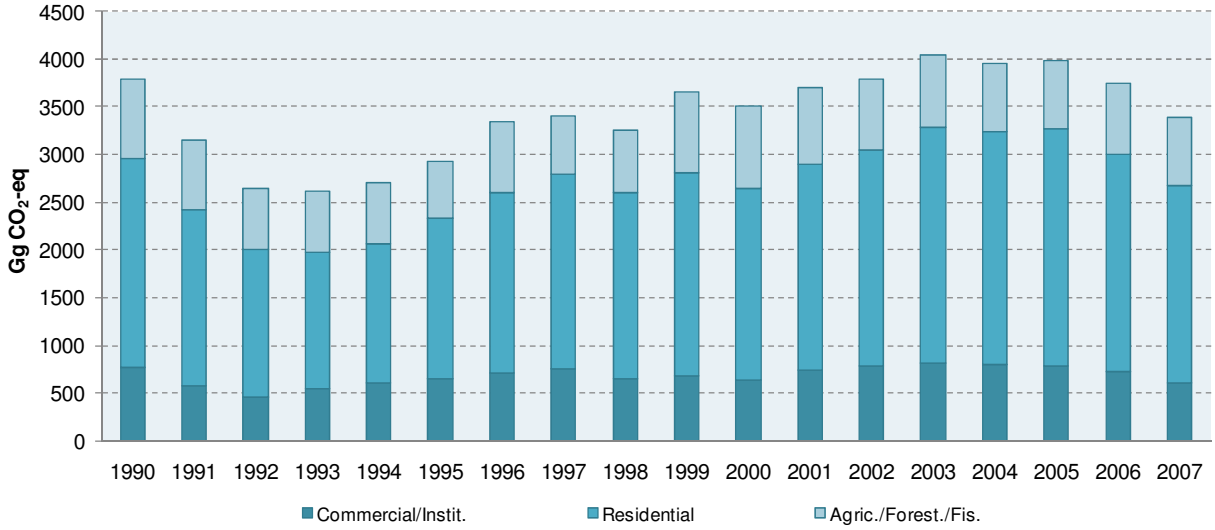


*Figure 3.2-12: The $CO_2$-eq emissions from Small Stationary Sources*

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 A2-16, A2-17 and A2-18 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 (1990-2007) was set up according to the SNAP 97 nomenclature of EMEP/CORINAIR methodology. Emissions were obtained from the emission inventory report 'Republic of Croatia *Informative Inventory Report to LRTAP Convention for the Year 2007* 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 2007 was 72.7 kt which is 3.3% higher than the year before and 6.7% lower compared to 1990. The $NO_X$ emissions from Energy sector contribute with 88.6% to national total $NO_X$ emission. The structure of $NO_x$ emission has not changed significantly in the period from 1990 – 2007 (Figure 3.2-13). The main source of $NO_x$ emission is still road transport (39.0% of total emission), but its contribution has been decreasing steadily since 1990 (-14.1 %), as a result of vehicles gradually being equipped with catalytic converters. Other mobile source sector also significantly contributes to national total of $NO_x$ emissions (28.2%). Emission of $NO_x$ from stationary combustion sectors accounted with 32.8% to the national total, mainly from the Combustion in energy transformation industry sector (18.4%).

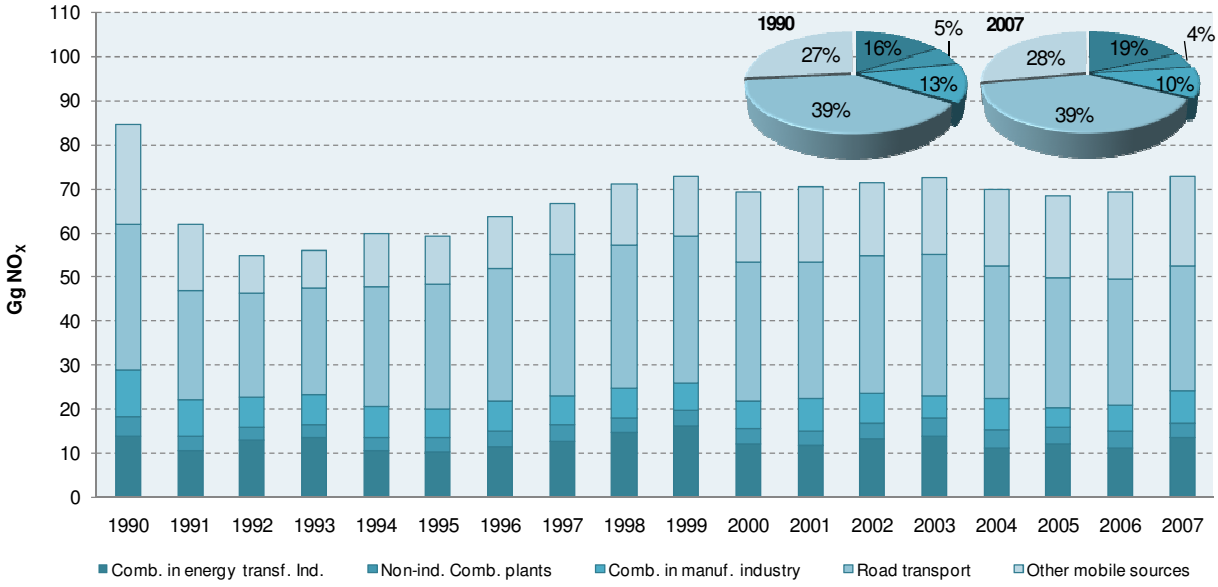


*Figure 3.2-13: $NO_x$ emissions in Croatia in the period 1990-2007*

## CO emissions

In 2007, the emission of CO in Energy sector was 322.4 kt which is 4.5% lower than in the year before and 35.4% lower compared to 1990, the year with maximum emission (498.8 kt) of CO in the observed period. The CO emissions from Energy sector contribute with 89.4% to national total CO emission. 49.3% of CO emission in Energy sector in 2007 was the result of incomplete fossil fuel combustion in Road transport sector and 31.0% in non-industrial combustion plants sector (Figure 3.2-14).

Road transport is still the largest sector of CO emission in the period from 1990 to 2007. Significant decrease is due to new vehicles equipped with catalytic converters. Other mobile source sector contributed with 9.4% in CO emission in 2007 and increased 1.6 times in the observed period. At the same time, the emission from Combustion in manufacturing industry sector decreased (-37.3%).

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).

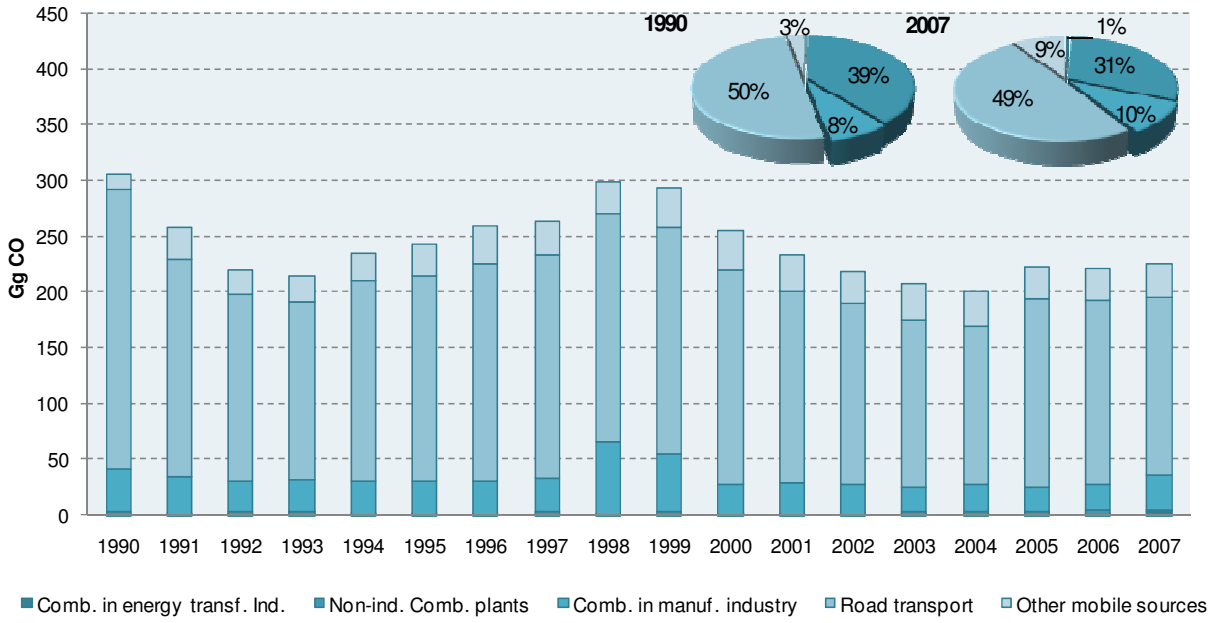


*Figure 3.2-14: CO emissions in Croatia in the period 1990-2007*

## 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 30.5 kt in 2007 which was 2.4% lower than the year before and 44.9% lower than 1990. The NMVOC emissions from Energy sector contribute only with 26.6% to national total NMVOC emission.

The structure of NMVOC emission from Energy sector has not changed significantly in the period from 1990 – 2007 (Figure 3.2-15). The main source of NMVOC emission is still Other mobile sources sector (50.3% of total emission. Emission of NMVOC from stationary combustion sectors accounted with 43.0% to the national total, mainly from the Combustion in manufacturing industry sector (30.7%).

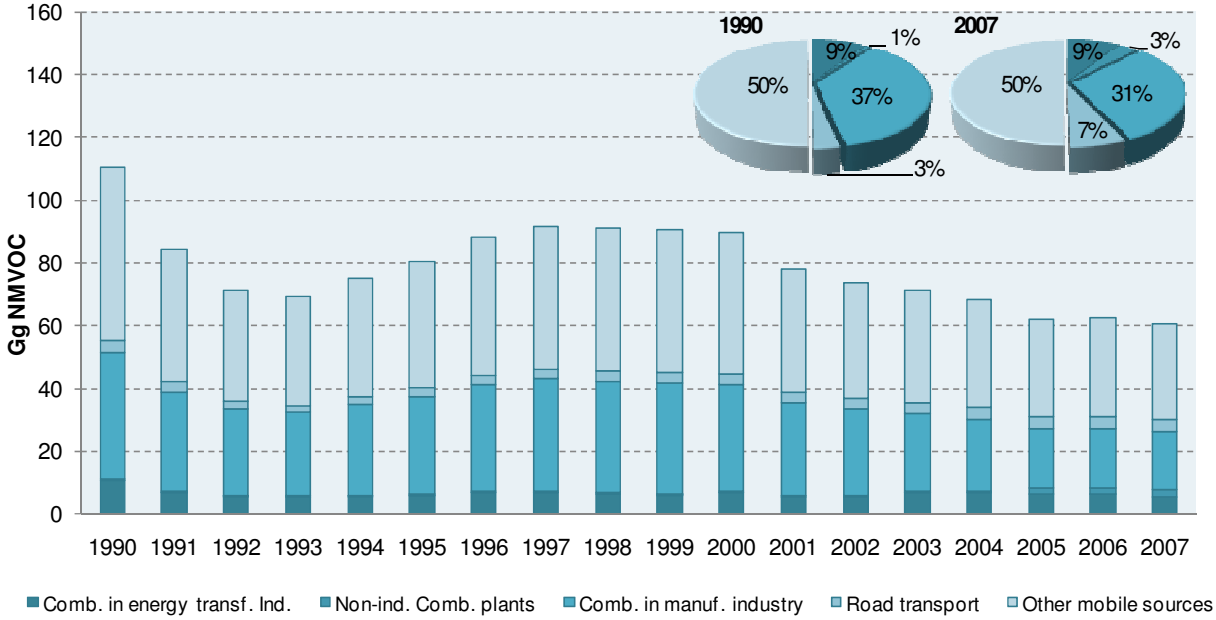


*Figure 3.2-15: NMVOC emissions in Croatia in the period 1990-2007*

## $SO_2$ emissions

In accordance with the calculated results, the level of $SO_2$ emission from energy sector in 2007 reached 58.5 kt which is 90.0% of total national $SO_2$ emission. The trend shows that emissions of $SO_2$ have increased by 2,3% compared to the emission in 2006 and decreased by 63.7 % 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 2007, 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 (-85.4% ). $SO_2$ emission increased only in road transport sector (+9.2%), although the sulphur content in fuel was lowered. This was due to increase of number of vehicle on the road.

Emission trend for $SO_2$ in the period of 1990 to 2007 as well as the share of the particular sectors in total emission of $SO_2$ in Energy sector 1990 and 2007 is presented in Figure 3.2-16.

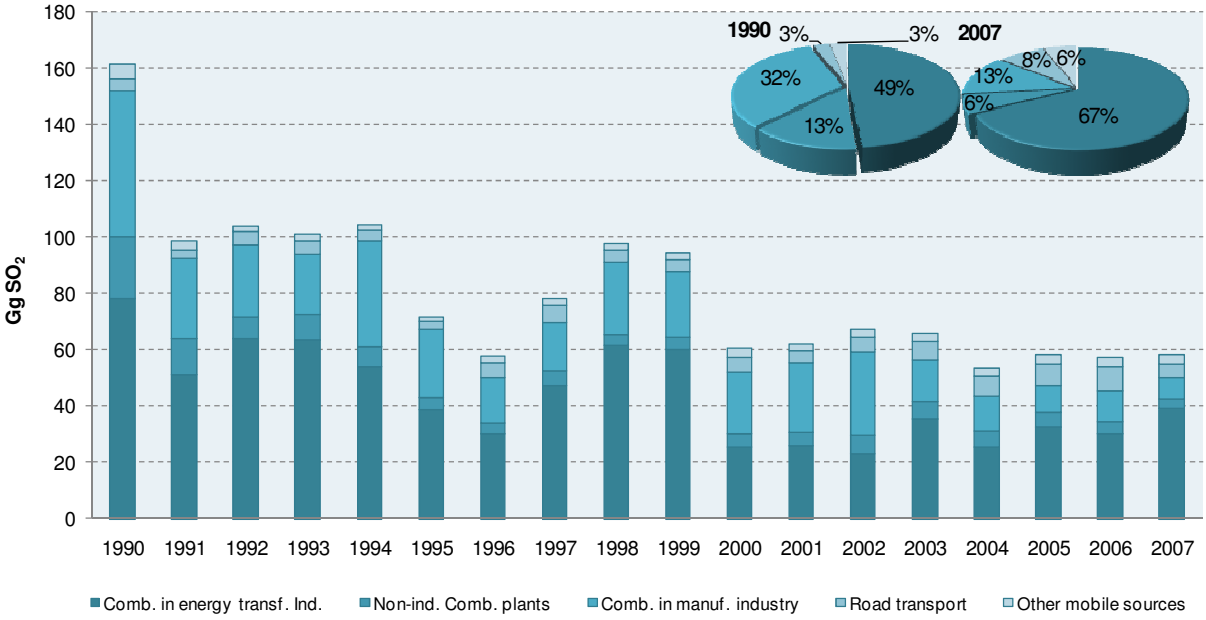


*Figure 3.2-16: $SO_2$ emissions in Croatia in the period 1990-2007*

The emissions of ozone precursors and $SO_2$ are shown in the Table 3.2-11.

*Table 3.2-11: Emissions of ozone precursors and $SO_2$ from fuel combustion (Gg)*

| Emission (Gg) | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| **$NO_x$ Emission** | **82.92** | **58.41** | **69.13** | **70.05** | **71.15** | **72.40** | **69.69** | **73.61** | **68.65** | **72.43** |
| Energy Industries | 13.61 | 10.30 | 11.99 | 11.58 | 13.19 | 13.77 | 11.20 | 12.04 | 11.15 | 13.39 |
| Manuf. Ind. & Cons. | 17.49 | 8.92 | 9.73 | 10.59 | 10.22 | 9.72 | 11.82 | 16.60 | 12.26 | 14.07 |
| Transport | 36.79 | 31.05 | 34.56 | 34.27 | 34.60 | 35.35 | 33.51 | 31.83 | 32.00 | 32.11 |
| Other Energy | 15.03 | 8.13 | 12.85 | 13.62 | 13.13 | 13.57 | 13.16 | 13.15 | 13.24 | 12.86 |
| **CO Emission** | **498.3** | **345.5** | **379.4** | **327.3** | **315.5** | **332.5** | **321.8** | **325.9** | **330.9** | **321.7** |
| Energy Industries | 1.54 | 0.99 | 1.21 | 1.04 | 0.97 | 1.38 | 1.23 | 0.93 | 1.35 | 1.89 |
| Manuf. Ind. & Cons. | 40.44 | 41.26 | 37.82 | 38.62 | 37.89 | 38.02 | 41.61 | 32.60 | 36.69 | 44.84 |
| Transport | 252.3 | 186.5 | 193.9 | 172.4 | 163.7 | 151.6 | 142.5 | 159.4 | 159.4 | 159.4 |
| Other Energy | 203.9 | 116.7 | 146.4 | 115.2 | 112.9 | 141.4 | 136.4 | 133.0 | 133.4 | 115.5 |
| **NMVOC Emission** | **55.07** | **40.22** | **44.86** | **39.06** | **36.87** | **35.74** | **34.12** | **28.88** | **30.55** | **29.93** |
| Energy Industries | 0.32 | 0.23 | 0.28 | 0.26 | 0.30 | 0.34 | 0.29 | 0.29 | 0.29 | 0.34 |
| Manuf. Ind. & Cons. | 1.70 | 1.37 | 1.44 | 1.47 | 1.44 | 1.73 | 1.93 | 1.76 | 3.33 | 3.61 |
| Transport | 40.90 | 31.71 | 34.12 | 29.85 | 27.83 | 24.86 | 23.39 | 18.54 | 18.56 | 18.58 |
| Other Energy | 12.15 | 6.91 | 9.01 | 7.48 | 7.29 | 8.82 | 8.50 | 8.30 | 8.37 | 7.41 |
| **$SO_2$ Emission** | **163.6** | **71.82** | **60.68** | **62.04** | **67.56** | **66.36** | **52.40** | **58.28** | **56.52** | **61.09** |
| Energy Industries | 78.51 | 38.98 | 25.39 | 26.04 | 23.29 | 35.70 | 25.66 | 32.76 | 30.44 | 38.94 |
| Manuf. Ind. & Cons. | 55.84 | 24.66 | 22.59 | 24.88 | 29.93 | 15.62 | 11.82 | 10.29 | 11.59 | 8.60 |
| Transport | 5.44 | 3.52 | 6.19 | 5.03 | 6.37 | 7.55 | 8.01 | 8.60 | 8.64 | 8.66 |
| Other Energy | 23.87 | 4.65 | 6.50 | 6.09 | 7.97 | 7.48 | 6.92 | 6.63 | 5.85 | 4.89 |

### 3.2.2. 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 3.2-12.

*Table 3.2-12: The fuel consumption and $CO_2$ emissions from fuel combustion (Reference & Sectoral approach)*

| | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Fuel cons. (PJ)** | | | | | | | | | | |
| Reference appr. | 321.1 | 231.5 | 268.6 | 279.5 | 301.7 | 316.5 | 311.3 | 313.2 | 311.4 | 332.7 |
| Sectoral appr. | 285.5 | 206.5 | 240.7 | 253.0 | 267.5 | 285.8 | 278.2 | 281.4 | 279.1 | 300.9 |
| **Relative Dif. (%)** | **2.6** | **-0.2** | **0.2** | **1.4** | **4.3** | **1.2** | **1.2** | **1.4** | **1.8** | **1.1** |
| **$CO_2$ Emission (Gg)** | | | | | | | | | | |
| Reference appr. | 21204 | 15228 | 17948 | 18749 | 20334 | 21328 | 20796 | 21165 | 20923 | 22402 |
| Sectoral appr. | 20167 | 14324 | 16800 | 17638 | 18710 | 20157 | 19556 | 19933 | 19931 | 21160 |
| **Relative Dif (%)** | **5.1** | **6.3** | **6.8** | **6.3** | **8.7** | **5.8** | **6.3** | **6.2** | **5.0** | **5.9** |

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.

### 3.2.3. 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 are shown in the Table 3.2-13.

International marine bunkers are included in national energy balance for the period from 1994 to 2007, 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 3.2-13: Fuel consumption and GHG emissions for International aviation and marine bunkers, from 1990 to 2007*

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|
| **Fuel combustion (PJ)** | | | | | | | | | |
| Aviation bunkers | 4.85 | 0.96 | 0.80 | 1.97 | 2.66 | 2.64 | 2.49 | 2.69 | 2.92 |
| Marine bunkers | 1.44 | 0.95 | 1.07 | 1.52 | 1.83 | 1.36 | 1.52 | 0.97 | 1.08 |
| **Total bunkers** | **6.29** | **1.91** | **1.87** | **3.48** | **4.49** | **4.00** | **4.01** | **3.66** | **4.00** |
| **$CO_2$-eq emission (Gg)** | | | | | | | | | |
| Aviation bunkers | 346.35 | 68.80 | 57.13 | 140.42 | 189.85 | 188.42 | 177.59 | 191.87 | 208.67 |
| Marine bunkers | 108.96 | 71.61 | 80.94 | 114.98 | 138.86 | 102.40 | 115.35 | 73.92 | 81.31 |
| **Total bunkers** | **455.31** | **140.41** | **138.06** | **255.40** | **328.71** | **290.82** | **292.94** | **265.78** | **289.98** |

*Table 3.2-13: Fuel consumption and GHG emissions for International aviation and marine bunkers, from 1990 to 2007 (cont.)*

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| **Fuel combustion (PJ)** | | | | | | | | | |
| Aviation bunkers | 2.79 | 2.39 | 2.39 | 2.30 | 2.28 | 2.65 | 3.19 | 3.25 | 3.43 |
| Marine bunkers | 0.88 | 0.76 | 1.19 | 0.98 | 0.91 | 0.97 | 1.05 | 0.81 | 1.00 |
| **Total bunkers** | **3.67** | **3.15** | **3.59** | **3.28** | **3.19** | **3.62** | **4.24** | **4.05** | **4.42** |
| **$CO_2$-eq emission (Gg)** | | | | | | | | | |
| Aviation bunkers | 199.35 | 170.91 | 170.99 | 164.44 | 162.90 | 189.06 | 228.16 | 231.87 | 245.98 |
| Marine bunkers | 65.94 | 57.24 | 89.71 | 73.52 | 68.93 | 73.35 | 79.29 | 61.22 | 75.94 |
| **Total bunkers** | **265.28** | **228.15** | **260.70** | **237.96** | **231.83** | **262.41** | **307.45** | **293.09** | **321.92** |

### 3.2.4. FEEDSTOCKS 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.

### 3.2.5. $CO_2$ CAPTURE FROM FLUE GASES AND SUBSEQUENT $CO_2$ STORAGE

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

### 3.2.6. 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 SNAP 97 nomenclature of EMEP/CORINAIR methodology. Emissions were obtained from the emission inventory report 'Republic of Croatia *Informative Inventory Report to LRTAP Convention for the Year 2007* 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 1990-2007, 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…). 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 III package (Tier 2/3 method) was used for air emission calculation from road transport emission in the period from 1990 to 2007 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 (Annex 4).

#### 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) for last four years in Energy Industries.

### 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 1990-2007, 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 III model was used for the whole period (1990-2007). 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 International Energy Agency 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

In this chapter two kinds of recalculations are described. First part of chapter relates to recalculations which were performed for '*Resubmission of Croatia's 2008 Inventory Submission'* and second part relates to recalculations performed during preparation of this submission.

This first part is given only as information about recalculations which were performed after National Inventory Report for 2008 completed ('Resubmission of Croatia's 2008 Inventory Submission').

#### 3.2.10.1. Recalculations performed for Resubmission of Croatia's 2008 Inventory Submission

During the in country review process held from 20 to 25 October 2008 ERT formulated review of Croatia's 2008 Inventory Submission. According to their recommendations few recalculations for the whole period from 1990 to 2006 were carried out. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

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

For emission recalculation Carbon content for Coke Oven Gas (13.0 t C/TJ) was used instead of Carbon content for Gas coke (29.5 t C/TJ).

$CO_2$ Emission from $SO_2$ scrubbing in TPP Plomin 2 was included in total $CO_2$ emission of 1.A.1.a sector. $CO_2$ emission is calculated from amount of $CaSO_4$ produced as by-product of $SO_2$ scrubbing process according to equation (4):

(1) $SO_2 + 1/2O_2 \rightarrow SO_3$

(2) $SO_3 + H_2O \rightarrow H_2SO_4$

(3) $H_2SO_4 + CaCO_3 \rightarrow CaSO_4 + CO_2 + H_2O$

---

(4) $SO_2 + 1/2O_2 + CaCO_3 + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O + CO_2$

$$n(CaSO_4) = n(CO_2)$$

$$m(CO_2) = \frac{m(CaSO_4 \cdot 2H_2O)}{M(CaSO_4 \cdot 2H_2O)} \cdot M(CO_2)$$

The recalculations were performed for the whole period from 1990 to 2006.

**Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c.)**

For emission recalculation Carbon content for Coke Oven Gas (13.0 t C/TJ) was used instead of Carbon content for Gas coke (29.5 t C/TJ). The recalculation was performed for the whole period from 1990 to 2006.

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

For emission recalculation Carbon content for Coke Oven Gas and Gas Works Gas (13.0 t C/TJ) was used instead of Carbon content for Gas coke (29.5 t C/TJ). Accordingly, Croatia applied correct fractions of carbon oxidised for gas works gas and coke oven gas.

When calculating $CO_2$, $CH_4$, $N_2O$ emissions from Iron and Steel Croatia reported emissions taking into account full oxidation of fuel and also $CO_2$, $CH_4$, $N_2O$ emissions from Blast Furnace Gas, which the ERT considers as a double counting of $CO_2$, $CH_4$, $N_2O$ emissions. Therefore, blast furnace gas which is produced as a by-product of incomplete combustion of coke oven coke was excluded from emission calculation to avoid double counting. The recalculations were performed for the whole period from 1990 to 2006.

**Domestic Air Transport (1.A.3.a.)**

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.
Data for the period from 1991 to 2006 were obtained from:

- Statistical yearbook 1994, Republic of Croatia, Zagreb 1994.
- Statistical yearbook 1997, Republic of Croatia, Zagreb 1997.
- Statistical yearbook 2007, Republic of Croatia, Zagreb 2007.

Since average km traveled per passenger on domestic/international routes for 1990 is not included in available Croatian statistical publications which was confirmed by the authorized person from Central Bureau of Statistics, this value was estimated using linear extrapolation from the period 1991-2006 and equals 0.3105 (see Figure 3.2-8).

**Commercial/Institutional (1.A.4.a.)**

During In country review ERT noted double counting. 19.6 million $m^3$ of natural gas which is used in Gas Works as a feedstock and 0.9 million $m^3$ of natural gas already accounted under 1.A.1.c. This amount of natural gas was subtracted to avoid double counting. The recalculations were performed for the whole period from 1990 to 2006.

During the in-country review the ERT and the inventory team recognized that 1.5 Gg of heavy fuel oil allocated in the energy balance under road, aviation and public transport was not accounted for in the emission estimates. Taking into account the national statistical system it is very likely that this amount of fuel was used in stationary combustion (e.g. for heating airport or public services buildings, etc).Because of that emissions from the combustion of 1.5 Gg of

heavy fuel oil was included, as well as amounts of petroleum, diesel, light heating oil and petroleum coke which were used for the same purpose and not accounted for in the latest submission. The recalculations were performed for the whole period from 1990 to 2006.

### 3.2.10.2. Recalculations performed during preparation of this submission

Recalculations performed after the *Resubmission of Croatia's 2008 Inventory Submission* are shown in table 3.2-14.

*Table 3.2-14: View of recalculations performed in this submission*

| Year | Subsector | | GHG | CHANGES IN: | |
|---|---|---|---|---|---|
| | | | | Emission factors | Activity data |
| 1990 | 1.AA.4 | Other Sectors | $CO_2$ | EF for gas coke was used insted of EF for coke oven gas | |
| 1991 | 1.AA.4 | Other Sectors | $CO_2$, $CH_4$ | | Error in inserting the AD |
| 1992 | 1.AA.4 | Other Sectors | $CO_2$, $CH_4$ | | Error in inserting the AD |
| 1994 | 1.AA.4 | Other Sectors | $CO_2$, $CH_4$, $N_2O$ | | Error in inserting the AD |
| 1996 | 1.AA.4 | Other Sectors | $CO_2$, $CH_4$, $N_2O$ | | Error in inserting the AD |
| 1997 | 1.AA.4 | Other Sectors | $CH_4$, $N_2O$ | | Error in inserting the AD |
| 1998 | 1.AA.4 | Other Sectors | $CH_4$, $N_2O$ | | Error in inserting the AD |
| 1999 | 1.AA.4 | Other Sectors | $CH_4$, $N_2O$ | | Error in inserting the AD |
| 2001 | 1.AA.4 | Other Sectors | $CO_2$, $CH_4$, $N_2O$ | | Error in inserting the AD |
| 2002 | 1.AA.4 | Other Sectors | $CO_2$, $CH_4$, $N_2O$ | | Error in inserting the AD |
| 2003 | 1.AA.3 | Transport | $CO_2$ | | Error in inserting the AD |
| | 1.AA.4 | Other Sectors | $CO_2$ | | Error in inserting the AD |

### 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 A2-19, Annex 2.

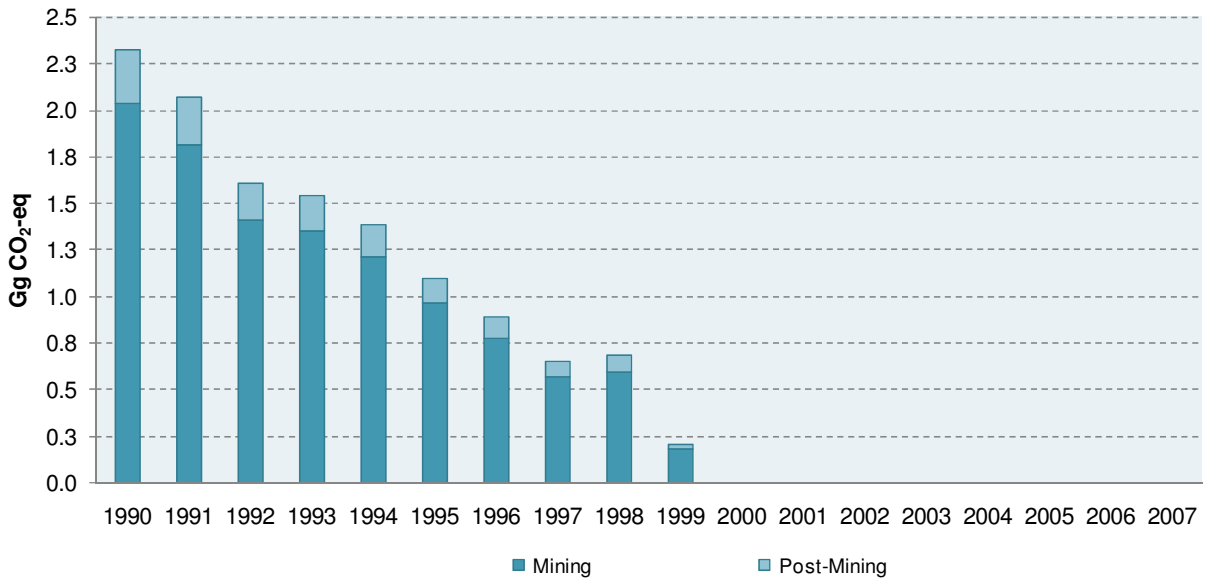


*Figure 3.3-1: The fugitive emissions of methane from coal mines*

### 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 A2-20, Annex 2.

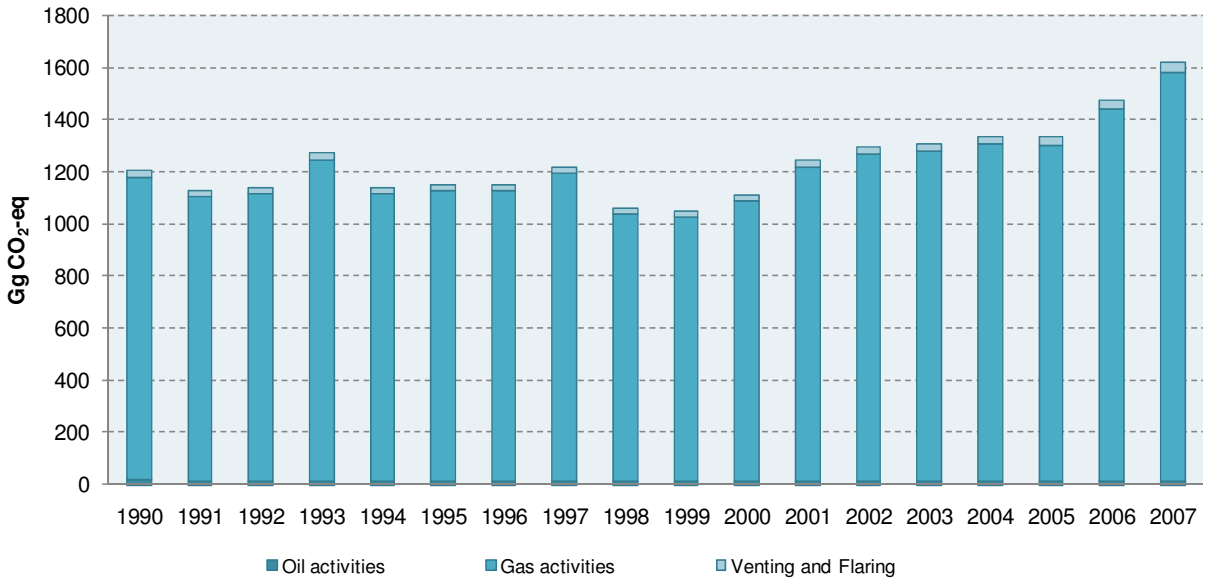


*Figure 3.3-2: The fugitive emissions of methane from oil and gas activities*

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 (1990-2007) was set up according to the SNAP 97 nomenclature of EMEP/CORINAIR methodology. Emissions were taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report to LRTAP Convention for the Year 2007* 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 2006. 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.

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

| Emissions (Gg) | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO emission | 0.64 | 0.44 | 0.33 | 0.31 | 0.31 | 0.30 | 0.33 | 0.32 | 0.31 | 0.33 |
| $NO_x$ emission | 0.64 | 0.49 | 0.47 | 0.44 | 0.44 | 0.44 | 0.46 | 0.45 | 0.43 | 0.46 |
| NMVOC emission | 8.23 | 7.77 | 9.73 | 10.41 | 10.81 | 10.51 | 9.70 | 9.05 | 9.03 | 9.61 |
| $SO_2$ emission | 6.38 | 4.96 | 4.80 | 4.49 | 4.49 | 4.52 | 4.72 | 4.60 | 4.39 | 4.70 |

## $CO_2$ emission from natural gas scrubbing

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 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| Central Gas Station MOLVE | 416 | 697 | 633 | 688 | 665 | 684 | 710 | 691 | 663 | 665 |

### 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 (±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 2009 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

Recalculations performed after the *Resubmission of Croatia's 2008 Inventory Submission* are shown in table 3.3-3.

*Table 3.3-3: View of recalculations performed in this submission*

| Year | Subsector | | GHG | CHANGES IN: Activity data |
|---|---|---|---|---|
| 1993 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 1994 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 1995 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 1996 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 1997 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 1998 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 1999 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 2000 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 2001 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 2003 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 2004 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |
| 2005 | 1.B.2 | Oil and Natural Gas | $CH_4$ | Error in inserting the AD from national energy balance |

### 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

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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)

# 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 1996-2007 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 1990-2007 are presented in the Figure 4.1-1.

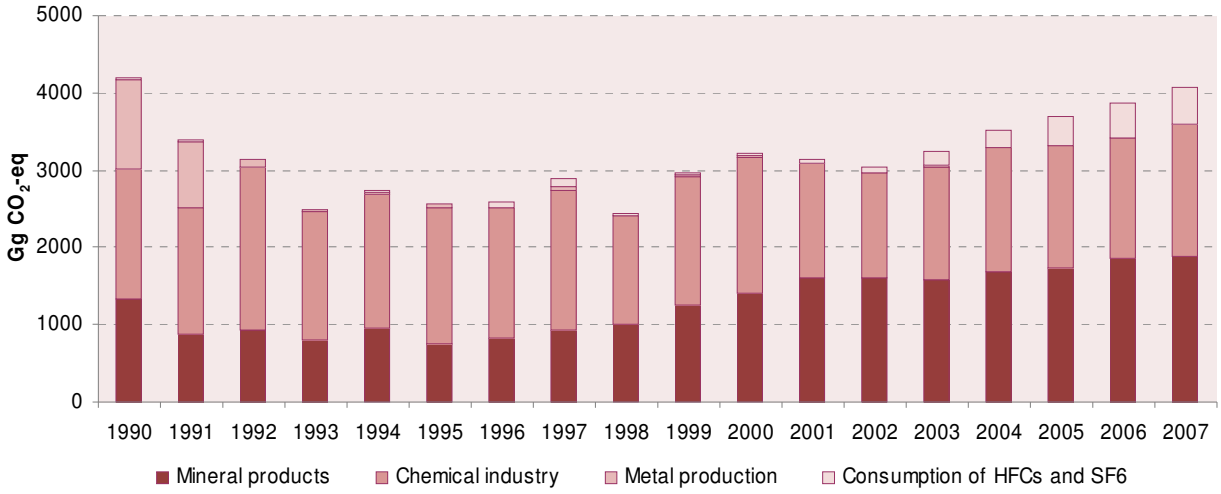


*Figure 4.1-1: Emissions of GHGs from Industrial Processes (1990-2007)*

## 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 (clays or shales) 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 clay raw 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 to 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 - 2007)*

| 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 |

*Table 4.2.1: Clinker production and emission factors (1990 - 2007), cont.*

| 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) |
|---|---|---|---|---|---|
| 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 | 3056503 | 114311 | 3234230 | 0.507 | 0.310 |

[1] Clinker production according to survey of cement manufacturers
[2] Actual clinker productions calculated as a product of clinker production and $CF_{ckd}$.

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

*Table 4.2.2: Import/export quantities of clinker (1990 - 2007)*

| 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 |
| 2005 | 0 | 0 | 195888 | 238 | -88696 | -1151 |
| 2006 | 0 | 0 | 243708 | 438 | -32078 | -1710 |
| 2007 | 24000 | 1632 | 0 | 1115 | 4442 | 4467 |

* 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 1990-2007 are presented in the Figure 4.2-1.

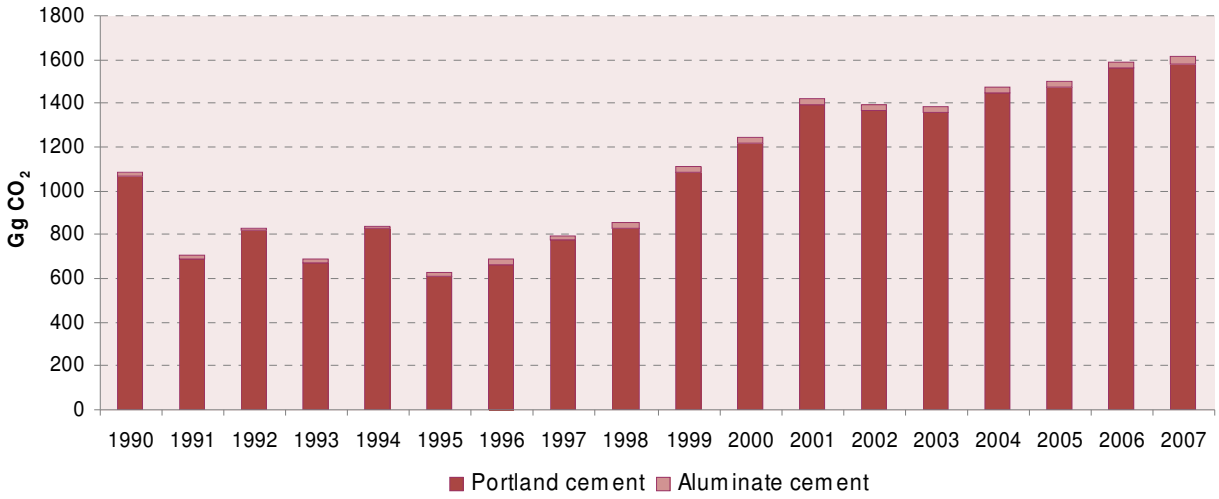


*Figure 4.2-1: Emissions of $CO_2$ from Cement Production (1990-2007)*

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 (1990-2007)*

| 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 |
| 2001 | 3152805 | 84655 |
| 2002 | 3415011 | 76737 |
| 2003 | 3607840 | 81860 |
| 2004 | 3553985 | 89563 |
| 2005 | 3528544 | 100509 |
| 2006 | 3657889 | 98041 |
| 2007 | 3658076 | 111624 |

$SO_2$ 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 2007* 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 1990-2007 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.

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. 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

According to ERT recommendation during the in-country review, country-specific EFs, which are calculated for each year of the time-series, have been recalculated. In NIR 2008 calculated EF (based on CaO and MgO content of clinker) were corrected by the difference in CaO and MgO content of raw material and clinker, by subtracting this difference. Because CaO and MgO content of the raw material is all carbonate, no correction can be made for non-carbonate CaO and MgO in the raw material. Due to the absence of plant-specific data for $CF_{CKD}$ calculation for the whole time series, the default $CF_{CKD}$ was used instead of $CF_{CKD}$ which was calculated in NIR 2008. New calculations of EFs are presented in the '*Resubmission of Croatia's 2008 Inventory*

*Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional source-specific recalculations in this report.

#### 4.2.1.6. Source–specific planned improvements

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

### 4.2.2. LIME PRODUCTION

#### 4.2.2.1. Source category description

The production of lime involves a series of steps which include qurrying the raw material, crushing and sizing, calcination and hydration. $CO_2$ is generated during the calcination stage, when limestone ($CaCO_3$) or dolomite ($CaCO_3$*$MgCO_3$) are burned at high temperature (900-1200 $^oC$) 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 (1990-2007)*

| 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 |

The resulting emissions of $CO_2$ from Lime Production in the period 1990-2007 are presented in the Figure 4.2-2.

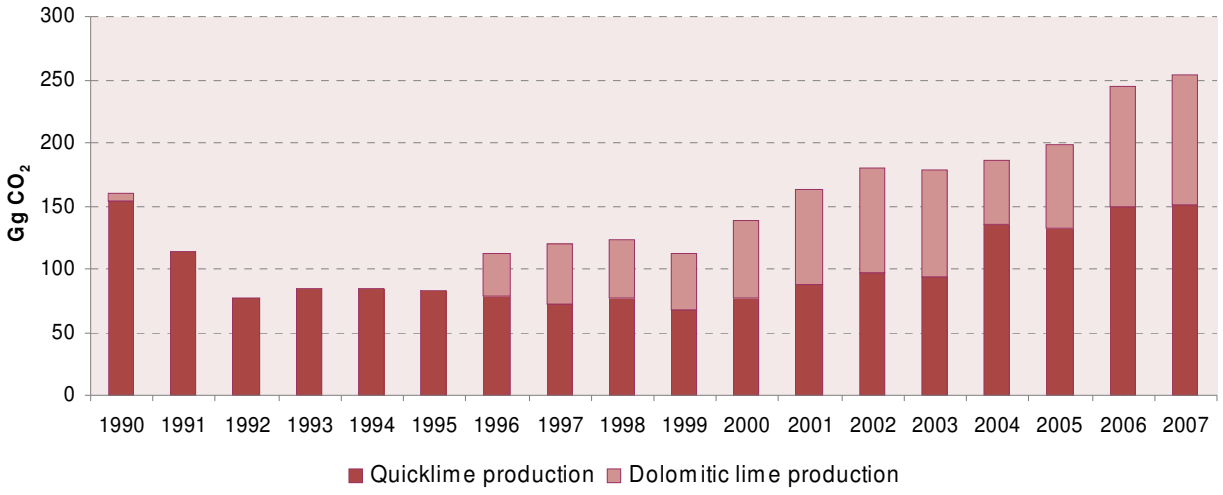


*Figure 4.2-2: Emissions of $CO_2$ from Lime Production (1990-2007)*

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 2007* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of CO from Lime Production in the period 1990-2007 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.

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. 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 1997-2007 were collected by survey of glass manufacturer. Some of these activities (from the period 1990-1996) were halted in the meantime. According to statistical data and data from survey there was no limestone use in abovementioned processes (see Table 4.2-5).

*Table 4.2-5: Limestone and dolomite use (1990-2007)*

| 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 |

*Table 4.2-5: Limestone and dolomite use (1990-2007), cont.*

| Year | Limestone use (tonnes) | Dolomite use (tonnes) |
|---|---|---|
| 1999 | 11782 | 16205 |
| 2000 | 12450 | 16695 |
| 2001 | 14097 | 18596 |
| 2002 | 14663 | 20022 |
| 2003 | 16933 | 23975 |
| 2004 | 20214 | 24088 |
| 2005 | 21318 | 25269 |
| 2006 | 18688 | 22350 |
| 2007 | 16524 | 20018 |

The resulting emissions of $CO_2$ from Limestone and Dolomite Use in the period 1990-2007 are presented in the Figure 4.2-3.

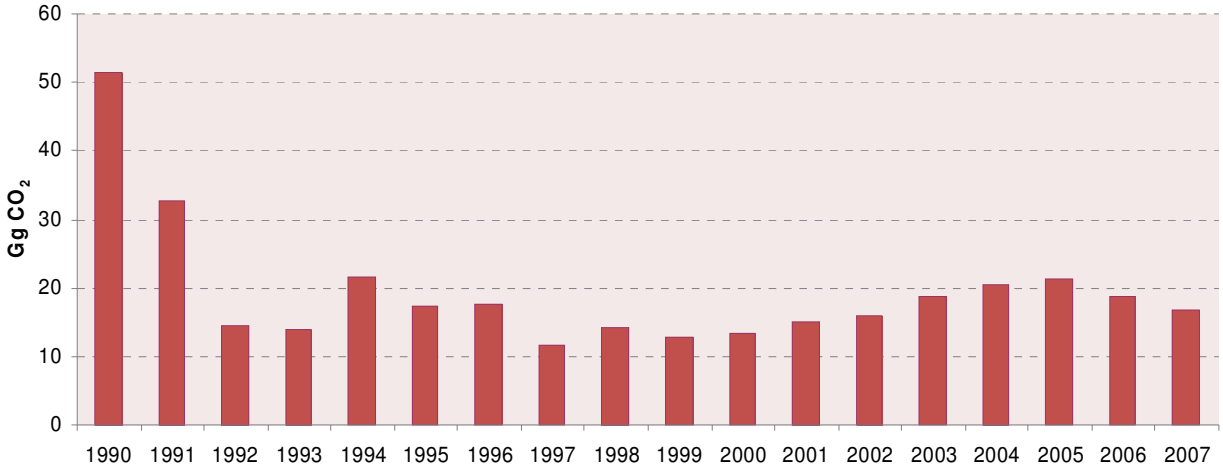


*Figure 4.2-3: Emissions of $CO_2$ from Limestone and Dolomite Use (1990-2007)*

### 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 1997-2007. 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.

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.

#### 4.2.3.5. Source specific recalculations

According to ERT recommendation during the in-country review, recalculation was performed upon new, updated data. Data were collected from statistical database 'Inputs of raw and material in industrial production'. According to statistical data, national classification of activities distinguished dolomite use in glass, ceramic and refractory materials manufacture in the period 1990-1996, as well as stressed previously. New data are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

However, after the resubmission, activity data obtained from one glass manufacturer have been corrected. Therefore additional recalculation was performed for the entire period in this report.

#### 4.2.3.6. Source–specific planned improvements

For the purpose of accurate calculation of national emission factors for dolomite use, knowledge of chemical composition of 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 1990-2007. 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 1997-2007 were collected by survey of glass manufacturers (see Table 4.2-6).

*Table 4.2-6: Soda ash use (1990-2007)*

| 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 |
| 2005 | 41498 |
| 2006 | 36487 |
| 2007 | 32329 |

The resulting emissions of $CO_2$ from Soda Ash Use in the period 1990-2007 are presented in the Figure 4.2-4.

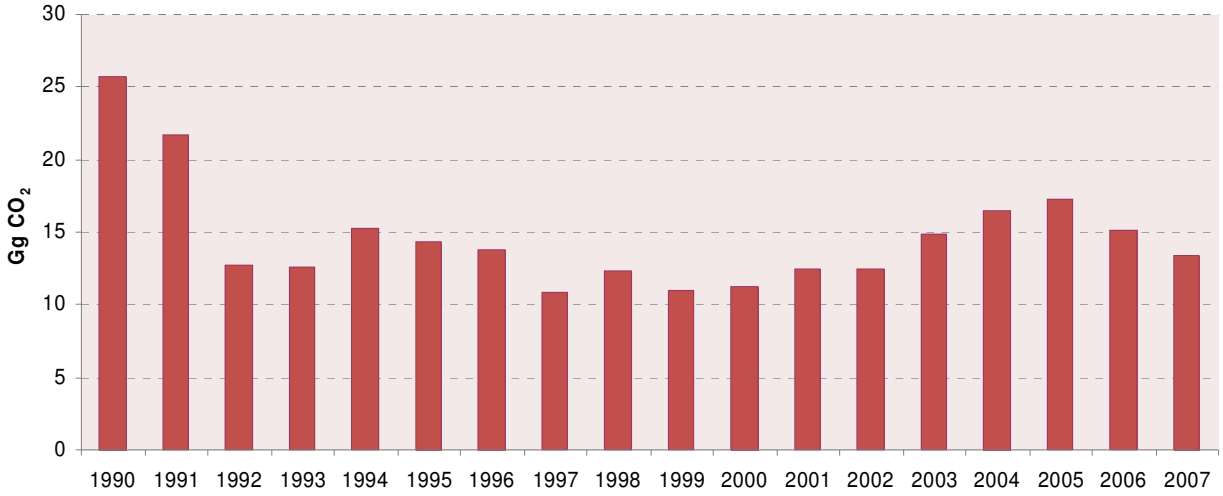


*Figure 4.2-4: Emissions of $CO_2$ from Soda Ash Use (1990-2007)*

### 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 1997-2007. 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

According to ERT recommendation during the in-country review, recalculation was performed upon new, updated data. Data were collected from statistical database 'Inputs of raw and material in industrial production'. According to statistical data, national classification of activities distinguished soda ash use in glass and ceramic manufacture and in the production of soap and detergents in the period 1990-1996, as well as stressed previously. New data for soda ash use in chemical production have been included for the period 1997-2003 and presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional 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 2007* 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 1990-2007 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.

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.

#### 4.2.5.5. 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 $^oC$). 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 (1990-2007)*

| 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 (1990-2007), 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 |

The resulting emissions of $CO_2$ from Ammonia Production in the period 1990-2007 are presented in the Figure 4.3-1.

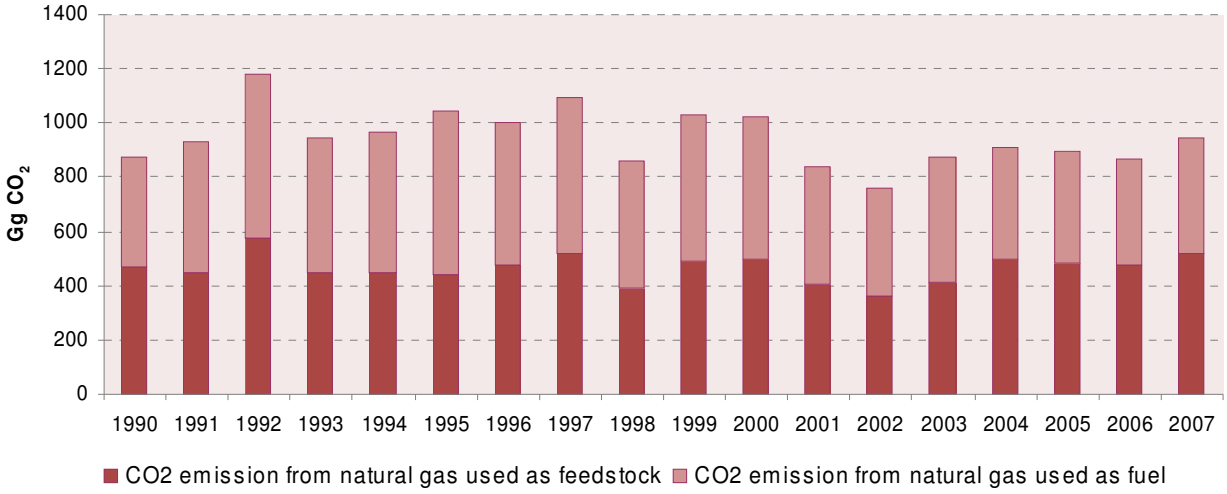


*Figure 4.3-1: Emissions of $CO_2$ from Ammonia Production (1990-2007)*

Emissions of $CH_4$ and $N_2O$ from natural gas used as fuel in Ammonia production in the period 1990-2007 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 (1990-2007)*

| 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 |
| 1998 | 0.03700 | 0.00074 |
| 1999 | 0.04206 | 0.00084 |
| 2000 | 0.04125 | 0.00082 |

*Table 4.3-2: Emission of $CH_4$ and $N_2O$ in Ammonia Production from consumption of natural gas as fuel (1990-2007), cont.*

| Year | $CH_4$ (Gg) | $N_2O$ (Gg) |
|---|---|---|
| 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 |

#### 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.

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

#### 4.3.1.5. Source–specific recalculations

According to ERT recommendation during the in-country review, information on the standard used for the measurements of natural gas composition have been obtained by experts from ammonia manufacturer. In line with recommendation, country-specific $CO_2$ EFs, which are calculated for each year of the time-series, have been recalculated. Also, derived EFs have been applied to the total amount of natural gas for ammonia production (in NIR 2008 amount of natural gas used as feedstock were used for calculation of process emissions, while calculation of $CO_2$ emission from natural gas used as fuel were performed by using default EF). Pursuant ERT recommendation, ammonia production is presented in CRF tables as activity data instead of natural gas consumption. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional 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 (1990-2007)*

| 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 |
| 2001 | 257534 |
| 2002 | 249992 |
| 2003 | 235645 |
| 2004 | 287567 |
| 2005 | 280746 |
| 2006 | 277590 |
| 2007 | 306619 |

The resulting emissions of $N_2O$ from Nitric Acid Production in the period 1990-2007 are presented in the Figure 4.3-2.

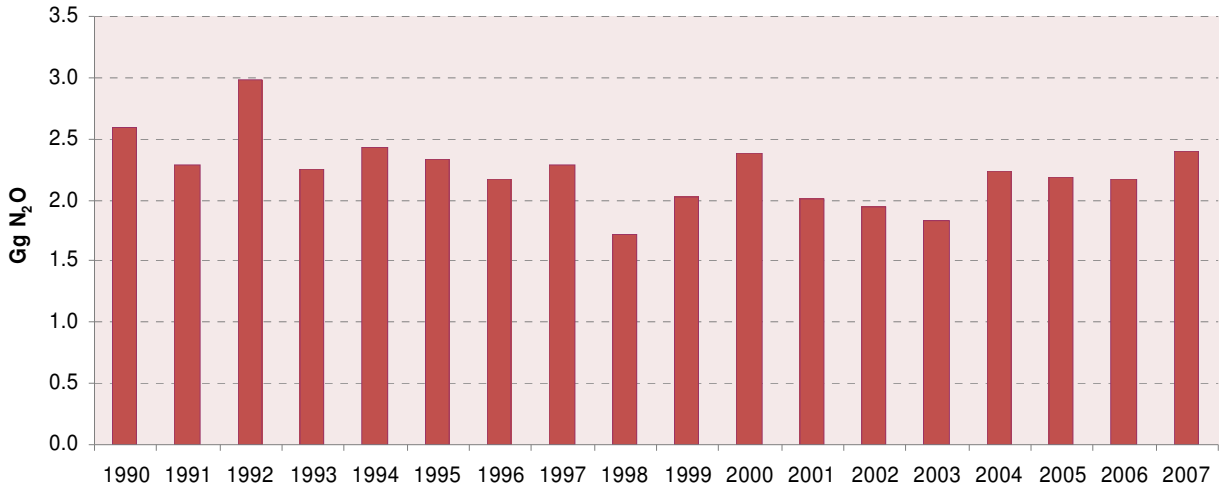


*Figure 4.3-2: Emissions of $N_2O$ from Nitric Acid Production (1990-2007)*

### 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.

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. 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

In NIR 2008 emissions of $N_2O$ from nitric acid production have been calculated using default EF of 9 kg $N_2O$/t $HNO_3$ from the IPCC good practice guidance, which is the mean of the range given for European designed, dual pressure, double absorption plants.

According to ERT recommendation during the in-country review, although Petrokemija Fertilizer Company does not continuously measure $N_2O$ emissions, data from a measurement in 1997 have been used for calculation of $N_2O$ EF. The measurement leads to an EF of 7.8 kg $N_2O$/t $HNO_3$. Information on technology and relevant parameters was provided by Petrokemija during the in-country review.
The ERT came to the conclusion that the use of a plant specific EF is in accordance with the IPCC good practice guidance and also corresponds to ranges of EFs provided in literature (BAT document on Large Volume Inorganic Chemicals – Ammonia, acids and fertilizers) for the parameters used by Petrokemija. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional 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.

*Table 4.3-4: Production of other chemicals (1990-2007)*

| 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 |

The resulting emissions of $CH_4$ from Production of Other Chemicals in the period 1990-2007 are reported in Table 4.3-5.

*Table 4.3-5: Emissions of $CH_4$ from Production of Other Chemicals (1990-2007)*

| 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 | - | - | - |

Emissions of indirect GHGs have been taken from the emission inventory report 'Republic of Croatia *Informative Inventory Report for LRTAP Convention for the Year 2007* Submission to the Convention on Long-range Transboundary Air Pollution'.

The emissions of indirect GHGs from Production of Other Chemicals for the period 1990-2007 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

There are no source-specific recalculations in this report.

#### 4.3.3.6. Source–specific planned improvements

For the purpose of accurate emission calculations, Croatia 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 emission factor applied was assumed to be applicable to both pig iron production and integrated pig iron and steel production.

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[6].

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**

Emissions of $CO_2$ have been calculated by multiplying annual steel production with related emission factor provided by *Revised 1996 IPCC Guidelines*. The carbon emission factor is based on carbon loss from the electrode. Accordingly to value recommended in *Good Practice Guidance* for carbon released from consumed electrodes (roughly 1-1.5 kg carbon/tonne steel), the arithmetic mean has been taken (1.25 kg carbon/tonne steel) and emission factor of 4.58 kg $CO_2$/tonne steel has been applied.

[6] 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 extracted from Annual Industrial Reports published by Central Bureau of Statistics, Department of Manufacturing and Mining.

*Table 4.4-1: Steel production (1990-2007)*

| Year | Steel production (tonnes) |
|---|---|
| 1990 | 189368 |
| 1991 | 171147 |
| 1992 | 119733 |
| 1993 | 101942 |
| 1994 | 32674 |
| 1995 | 17021 |
| 1996 | 46424 |
| 1997 | 70660 |
| 1998 | 104854 |
| 1999 | 77213 |
| 2000 | 70998 |
| 2001 | 57963 |
| 2002 | 33839 |
| 2003 | 42235 |
| 2004 | 85947 |
| 2005 | 73640 |
| 2006 | 80516 |
| 2007 | 76252 |

The resulting emissions of $CO_2$ from Steel Production in the period 1990-2007 are presented in the Figure 4.4-1.

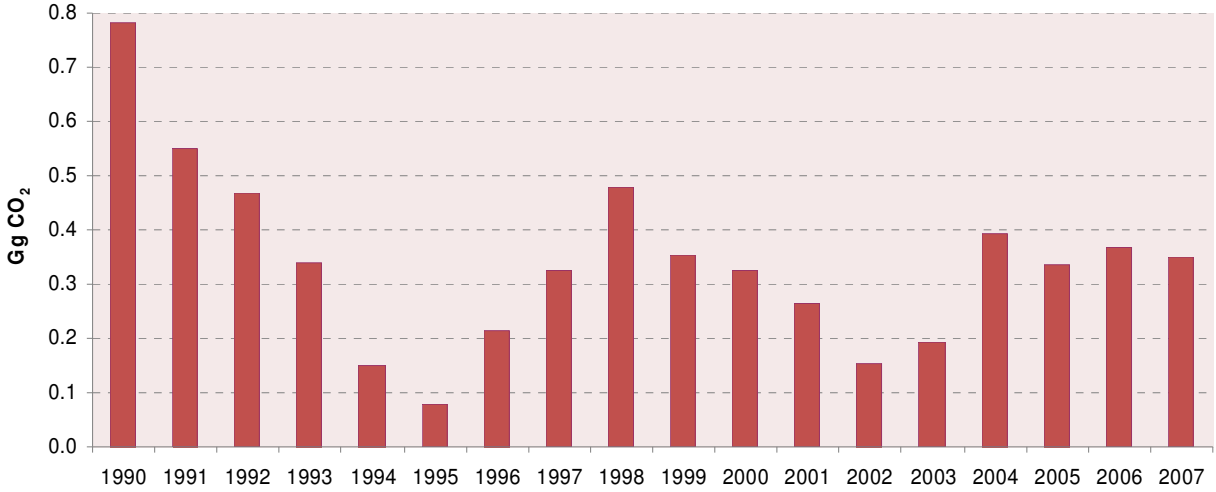


*Figure 4.4-1: Emissions of $CO_2$ from Steel Production (1990-2007)*

### 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. The use of plant-specific emission factors would minimize uncertainty, but these factors were not available in adequate form.

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 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.

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.

#### 4.4.1.5. Source–specific recalculations

According to ERT recommendation during the in-country review, activity data were checked for 1990, 1991, 1992 and 1993 and errors were corrected. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional source-specific recalculations in this report.

#### 4.4.1.6. Source–specific planned improvements

For the purpose of accurate calculation of national emission factors, Croatia planned to investigate the plant-specific emission factor to minimize emission calculation uncertainty.

### 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: Production of ferroalloys (1990-2007)*

| 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 | 0 |
| 1998 | 5166 | 0 |
| 1999 | 6054 | 0 |
| 2000 | 3624 | 0 |
| 2001 | 1195 | 0 |
| 2002 | 4 | 0 |
| 2003 | 7597 | 0 |
| 2004 | 0 | 0 |
| 2005 | 0 | 0 |
| 2006 | 0 | 0 |
| 2007 | 0 | 0 |

The resulting emissions of $CO_2$ from Ferroalloys Production in the period 1990-2007 are presented in the Figure 4.4-2.

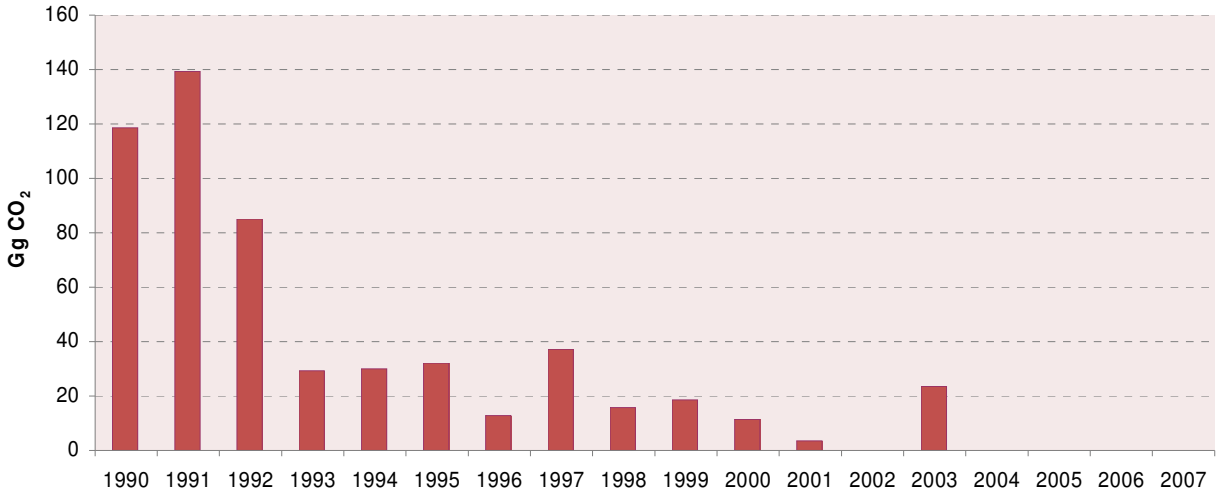


*Figure 4.4-2: Emissions of $CO_2$ from Ferroalloys Production (1990-2007)*

#### 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.

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.

#### 4.4.2.5. Source–specific recalculations

In NIR 2008 emissions of $CO_2$ have been calculated by multiplying annual ferroalloys production by material-specific emission factor.

According to ERT recommendation during the in-country review, a higher tier method based on reducing agents has been used for $CO_2$ emissions calculation. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional 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[7] .

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. Emissions vary depending on the specific technology used by each plant, however evidence suggests that there is little variation in $CO_2$ emissions from plants utilising similar technology.

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 $CO_2$ emissions amounts 3 percent (1 to 5 percent), based on expert judgements since statistics and manufacturer have not been particularly assessed the uncertainties.

[7] 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.

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.

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.

## 4.5. 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 2007* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of indirect GHGs from Pulp and Paper in the period 1990-2007 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.

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.

#### 4.5.1.5. 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 2007* Submission to the Convention on Long-range Transboundary Air Pollution'.

The resulting emissions of NMVOC from Food and Drink in the period 1990-2007 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.

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.

### 4.5.2.5. Source specific recalculations

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

# 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 1990-2007 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 1990-2007. 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 1990-2007, are presented in the Table 4.6-1.

*Table 4.6-1: Emissions of HFCs (Gg $CO_2$-eq) (1990 – 2007)*

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

*Table 4.6-1: Emissions of HFCs (Gg $CO_2$-eq) (1990 – 2006), cont.*

| Gas | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| HFC 32 | 0.09 | 0.07 | 0.12 | 0.06 | 1.29 | 1.58 | 3.25 | 7.29 | 9.49 |
| HFC 125 | 1.76 | 5.35 | 12.91 | 13.29 | 45.09 | 52.12 | 98.76 | 125.65 | 142.03 |
| HFC 134a | 4.63 | 8.92 | 14.53 | 14.32 | 41.80 | 47.81 | 82.71 | 86.16 | 86.47 |
| HFC 143a | 2.70 | 8.82 | 21.43 | 21.64 | 75.52 | 87.36 | 164.46 | 195.93 | 214.51 |
| ***Total emission* (Gg $CO_2$-eq)** | **9.18** | **23.16** | **48.99** | **49.31** | **163.71** | **188.87** | **349.18** | **415.03** | **452.50** |

### 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.

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. 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

In NIR 2008 potential HFCs emissions from Refrigeration and Air Conditioning Equipment were calculated. Data were provided by the Ministry of Environmental Protection, Physical Planning and Construction. Emissions for all gases for the period 1990-1995 were estimated by extrapolation method.
Pursuant ERT explanation, extrapolation should not be used because emission growth trend is not constant over time. Extrapolation should also not be used over long periods of time without detailed checks at intervals to confirm the continued validity of the trend. Consequently, according to ERT recommendation method for HFC emission calculation has been changed from extrapolation to cluster analysis of countries with similar circumstances (e.g. CZ, HU, SK, SL) and consequently HFC emissions were identified as not occurred. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional 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 2006 and 2007, 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.

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.

### 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 2006.

The emissions from Foam Blowing in 2006 as well as in 2007 have been amounted to 0.00006 Gg $CO_2$-eq of HFC-152a. The resulting emissions from Fire Extinguishers in 2006 amounts 3.55 Gg $CO_2$-eq of HFC-125, 5.80 Gg $CO_2$-eq of HFC-227ea and 6.30 Gg $CO_2$-eq of HFC-236fa. In 2007 the emissions from Fire Extinguishers originated only from consumption of HFC-236fa and amounts 12.60 Gg $CO_2$-eq.

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);
- 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.

Annual emissions of $SF_6$, expressed in Gg $CO_2$-eq, in the period 1990-2007, are presented in the Table 4.6-2.

*Table 4.6-2: Emissions of $SF_6$ (Gg $CO_2$-eq) (1990 – 2007)*

| 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 | 11.61 |
| 1996 | 11.85 |
| 1997 | 11.62 |
| 1998 | 12.27 |
| 1999 | 12.27 |
| 2000 | 12.15 |
| 2001 | 12.75 |
| 2002 | 13.63 |
| 2003 | 14.30 |
| 2004 | 14.90 |
| 2005 | 15.73 |
| 2006 | 16.43 |
| 2007 | 16.69 |

### 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 and 2007 because the data for the period 1990-2005 are not available. 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.

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.

### 4.6.2.5. Source–specific recalculations

In NIR 2008 $SF_6$ emissions were not estimated for the whole time series due to lack of activity data. According to ERT recommendation during the in-country review, 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 were provided by Croatian Electricity Utility Company (Hrvatska elektroprivreda, HEP) and Končar – Electrical Industries Inc. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$-eq emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional source-specific recalculations in this report.

### 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 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 1990-2007 are presented in the Figure 4.6-1.

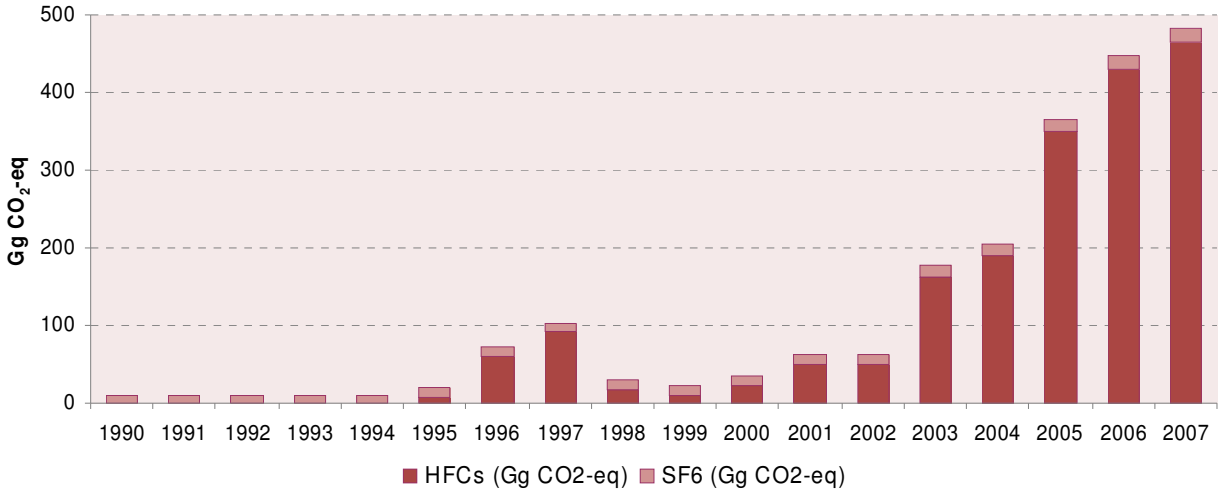


*Figure 4.6-1: Emissions of HFCs and $SF_6$ (Gg $CO_2$-eq) from Consumption of Halocarbons and $SF_6$ (1990-2007)*

## 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. Explanations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

## 4.8. EMISSION OVERVIEW

### 4.8.1. GHG EMISSIONS

Emissions of GHGs from Industrial Processes in the period 1990-2007 are presented in Table 4.8-1.

*Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2007)*

| 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 | 38.59 | 4.79 |
| | 2001 | | 1423.55 | | 1423.55 | 45.18 | 5.24 |
| | 2002 | | 1392.12 | | 1392.12 | 45.82 | 4.95 |
| | 2003 | | 1383.62 | | 1383.62 | 42.63 | 4.62 |
| | 2004 | | 1470.38 | | 1470.38 | 41.92 | 4.93 |
| | 2005 | | 1499.86 | | 1499.86 | 40.74 | 4.93 |
| | 2006 | | 1588.04 | | 1588.04 | 41.10 | 5.16 |
| | 2007 | | 1612.03 | | 1612.03 | 39.58 | 4.98 |
| **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 |

*Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2007), 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 | | 13.44 | | 13.44 | 0.42 | 0.05 |
| | 2001 | | 15.07 | | 15.07 | 0.48 | 0.06 |
| | 2002 | | 16.00 | | 16.00 | 0.53 | 0.06 |
| | 2003 | | 18.89 | | 18.89 | 0.58 | 0.06 |
| | 2004 | | 20.38 | | 20.38 | 0.58 | 0.07 |
| | 2005 | | 21.43 | | 21.43 | 0.58 | 0.07 |
| | 2006 | | 18.88 | | 18.88 | 0.49 | 0.06 |
| | 2007 | | 16.82 | | 16.82 | 0.41 | 0.05 |
| **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 |
| **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 | 31.75 | 3.94 |
| | 2001 | | 842.25 | | 842.25 | 26.73 | 3.10 |
| | 2002 | | 764.42 | | 764.42 | 25.16 | 2.72 |
| | 2003 | | 872.94 | | 872.94 | 26.90 | 2.92 |
| | 2004 | | 909.21 | | 909.21 | 25.92 | 3.05 |
| | 2005 | | 895.50 | | 895.50 | 24.32 | 2.94 |
| | 2006 | | 871.24 | | 871.24 | 22.55 | 2.83 |
| | 2007 | | 945.91 | | 945.91 | 23.23 | 2.92 |

*Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2007), cont.*

| Source | Year | GHG | Emission (Gg) | GWP[1] | Emission (Gg $CO_2$-eq) | Percent in Industrial Processes | Percent in Total Country Emission |
|---|---|---|---|---|---|---|---|
| **Nitric acid production** | 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 | 3.03 |
| | 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 | 22.97 | 2.85 |
| | 2001 | | 2.01 | | 622.72 | 19.76 | 2.29 |
| | 2002 | | 1.95 | | 604.48 | 19.89 | 2.15 |
| | 2003 | | 1.84 | | 569.79 | 17.56 | 1.90 |
| | 2004 | | 2.24 | | 695.34 | 19.82 | 2.33 |
| | 2005 | | 2.19 | | 678.84 | 18.44 | 2.23 |
| | 2006 | | 2.17 | | 671.21 | 17.37 | 2.18 |
| | 2007 | | 2.39 | | 741.40 | 18.20 | 2.29 |
| **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 |
| **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 | 0.000 |
| | 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 |

*Table 4.8-1: Emissions of GHGs from Industrial Processes (1990-2007), cont.*

| Source | Year | GHG | Emission (Gg) | GWP[1] | Emission (Gg $CO_2$-eq) | Percent in Industrial Processes | Percent in Total Country Emission |
|---|---|---|---|---|---|---|---|
| **Ferroalloys production** | 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 - 2007 | | - | | - | - | - |
| **Aluminium production** | 1990 | $CO_2$ | 111.37 | 1 | 111.37 | 2.66 | 0.35 |
| | 1991 | | 76.40 | | 76.40 | 2.26 | 0.31 |
| | 1992 - 2007 | | - | | - | - | - |
| | 1990 | $CF_4$ | 0.13 | 6500 | 820.44 | 19.56 | 2.62 |
| | 1991 | | 0.09 | | 562.79 | 16.62 | 2.27 |
| | 1992 - 2007 | | - - | | - - | - - | - - |
| | 1990 | $C_2F_6$ | 0.013 | 9200 | 116.12 | 2.77 | 0.37 |
| | 1991 | | 0.009 | | 79.66 | 2.35 | 0.32 |
| | 1992 - 2007 | | - | | - | - | - |
| **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 |

[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 2007* 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 1990-2007 are reported in table 4.8-3.

*Table 4.8-3: Emissions of indirect GHGs from Industrial Processes (1990-2007)*

| 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 |

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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)

# 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 2007* 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: Table 5.1-1: Activity data for NMVOC emissions from Solvent and Other Product Use (1990-2007)*

| 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 | 1990-2007 |
| **Paint application** | | | | | | | | | | | | | | | | | | | |
| Paint application | 21955 | 13872 | 9145 | 9066 | 10797 | 11083 | 13934 | 15003 | 15472 | 15193 | 15107 | 16793 | 15172 | 15331 | 14983 | 16393 | 17318 | 17318 | 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 | 0.85 |
| Dry cleaning * | 4778 | 4513 | 4470 | 4641 | 4649 | 4669 | 4494 | 4572.5 | 4501 | 4554 | 4381 | 4437 | 4443 | 4442 | 4439 | 4442 | 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 | 15 |
| Polyurethane process.– soft foam | 3616 | 2717 | 1660 | 2025 | 2427 | 2880 | 1800 | 1710 | 1790 | 1770 | 1800 | 2655 | 5431 | 2855 | 2424 | 2799 | 2240 | 1607 | 25 |
| Polyester processing | 6047 | 4159 | 3523 | 2570 | 2546 | 2225 | 3367 | 7022 | 8258 | 5609 | 12848 | 9661 | 14693 | 9704 | 10948 | 10886 | 14112 | 16548 | 40 |
| Polystyrene foam process. | 39069 | 26383 | 57045 | 57666 | 58215 | 49356 | 56513 | 50894 | 54240 | 53047 | 16518 | 47146 | 45439 | 46361 | 34311 | 52933 | 47755 | 54069 | 15 |
| Polyvinylchloride processing | 104602 | 67934 | 70969 | 44259 | 84546 | 99243 | 44791 | 23094 | 77811 | 34202 | 7368 | 1036 | 661 | 8387 | 10064 | 9396 | 8045 | 7866 | 40 |
| Rubber processing | 5739 | 5442 | 2439 | 2477 | 2338 | 2285 | 1279 | 26 | 17 | 20 | 21 | 21 | 15 | 6 | 11 | 4 | 4 | 0 | 15 |
| Pharmaceutical products manufac.* | 4778 | 4513 | 4470 | 4641 | 4649 | 4669 | 4494 | 4572.5 | 4501 | 4554 | 4381 | 4437 | 4443 | 4442 | 4439 | 4442 | 4440 | 4440 | 0.014 |
| Paints manufacturing | 21956 | 13827 | 9493 | 9064 | 10797 | 10773 | 13933 | 15002 | 15473 | 15194 | 15107 | 16794 | 15174 | 15332 | 14984 | 16393 | 17318 | 20097 | 15 |
| Inks manufacturing | 4672 | 3605 | 1343 | 985 | 1416 | 1367 | 1420 | 1430 | 1071 | 797 | 916 | 822 | 863 | 789 | 673 | 630 | 684 | 438 | 30 |
| Glues manufacturing | 5139 | 13451 | 7151 | 10910 | 11166 | 10076 | 17197 | 10874 | 10379 | 8206 | 10355 | 12385 | 25851 | 30873 | 46119 | 56573 | 71330 | 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 | 684 | 100 |
| Application of glues and adhesives | 5139 | 13451 | 7151 | 10910 | 11166 | 10076 | 17197 | 10874 | 10379 | 8206 | 10355 | 12385 | 25851 | 30873 | 46119 | 56573 | 71330 | 71330 | 600 |
| Domestic solvent use* | 4778 | 4513 | 4470 | 4641 | 4649 | 4669 | 4494 | 4572.5 | 4501 | 4554 | 4381 | 4437 | 4443 | 4442 | 4439 | 4442 | 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.

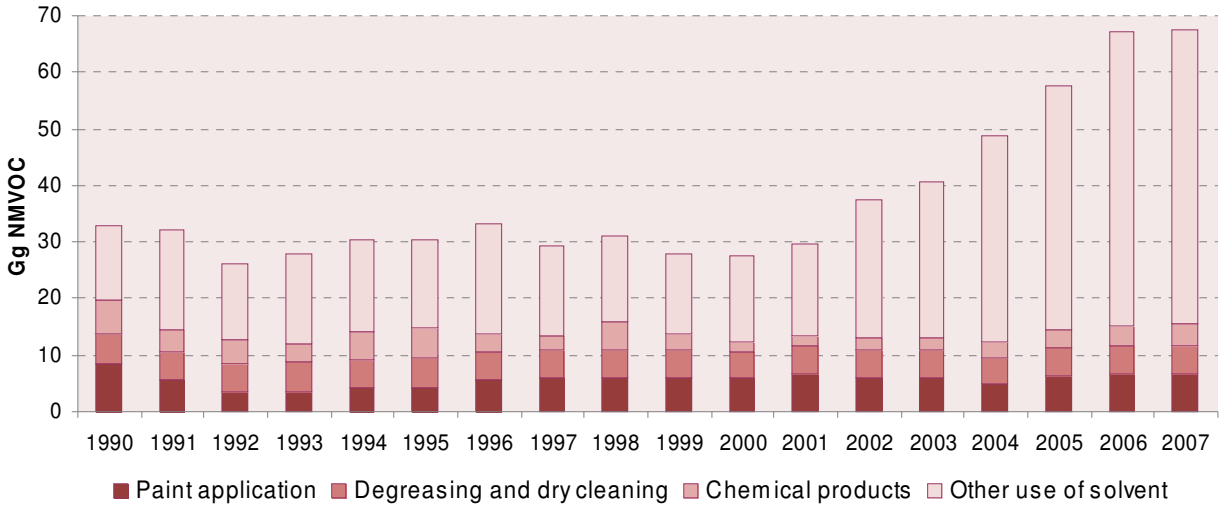


*Figure 5.1-1: Emissions of NMVOC from Solvent and Other Product Use (1990-2007)*

**$CO_2$ 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 1990-2007 are presented in the Figure 5.1-2.

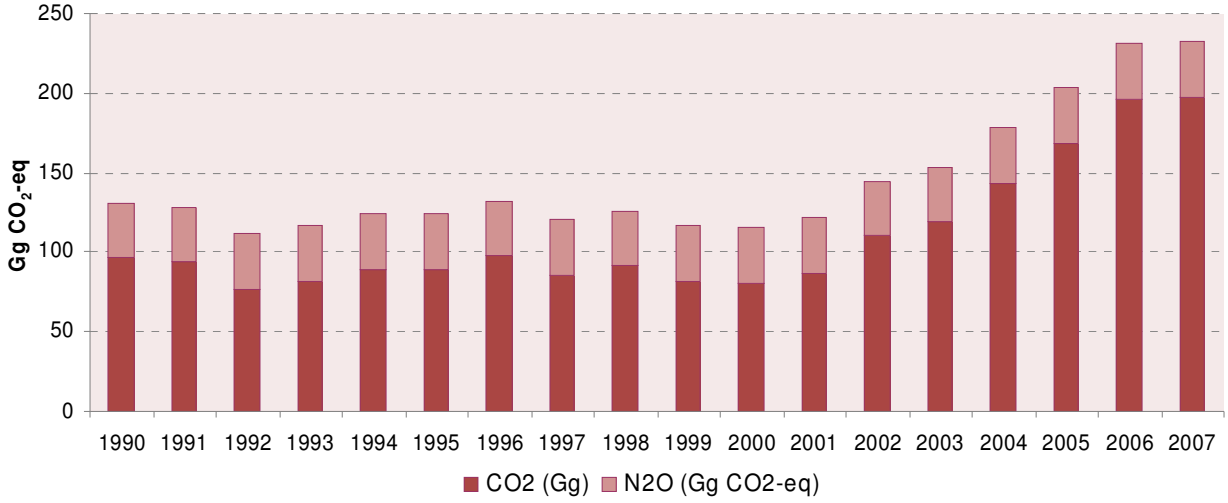


*Figure 5.1-2: Emissions of $CO_2$ and $N_2O$ from Solvent and Other Product Use (1990-2007)*

### 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.

After preparation of final draft of this chapter an audit was carried out to check selected activities from Tier 1 General inventory level QC and Tier 2 source-specific QC procedures. 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 2007* Submission to the Convention on Long-range Transboundary Air Pollution'. NMVOC emissions for Paint application have been changed over time. Also, NMVOC emissions from the other group of

activities have been changed for some years. Therefore, $CO_2$ emissions have been recalculated for the period 1990-2006 in this report.

In previous report (NIR 2008) $N_2O$ emissions from medical uses and other possible sources were not estimated because input data were not available. In this report, $N_2O$ used for anaesthesia and aerosol cans, obtained by only producer and distributor of $N_2O$ in Croatia, were included in $N_2O$ emission calculation. Therefore, $N_2O$ emissions have been recalculated for the period 1990-2006 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.

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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)

# 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 2007 produced by the agricultural activities were 3409.66 Gg $CO_2$-eq, which represents 10.53 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 results of agricultural soil management, manure management and the agricultural engineering in cultivation of some crops are relatively high emissions 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.

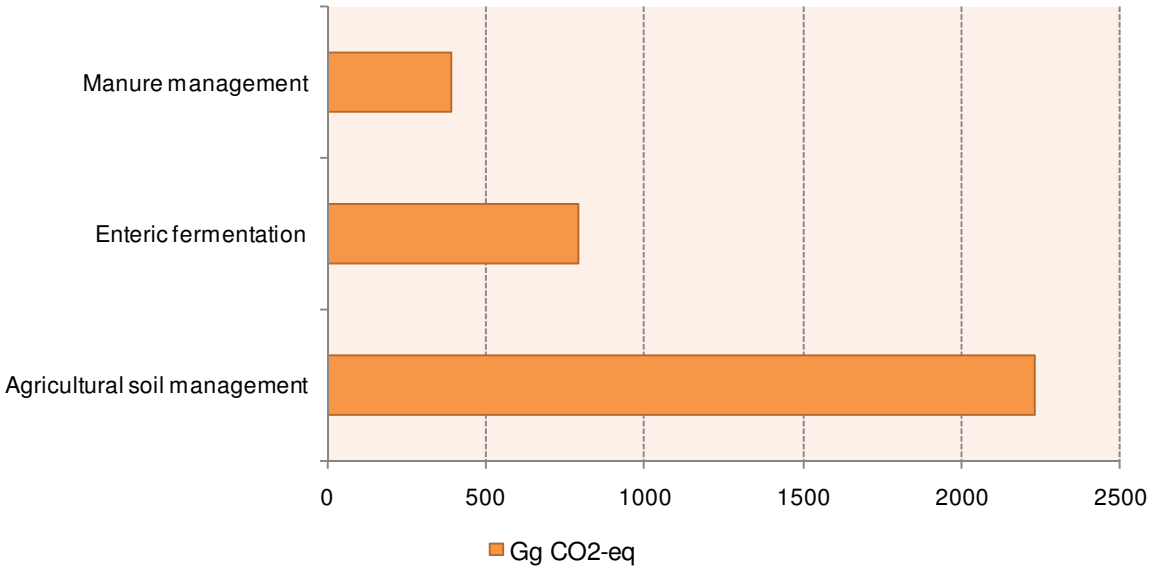


*Figure 6.1-1: Agriculture GHG Sources (year 2007)*

Table 6.1-1 and Table 6.1-2 show the total emission from Agriculture sector by gases and by emission sources for the period 1990-2007. 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 |
|---|---|---|---|---|---|---|---|---|---|
| **$CH_4$** | 69.09 | 64.45 | 50.52 | 49.96 | 45.80 | 43.77 | 42.00 | 41.48 | 40.70 |
| Enteric fermentation | 58.21 | 53.70 | 42.44 | 41.60 | 37.45 | 36.22 | 34.56 | 34.18 | 33.52 |
| Manure management | 10.88 | 10.75 | 8.08 | 8.36 | 8.36 | 7.54 | 7.44 | 7.29 | 7.18 |
| **$N_2O$** | 9.26 | 9.15 | 8.13 | 7.16 | 7.16 | 6.85 | 6.92 | 7.71 | 6.85 |
| Manure management | 1.22 | 1.15 | 0.90 | 0.90 | 0.82 | 0.78 | 0.74 | 0.72 | 0.70 |
| Agricultural soil | 8.04 | 8.00 | 7.23 | 6.27 | 6.33 | 6.07 | 6.19 | 6.99 | 6.15 |
| **TOTAL** | 78.35 | 73.60 | 58.65 | 57.12 | 52.96 | 50.62 | 48.93 | 49.19 | 47.56 |

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

| Gas/Source | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| **$CH_4$** | 41.41 | 40.33 | 41.17 | 40.74 | 42.69 | 44.35 | 45.19 | 46.40 | 45.47 |
| Enteric fermentation | 33.46 | 32.95 | 33.75 | 33.20 | 34.80 | 35.84 | 37.77 | 38.84 | 37.52 |
| Manure management | 7.95 | 7.38 | 7.42 | 7.53 | 7.90 | 8.52 | 7.42 | 7.56 | 7.95 |
| **$N_2O$** | 7.45 | 7.42 | 8.01 | 7.96 | 7.46 | 7.89 | 8.09 | 7.88 | 7.92 |
| Manure management | 0.72 | 0.69 | 0.70 | 0.68 | 0.72 | 0.73 | 0.72 | 0.73 | 0.72 |
| Agricultural soil | 6.74 | 6.72 | 7.31 | 7.28 | 6.75 | 7.16 | 7.37 | 7.15 | 7.20 |
| **TOTAL** | 48.86 | 47.75 | 49.19 | 48.70 | 50.16 | 52.24 | 53.28 | 54.28 | 53.39 |

*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 |
|---|---|---|---|---|---|---|---|---|---|
| **$CH_4$** | 1450.81 | 1353.47 | 1060.91 | 1049.18 | 961.84 | 919.12 | 882.02 | 871.05 | 854.78 |
| Enteric fermentation | 1222.37 | 1127.78 | 891.26 | 873.65 | 786.35 | 760.72 | 725.74 | 717.86 | 703.96 |
| Manure management | 228.44 | 225.68 | 169.65 | 175.54 | 175.50 | 158.40 | 156.28 | 153.19 | 150.82 |
| **$N_2O$** | 2870.60 | 2837.72 | 2520.55 | 2220.58 | 2219.23 | 2122.74 | 2146.59 | 2390.28 | 2125.03 |
| Manure management | 378.74 | 357.41 | 279.24 | 277.91 | 255.72 | 242.49 | 228.55 | 223.41 | 217.46 |
| Agricultural soil | 2491.86 | 2480.31 | 2241.30 | 1942.67 | 1963.51 | 1880.25 | 1918.04 | 2166.87 | 1907.57 |
| **TOTAL** | 4321.41 | 4191.18 | 3581.46 | 3269.77 | 3181.07 | 3041.86 | 3028.61 | 3261.33 | 2979.80 |

*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 |
|---|---|---|---|---|---|---|---|---|---|
| **$CH_4$** | 869.61 | 846.90 | 864.65 | 855.46 | 896.58 | 931.41 | 948.98 | 974.36 | 954.85 |
| Enteric fermentation | 702.63 | 691.90 | 708.75 | 697.23 | 730.72 | 752.59 | 793.14 | 815.70 | 787.92 |
| Manure management | 166.97 | 155.00 | 155.90 | 158.22 | 165.86 | 178.82 | 155.84 | 158.66 | 166.93 |
| **$N_2O$** | 2310.16 | 2299.58 | 2484.09 | 2468.36 | 2313.03 | 2446.03 | 2509.12 | 2443.80 | 2454.82 |
| Manure management | 221.77 | 214.98 | 217.31 | 211.94 | 221.72 | 227.10 | 223.67 | 226.34 | 222.83 |
| Agricultural soil | 2088.40 | 2084.59 | 2266.77 | 2256.42 | 2091.31 | 2218.93 | 2285.46 | 2217.46 | 2232.00 |
| **TOTAL** | 3179.77 | 3146.48 | 3348.74 | 3323.82 | 3209.61 | 3377.44 | 3458.10 | 3418.16 | 3409.67 |

Below there is a review of the greenhouse gas emission calculation according to previously stated sources.

## 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, 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 1990-2007. 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.*

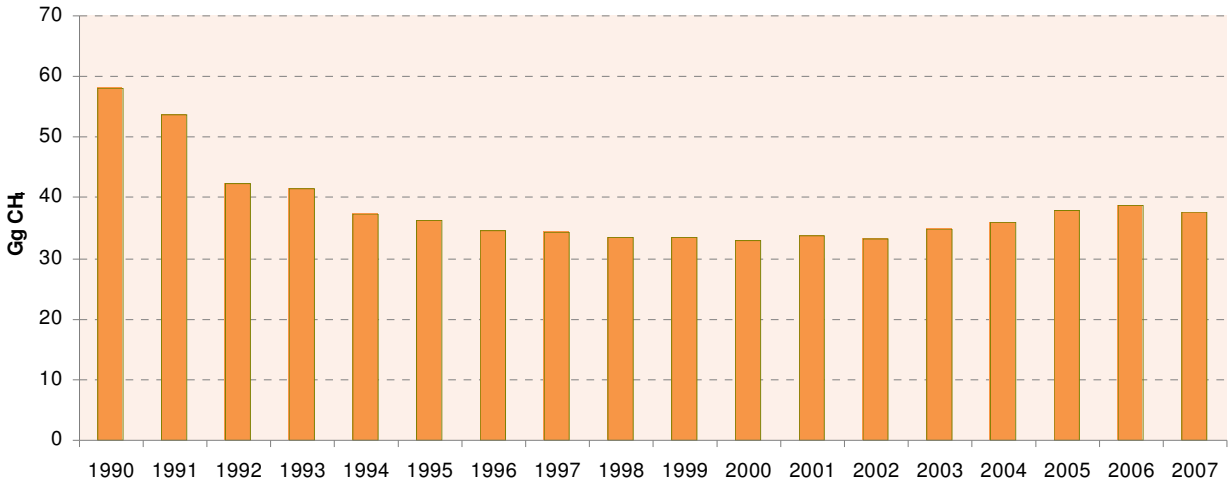


*Figure 6.2-1: $CH_4$ emission from Enteric Fermentation (Gg)*

### 6.2.2. METHODOLOGICAL ISSUES

The IPCC methodology has been used to calculate the methane emission from Enteric Fermentation. IPCC methodology provides two different methods for estimating the quantity of methane from enteric fermentation. Since more detailed data on the number of dairy and non-dairy cattle and milk yield were obtained from the Central Bureau of Statistics, Tier 2 method was applied (GPG 2000). Default data used are presented in Table 6.2-1.

*Table 6.2-1: Default data used in emission factor calculation*

| Animal | weight (kg) | $Cf_i$ | Ca | WG (kg/day) | fat (%) | $C_{pregnancy}$ | DE (%) | Ym |
|---|---|---|---|---|---|---|---|---|
| dairy-cattle | 550 | 0.335 | 0.000 | 0.000 | 4.000 | 0.100 | 60.000 | 0.060 |
| male | 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 1990-2007 is presented in Table 6.2-2.

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

| | Milk yield |
|---|---|
| 1990 | 5.47 |
| 1991 | 5.03 |
| 1992 | 5.28 |
| 1993 | 5.12 |
| 1994 | 5.03 |
| 1995 | 5.26 |
| 1996 | 5.77 |
| 1997 | 6.12 |
| 1998 | 6.45 |
| 1999 | 6.37 |
| 2000 | 6.54 |
| 2001 | 7.08 |
| 2002 | 7.44 |
| 2003 | 7.67 |
| 2004 | 7.90 |
| 2005 | 9.08 |
| 2006 | 9.94 |
| 2007 | 10.04 |

Other parameters are calculated as follows:

- net energy required by the animal for maintenance ($NE_m$) – Equation 4.1
- net energy for animal activity ($NE_a$) – Equation 4.2a
- net energy needed for growth ($NE_g$) – Equation 3 *(IPCC Guidelines)*
- net energy for lactation ($NE_l$) – Equation 4.5a
- net energy required for pregnancy ($NE_p$) – Equation 4.8
- ratio of net energy available for growth in a diet to digestible energy consumed ($NE_{ga}$/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 $Y_m$ x (365 days/yr)] / 55.65 MJ/kg of methane]*

For other animals, Tier 1 (a simplified method) 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)(*Revised 1996 IPCC Guidelines*). Data for Sheep, Horses, Swine and Poultry for the period 1990-2007 were obtained from Croatian Statistical Yearbooks, published by the Central Bureau of Statistics. Data for Goats and Mules and Asses for the period 1990-2006 were obtained directly from the Central Bureau of Statistics. For 2007, data source regarding the number of Goats was FAO database. As for Mules and Asses, average animal number in the period from 1995-2006 was taken for the year 2007. The numbers of livestock are reported in Figure 6.2-2 and Figure 6.2-3.

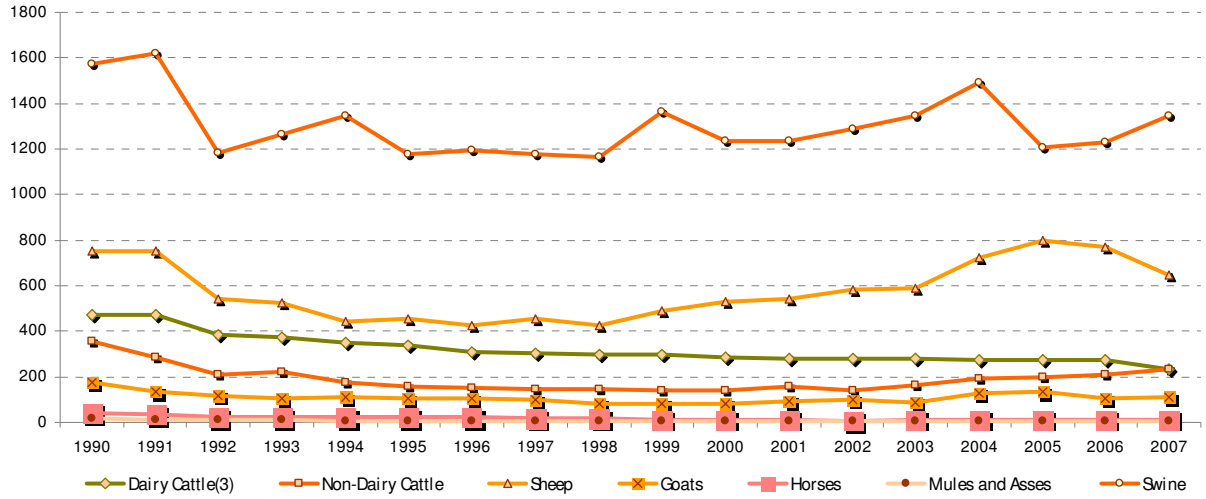


*Figure 6.2-2: Number of dairy cattle, cattle, swine sheep, goats and horses*

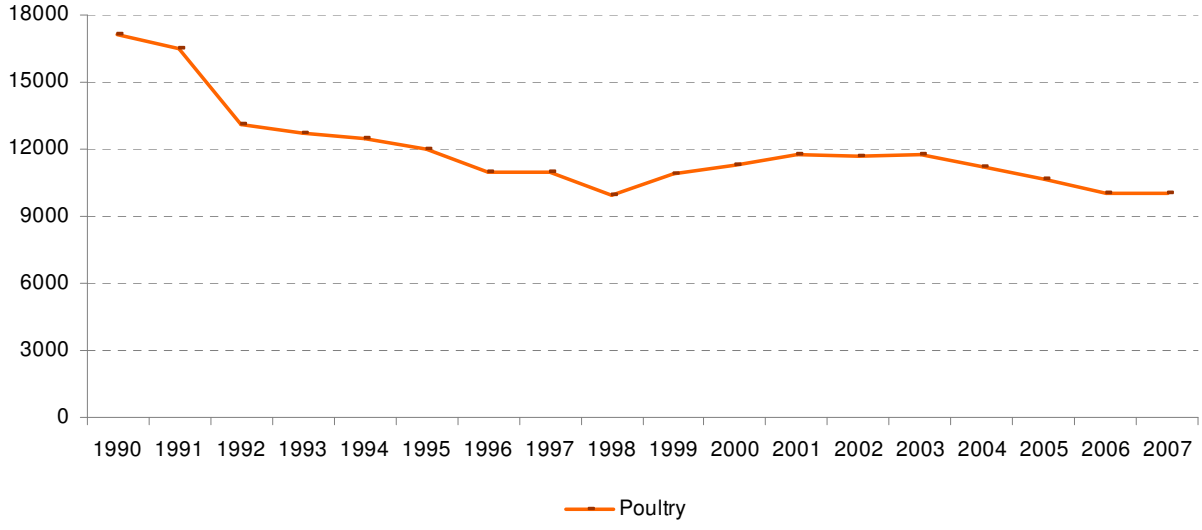


*Figure 6.2-3: Number of poultry*

### 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

According to ERT recommendation during the in-country review, certain recalculations were performed upon new, updated and more precise data. The latter are presented in the document 'Resubmission of Croatia's 2008 Inventory Submission', CRF tables 'Official Resubmission 2008' and also within this report. However, after the resubmission, some errors were noticed and additional corrections were necessary which are explained and presented only within this Inventory 2009.

Regarding $CH_4$ emission from Enteric Fermentation in domestic livestock, more accurate and more detailed data were obtained from the Central Bureau of Statistics. The latter refers to:

- number of dairy and non-dairy cattle
- milk yield

Therefore, for recalculation of emission from Enteric Fermentation, Tier 2 methodology (GPG 2000) was used for dairy and non-dairy cattle. Emissions were recalculated for the entire period 1990-2007.

However, after the resubmission, an error was noticed regarding the $Cf_i$ (coefficient for calculating the $NE_m$). Previously used value for non-dairy cattle was 0.332. Correct coefficient value is 0.322; therefore additional recalculation was performed for the entire period.

## 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 2007 is presented in Figure 6.3-1.

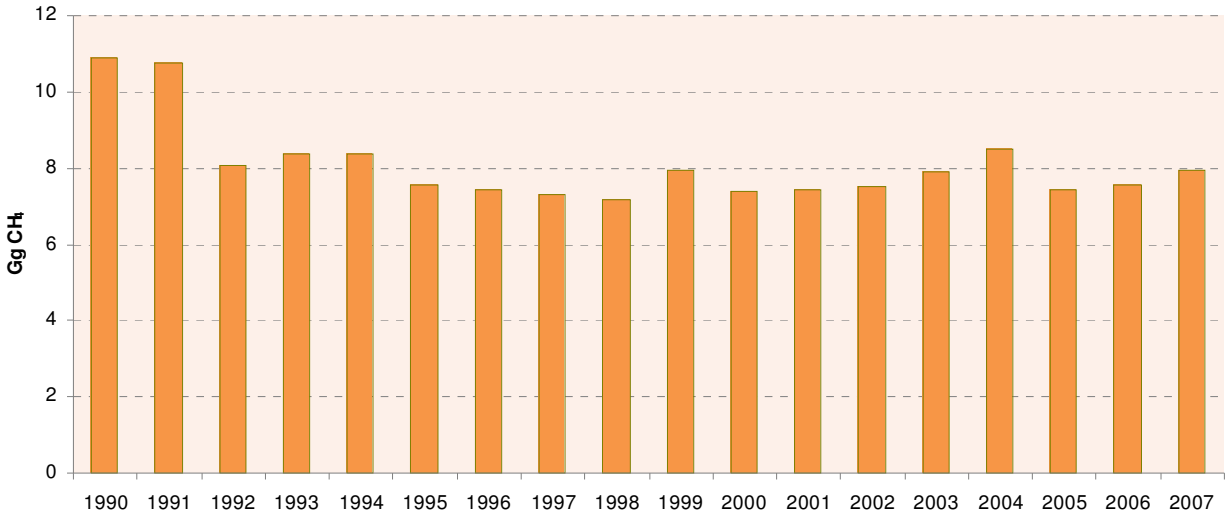


*Figure 6.3-1: $CH_4$ emission from Manure Management (Gg)*

### 6.3.2. METHODOLOGICAL ISSUES

The IPCC methodology (Tier 1) has been used to calculate methane emission from Manure Management. The basic input is the head of cattle (dairy cattle, non-dairy cattle, sheep, horses, pigs, poultry, goats, mules and asses). 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. Data for Sheep, Horses, Swine and Poultry for the period 1990-2007 were obtained from Croatian Statistical Yearbooks, published by the Central Bureau of Statistics. Data for Goats and Mules and Asses for the period 1990-1991 were obtained directly from the Central Bureau of Statistics and for 1992-2006 period from FAO database. For 2007, data source regarding the number of Goats was again FAO database. As for Mules and Asses, average animal number in the period from 1995-2006 was taken for the year 2007. Emission factors have been taken from the *Revised 1996 IPCC Reference Manual*.

### 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

There were neither recalculations nor additional corrections regarding $CH_4$ emissions from Manure Management.

## 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 *Revised 1996 IPCC Reference Manual.* Nitrous oxide ($N_2O$) emission is calculated according to the following equations:

$$Nex_{(AWMS)} = \Sigma_{(T)} [N_{(T)} \times Nex_{(T)} \times AMWS_{(T)}]$$

$Nex_{(AWMS)}$ - N excretion per Animal Waste Management System
$N_{(T)}$ - numbers of animals of type
$Nex_{(T)}$ - N excretion of animals of type
$AMWS_{(T)}$ - fraction of Nex(T) that is managed in one of the different distinguished animal waste management systems
T - type of animal category

$$N_2O_{(AWMS)} = \Sigma [Nex(_{AWMS)} \times EF_3]$$

$N_2O_{(AWMS)}$ - $N_2O$ emissions from all Animal Waste Management Systems (kg N/yr)
$Nex_{(AWMS)}$ - N excretion per Animal Waste Management System (kg/yr)
$EF_3$ - emission factor

Nitrous oxide ($N_2O$) emissions from Manure Management for the period from 1990 to 2007 are presented in Figure 6.4-2.

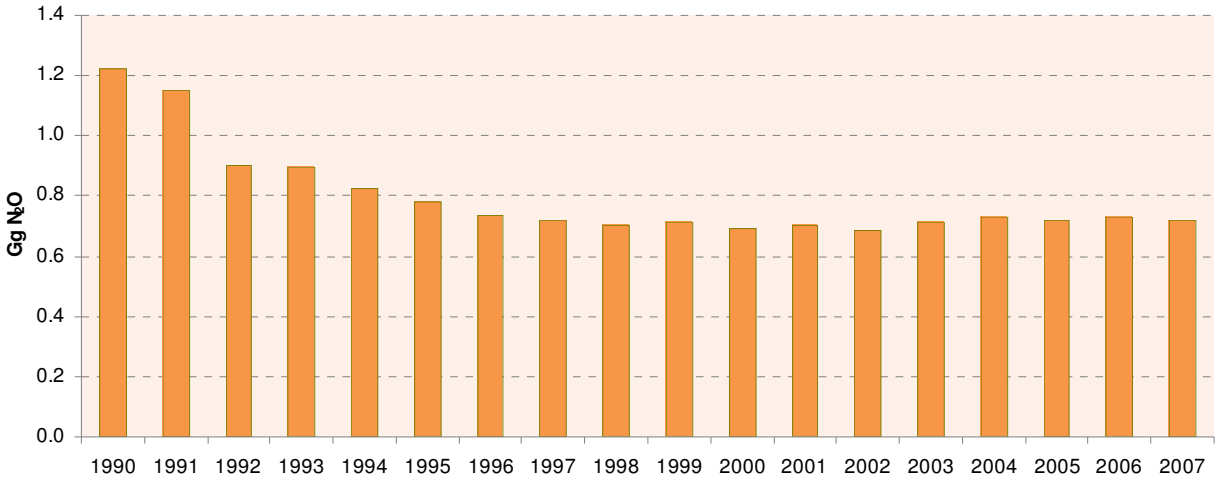


*Figure 6.4-1: $N_2O$ Emissions from Manure Management (Gg)*

Data for Sheep, Horses, Swine and Poultry for the period 1990-2007 were obtained from Croatian Statistical Yearbooks, published by the Central Bureau of Statistics. Data for Goats and Mules and Asses for the period 1990-1991 were obtained directly from the Central Bureau of Statistics and for 1992-2006 period from FAO database. For 2007, data source regarding the number of Goats was again FAO database. As for Mules and Asses, average animal number in the period from 1995-2006 was taken for the year 2007. Nitrogen excretion for each manure management system and emission factors were taken from the *Revised 1996 IPCC Reference Manual (Table 5.1.7).*

### 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

There were neither recalculations nor additional corrections regarding $N_2O$ emissions from Manure Management.

## 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 2007 are presented in Figure 6.5-1.

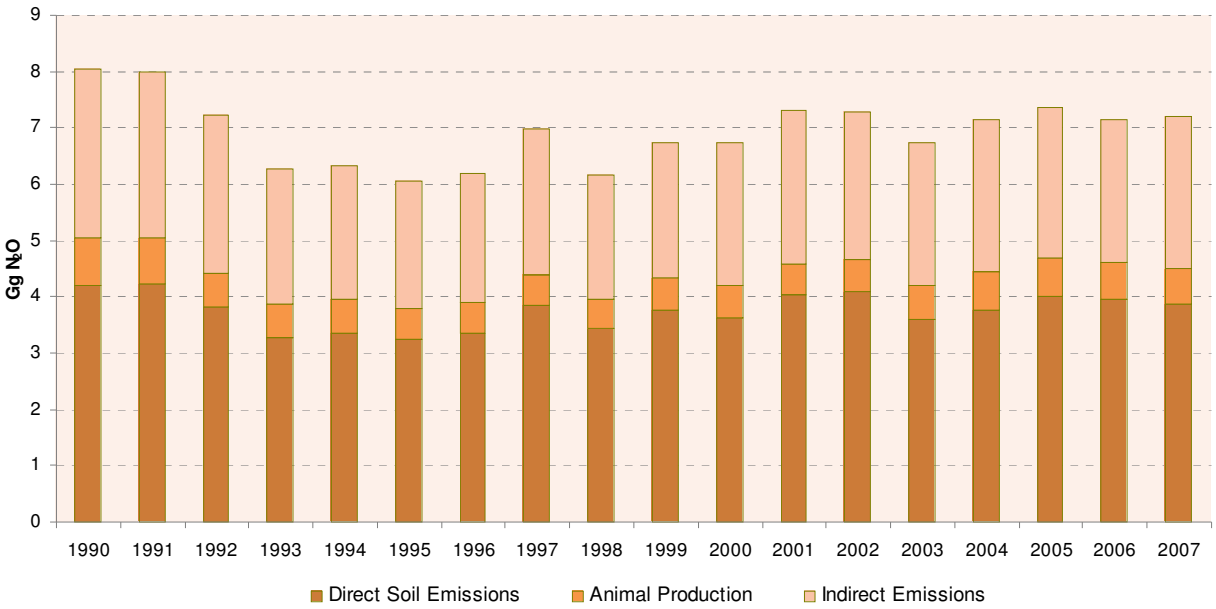


*Figure 6.5-1: Total $N_2O$ Emissions from Agricultural Soils (Gg)*

## 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 quantity of the synthetic fertilizer used
- the quantity of organic fertilizer used
- the head of animals by its category
- the biomass of leguminous plants and soybean
- the surface of histosols

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

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

$N_2O_{DIRECT}$ - direct $N_2O$ emission from agricultural soils (kg N/yr)
$F_{SN}$ - nitrogen from synthetic fertilizer excluding emissions of $NH_3$ and $NO_x$ (kg N/yr)
$F_{AW}$ - nitrogen from animal waste (kg N/yr)

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

Direct Emissions of $N_2O$ from Agricultural Soils for the period from 1990 to 2007 are shown in Figure 6.5-2.

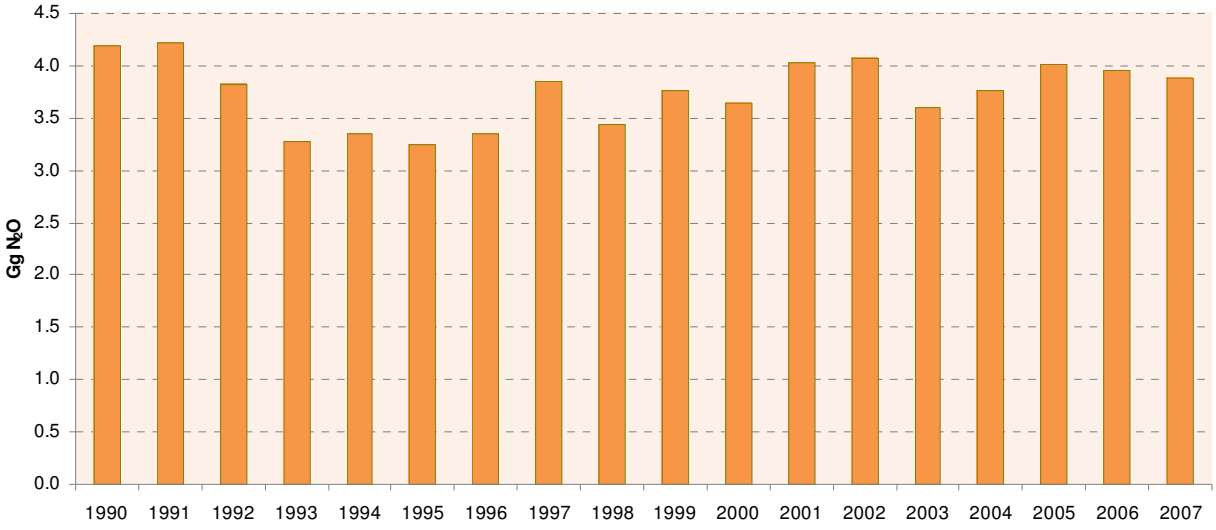


*Figure 6.5-2: Direct $N_2O$ Emissions from Agricultural Soils (Gg)*

### 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.*

**Nitrous oxide from mineral fertilisers**

This estimate is based on the amount of N in mineral fertiliser that is annually consumed in the Republic of Croatia. Data on the consumption of mineral fertilisers that are produced and applied in Croatia, were obtained from Petrokemija Fertilizer Company Kutina, for the period 1992-2007. 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 2000-2007. Data on import before the year 2000 are negligible due to tariffs which were eliminated in 2000. Nitrogen dispersed into atmosphere in the form of ammonia and $NO_x$ was subtracted from the total estimated quantity of emitted nitrogen N.
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). Consequently, recalculation was required.

*Table 6.5-1: Nitrogen fraction emitted as ammonia and $NO_x$*

| Fertilizer type | Fraction of N emitted as $NH_3$ and $NO_x$ |
|---|---|
| Urea | 0.15 |
| KAN | 0.2 |
| NPK | 0.2 |
| Ammonium nitrate | 0.2 |
| Urea ammonium nitrate | 0.2 |

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 fertilizing crops. Of the total estimated quantity of emitted nitrogen, the N that is emitted on pasture (24%, country specific) and N that is dispersed into the atmosphere in the form of ammonia 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 applied in calculation of nitrous oxide emission from biological fixation of N. The estimate is based on the amount of pulses and soybeans produced in the country as dry biomass. Data on N fixing crops were obtained from the Central Bureau of Statistics and FAO database. More accurately, amount of Soybeans, Beans, Clover and Alfalfa were obtained from the Central Bureau of Statistics for the whole period 1990-2007. Data on Cow peas, Lentils, Peas and Vetches were obtained from FAO database for the period 1992-2007. Data for 1990 and 1991 were obtained by extrapolating the data for the period 1992-1995. More accurate data were also used in regard to the following parameters:

- dry matter fraction
- residue/crop ratio
- N fraction

There were four main data sources for the latter:

- Slovenian National Inventory Report (due to similar circumstances)
- *Good Practice Guidance 2000*
- *Revised 1996 Guidelines*
- Expert judgement

The data used are presented in Table 6.5-2. 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 and more accurate data were used, $N_2O$ emissions from N fixing crops needed to be recalculated for the entire period 1990-2007.

*Table 6.5-2: Dry matter fraction, residue/crop ratio and N fraction*

| | dry matter fraction | residue/crop ratio | N fraction |
|---|---|---|---|
| Soybeans | 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 |

**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). 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. 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. The latter represents a change in regard to the last report.
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*).

*Table 6.5-3: Dry matter fraction, residue/crop ratio and N fraction*

| | 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 |
| Soybeans | 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 |

**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 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

According to ERT recommendation during the in-country review, certain recalculations were performed upon new, updated and more precise data. The latter are presented in the document 'Resubmission of Croatia's 2008 Inventory Submission', CRF tables 'Official Resubmission 2008' and also within this report. However, after the resubmission, some errors were noticed and additional corrections were necessary which are explained and presented only within this Inventory 2009.

In previous reports, a default value of the fraction of total synthetic fertiliser nitrogen that is emitted as $NO_x$ and $NH_3$ ($Frac_{GASF}$) was used. According to *Revised 1996 Guidelines*, the latter refers to 10%. However, in order to improve the emission calculation, 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. They are presented in Table 6.5-1. The abovementioned data were used in recalculation of $N_2O$ soil emissions for the entire period 1990-2007. The latter influenced both direct and indirect soil emissions. No errors were noticed after the resubmission; therefore, no additional recalculations were necessary.

Regarding the $N_2O$ emissions from N fixing crops, they were recalculated since new and more accurate data on dry matter fraction, residue/crop ratio, N fraction (see Table 6.5-2) and crop production were obtained. However, after the resubmission, an error was noticed which refers to the residue/crop ratio for lentils. Previously used value was 1.5 but the correct one is 1.0. Therefore, additional recalculation was necessary. In this way, data used for $F_{BN}$ and $F_{CR}$ are harmonized.

As for the emissions of nitrous oxide from crop residue, they were also recalculated since new and more accurate data on dry matter fraction, residue/crop ratio, N fraction (see Table 6.5-3) and crop production were obtained. In this case, the residue/crop ratio used for lentils was 1; therefore, after the resubmission, no additional corrections were necessary. Moreover, since field burning of crop residues does not occur in Croatia, $Frac_{BURN}$ was set to 0 in comparison to previous reports where a default value of 10% was used (*Revised 1996 IPCC Guidelines*).

Emissions of nitrous oxide due to cultivation of organic soils were recalculated for the entire period from 1990-2007 since the *IPCC Good Practice Guidance* provided an updated default factor of 8 kg $N_2O$-N/ha/yr. No additional corrections were necessary.

### 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:

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

$N_2O_{ANIMALS}$ - $N_2O$ emissions from animal production (kg N/yr)
$N_2O_{(AWMS)}$ - $N_2O$ emissions from Animal Waste Management Systems (kg N/yr)
$N_{(T)}$ - number of animals of type T
$Nex_{(T)}$ - N excretion of animals of type T (kg N/animal/yr)
$AWMS_{(T)}$ - fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems for animals of type T
$EF_{3(AWMS)}$ - 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 2007 are shown in the Figure 6.5-3.

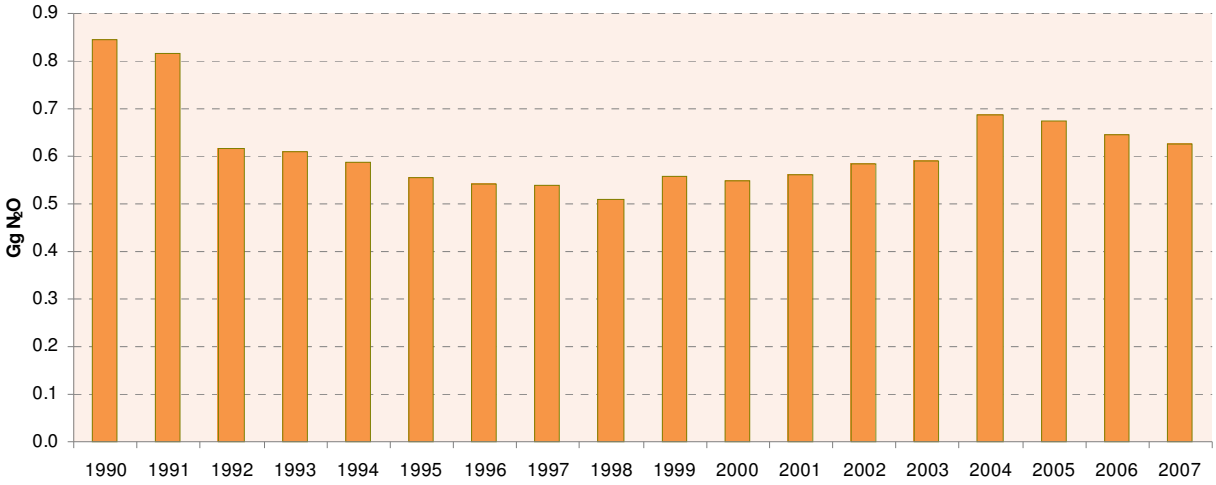


*Figure 6.5-3: Direct $N_2O$ Emissions from Animals (Gg)*

### 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

Neither recalculations nor additional corrections, regarding $N_2O$ emissions from Pasture, Range and Paddock Manure, were necessary.

## 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 N 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 by the following equation:

$$N_2O_{INDIRECT} = N_2O_{(G)} + N_2O_{(L)}$$

$N_2O_{INDIRECT}$ - indirect $N_2O$ emissions (kg N/yr)
$N_2O_{(G)}$ - $N_2O$ emissions due to atmospheric deposition of $NH_3$ and $NO_x$ (kg N/yr)

$N_2O_{(L)}$ - $N_2O$ 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 for the period from 1990 to 2007 is shown in Figure 6.5-4.

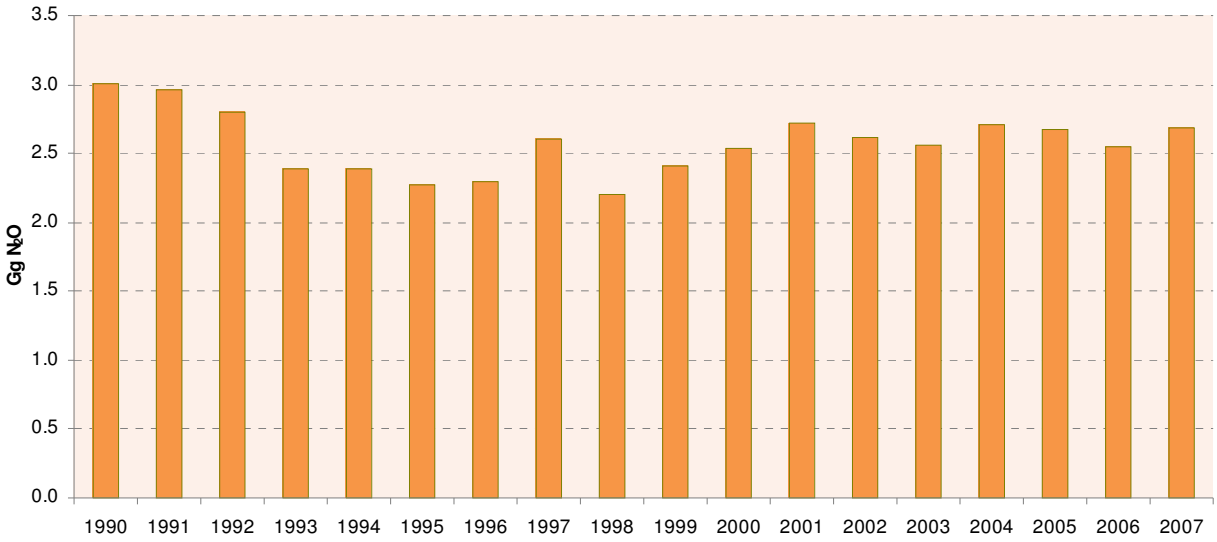


*Figure 6.5-4: Indirect $N_2O$ Emissions from Agriculture (Gg)*

### 6.5.3.2. Methodological issues

**Nitrous oxide arising due to volatilization of ammonia ($NH_3$) and nitrogen oxides ($NO_x$)**

In fertilizing agricultural soils with nitrogen fertilizers, some N volatilises in form of ammonia 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. In previous reports, it was considered that 10% of N from mineral fertilizers volatilises (*Revised 1996 IPCC Guidelines*). However, new and more 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). Therefore, recalculation was performed. For calculation of indirect emissions of nitrous oxide, the emission factor 0.01 kg $N_2O$-N/kg $NH_3$ and $NO_x$-N has been used (*Revised 1996 IPCC Guidelines*).

*Emissions from animal manure*

Numerous factors influence the fraction of volatilised N in form of ammonia and nitrogen oxides, such as: the ratio between N excreted in dung and N excreted in urine, the manner of slurry storage, the manner of slurry application etc. Generic IPCC emission factor (20%, *Revised 1996 IPCC Guidelines*) of the excreted N is supposed to volatilise in form of ammonia and nitrogen oxides. Emissions of nitrous oxide have been calculated by multiplying the estimated quantities of volatilised N with emission factor 0.01 kg $N_2O$-N/kg $NH_3$-N and $NO_x$-N (*Revised 1996 IPCC Guidelines*).

**Nitrous oxide from leaching and runoff of nitrogen compounds into surface waters, groundwater and watercourses**

*Surface runoff and leaching of N into groundwater, surface waters, and watercourses due to mineral fertilisers*

It has been considered that 30% of N from mineral fertilizers is lost through surface runoff and leaching into the groundwater and watercourses. For calculation of emissions of nitrous oxide, it has been considered that, for every kg of leached/run-off nitrogen, 0.025 kg of $N_2O$-N is emitted (*Revised 1996 IPCC Guidelines*).
Since more accurate and detailed data on the use of fertilizers (type, amount) was obtained, recalculation was performed.

*Nitrogen leaching and runoff into groundwater, surface waters, and watercourses due to animal manure*

It has been considered that, for every kg of N excreted by farm animals, 0.3 kg of N is lost through surface runoff to watercourses and groundwater *(Revised 1996 IPCC Guidelines*). For calculation of emissions of nitrous oxide, the same emission factors have been considered, as in the case of nitrogen leaching/runoff due to mineral fertilizer (0.025 kg $N_2O$-N/kg of leached/run-off N).

#### 6.5.3.3. Uncertainty and time-series consistency

The uncertainty of the calculation is conditioned by the use of emission factors recommended by the methodology and the input data unreliability. According to the bibliography, uncertainty of the recommended emission factors is high. 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

New and more detailed data on the use of fertilizers and the fraction of synthetic fertilizer nitrogen applied to soils were obtained. Therefore, recalculation of indirect emissions of $N_2O$ from mineral fertilizers due to volatilization and surface runoff/leaching was executed for the entire period 1990-2007. No additional source specific corrections were necessary.

## 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.

Regarding Tier 2 activities, emission factors and activity data were checked for key source categories. Activity data for livestock were compared with the FAO database. Results of this comparison showed that there is no significant difference between these two sets of data. In Agriculture five source categories represent key source category (Table 6.6-1): $CH_4$ Emissions from Enteric Fermentation in Domestic Livestock, $N_2O$ Emissions from Manure Management, Direct $N_2O$ Emission form Agricultural Soils and Indirect $N_2O$ Emissions from Nitrogen Use in Agriculture.

*Table 6.6-1: Key categories in Agriculture sector based on the level and trend assessment*[1]

| IPCC Source Categories | Direct GHG | Criteria for Identification | | | |
|---|---|---|---|---|---|
| | | Level | | Trend | |
| | | 2006 | 2007 | 2006 | 2007 |
| **AGRICULTURE SECTOR** | | | | | |
| $CH_4$ Emissions from Enteric Fermentation in Domestic Livestock | $CH_4$ | Yes | Yes | Yes/No* | Yes |
| $N_2O$ Emissions from Manure Management | $N_2O$ | Yes | Yes | No | No |
| Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | Yes | Yes | No | Yes |
| $N_2O$ Emissions from Pasture, Range and Paddock Manure | $N_2O$ | No | No | No | No |
| Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture | $N_2O$ | Yes | Yes | No | Yes |

[1]Data on key categories are taken from Annex 1 Key Categories
*Key category only for excluding LULUCF

## 6.7. SOURCE SPECIFIC PLANNED IMPROVEMENT

The availability of activity data is still a major problem in other key source categories within this sector and application of higher Tier methodologies will be possible in the future after detailed research and adjustments of statistical methods for data collection have been performed. Moreover, in order to increase the calculation quality, national emission factors should be developed.

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

## 7.1. OVERVIEW OF SECTOR

Forests and woodland in the Republic of Croatia are goods of a general interest and are under special protection of the state. Forest is an area of land of minimum 0.1 ha covered with trees (*Forestry Act, Official Gazette 140/05, 82/06*). The terms and the way of their use have been prescribed in the Forestry Act. 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 No. 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 area, agricultural area, grasslands, wetlands, settlements and other land. Based on the Forest Management Area Plan of the Republic of Croatia (2006-2015), the forests and the forest land cover 42 percent of the total surface area. By its origin, approximately 95 percent of forests in Croatia were formed by natural regeneration and 5 percent are grown artificially. In the Republic of Croatia, 78% of forest are state owned and 22% are private. The basic principles of Croatian forestry are sustainable forest management along with the preservation of forest natural structure and diversity, as well as the permanent enhancement of the stability and quality of forests' commercial and welfare functions.

The total growing stock in Croatian forests is around 398 million $m^3$. The most frequent species are Beech (*Fagus sylvatica*), Common Oak (*Quercus robur*), Sessile Oak (*Quercus petrea*), European Hornbeam (*Carpinus betulus*), Common Fir (*Abies alba*) and other types of deciduous and evergreen trees. The average growing stock in the state-owned forests is 190 $m^3$/ha and in the privately owned forests 80 $m^3$/ha. The annual increment in Croatian forests is around 10.5 million $m^3$ of wood. 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 ($m^3$, $m^3$/ha) or by the surface area. To satisfy the basic principles of sustainable forest management, the annual cut must not be larger than the increment value.

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. All emission factors were used according to GPG 2003. The Forest Management Area Plan of the Republic of Croatia for the period 1986-1995, 1996-2005 and 2006-2015 are the main data sources in regard to forest land and the annual increment. Data on commercial harvesting and wood fuel for period 1991-1996 are obtained from Statistical Yearbooks. Data on commercial harvest including wood for fuel for the year 1990 and period 1997-2007 are obtained from experts preparing data for UNECE. Data on forest fires are obtained from Ministry of Regional Development, Forestry and Water Management for the period 1992-2007 which as a source of data used official statistics of Croatian Forest Ltd., national establishment for management of state-owned forests. Data for 1990 and 1991 were estimated as average value of period 1992-2006. The criteria in choosing data were the following: continuity, quality, comparability as well as accessibility of sources. The completion of Croatian National Forest Inventory (CRONFI) is anticipated in the fourth quarter of this year; therefore, the data will be available at the beginning of 2010. The Forestry Act (*Official Gazette No. 140/05, 82/06*) prohibits the renewal of forests by clear cutting, thus natural rejuvenation is the principal method for renewal of all natural forests.

#### 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 ($\Delta C_{FFL}$) to be subtracted from the biomass carbon increment ($\Delta C_{FFG}$) for the reporting year (GPG 2003, Equation 3.2.2.)

Annual increase in carbon stock due to biomass increment ($\Delta C_{FFG}$) 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. Areas with degraded forest vegetation are not included because annual increment for these vegetation types could not be obtained. Areas of mixed forest are divided in half and split between coniferous and deciduous category. The used carbon fraction of biomass (CF) is a default value of 0.5.

$G_{TOTAL}$ 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, 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 (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 ($\Delta C_{FFL}$) 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, $m^3\ yr^{-1}$ (Statistical Yearbooks 1991-1996, UNECE 1990 and 1997-2007)
- 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 $yr^{-1}$. (Statistical Yearbooks 1991-1996, UNECE 1990 and 1997-2007
- 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 $yr^{-1}$. Data for period 1992-2007 were obtained from Ministry of Regional Development, Forestry and Water Management. Data for 1990 and 1991 were estimated as average value of period 1992-2006
- 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 1990-2007 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 due to carbon loss | Annual change in carbon stock in living biomass |
|---|---|---|---|
| 1990 | 13505.18 | 9320.26 | 4184.92 |
| 1991 | 13505.18 | 4805.54 | 8699.63 |
| 1992 | 13505.18 | 4210.85 | 9294.32 |
| 1993 | 13505.18 | 5468.55 | 8036.63 |
| 1994 | 13505.18 | 4846.85 | 8658.32 |
| 1995 | 13505.18 | 4350.94 | 9154.24 |
| 1996 | 14876.47 | 5386.52 | 9489.95 |
| 1997 | 14876.47 | 6673.55 | 8202.93 |
| 1998 | 14876.47 | 8035.35 | 6841.12 |
| 1999 | 14876.47 | 6723.39 | 8153.08 |
| 2000 | 14876.47 | 9595.78 | 5280.69 |
| 2001 | 14876.47 | 6662.69 | 8213.78 |
| 2002 | 14876.47 | 6670.87 | 8205.61 |
| 2003 | 14876.47 | 8600.00 | 6276.47 |
| 2004 | 14876.47 | 6976.63 | 7899.85 |
| 2005 | 14876.47 | 7150.10 | 7726.37 |
| 2006 | 16333.04 | 8842.74 | 7490.29 |
| 2007 | 16254.26 | 9951.61 | 6302.65 |

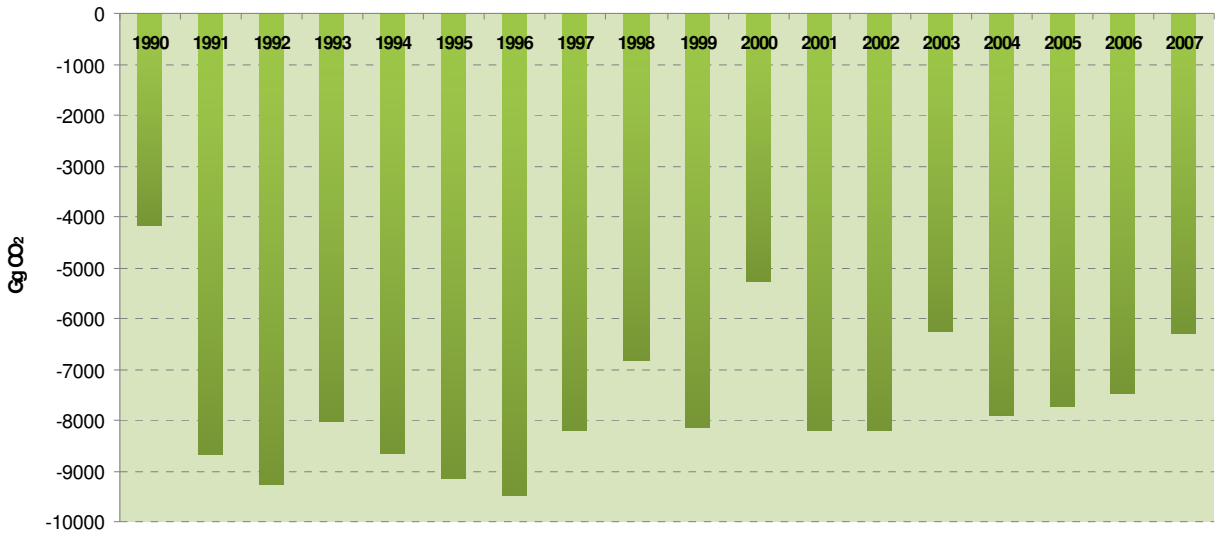


*Figure 7.2-1: Trend of $CO_2$ removals by sinks in Croatia*

### 7.2.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty of the input data for $CO_2$ emissions was estimated at 40 to 50 percent, while uncertainty of using wood density and BEFs was estimated at 30 percent.
The uncertainty of activity data for non-$CO_2$ emissions from fires was estimated at 25 percent, while for emission factors at 70 percent.
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 commercial harvesting and wood fuel. Data on commercial harvesting and wood fuel for period 1991-1996 are obtained from Statistical Yearbooks. Data on commercial harvest including wood for fuel for the year 1990 and period 1997-2007 are obtained from experts preparing data for UNECE.

### 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 during inventory preparation despite the fact that formal QC procedures were not prepared.
Due to the discrepancy in data on annual increment between Croatian Forestry Plans and Forest Resources Assessment 2005, data were checked with experts from Ministry of Regional Development, Forestry and Water Management and Croatian Forest Ltd. Moreover, data were compared with the data on annual increment from Slovenian National Inventory Report. Afterwards, it was decided that data from Croatian Forestry Plans are relevant and were included in estimation of emissions. There are three possible sources of data on wildfires in Croatia, Croatian Forests Ltd., Ministry of Interior and Croatian Protection and Rescue Directorate, all of which have the obligation to deliver the data on forest fires to different international institutions. Data obtained from Croatian Forest Ltd. are considered relevant and were included in estimation of emissions.

### 7.2.5. SOURCE-SPECIFIC RECALCULATIONS

There were no source specific recalculations.

### 7.2.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Major areas for improvement:

- Development of land use database needed for greenhouse gas inventories with aim to collect more quality data and to use complete land inventories. Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (*Official Gazette No. 1/07*) prescribes obligation and procedure for emissions monitoring. Among others, the regulation prescribes monitoring of areas within different land use categories, such as forest area, agricultural area, grasslands, wetlands, settlements and other land.
- Development of country specific factors (BEFs).

### 7.2.7. KYOTO PROTOCOL REPORTING

Under the Kyoto Protocol, each Party is obligated to report emissions by sources and removals by sinks of $CO_2$ and other greenhouse gases resulting from LULUCF activities under Article 3.3. (afforestation, reforestation, deforestation) and any elected human-induced activities under Article 3.4. (forest management, cropland management, grazing land management, revegetation). **Croatia has decided to account for Forest Management under Article 3 paragraph 4 during the first commitment period** (for further information see *Initial Report of the Republic of Croatia under the Kyoto Protocol*). Regarding the latter, each Party is required to identify lands subject to activities under Article 3.3. and elected activities under Article 3.4.

For each ten year period, Forest Management Plan is prepared by the state owned company Croatian Forests (Hrvatske šume) using the bottom-up approach. Management of state forests, which represent 78% of all forests in Croatia, is under authority of Croatian Forests (Hrvatske šume). State owned forests are divided into 16 Forest Administrations. Each administration has its own management master plan based on the principles of sustainable management. In addition, state forest are divided in 653 management units, average surface of 3092 ha, managed by Croatian Forests and 27 administration units managed by other legal entities. Information on state forests for the Forest Management Plan 2006-2015 are obtained by analysis of data from the Croatian Forests' *HS-Fond* database. These data are attained by different methods and procedures and contain data such as surface area, tree species, biomass stock, increment, harvesting, age classes, width classes etc. To estimate forest reserves for 2005 from obtained data, a programme developed by the Service for Silviculture was used. Information on private forests, due to their dissipation and time shortage, was obtained by combined method using field work and remote sensing data. Moreover, different GIS-based thematic maps, such as ownership, main tree specie, phytocenology map are created using spatial data from *HS-Fond* database.

Croatian National Forest Inventory (CRONFI) is being finalized; the data will be available at the beginning of 2010. The project is conducted by the Faculty of Forestry at the University of Zagreb. It is based on the combination of remote sensing data and data obtained from field work. Basic outputs, among others, are information on areas, stocks and increments of forests in Croatia.

Remote sensing data will be used as supplemental information for identifying land areas associated with activities under 3.3. and 3.4.

Therefore, the Republic of Croatia will identify the abovementioned lands subject to activities under Articles 3.3. and 3.4. by using all available data/maps from *HS-Fond* database and CRONFI mainly.

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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 1990-2007 are presented in the Figure 8.1-1.

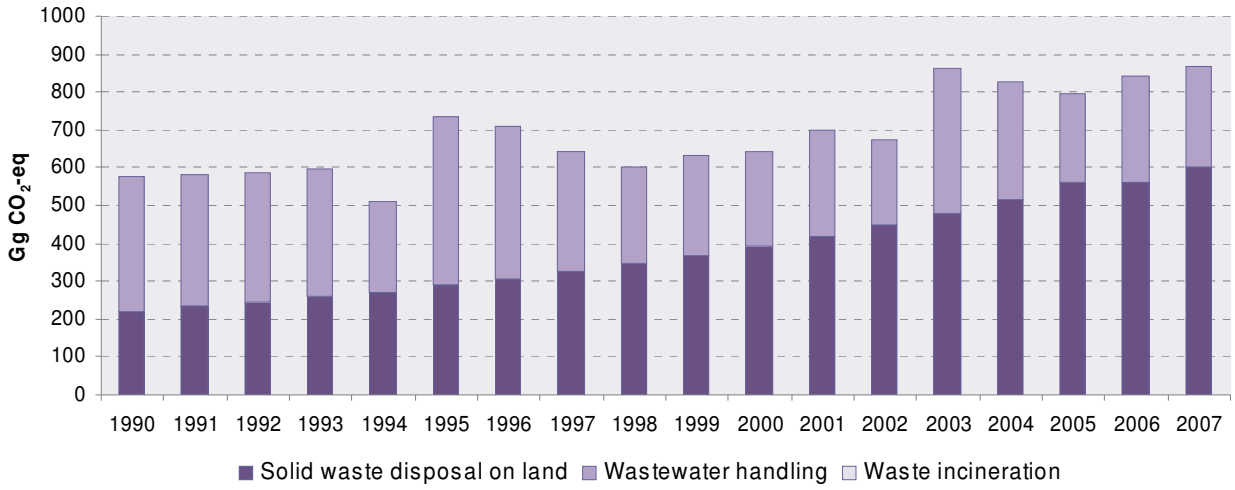


*Figure 8.1-1: Emissions of GHGs from Waste (1990-2007)*

## 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

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.

*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 2005-2007. 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[8] 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.

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.

[8] 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.

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 2006 and 2007 were obtained from *Cadastre of Waste - Municipal Solid Waste, Reports 2006 and 2007,* Croatian Environment Agency. Recovered $CH_4$ in the period 2005-2007 have been obtained. Information on $CH_4$ that is recovered and burned in a flare or energy recovery device in the period 2005-2007 has been estimated by official document provided by ZGOS Ltd. and document *Guidelines Development for starting implementation of Waste Management Plan in the Republic of Croatia,* provided by EKONERG Ltd. 2.48 Gg $CH_4$ has been recovered in 2005, 1.61 Gg $CH_4$ in 2006 and 1.99 Gg $CH_4$ in 2007.
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 1990-2007 and related MCF are reported in the Table 8.2-2.

*Table 8.2-2: Total annual MSW disposed to SWDSs and related MCF (1990-2007)*

| Year | Managed SWDS (Gg) | Unmanaged SWDS (≥5m) (Gg) | Unmanaged SWDS (<5m) (Gg) | MCF (fraction) |
|---|---|---|---|---|
| 1990 | 18 | 277 | 295 | 0.606 |
| 1991 | 19 | 280 | 300 | 0.606 |
| 1992 | 20 | 284 | 309 | 0.605 |
| 1993 | 22 | 297 | 324 | 0.606 |
| 1994 | 26 | 322 | 329 | 0.613 |
| 1995 | 31 | 364 | 342 | 0.623 |
| 1996 | 35 | 392 | 361 | 0.625 |
| 1997 | 40 | 433 | 375 | 0.632 |
| 1998 | 45 | 470 | 398 | 0.636 |
| 1999* | 54 | 538 | 383 | 0.654 |
| 2000 | 60 | 618 | 260 | 0.702 |
| 2001* | 131 | 627 | 250 | 0.727 |
| 2002* | 202 | 635 | 240 | 0.748 |
| 2003* | 273 | 644 | 230 | 0.767 |
| 2004* | 344 | 652 | 220 | 0.784 |
| 2005 | 415 | 661 | 210 | 0.799 |
| 2006 | 528 | 720 | 200 | 0.818 |
| 2007 | 660 | 760 | 190 | 0.835 |

* 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 2005-2007 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 1990-2007 are presented in the Figure 8.2-1.

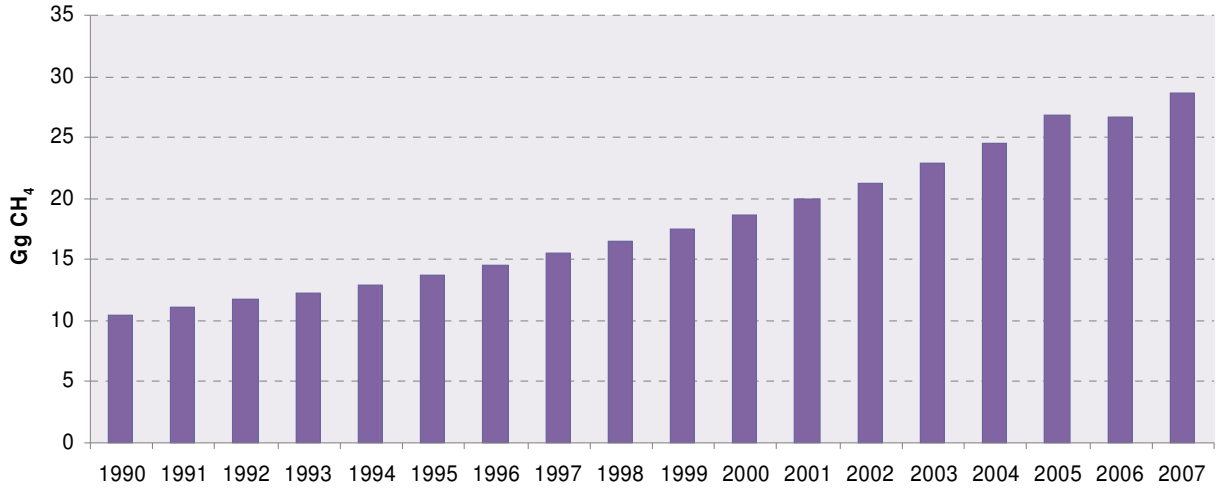


*Figure 8.2-1: Emissions of $CH_4$ from Solid Waste Disposal on Land (1990-2007)*

### 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

In this report, the quantity of MSW disposed to different types of SWDSs and the main characteristic of SWDSs in the period 2001-2004 have been assessed by interpolation method, taking into account the pattern over 2000 and 2005. Fraction of MSW disposed at solid waste disposal sites in 2005 and 2006 has been assessed according to information provided by official document *Waste Management Plan in the Republic of Croatia (2007-2015*) and expert judgement, whereas national classification of SWDSs is not adjusted to IPCC SWDSs classification. Since MCF is assigned to each of three categories of SWDSs, calculated MCFs have been corrected also. Recovered $CH_4$ in 2005 and 2006 has been corrected because in the previous report total quantity of landfill gas were calculated as methane (it is assumed that 50% of landfill gas is methane). Also, errors made in total emission calculation for 2005 and 2006 have been corrected. Thereupon, $CH_4$ emissions have been recalculated for the period 2001-2006.

### 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

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.

Aerobic biological process is used mostly in wastewater treatment. 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 1990-2007.

### 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 2003-2007. Insufficient data have been assessed by interpolation method. Data for $CH_4$ emission calculation for the period 1990-2007 are presented in the Table 8.3.1.

*Table 8.3-1: Data for $CH_4$ emission calculation from Domestic and Commercial Wastewater (1990-2007)*

| 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 |
| 1999 | 21900.00 | 2678000 |

*Table 8.3-1: Data for $CH_4$ emission calculation from Domestic and Commercial Wastewater (1990-2007), cont.*

| Year | DOC (kg BOD/1000persons/yr) | Population* |
|---|---|---|
| 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 | 22008.75 | 2513000 |

* data for population with individual system of drainage

The resulting annual emissions of $CH_4$ from Domestic and Commercial Wastewater in the period 1990-2007 are presented in the Figure 8.3-1.

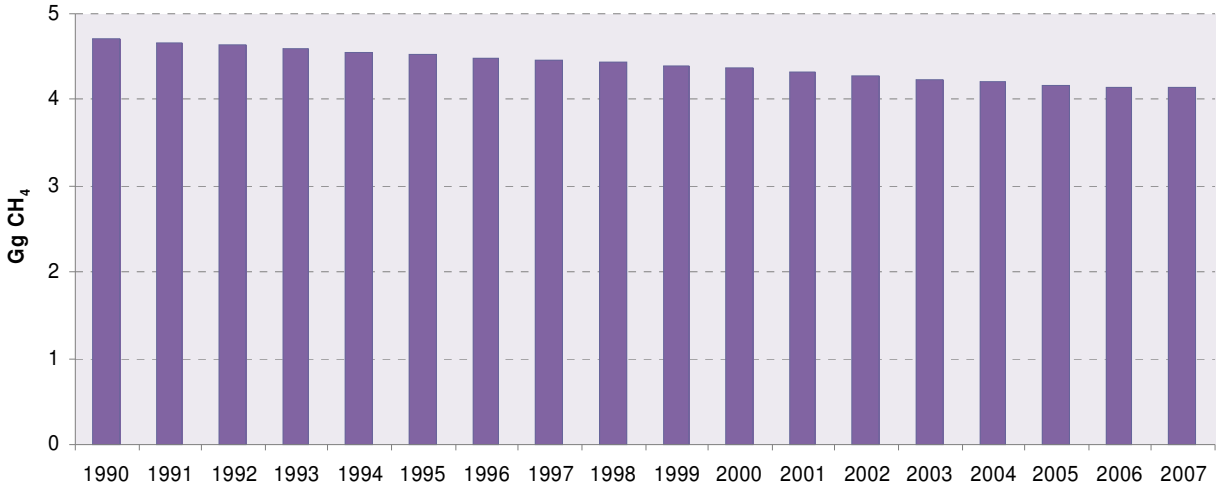


*Figure 8.3-1: Emissions of $CH_4$ from Domestic and Commercial Wastewater (1990-2007)*

### 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).
Data for $CH_4$ emission calculation for the period 1990-2007 are presented in the Table 8.3.2.

*Table 8.3-2: Data for $CH_4$ emission calculation from Industrial Wastewater (1990-2007)*

| 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 |

The resulting annual emissions of $CH_4$ from Industrial Wastewater in the period 1990-2007 are presented in the Figure 8.3-2.

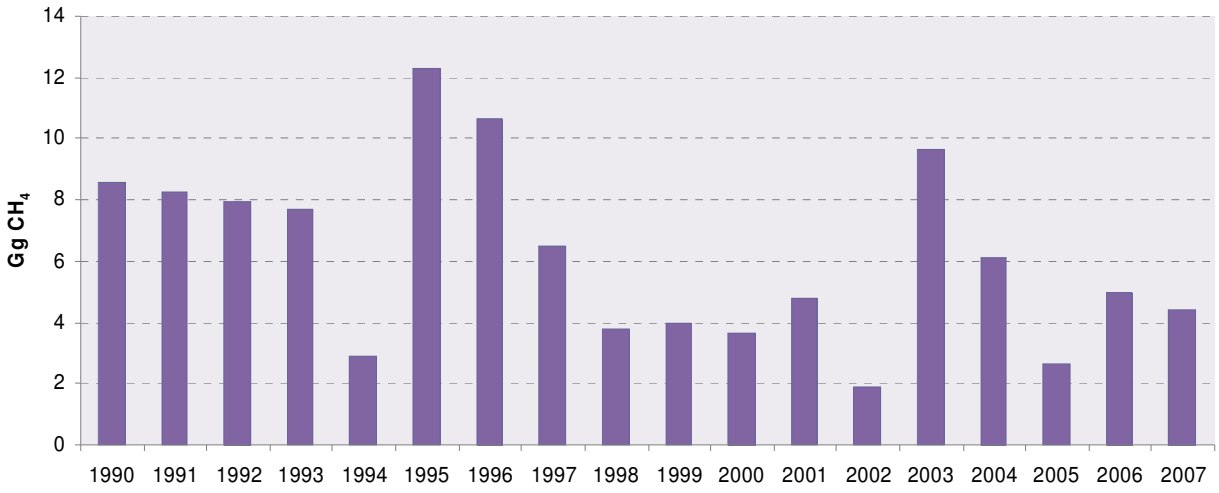


*Figure 8.3-2: Emissions of $CH_4$ from Industrial Wastewater (1990-2007)*

### 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 1990-2006 were taken from Statistical Yearbooks. Croatian data on the annual per capita Protein intake value (PIV), for the period 1992-2003, 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 for 2002 and 2003 have been used as the pattern for data calculation in the period 2004-2007.

Data for $N_2O$ emission calculation from Human Sewage for the period 1990-2007 are presented in the Table 8.3.3.

*Table 8.3-3: Data for $N_2O$ emission calculation from Human Sewage (1990-2007)*

| Year | Protein intake (kg/person/yr) | Population |
|---|---|---|
| 1990 | 21.13 | 4778000 |
| 1991 | 21.53 | 4513000 |
| 1992 | 22.16 | 4470000 |
| 1993 | 21.86 | 4641000 |
| 1994 | 22.96 | 4649000 |
| 1995 | 25.00 | 4669000 |
| 1996 | 24.78 | 4494000 |
| 1997 | 24.38 | 4572000 |
| 1998 | 23.98 | 4501000 |
| 1999 | 24.86 | 4554000 |
| 2000 | 24.67 | 4381000 |
| 2001 | 26.10 | 4437000 |
| 2002 | 27.52 | 4443000 |
| 2003 | 26.94 | 4442000 |
| 2004 | 26.38 | 4439000 |
| 2005 | 25.80 | 4442000 |
| 2006 | 25.22 | 4440000 |
| 2007 | 24.64 | 4436000 |

The resulting annual emissions of $N_2O$ from Human Sewage in the period 1990-2007 are presented in the Figure 8.3-3.

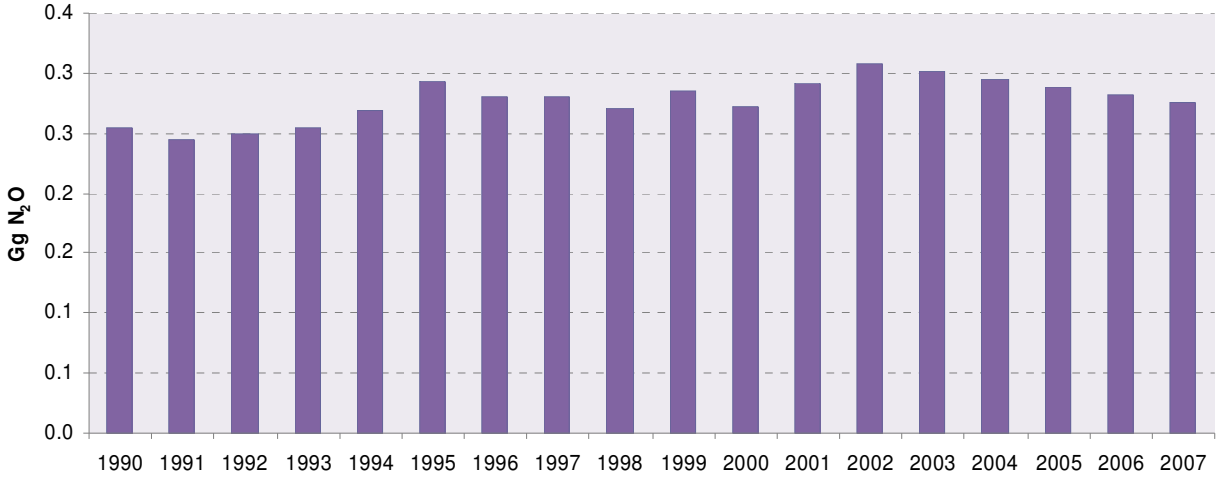


*Figure 8.3-3: Emissions of $N_2O$ from Human Sewage (1990-2007)*

### 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

In NIR 2008 $CH_4$ emissions from Industrial Wastewaters were not estimated for the whole time series due to lack of activity data. According to ERT recommendation during the in-country review, 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) have been used for emission calculation. Data were taken from Statistical Yearbooks. Insufficient data were assessed by interpolation. The other parameters required for the calculation were taken from the IPCC good practice guidance or assessed by expert judgement. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$-eq emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

There are no additional source-specific recalculations in this report.

### 8.3.6. SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Improvements in the sub-sector Disposal of Domestic and Commercial Wastewater are related primarily to establishment of effectively *Water Information System* with base for systematic gathering and saving data needed for monitoring and planning of development of all wastewater handling systems.

In order to 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 1990-2007. $CO_2$ 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, sewage sludge and plastics are available for 2007.

### 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 2004-2007 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, sewage sludge and plastics only for 2007 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 1990-2007 are presented in the Table 8.3.3.

*Table 8.3-3: Incinerated clinical waste (1990-2007)*

| 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 8.3-3: Incinerated clinical waste (1990-2007), cont.*

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

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.

The resulting annual emissions of $CO_2$ from Waste Incineration in the period 1990-2007 are presented in the Figure 8.3-3.

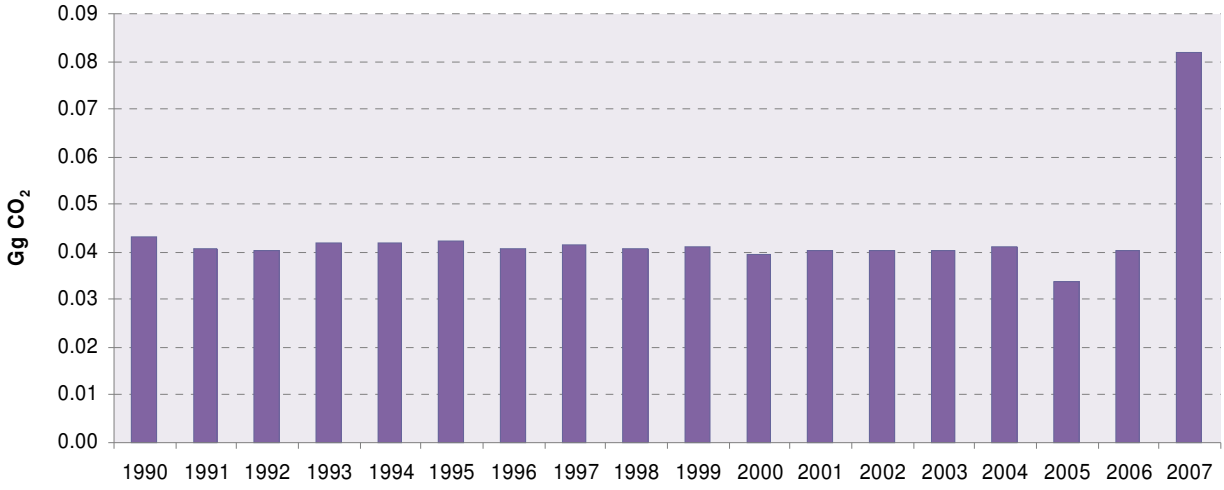


*Figure 8.3-3: Emissions of $CO_2$ from Waste Incineration (1990-2007)*

### 8.4.3. UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainties contained in $CO_2$ emissions estimates from incineration of clinical 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

Data for $CO_2$ emission calculation from Waste Incineration for the period 1990-2006 have been corrected according to detailed information on incineration type of waste for 2007, which have been provided by Croatian Environment Agency that collects data from emission point sources in the Environmental Pollution Register (ROO). Accordingly, some quantity of incinerated waste in the period 1990-2006 can not be included in inventory because waste was incinerated with energy recovery. Consequently, data have been corrected and $CO_2$ emissions have been recalculated for the period 1990-2006 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 1990-2007 are presented in Table 8.5-1.

*Table 8.5-1: Emissions from Waste (1990-2007)*

| 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 | 38.23 | 0.71 |
| | 1991 | | 11.12 | | 233.57 | 40.20 | 0.94 |
| | 1992 | | 11.71 | | 245.85 | 41.84 | 1.07 |
| | 1993 | | 12.32 | | 258.72 | 43.46 | 1.12 |
| | 1994 | | 12.98 | | 272.60 | 53.21 | 1.23 |
| | 1995 | | 13.74 | | 288.58 | 39.41 | 1.26 |
| | 1996 | | 14.57 | | 305.93 | 43.03 | 1.30 |
| | 1997 | | 15.49 | | 325.21 | 50.69 | 1.31 |
| | 1998 | | 16.45 | | 345.39 | 57.41 | 1.38 |
| | 1999 | | 17.53 | | 368.18 | 58.23 | 1.41 |
| | 2000 | | 18.62 | | 391.12 | 60.75 | 1.51 |
| | 2001 | | 19.88 | | 417.47 | 59.76 | 1.54 |
| | 2002 | | 21.29 | | 447.14 | 66.52 | 1.59 |
| | 2003 | | 22.86 | | 479.97 | 55.55 | 1.60 |
| | 2004 | | 24.56 | | 515.76 | 62.58 | 1.73 |
| | 2005 | | 26.81 | | 563.07 | 70.80 | 1.85 |
| | 2006 | | 26.68 | | 560.32 | 66.71 | 1.82 |
| | 2007 | | 28.70 | | 602.71 | 69.47 | 1.86 |
| **Domestic and Commercial Wastewater** | 1990 | $CH_4$ | 4.71 | 21 | 98.85 | 17.08 | 0.32 |
| | 1991 | | 4.67 | | 98.05 | 16.88 | 0.40 |
| | 1992 | | 4.63 | | 97.25 | 16.55 | 0.42 |
| | 1993 | | 4.59 | | 96.45 | 16.20 | 0.42 |
| | 1994 | | 4.55 | | 95.65 | 18.67 | 0.43 |
| | 1995 | | 4.52 | | 94.85 | 12.95 | 0.41 |
| | 1996 | | 4.49 | | 94.23 | 13.25 | 0.40 |
| | 1997 | | 4.46 | | 93.61 | 14.59 | 0.38 |
| | 1998 | | 4.43 | | 92.99 | 15.46 | 0.37 |
| | 1999 | | 4.40 | | 92.37 | 14.61 | 0.35 |
| | 2000 | | 4.37 | | 91.75 | 14.25 | 0.35 |
| | 2001 | | 4.32 | | 90.73 | 12.99 | 0.33 |
| | 2002 | | 4.27 | | 89.74 | 13.35 | 0.32 |
| | 2003 | | 4.23 | | 88.78 | 10.28 | 0.30 |
| | 2004 | | 4.20 | | 88.30 | 10.71 | 0.30 |
| | 2005 | | 4.17 | | 87.66 | 11.02 | 0.29 |
| | 2006 | | 4.15 | | 87.11 | 10.37 | 0.28 |
| | 2007 | | 4.15 | | 87.11 | 10.04 | 0.27 |

*Table 8.5-1: Emissions from Waste (1990-2007), 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 | 31.08 | 0.57 |
| | 1991 | | 8.27 | | 173.58 | 29.88 | 0.70 |
| | 1992 | | 7.97 | | 167.29 | 28.47 | 0.73 |
| | 1993 | | 7.67 | | 160.99 | 27.04 | 0.70 |
| | 1994 | | 2.89 | | 60.77 | 11.86 | 0.27 |
| | 1995 | | 12.28 | | 257.84 | 35.21 | 1.13 |
| | 1996 | | 10.66 | | 223.92 | 31.50 | 0.95 |
| | 1997 | | 6.47 | | 135.81 | 21.17 | 0.55 |
| | 1998 | | 3.77 | | 79.12 | 13.15 | 0.32 |
| | 1999 | | 3.98 | | 83.49 | 13.20 | 0.32 |
| | 2000 | | 3.65 | | 76.64 | 11.90 | 0.30 |
| | 2001 | | 4.76 | | 100.05 | 14.32 | 0.37 |
| | 2002 | | 1.90 | | 39.93 | 5.94 | 0.14 |
| | 2003 | | 9.62 | | 202.01 | 23.38 | 0.68 |
| | 2004 | | 6.13 | | 128.75 | 15.62 | 0.43 |
| | 2005 | | 2.63 | | 55.26 | 6.95 | 0.18 |
| | 2006 | | 5.01 | | 105.24 | 12.53 | 0.34 |
| | 2007 | | 4.40 | | 92.50 | 10.66 | 0.29 |
| **Human Sewage** | 1990 | $N_2O$ | 0.25 | 310 | 78.69 | 13.60 | 0.25 |
| | 1991 | | 0.24 | | 75.73 | 13.04 | 0.31 |
| | 1992 | | 0.25 | | 77.21 | 13.14 | 0.33 |
| | 1993 | | 0.26 | | 79.07 | 13.28 | 0.34 |
| | 1994 | | 0.27 | | 83.20 | 16.24 | 0.37 |
| | 1995 | | 0.29 | | 90.98 | 12.42 | 0.40 |
| | 1996 | | 0.28 | | 86.80 | 12.21 | 0.37 |
| | 1997 | | 0.28 | | 86.88 | 13.54 | 0.35 |
| | 1998 | | 0.27 | | 84.13 | 13.98 | 0.34 |
| | 1999 | | 0.28 | | 88.24 | 13.96 | 0.34 |
| | 2000 | | 0.27 | | 84.24 | 13.09 | 0.32 |
| | 2001 | | 0.29 | | 90.26 | 12.92 | 0.33 |
| | 2002 | | 0.31 | | 95.30 | 14.18 | 0.34 |
| | 2003 | | 0.30 | | 93.27 | 10.79 | 0.31 |
| | 2004 | | 0.29 | | 91.27 | 11.08 | 0.31 |
| | 2005 | | 0.29 | | 89.33 | 11.23 | 0.29 |
| | 2006 | | 0.28 | | 87.28 | 10.39 | 0.28 |
| | 2007 | | 0.27 | | 85.19 | 9.82 | 0.26 |

*Table 8.5-1: Emissions from Waste (1990-2007), 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 | | 0.082 | | 0.082 | 0.009 | 0.0003 |

## 8.6. REFERENCES

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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)

# 9. RECALCULATIONS AND IMPROVEMENTS

The key differences between the previous and latest submission of CRF tables for the time series 1990-2007 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[9]

Recalculations are performed in the following sectors:

- Energy
  - Recalculations performed for Resubmission of Croatia's 2008 Inventory Submission: Public Electricity and Heat Production, Manufacture of Solid Fuels and Other Energy Industries, Manufacturing Industries and Construction, Domestic Air Transport, Commercial/Institutional
  - Recalculations performed during preparation of this submission: Other Sectors, Transport
- Industrial Processes
  - Recalculations performed for Resubmission of Croatia's 2008 Inventory Submission: Cement Production, Limestone and Dolomite Use, Soda Ash Production and Use, Ammonia Production, Nitric Acid Production, Steel Production, Ferroalloys Production, Consumption of Halocarbons and $SF_6$, Non-energy use
  - Recalculations performed during preparation of this submission: Limestone and Dolomite Use
- Solvent and Other Product Use
  - Recalculations performed during preparation of this submission: $CO_2$ emission from solvent and other product use, $N_2O$ emission from solvent and other product use
- Agriculture
  - Recalculations performed for Resubmission of Croatia's 2008 Inventory Submission: $CH_4$ Emissions from Enteric Fermentation in Domestic Livestock, Direct $N_2O$ Emission from Agricultural Soils, Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture
  - Recalculations performed during preparation of this submission: $CH_4$ Emissions from Enteric Fermentation in Domestic Livestock, Direct $N_2O$ Emission from Agricultural Soils
- Waste
  - Recalculations performed for Resubmission of Croatia's 2008 Inventory Submission: Wastewater Handling

- Recalculations performed during preparation of this submission: Solid Waste disposal on Land, 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.

The changes were already included and explained in the document '*Resubmission of Croatia's 2008 Inventory Submission*', CRF tables 'Official Resubmission 2008' and also within this report.

### 9.1.1.1. Changes in available data

***Energy***

**Domestic Air Transport (1.A.3.a.)**

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.
Data for the period from 1991 to 2006 were obtained from:

- Statistical yearbook 1994, Republic of Croatia, Zagreb 1994.
- Statistical yearbook 1997, Republic of Croatia, Zagreb 1997.
- Statistical yearbook 2007, Republic of Croatia, Zagreb 2007.

Since average km traveled per passenger on domestic/international routes for 1990 is not included in available Croatian statistical publications which was confirmed by the authorized person from Central Bureau of Statistics, this value was estimated using linear extrapolation from the period 1991-2006 and equals 0.3105 (see Figure 3.2-8).

[9] Suggestions reported in "Report of the individual review of the greenhouse gas inventory of Croatia submitted in 2006"

***Industrial processes***

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

According to ERT recommendation during the in-country review, country-specific EFs, which are calculated for each year of the time-series, have been recalculated. In NIR 2008 calculated EF (based on CaO and MgO content of clinker) were corrected by the difference in CaO and MgO content of raw material and clinker, by subtracting this difference. Because CaO and MgO content of the raw material is all carbonate, no correction can be made for non-carbonate CaO and MgO in the raw material. Due to the absence of plant-specific data for $CF_{CKD}$ calculation for the whole time series, the default $CF_{CKD}$ was used instead of $CF_{CKD}$ which was calculated in NIR 2008. New calculations of EFs are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

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

According to ERT recommendation during the in-country review, recalculation was performed upon new, updated data. Data were collected from statistical database 'Inputs of raw and material in industrial production'. According to statistical data, national classification of activities distinguished dolomite use in glass, ceramic and refractory materials manufacture in the period 1990-1996, as well as stressed previously. New data are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

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

According to ERT recommendation during the in-country review, recalculation was performed upon new, updated data. Data were collected from statistical database 'Inputs of raw and material in industrial production'. According to statistical data, national classification of activities distinguished soda ash use in glass and ceramic manufacture and in the production of soap and detergents in the period 1990-1996, as well as stressed previously. New data for soda ash use in chemical production have been included for the period 1997-2003 and presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

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

According to ERT recommendation during the in-country review, information on the standard used for the measurements of natural gas composition have been obtained by experts from ammonia manufacturer. In line with recommendation, country-specific $CO_2$ EFs, which are calculated for each year of the time-series, have been recalculated. Also, derived EFs have been applied to the total amount of natural gas for ammonia production (in NIR 2008 amount of natural gas used as feedstock were used for calculation of process emissions, while calculation of $CO_2$ emission from natural gas used as fuel were performed by using default EF). Pursuant ERT recommendation, ammonia production is presented in CRF tables as activity data instead

of natural gas consumption. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

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

According to ERT recommendation during the in-country review, activity data were checked for 1990, 1991, 1992 and 1993 and errors were corrected. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

**Consumption of Halocarbons and $SF_6$ (2.F.); Refrigeration and Air Conditioning Eqiuipment (2.F.1.)**

In NIR 2008 potential HFCs emissions from Refrigeration and Air Conditioning Equipment were calculated. Data were provided by the Ministry of Environmental Protection, Physical Planning and Construction. Emissions for all gases for the period 1990-1995 were estimated by extrapolation method. Pursuant ERT explanation, extrapolation should not be used because emission growth trend is not constant over time. Extrapolation should also not be used over long periods of time without detailed checks at intervals to confirm the continued validity of the trend. Consequently, according to ERT recommendation method for HFC emission calculation has been changed from extrapolation to cluster analysis of countries with similar circumstances (e.g. CZ, HU, SK, SL) and consequently HFC emissions were identified as not occurred. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

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

In NIR 2008 $SF_6$ emissions were not estimated for the whole time series due to lack of activity data. According to ERT recommendation during the in-country review, 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 were provided by Croatian Electricity Utility Company (Hrvatska elektroprivreda, HEP) and Kočar – Electrical Industries Inc. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$-eq emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

**Other (2.G.); Non-energy Use (2.G.)**

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. Explanations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

## ***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 2007* Submission to the Convention on Long-range Transboundary Air Pollution'. NMVOC emissions for Paint application have been changed over time. Also, NMVOC emissions from the other group of activities have been changed for some years. Therefore, $CO_2$ emissions have been recalculated for the period 1990-2006 in this report.

In previous report (NIR 2008) $N_2O$ emissions from medical uses and other possible sources were not estimated because input data were not available. In this report, $N_2O$ used for anaesthesia and aerosol cans, obtained by only producer and distributor of $N_2O$ in Croatia, were included in $N_2O$ emission calculation. Therefore, $N_2O$ emissions have been recalculated for the period 1990-2006 in this report.

## ***Agriculture***

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

More accurate and more detailed data were obtained from the Central Bureau of Statistics for the whole period from 1990-2007. The latter refers to the number of dairy and non-dairy cattle and milk yield which improved the calculation of $CH_4$ emissions.

### Direct Emission from Agricultural Soils (4.D.1.)

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 which lead to more precise calculation of $N_2O$ emission from mineral fertilizers.

Detailed data on N fixing crops were obtained from the Central Bureau of Statistics and FAO database. Crop production of Soybeans, Beans, Clover and Alfalfa were obtained from the Central Bureau of Statistics for the whole period 1990-2007. Data on Cow peas, Lentils, Peas and Vetches were obtained from FAO database for the period 1992-2007. Data for 1990 and 1991 were obtained by extrapolating the data for the period 1992-1995, which represents war period in Croatia. More accurate data were also used in regard to dry matter fraction, residue/crop ratio and N fraction. The final result was more precise calculation of $N_2O$ emission due to biological fixation of nitrogen.

More detailed data on non-nitrogen fixing crops was also attained (crop production) for the whole period from 1990-2007. Along with more precise data on dry matter fraction, residue/crop ratio and N fraction, the quality of $N_2O$ emission calculation from crop residue was raised.

### Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture (4.D.3.)

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 which led to more precise calculation of indirect $N_2O$ emission from mineral fertilizers.

## ***Waste***

### Solid Waste Disposal on Land (6.A.)

In this report, the quantity of MSW disposed to different types of SWDSs and the main characteristic of SWDSs in the period 2001-2004 have been assessed by interpolation method, taking into account the pattern over 2000 and 2005. Fraction of MSW disposed at solid waste disposal sites in 2005 and 2006 has been assessed according to information provided by official document *Waste Management Plan in the Republic of Croatia (2007-2015*) and expert judgement, whereas national classification of SWDSs is not adjusted to IPCC SWDSs classification. Since MCF is assigned to each of three categories of SWDSs, calculated MCFs have been corrected also. Recovered $CH_4$ in 2005 and 2006 has been corrected because in the previous report total quantity of landfill gas were calculated as methane (it is assumed that 50% of landfill gas is methane). Also, errors made in total emission calculation for 2005 and 2006 have been corrected. Thereupon, $CH_4$ emissions have been recalculated for the period 2001-2006.

### Wastewater Handling (6.B.); Industrial Wastewater (6.B.1)

In NIR 2008 $CH_4$ emissions from Industrial Wastewaters were not estimated for the whole time series due to lack of activity data. According to ERT recommendation during the in-country review, 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) have been used for emission calculation. Data were taken from Statistical Yearbooks. Insufficient data were assessed by interpolation. The other parameters required for the calculation were taken from the IPCC good practice guidance or assessed by expert judgement. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$-eq emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

### Waste Incineration (6.C.)

Data for $CO_2$ emission calculation from Waste Incineration for the period 1990-2006 have been corrected according to detailed information on incineration type of waste for 2007, which have been provided by Croatian Environment Agency that collects data from emission point sources in the Environmental Pollution Register (ROO). Accordingly, some quantity of incinerated waste in the period 1990-2006 can not be included in inventory because waste was incinerated with energy recovery. Consequently, data have been corrected and $CO_2$ emissions have been recalculated for the period 1990-2006 in this report.

### 9.1.1.2. Consistency with good practice guidance

***Energy***

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

For emission recalculation Carbon content for Coke Oven Gas (13.0 t C/TJ) was used instead of Carbon content for Gas coke (29.5 t C/TJ).

**Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c.)**

For emission recalculation Carbon content for Coke Oven Gas (13.0 t C/TJ) was used instead of Carbon content for Gas coke (29.5 t C/TJ). The recalculation was performed for the whole period from 1990 to 2006.

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

For emission recalculation Carbon content for Coke Oven Gas and Gas Works Gas (13.0 t C/TJ) was used instead of Carbon content for Gas coke (29.5 t C/TJ). Accordingly, Croatia applied correct fractions of carbon oxidised for gas works gas and coke oven gas.

When calculating $CO_2$, $CH_4$, $N_2O$ emissions from Iron and Steel Croatia reported emissions taking into account full oxidation of fuel and also $CO_2$, $CH_4$, $N_2O$ emissions from Blast Furnace Gas, which the ERT considers as a double counting of $CO_2$, $CH_4$, $N_2O$ emissions. Therefore, blast furnace gas which is produced as a by-product of incomplete combustion of coke oven coke was excluded from emission calculation to avoid double counting. The recalculations were performed for the whole period from 1990 to 2006.

**Commercial/Institutional (1.A.4.a.)**

During In country review ERT noted double counting. 19.6 million $m^3$ of natural gas which is used in Gas Works as a feedstock and 0.9 million $m^3$ of natural gas already accounted under 1.A.1.c. This amount of natural gas was subtracted to avoid double counting. The recalculations were performed for the whole period from 1990 to 2006.

During the in-country review the ERT and the inventory team recognized that 1.5 Gg of heavy fuel oil allocated in the energy balance under road, aviation and public transport was not accounted for in the emission estimates. Taking into account the national statistical system it is very likely that this amount of fuel was used in stationary combustion (e.g. for heating airport or public services buildings, etc).Because of that emissions from the combustion of 1.5 Gg of heavy fuel oil was included, as well as amounts of petroleum, diesel, light heating oil and petroleum coke which were used for the same purpose and not accounted for in the latest submission. The recalculations were performed for the whole period from 1990 to 2006.

***Industrial Processes***

**Chemical Industry (2.B.); Nitric Acid Production (2.B.2.)**

In NIR 2008 emissions of $N_2O$ from nitric acid production have been calculated using default EF of 9 kg $N_2O$/t $HNO_3$ from the IPCC good practice guidance, which is the mean of the range given for European designed, dual pressure, double absorption plants. According to ERT recommendation during the in-country review, although Petrokemija Fertilizer Company does not continuously measure $N_2O$ emissions, data from a measurement in 1997 have been used for calculation of $N_2O$ EF. The measurement leads to an EF of 7.8 kg $N_2O$/t $HNO_3$. Information on technology and relevant parameters was provided by Petrokemija during the in-country review. The ERT came to the conclusion that the use of a plant specific EF is in accordance with the IPCC good practice guidance and also corresponds to ranges of EFs provided in literature (BAT document on Large Volume Inorganic Chemicals – Ammonia, acids and fertilizers) for the parameters used by Petrokemija. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

***Agriculture***

**Direct Emission from Agricultural Soils (4.D.1.)**

Previously used emission factor, needed for calculation of $N_2O$ emission due to cultivation of organic soils (histosols), was not consistent with the new emission factor in GPG 2000. Therefore, an updated emission factor was applied.

**9.1.1.4. New methods**

***Energy***

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

$CO_2$ Emission from $SO_2$ scrubbing in TPP Plomin 2 was included in total $CO_2$ emission of 1.A.1.a sector. $CO_2$ emission is calculated from amount of $CaSO_4$ produced as by-product of $SO_2$ scrubbing process according to equation (4):

(1) $SO_2 + 1/2O_2 \rightarrow SO_3$

(2) $SO_3 + H_2O \rightarrow H_2SO_4$

(3) $H_2SO_4 + CaCO_3 \rightarrow CaSO_4 + CO_2 + H_2O$

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(4) $SO_2 + 1/2O_2 + CaCO_3 + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O + CO_2$

$$n(CaSO_4) = n(CO_2)$$

$$m(CO_2) = \frac{m(CaSO_4 \cdot 2H_2O)}{M(CaSO_4 \cdot 2H_2O)} \cdot M(CO_2)$$

The recalculations were performed for the whole period from 1990 to 2006.

***Industrial Processes***

**Metal Production (2.C.); Ferroalloys Production (2.C.2.)**

In NIR 2008 emissions of $CO_2$ have been calculated by multiplying annual ferroalloys production by material-specific emission factor. According to ERT recommendation during the in-country review, a higher tier method based on reducing agents has been used for $CO_2$ emissions calculation. New calculations are presented in the '*Resubmission of Croatia's 2008 Inventory Submission*'. Thereupon, $CO_2$ emissions have been recalculated and presented in CRF tables '*Official Resubmission 2008'*.

***Agriculture***

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

Since more detailed data on the number of dairy and non-dairy cattle and milk yield were obtained, Tier 2 method was applied (GPG 2000).

**Direct Emission from Agricultural Soils (4.D.1.)**

Tier 1b method was used in calculation of $N_2O$ emissions from biological fixation of N and from crop residue since more detailed data was obtained.

### 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.AA.4)**

During the activity data checking errors in copying the consumed fuel occurred for the period from 1991 to 2003.

**Transport sector (1.AA.3)**

During the activity data checking error in copying the consumed fuel occurred for the 2003.

**Fugitive emissions from fuels (1.B.2)**

During the activity data checking errors in copying the consumed fuel from national energy balance occurred for the period from 1993 to 2005.

## ***Industrial Processes***

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

After the resubmission, activity data obtained from one glass manufacturer have been corrected. Therefore additional recalculation was performed for the entire period in this report.

## ***Agriculture***

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

An error was noticed regarding the coefficient for calculating the $NE_m$ ($Cf_i$). Previously used value for non-dairy cattle was 0.332. Correct coefficient value is 0.322.

### Direct Emission from Agricultural Soils (4.D.1.)

In regard to direct $N_2O$ emission from N-fixing crops, an error was noticed which relates to the residue/crop ratio for lentils. Previously used value was 1.5 but the correct one is 1.0. In this way, data used for $F_{BN}$ and $F_{CR}$ are harmonized.

## 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 2008), resubmission of NIR 2008 and current submission (NIR 2009), on the level of the different greenhouse gases.

*Table 9.2-1: Differences between NIR 2008, Resubmission of NIR 2008 and NIR 2009 for 1990-2006 due to recalculations*

| | Source | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ (Tg) Incl. LULUCF | 1. NIR 2008 | 19.9 | 9.0 | 7.6 | 9.1 | 7.8 | 7.9 | 8.2 | 10.5 | 12.8 |
| | 2. Resub. 2008 | 18.9 | 8.5 | 7.3 | 8.8 | 7.7 | 7.8 | 8.0 | 10.4 | 12.6 |
| | 3. NIR 2009 | 18.9 | 8.5 | 7.3 | 8.9 | 7.7 | 7.8 | 8.1 | 10.4 | 12.6 |
| | ***Difference % 1.-2.*** | ***-4.9*** | ***-5.7*** | ***-4.3*** | ***-3.1*** | ***-2.2*** | ***-1.2*** | ***-1.7*** | ***-1.5*** | ***-1.8*** |
| | ***Difference % 2.-3.*** | ***0.0*** | ***0.2*** | ***0.2*** | ***0.1*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** |
| $CO_2$ (Tg) Excl. LULUCF | 1. NIR 2008 | 24.1 | 17.7 | 16.9 | 17.2 | 16.5 | 17.0 | 17.7 | 18.8 | 19.7 |
| | 2. Resub. 2008 | 23.1 | 17.2 | 16.5 | 16.9 | 16.3 | 16.9 | 17.5 | 18.6 | 19.4 |
| | 3. NIR 2009 | 23.1 | 17.2 | 16.6 | 16.9 | 16.3 | 16.9 | 17.6 | 18.6 | 19.5 |
| | ***Difference % 1.-2.*** | ***-4.0*** | ***-2.9*** | ***-2.0*** | ***-1.6*** | ***-1.0*** | ***-0.5*** | ***-0.8*** | ***-0.8*** | ***-1.2*** |
| | ***Difference % 2.-3.*** | ***0.0*** | ***01*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** |
| $CH_4$ ($CO_2$-eq Gg) | 1. NIR 2008 | 3390 | 3156 | 2802 | 2941 | 2717 | 2684 | 2658 | 2724 | 2557 |
| | 2. Resub. 2008 | 3426 | 3180 | 2863 | 2989 | 2679 | 2856 | 2815 | 2799 | 2578 |
| | 3. NIR 2009 | *3419* | *3174* | *2859* | *2984* | *2675* | *2853* | *2812* | *2796* | *2581* |
| | ***Difference % 1.-2.*** | ***1.1*** | ***0.8*** | ***2.2*** | ***1.6*** | ***-1.4*** | ***6.4*** | ***5.9*** | ***2.8*** | ***0.8*** |
| | ***Difference % 2.-3.*** | ***-0.2*** | ***-0.2*** | ***-0.2*** | ***-0.2*** | ***-0.1*** | ***-0.1*** | ***-0.1*** | ***-0.1*** | ***0.1*** |
| $N_2O$ ($CO_2$-eq Gg) | 1. NIR 2008 | 4079 | 3910 | 3804 | 3263 | 3315 | 3197 | 3149 | 3486 | 3026 |
| | 2. Resub. 2008 | 3868 | 3705 | 3600 | 3081 | 3139 | 3028 | 3007 | 3299 | 2867 |
| | 3. NIR 2009 | 3903 | 3740 | 3635 | 3116 | 3174 | 3063 | 3042 | 3334 | 2903 |
| | ***Difference % 1.-2.*** | ***-5.2*** | ***-5.2*** | ***-5.4*** | ***-5.6*** | ***-5.3*** | ***-5.3*** | ***-4.5*** | ***-5.4*** | ***-5.3*** |
| | ***Difference % 2.-3.*** | ***0.9*** | ***0.9*** | ***1.0*** | ***1.1*** | ***1.1*** | ***1.1*** | ***1.2*** | ***1.1*** | ***1.3*** |
| HFCs ($CO_2$-eq Gg) | 1. NIR 2008 | 52.9 | 51.7 | 50.5 | 49.3 | 48.2 | 43.2 | 60.3 | 91.3 | 17.6 |
| | 2. Resub. 2008 | NO | NO | NO | NO | NO | 7.8 | 60.3 | 91.3 | 17.6 |
| | 3. NIR 2009 | NO | NO | NO | NO | NO | 7.8 | 60.3 | 91.3 | 17.6 |
| | ***Difference % 1.-2.*** | NO | NO | NO | NO | NO | ***-81.9*** | ***0.0*** | ***0.0*** | ***0.0*** |
| | ***Difference % 2.-3.*** | NO | NO | NO | NO | NO | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** |
| PFCs ($CO_2$-eq Gg) | 1. NIR 2008 | 936.6 | 642.4 | NO | NO | NO | NO | NO | NO | NO |
| | 2. Resub. 2008 | 936.6 | 642.4 | NO | NO | NO | NO | NO | NO | NO |
| | 3. NIR 2009 | 936.6 | 642.4 | NO | NO | NO | NO | NO | NO | NO |
| | ***Difference % 1.-2.*** | ***0.0*** | ***0.0*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** |
| | ***Difference % 2.-3.*** | ***0.0*** | ***0.0*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** |
| $SF_6$ ($CO_2$-eq Gg) | 1. NIR 2008 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 2. Resub. 2008 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 3. NIR 2009 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | ***Difference % 1.-2.*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** |
| | ***Difference % 2.-3.*** | ***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 | 1. NIR 2008 | 28.3 | 16.7 | 14.2 | 15.4 | 13.9 | 13.8 | 14.1 | 16.9 | 18.4 |
| | 2. Resub. 2008 | 27.2 | 16.0 | 13.7 | 14.9 | 13.5 | 13.7 | 13.9 | 16.6 | 18.1 |
| | 3. NIR 2009 | 27.2 | 16.1 | 13.8 | 15.0 | 13.5 | 13.7 | 14.0 | 16.6 | 18.1 |
| | ***Difference % 1.-2.*** | ***-4.2*** | ***-4.4*** | ***-3.6*** | ***-2.9*** | ***-3.0*** | ***-0.8*** | ***-0.8*** | ***-1.5*** | ***-1.9*** |
| | ***Difference % 2.-3.*** | ***0.1*** | ***0.3*** | ***0.3*** | ***0.3*** | ***0.3*** | ***0.3*** | ***0.3*** | ***0.3*** | ***0.3*** |
| Total (Tg $CO_2$-eq) Excl.LULUCF | 1. NIR 2008 | 32.5 | 25.4 | 23.5 | 23.4 | 22.6 | 22.9 | 23.5 | 25.1 | 25.3 |
| | 2. Resub. 2008 | 31.3 | 24.7 | 23.0 | 23.0 | 22.2 | 22.8 | 23.4 | 24.8 | 24.9 |
| | 3. NIR 2009 | 31.4 | 24.8 | 23.1 | 23.0 | 22.2 | 22.9 | 23.5 | 24.8 | 25.0 |
| | ***Difference % 1.-2.*** | ***-3.6*** | ***-2.9*** | ***-2.2*** | ***-1.9*** | ***-1.9*** | ***-0.5*** | ***-0.5*** | ***-1.0*** | ***-1.4*** |
| | ***Difference % 2.-3.*** | ***0.1*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** |

*Table 9.2-1: Differences between NIR 2008, Resubmission of NIR 2008 and NIR 2009 for 1990-2006 due to recalculations (cont.)*

| | Source | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ (Tg) Incl. LULUCF | 1. NIR 2008 | 12.3 | 14.8 | 12.8 | 13.8 | 17.3 | 15.3 | 15.9 | 16.2 |
| | 2. Resub. 2008 | 12.1 | 14.7 | 12.6 | 13.6 | 17.2 | 15.1 | 15.7 | 16.0 |
| | 3. NIR 2009 | 12.1 | 14.7 | 12.7 | 13.6 | 17.2 | 15.1 | 15.7 | 16.0 |
| | ***Difference % 1.-2.*** | ***-1.2*** | ***-1.1*** | ***-1.3*** | ***-1.2*** | ***-0.8*** | ***-1.2*** | ***-1.2*** | ***-1.2*** |
| | ***Difference % 2.-3.*** | ***0.2*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** |
| $CO_2$ (Tg) Excl. LULUCF | 1. NIR 2008 | 20.4 | 20.1 | 21.0 | 22.0 | 23.6 | 23.2 | 23.6 | 23.7 |
| | 2. Resub. 2008 | 20.3 | 19.9 | 20.9 | 21.8 | 23.4 | 23.0 | 23.4 | 23.5 |
| | 3. NIR 2009 | 20.3 | 20.0 | 20.9 | 21.9 | 23.5 | 23.0 | 23.4 | 23.5 |
| | ***Difference % 1.-2.*** | ***-0.7*** | ***-0.8*** | ***-0.8*** | ***-0.7*** | ***-0.6*** | ***-0.8*** | ***-0.8*** | ***-0.8*** |
| | ***Difference % 2.-3.*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** | ***0.1*** |
| $CH_4$ ($CO_2$-eq Gg) | 1. NIR 2008 | 2576 | 2638 | 2785 | 2847 | 2953 | 3070 | 2962 | 3110 |
| | 2. Resub. 2008 | 2600 | 2662 | 2837 | 2848 | 3116 | 3139 | 2990 | 3199 |
| | 3. NIR 2009 | *2596* | *2658* | *2833* | *2844* | *3111* | *3133* | *3124* | *3338* |
| | ***Difference % 1.-2.*** | ***0.9*** | ***0.9*** | ***1.9*** | ***0.0*** | ***5.5*** | ***2.2*** | ***0.9*** | ***2.9*** |
| | ***Difference % 2.-3.*** | ***-0.1*** | ***-0.1*** | ***-0.1*** | ***-0.1*** | ***-0.2*** | ***-0.2*** | ***4.5*** | ***4.3*** |
| $N_2O$ ($CO_2$-eq Gg) | 1. NIR 2008 | 3307 | 3465 | 3531 | 3463 | 3352 | 3649 | 3654 | 3594 |
| | 2. Resub. 2008 | 3162 | 3272 | 3353 | 3340 | 3150 | 3442 | 3485 | 3421 |
| | 3. NIR 2009 | 3196 | 3307 | 3388 | 3375 | 3185 | 3477 | 3520 | 3456 |
| | ***Difference % 1.-2.*** | ***-4.4*** | ***-5.6*** | ***-5.0*** | ***-3.5*** | ***-6.0*** | ***-5.7*** | ***-4.6*** | ***-4.8*** |
| | ***Difference % 2.-3.*** | ***1.1*** | ***1.1*** | ***1.0*** | ***1.0*** | ***1.1*** | ***1.0*** | ***1.0*** | ***1.0*** |
| HFCs ($CO_2$-eq Gg) | 1. NIR 2008 | 9.2 | 23.2 | 49.0 | 49.3 | 163.7 | 188.9 | 349.2 | 430.7 |
| | 2. Resub. 2008 | 9.2 | 23.2 | 49.0 | 49.3 | 163.7 | 188.9 | 349.2 | 430.7 |
| | 3. NIR 2009 | 9.2 | 23.2 | 49.0 | 49.3 | 163.7 | 188.9 | 349.2 | 430.7 |
| | ***Difference % 1.-2.*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** |
| | ***Difference % 2.-3.*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** |
| PFCs ($CO_2$-eq Gg) | 1. NIR 2008 | NO | NO | NO | NO | NO | NO | NA,NO | NA,NO |
| | 2. Resub. 2008 | NO | NO | NO | NO | NO | NO | NA,NO | NA,NO |
| | 3. NIR 2009 | NO | NO | NO | NO | NO | NO | NA,NO | NA,NO |
| | ***Difference % 1.-2.*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** |
| | ***Difference % 2.-3.*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** | ***NO*** |
| $SF_6$ ($CO_2$-eq Gg) | 1. NIR 2008 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 2. Resub. 2008 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 3. NIR 2009 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | ***Difference % 1.-2.*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** |
| | ***Difference % 2.-3.*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** | ***0.0*** |
| Total (Tg $CO_2$-eq) Incl. LULUCF | 1. NIR 2008 | 18.1 | 20.9 | 19.2 | 20.1 | 23.8 | 22.2 | 22.8 | 23.3 |
| | 2. Resub. 2008 | 17.9 | 20.6 | 18.9 | 19.9 | 23.6 | 21.9 | 22.5 | 23.1 |
| | 3. NIR 2009 | 17.9 | 20.7 | 18.9 | 19.9 | 23.6 | 21.9 | 22.7 | 23.3 |
| | ***Difference % 1.-2.*** | ***-1.4*** | ***-1.5*** | ***-1.4*** | ***-1.3*** | ***-0.7*** | ***-1.4*** | ***-1.4*** | ***-1.1*** |
| | ***Difference % 2.-3.*** | ***0.3*** | ***0.2*** | ***0.3*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.9*** | ***0.8*** |
| Total (Tg $CO_2$-eq) Excl.LULUCF | 1. NIR 2008 | 26.3 | 26.2 | 27.4 | 28.4 | 30.0 | 30.1 | 30.6 | 30.8 |
| | 2. Resub. 2008 | 26.0 | 25.9 | 27.1 | 28.1 | 29.9 | 29.8 | 30.2 | 30.6 |
| | 3. NIR 2009 | 26.1 | 26.0 | 27.2 | 28.1 | 29.9 | 29.8 | 30.4 | 30.8 |
| | ***Difference % 1.-2.*** | ***-1.0*** | ***-1.2*** | ***-1.0*** | ***-1.0*** | ***-0.6*** | ***-1.0*** | ***-1.0*** | ***-0.8*** |
| | ***Difference % 2.-3.*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.2*** | ***0.6*** | ***0.6*** |

The change in the 1990-2007 trend for the greenhouse gas emissions compared to the Resubmission and 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 2008, Resubmission of NIR 2008 and NIR 2009 for the emission trends 1990-2005*

| Gas | Trend (absolute) | | | | |
|---|---|---|---|---|---|
| $CO_2$-eq (Gg) | 1. NIR 2008 | 2. RESUB. 2008 | 3. NIR 2009 | *Difference 1.-2.* | *Difference 2.-3.* |
| $CO_2$ emissions including net $CO_2$ from LULUCF | -3674.98 | -2903.10 | -357.73 | *-771.88* | *-2545.37* |
| $CO_2$ emissions excluding net $CO_2$ from LULUCF | -369.62 | 402.26 | 1759.98 | *-771.88* | *-1357.72* |
| $CH_4$ | -279.68 | -226.82 | 62.63 | *-52.86* | *-289.45* |
| $N_2O$ | -485.26 | -446.65 | -345.59 | *-38.61* | *-101.06* |
| HFCs | 377.78 | 0.00 | 0.00 | *377.78* | *0.00* |
| PFCs | 0.00 | 0.00 | 0.00 | *0.00* | *0.00* |
| SF6 | 0.00 | 5.42 | 5.68 | *-5.42* | *-0.26* |
| **Total (including LULUCF)** | **-4998.72** | **-4077.06** | **-1106.48** | ***-921.66*** | ***-2970.58*** |
| **Total (excluding LULUCF)** | **-1693.34** | **-771.68** | **1011.24** | ***-921.66*** | ***-1782.92*** |

*Table 9.2-2: Differences between NIR 2008, Resubmission of NIR 2008 and NIR 2009 for the emission trends 1990-2005 (cont)*

| Gas | Trend (percent) | | | | |
|---|---|---|---|---|---|
| $CO_2$-eq (Gg) | 1. NIR 2008 | 2. RESUB. 2008 | 3. NIR 2009 | *Difference 1.-2.* | *Difference 2.-3.* |
| $CO_2$ emissions including net $CO_2$ from LULUCF | -18.48 | -15.35 | -1.89 | *-3.14* | *-13.45* |
| $CO_2$ emissions excluding net $CO_2$ from LULUCF | -1.54 | 1.74 | 7.62 | *-3.28* | *-5.88* |
| $CH_4$ | -8.25 | -6.62 | 1.83 | *-1.63* | *-8.45* |
| $N_2O$ | -11.90 | -11.55 | -8.86 | *-0.35* | *-2.69* |
| HFCs | 714.15 | 100.00 | 100.00 | *614.15* | *0.00* |
| PFCs | -100.00 | -100.00 | -100.00 | *0.00* | *0.00* |
| SF6 | 0.00 | 49.20 | 51.58 | *-49.20* | *-2.38* |
| **Total (including LULUCF)** | **-17.64** | **-15.01** | **-4.07** | ***-2.63*** | ***-10.94*** |
| **Total (excluding LULUCF)** | **-5.21** | **-2.46** | **3.22** | ***-2.74*** | ***-5.69*** |

## 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, and this latest submission in May 2009.

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[10]. 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.

[10] 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 and application of higher Tier methodologies will be possible in the future after detailed research and adjustments of statistical methods for data collection have been performed. Moreover, in order to increase the calculation quality, national emission factors should be developed.

**LAND-USE CHANGE AND FORESTRY**

Major areas for improvement:

- Development of land use database needed for greenhouse gas inventories with aim to collect more quality data and to use complete land inventories. Regulation on the Greenhouse Gases Emissions Monitoring in the Republic of Croatia (Official gazette No. 1/07) prescribes obligation and procedure for emissions monitoring. Among others, the regulation prescribes monitoring of areas within different land use categories, such as forest area, agricultural area, grasslands, wetlands, settlements and other land.
- Development of country specific factors (BEFs).

**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 mentionend 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 aditionally, 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)*

| 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 (%) |
| $CO_2$ Emissions from Stationary Combustion - Oil | $CO_2$ | 8497.04 | 6317.13 | 0.195 | 20% |
| Mobile Combustion - Road Vehicles | $CO_2$ | 3561.40 | 6059.43 | 0.187 | 38% |
| $CO_2$ Emissions from Stationary Combustion - Gas | $CO_2$ | 4042.45 | 5115.01 | 0.158 | 54% |
| $CO_2$ Emissions from Stationary Combustion - Coal | $CO_2$ | 2800.91 | 2660.44 | 0.082 | 62% |
| Fugitive Emissions from Oil and Gas Operations | $CH_4$ | 1201.18 | 1617.80 | 0.050 | 67% |
| $CO_2$ Emissions from Cement Production | $CO_2$ | 1085.79 | 1612.03 | 0.050 | 72% |
| Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | 1298.05 | 1203.70 | 0.037 | 76% |
| $CO_2$ Emissions from Ammonia Production | $CO_2$ | 870.99 | 945.00 | 0.029 | 79% |
| Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture | $N_2O$ | 931.84 | 833.98 | 0.026 | 81% |
| $CH_4$ Emissions from Enteric Fermentation | $CH_4$ | 1222.37 | 787.92 | 0.024 | 84% |
| Nitric Acid Production | $N_2O$ | 804.08 | 741.61 | 0.023 | 86% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CO_2$ | 839.19 | 721.87 | 0.022 | 88% |
| $CO_2$ Emissions from Natural Gas Scrubbing* | $CO_2$ | 415.95 | 665.00 | 0.021 | 90% |
| Solid Waste Disposal Sites | $CH_4$ | 221.21 | 602.71 | 0.019 | 92% |
| HFC Emissions from Consumption of HFCs, PFCs and $SF_6$ | HFC | 11.01 | 481.79 | 0.015 | 94% |
| $CO_2$ Emissions from Lime Production | $CO_2$ | 160.63 | 254.46 | 0.008 | 95% |
| $N_2O$ Emissions from Manure Management | $N_2O$ | 378.74 | 222.83 | 0.007 | 95% |
| Total Solvent and Other Product Use | $CO_2$ | 96.23 | 197.80 | 0.006 | 96% |
| $N_2O$ Emissions from Pasture, Range and Paddock Manure | $N_2O$ | 261.96 | 194.31 | 0.006 | 96% |
| Mobile Combustion - Road Vehicles | $N_2O$ | 48.08 | 191.06 | 0.006 | 97% |
| Emissions from Waste Water Handling | $CH_4$ | 278.73 | 179.61 | 0.006 | 98% |
| $CH_4$ Emissions from Manure Management | $CH_4$ | 228.44 | 166.93 | 0.005 | 98% |
| Mobile Combustion: Water-borne Navigation | $CO_2$ | 132.98 | 107.73 | 0.003 | 98% |
| Mobile Combustion: Railways | $CO_2$ | 138.14 | 102.10 | 0.003 | 99% |
| Fuel Combustion - Stationary Sources | $CH_4$ | 167.85 | 85.77 | 0.003 | 99% |
| Emissions from Waste Water Handling | $N_2O$ | 78.69 | 85.19 | 0.003 | 99% |
| Mobile Combustion: Aircraft | $CO_2$ | 154.72 | 76.00 | 0.002 | 100% |
| Fuel Combustion - Stationary Sources | $N_2O$ | 62.32 | 46.64 | 0.001 | 100% |
| Total Solvent and Other Product Use | $N_2O$ | 34.72 | 34.72 | 0.001 | 100% |
| Mobile Combustion - Road Vehicles | $CH_4$ | 32.13 | 32.20 | 0.001 | 100% |
| $CO_2$ Emissions from Limestone and Dolomite Use | $CO_2$ | 51.49 | 16.82 | 0.001 | 100% |
| $CO_2$ Emissions from Soda Ash Production and Use | $CO_2$ | 25.74 | 13.42 | 0.000 | 100% |
| Production of Chemicals | $CH_4$ | 16.45 | 7.14 | 0.000 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $N_2O$ | 2.04 | 1.77 | 0.000 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CH_4$ | 1.30 | 1.08 | 0.000 | 100% |
| Mobile Combustion: Aircraft | $N_2O$ | 1.36 | 0.67 | 0.000 | 100% |
| $CO_2$ Emissions from Iron and Steel Production | $CO_2$ | 0.78 | 0.35 | 0.000 | 100% |
| Mobile Combustion: Water-borne Navigation | $N_2O$ | 0.34 | 0.27 | 0.000 | 100% |
| Mobile Combustion: Railways | $N_2O$ | 0.39 | 0.26 | 0.000 | 100% |
| Mobile Combustion: Water-borne Navigation | $CH_4$ | 0.19 | 0.15 | 0.000 | 100% |
| Mobile Combustion: Railways | $CH_4$ | 0.21 | 0.15 | 0.000 | 100% |
| Emissions from Waste Incineration | $CO_2$ | 0.04 | 0.08 | 0.000 | 100% |
| Mobile Combustion: Aircraft | $CH_4$ | 0.02 | 0.01 | 0.000 | 100% |
| PFC Emissions from Aluminium production | PFC | 936.56 | - | 0.000 | 100% |
| Other non-specified NEU | $CO_2$ | 0.00 | - | 0.000 | 100% |
| Fugitive Emissions from Coal Mining and Handling | $CH_4$ | 48.76 | - | 0.000 | 100% |
| $CO_2$ Emissions from Ferroalloys Production | $CO_2$ | 118.84 | - | 0.000 | 100% |
| Aluminium Production | $CO_2$ | 111.37 | - | 0.000 | 100% |
| **TOTAL** | | **31,373.710** | **32,384.950** | | |

*Table A1-3: Key categories analysis – Level Assessment - Tier 1 (Including LULUCF)*

| 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 (%) |
| $CO_2$ Emissions from Stationary Combustion - Oil | $CO_2$ | 8497.044 | 6317.130 | 0.163 | 16% |
| Forest land remaining forest land | $CO_2$ | 4184.932 | 6302.646 | 0.163 | 33% |
| Mobile Combustion - Road Vehicles | $CO_2$ | 3561.401 | 6059.434 | 0.157 | 48% |
| $CO_2$ Emissions from Stationary Combustion - Gas | $CO_2$ | 4042.451 | 5115.013 | 0.132 | 62% |
| $CO_2$ Emissions from Stationary Combustion - Coal | $CO_2$ | 2800.914 | 2660.440 | 0.069 | 68% |
| Fugitive Emissions from Oil and Gas Operations | $CH_4$ | 1201.180 | 1617.803 | 0.042 | 73% |
| $CO_2$ Emissions from Cement Production | $CO_2$ | 1085.790 | 1612.032 | 0.042 | 77% |
| Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | 1298.048 | 1203.696 | 0.031 | 80% |
| $CO_2$ Emissions from Ammonia Production | $CO_2$ | 870.990 | 945.003 | 0.024 | 82% |
| Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture | $N_2O$ | 931.837 | 833.978 | 0.022 | 84% |
| $CH_4$ Emissions from Enteric Fermentation in Domestic | $CH_4$ | 1222.369 | 787.916 | 0.020 | 86% |
| Nitric Acid Production | $N_2O$ | 804.078 | 741.612 | 0.019 | 88% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CO_2$ | 839.186 | 721.869 | 0.019 | 90% |
| $CO_2$ Emissions from Natural Gas Scrubbing* | $CO_2$ | 415.949 | 665.000 | 0.017 | 92% |
| Solid Waste Disposal Sites | $CH_4$ | 221.208 | 602.715 | 0.016 | 94% |
| HFC Emissions from Consumption of HFCs, PFCs and SF6 | HFC | 11.013 | 481.793 | 0.012 | 95% |
| $CO_2$ Emissions from Lime Production | $CO_2$ | 160.629 | 254.456 | 0.007 | 95% |
| $N_2O$ Emissions from Manure Management | $N_2O$ | 378.738 | 222.825 | 0.006 | 96% |
| Total Solvent and Other Product Use | $CO_2$ | 96.229 | 197.796 | 0.005 | 97% |
| $N_2O$ Emissions from Pasture, Range and Paddock Manure | $N_2O$ | 261.958 | 194.314 | 0.005 | 97% |
| Mobile Combustion - Road Vehicles | $N_2O$ | 48.084 | 191.059 | 0.005 | 98% |
| Emissions from Waste Water Handling | $CH_4$ | 278.732 | 179.612 | 0.005 | 98% |
| $CH_4$ Emissions from Manure Management | $CH_4$ | 228.445 | 166.930 | 0.004 | 98% |
| Mobile Combustion: Water-borne Navigation | $CO_2$ | 132.980 | 107.732 | 0.003 | 99% |
| Mobile Combustion: Railways | $CO_2$ | 138.142 | 102.095 | 0.003 | 99% |
| Fuel Combustion - Stationary Sources | $CH_4$ | 167.855 | 85.775 | 0.002 | 99% |
| Emissions from Waste Water Handling | $N_2O$ | 78.690 | 85.194 | 0.002 | 99% |
| Mobile Combustion: Aircraft | $CO_2$ | 154.724 | 76.005 | 0.002 | 100% |
| Fuel Combustion - Stationary Sources | $N_2O$ | 62.317 | 46.639 | 0.001 | 100% |
| Total Solvent and Other Product Use | $N_2O$ | 34.720 | 34.720 | 0.001 | 100% |
| Mobile Combustion - Road Vehicles | $CH_4$ | 32.130 | 32.195 | 0.001 | 100% |
| $CO_2$ Emissions from Limestone and Dolomite Use | $CO_2$ | 51.487 | 16.819 | 0.000 | 100% |
| $CO_2$ Emissions from Soda Ash Production and Use | $CO_2$ | 25.740 | 13.416 | 0.000 | 100% |
| Production of Other Chemicals | $CH_4$ | 16.450 | 7.137 | 0.000 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $N_2O$ | 2.038 | 1.770 | 0.000 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CH_4$ | 1.299 | 1.085 | 0.000 | 100% |
| Mobile Combustion: Aircraft | $N_2O$ | 1.355 | 0.667 | 0.000 | 100% |
| $CO_2$ Emissions from Iron and Steel Production | $CO_2$ | 0.784 | 0.349 | 0.000 | 100% |
| Mobile Combustion: Water-borne Navigation | $N_2O$ | 0.337 | 0.273 | 0.000 | 100% |
| Mobile Combustion: Railways | $N_2O$ | 0.392 | 0.259 | 0.000 | 100% |
| Mobile Combustion: Water-borne Navigation | $CH_4$ | 0.190 | 0.154 | 0.000 | 100% |
| Mobile Combustion: Railways | $CH_4$ | 0.214 | 0.146 | 0.000 | 100% |
| Emissions from Waste Incineration | $CO_2$ | 0.043 | 0.082 | 0.000 | 100% |
| Mobile Combustion: Aircraft | $CH_4$ | 0.023 | 0.011 | 0.000 | 100% |
| Forest land remaining forest land | $CH_4$ | 0.011 | 0.010 | 0.000 | 100% |
| Forest land remaining forest land | $N_2O$ | 0.003 | 0.002 | 0.000 | 100% |
| PFC Emissions from Aluminium production | PFC | 936.564 | - | - | 100% |
| Other non-specified NEU | $CO_2$ | 0.000 | - | - | 100% |
| Fugitive Emissions from Coal Mining and Handling | $CH_4$ | 48.757 | - | - | 100% |
| $CO_2$ Emissions from Ferroalloys Production | $CO_2$ | 118.836 | - | - | 100% |
| Aluminium Production | $CO_2$ | 111.37 | - | - | 100% |
| **TOTAL** | | **35,558.656** | **38,687.609** | | |

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

| 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 | 6317.13 | 0.056 | 0.056 | 6% |
| Mobile Combustion - Road Vehicles | $CO_2$ | 3561.40 | 6059.43 | 0.125 | 0.124 | 18% |
| $CO_2$ Emissions from Stationary Combustion - Gas | $CO_2$ | 4042.45 | 5115.01 | 0.037 | 0.037 | 22% |
| $CO_2$ Emissions from Stationary Combustion - Coal | $CO_2$ | 2800.91 | 2660.44 | 0.007 | 0.007 | 22% |
| Fugitive Emissions from Oil and Gas Operations | $CH_4$ | 1201.18 | 1617.80 | 0.016 | 0.016 | 24% |
| $CO_2$ Emissions from Cement Production | $CO_2$ | 1085.79 | 1612.03 | 0.023 | 0.022 | 26% |
| Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | 1298.05 | 1203.70 | 0.004 | 0.004 | 27% |
| $CO_2$ Emissions from Ammonia Production | $CO_2$ | 870.99 | 945.00 | 0.002 | 0.002 | 27% |
| Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture | $N_2O$ | 931.84 | 833.98 | 0.004 | 0.003 | 27% |
| $CH_4$ Emissions from Enteric Fermentation in Domestic | $CH_4$ | 1222.37 | 787.92 | 0.009 | 0.009 | 28% |
| Nitric Acid Production | $N_2O$ | 804.08 | 741.61 | 0.002 | 0.002 | 28% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CO_2$ | 839.19 | 721.87 | 0.004 | 0.004 | 29% |
| $CO_2$ Emissions from Natural Gas Scrubbing* | $CO_2$ | 415.95 | 665.00 | 0.012 | 0.012 | 30% |
| Solid Waste Disposal Sites | $CH_4$ | 221.21 | 602.71 | 0.032 | 0.031 | 33% |
| HFC Emissions from Consumption of HFCs, PFCs and | HFC | 11.01 | 481.79 | 0.635 | 0.630 | 96% |
| $CO_2$ Emissions from Lime Production | $CO_2$ | 160.63 | 254.46 | 0.004 | 0.004 | 96% |
| $N_2O$ Emissions from Manure Management | $N_2O$ | 378.74 | 222.83 | 0.003 | 0.003 | 97% |
| Total Solvent and Other Product Use | $CO_2$ | 96.23 | 197.80 | 0.006 | 0.006 | 97% |
| $N_2O$ Emissions from Pasture, Range and Paddock | $N_2O$ | 261.96 | 194.31 | 0.002 | 0.002 | 97% |
| Mobile Combustion - Road Vehicles | $N_2O$ | 48.08 | 191.06 | 0.017 | 0.017 | 99% |
| Emissions from Waste Water Handling | $CH_4$ | 278.73 | 179.61 | 0.002 | 0.002 | 99% |
| $CH_4$ Emissions from Manure Management | $CH_4$ | 228.44 | 166.93 | 0.002 | 0.002 | 99% |
| Mobile Combustion: Water-borne Navigation | $CO_2$ | 132.98 | 107.73 | 0.001 | 0.001 | 100% |
| Mobile Combustion: Railways | $CO_2$ | 138.14 | 102.10 | 0.001 | 0.001 | 100% |
| Fuel Combustion - Stationary Sources | $CH_4$ | 167.85 | 85.77 | 0.001 | 0.001 | 100% |
| Emissions from Waste Water Handling | $N_2O$ | 78.69 | 85.19 | 0.000 | 0.000 | 100% |
| Mobile Combustion: Aircraft | $CO_2$ | 154.72 | 76.00 | 0.0013 | 0.0013 | 100% |
| Fuel Combustion - Stationary Sources | $N_2O$ | 62.32 | 46.64 | 0.0004 | 0.0004 | 100% |
| Total Solvent and Other Product Use | $N_2O$ | 34.72 | 34.72 | 0.0000 | 0.0000 | 100% |
| Mobile Combustion - Road Vehicles | $CH_4$ | 32.13 | 32.20 | 0.0000 | 0.0000 | 100% |
| $CO_2$ Emissions from Limestone and Dolomite Use | $CO_2$ | 51.49 | 16.82 | 0.0004 | 0.0004 | 100% |
| $CO_2$ Emissions from Soda Ash Production and Use | $CO_2$ | 25.74 | 13.42 | 0.0002 | 0.0002 | 100% |
| Production of Chemicals | $CH_4$ | 16.45 | 7.14 | 0.0001 | 0.0001 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $N_2O$ | 2.04 | 1.77 | 0.0000 | 0.0000 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CH_4$ | 1.30 | 1.08 | 0.00001 | 0.00001 | 100% |
| Mobile Combustion: Aircraft | $N_2O$ | 1.36 | 0.67 | 0.00001 | 0.00001 | 100% |
| $CO_2$ Emissions from Iron and Steel Production | $CO_2$ | 0.78 | 0.35 | 0.00001 | 0.00001 | 100% |
| Mobile Combustion: Water-borne Navigation | $N_2O$ | 0.34 | 0.27 | 0.00000 | 0.00000 | 100% |
| Mobile Combustion: Railways | $N_2O$ | 0.39 | 0.26 | 0.00000 | 0.000003 | 100% |
| Mobile Combustion: Water-borne Navigation | $CH_4$ | 0.19 | 0.15 | 0.00000 | 0.000001 | 100% |
| Mobile Combustion: Railways | $CH_4$ | 0.21 | 0.15 | 0.00000 | 0.000002 | 100% |
| Emissions from Waste Incineration | $CO_2$ | 0.04 | 0.08 | 0.00000 | 0.000002 | 100% |
| Mobile Combustion: Aircraft | $CH_4$ | 0.02 | 0.01 | 0.00000 | 0.0000002 | 100% |
| $CO_2$ Emissions from Ferroalloys Production | $CO_2$ | 118.84 | - | 0.00000 | 0.0000000 | 100% |
| Aluminium Production | $CO_2$ | 111.37 | - | 0.00000 | 0.0000000 | 100% |
| Other non-specified NEU | $CO_2$ | 0.00 | - | 0.00000 | 0.0000000 | 100% |
| Fugitive Emissions from Coal Mining and Handling | $CH_4$ | 48.76 | - | 0.00000 | 0.0000000 | 100% |
| PFC Emissions from Aluminium production | PFC | 936.56427 | - | 0.000 | 0.0000000 | 100% |
| **TOTAL** | | **31,373.71** | **32,384.95** | | | |

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

| 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 | 6317.13 | 0.055 | 0.061 | 6% |
| Forest land remaining forest land | $CO_2$ | 4184.932 | 6302.64 | 0.069 | 0.076 | 14% |
| Mobile Combustion - Road Vehicles | $CO_2$ | 3561.401 | 6059.43 | 0.097 | 0.107 | 24% |
| $CO_2$ Emissions from Stationary Combustion - Gas | $CO_2$ | 4042.451 | 5115.01 | 0.024 | 0.027 | 27% |
| $CO_2$ Emissions from Stationary Combustion - Coal | $CO_2$ | 2800.914 | 2660.44 | 0.009 | 0.010 | 28% |
| Fugitive Emissions from Oil and Gas Operations | $CH_4$ | 1201.180 | 1617.80 | 0.011 | 0.012 | 29% |
| $CO_2$ Emissions from Cement Production | $CO_2$ | 1085.790 | 1612.03 | 0.017 | 0.018 | 31% |
| Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | 1298.048 | 1203.69 | 0.005 | 0.005 | 32% |
| $CO_2$ Emissions from Ammonia Production | $CO_2$ | 870.990 | 945.003 | 0.000 | 0.000 | 32% |
| Indirect N2O Emissions from Nitrogen Used in Agriculture | $N_2O$ | 931.837 | 833.978 | 0.004 | 0.004 | 32% |
| $CH_4$ Emissions from Enteric Fermentation in Domestic | $CH_4$ | 1222.369 | 787.916 | 0.009 | 0.010 | 33% |
| Nitric Acid Production | $N_2O$ | 804.078 | 741.612 | 0.003 | 0.003 | 33% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CO_2$ | 839.186 | 721.869 | 0.004 | 0.005 | 34% |
| $CO_2$ Emissions from Natural Gas Scrubbing* | $CO_2$ | 415.949 | 665.000 | 0.009 | 0.010 | 35% |
| Solid Waste Disposal Sites | $CH_4$ | 221.208 | 602.715 | 0.026 | 0.028 | 38% |
| HFC Emissions from Consumption of HFCs, PFCs and | HFC | 11.013 | 481.793 | 0.531 | 0.584 | 96% |
| $CO_2$ Emissions from Lime Production | $CO_2$ | 160.629 | 254.456 | 0.003 | 0.004 | 96% |
| $N_2O$ Emissions from Manure Management | $N_2O$ | 378.738 | 222.825 | 0.003 | 0.003 | 97% |
| Total Solvent and Other Product Use | $CO_2$ | 96.229 | 197.796 | 0.005 | 0.005 | 97% |
| $N_2O$ Emissions from Pasture, Range and Paddock | $N_2O$ | 261.958 | 194.314 | 0.002 | 0.002 | 97% |
| Mobile Combustion - Road Vehicles | $N_2O$ | 48.084 | 191.059 | 0.014 | 0.016 | 99% |
| Emissions from Waste Water Handling | $CH_4$ | 278.732 | 179.612 | 0.002 | 0.002 | 99% |
| $CH_4$ Emissions from Manure Management | $CH_4$ | 228.445 | 166.930 | 0.002 | 0.002 | 99% |
| Mobile Combustion: Water-borne Navigation | $CO_2$ | 132.980 | 107.732 | 0.001 | 0.001 | 99% |
| Mobile Combustion: Railways | $CO_2$ | 138.142 | 102.095 | 0.001 | 0.001 | 100% |
| Fuel Combustion - Stationary Sources | $CH_4$ | 167.855 | 85.775 | 0.0013 | 0.0014 | 100% |
| Emissions from Waste Water Handling | $N_2O$ | 78.690 | 85.194 | 0.0000 | 0.0000 | 100% |
| Mobile Combustion: Aircraft | $CO_2$ | 154.724 | 76.005 | 0.0012 | 0.0013 | 100% |
| Fuel Combustion - Stationary Sources | $N_2O$ | 62.317 | 46.639 | 0.0004 | 0.0004 | 100% |
| Total Solvent and Other Product Use | $N_2O$ | 34.720 | 34.720 | 0.0001 | 0.0001 | 100% |
| Mobile Combustion - Road Vehicles | $CH_4$ | 32.130 | 32.195 | 0.0001 | 0.0001 | 100% |
| $CO_2$ Emissions from Limestone and Dolomite Use | $CO_2$ | 51.487 | 16.819 | 0.0003 | 0.0004 | 100% |
| $CO_2$ Emissions from Soda Ash Production and Use | $CO_2$ | 25.740 | 13.416 | 0.0002 | 0.0002 | 100% |
| Production of Other Chemicals | $CH_4$ | 16.450 | 7.137 | 0.00012 | 0.00013 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $N_2O$ | 2.038 | 1.770 | 0.00001 | 0.00001 | 100% |
| Mobile Combustion - Agriculture/Forestry/Fishing | $CH_4$ | 1.299 | 1.085 | 0.00001 | 0.00001 | 100% |
| Mobile Combustion: Aircraft | $N_2O$ | 1.355 | 0.667 | 0.00001 | 0.00001 | 100% |
| $CO_2$ Emissions from Iron and Steel Production | $CO_2$ | 0.784 | 0.349 | 0.00000 | 0.000006 | 100% |
| Mobile Combustion: Water-borne Navigation | $N_2O$ | 0.337 | 0.273 | 0.00000 | 0.000002 | 100% |
| Mobile Combustion: Railways | $N_2O$ | 0.392 | 0.259 | 0.00000 | 0.000003 | 100% |
| Mobile Combustion: Water-borne Navigation | $CH_4$ | 0.190 | 0.154 | 0.00000 | 0.0000012 | 100% |
| Mobile Combustion: Railways | $CH_4$ | 0.214 | 0.146 | 0.00000 | 0.0000016 | 100% |
| Emissions from Waste Incineration | $CO_2$ | 0.043 | 0.082 | 0.00000 | 0.0000019 | 100% |
| Mobile Combustion: Aircraft | $CH_4$ | 0.023 | 0.011 | 0.00000 | 0.0000002 | 100% |
| Forest land remaining forest land | $CH_4$ | 0.011 | 0.010 | 0.00000 | 0.0000000 | 100% |
| Forest land remaining forest land | $N_2O$ | 0.003 | 0.002 | 0.00000 | 0.0000000 | 100% |
| $CO_2$ Emissions from Ferroalloys Production | $CO_2$ | 118.836 | - | 0.00000 | 0.0000000 | 100% |
| Aluminium Production | $CO_2$ | 111.372 | - | 0.00000 | 0.0000000 | 100% |
| Other non-specified NEU | $CO_2$ | 0.00 | - | 0.00000 | 0.0000000 | 100% |
| Fugitive Emissions from Coal Mining and Handling | $CH_4$ | 48.76 | - | 0.00000 | 0.0000000 | 100% |
| PFC Emissions from Aluminium production | PFC | 936.56 | - | 0.00000 | 0.0000000 | 100% |
| **TOTAL** | | **35,558.66** | **38,687.61** | | | |

*Table A1-6: Key categories for Croatia – summary (Excluding LULUCF)*

| 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 | $CH_4$ | Yes | |
| 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 | $CO_2$ | No | |
| Mobile Combustion: Road Vehicles | $CH_4$ | No | |
| Mobile Combustion: Railways | $CH_4$ | No | |
| Mobile Combustion: Domestic Aviation | $CH_4$ | No | |
| Mobile Combustion: National Navigation | $CH_4$ | No | |
| Mobile Combustion: Agriculture/Forestry/Fishing | $CH_4$ | Yes | Level, Trend |
| 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 |
| $CO_2$ 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 | $CO_2$ | 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, Trend |
| HFC Emissions from Consumption of HFCs, PFCs, $SF_6$ | HFC | Yes | Level |
| PFC Emissions from Aluminium production | PFC | No | |
| $CO_2$ 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 | $CH_4$ | No | |
| $CH_4$ 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, Trend |
| $N_2O$ Emissions from Pasture Range and Paddock Manure | $N_2O$ | No | |
| 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 |
| $N_2O$ Emissions from Human Sewage | $N_2O$ | No | |

*Table A1-7: Key categories for Croatia – summary (Including LULUCF)*

| 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 |
| **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 | |
| **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 | $CO_2$ | 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, Trend |
| HFC Emissions from Consumption of HFCs, PFCs, $SF_6$ | HFC | Yes | Level |
| 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, Trend |
| $CH_4$ Emissions from Manure Management | $CH_4$ | No | |
| $CH_4$ and $N_2O$ Emissions from Agricultural Residue Burning | $CH_4$ | No | |
| $N_2O$ Emissions from Manure Management | $N_2O$ | No | |
| Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | Yes | Level, Trend |
| $N_2O$ Emissions from Pasture Range and Paddock Manure | $N_2O$ | No | |
| 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, Trend |
| $CH_4$ 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 |
| $N_2O$ Emissions from Human Sewage | $N_2O$ | No | |

*Table A1-8: 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 | |
| | | 2006 | 2007 | 2006 | 2007 |
| **ENERGY SECTOR** | | | | | |
| $CO_2$ Emissions from Stationary Combustion: Coal | $CO_2$ | Yes | Yes | Yes | Yes |
| $CO_2$ Emissions from Stationary Combustion: Oil | $CO_2$ | Yes | Yes | Yes/No* | 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 | No | Yes |
| Fugitive Emissions from Oil and Gas Operations | $CH_4$ | Yes | Yes | Yes | Yes |
| $CO_2$ Emissions from Natural Gas Scrubbing | $CO_2$ | Yes | Yes | Yes | Yes |
| **INDUSTRIAL SECTOR** | | | | | |
| $CO_2$ Emissions from Cement Production | $CO_2$ | Yes | Yes | Yes | Yes |
| $CO_2$ Emissions from Lime Production | $CO_2$ | Yes | Yes | Yes/No* | Yes/No* |
| $CO_2$ Emissions from Ammonia Production | $CO_2$ | Yes | Yes | No | Yes |
| $N_2O$ Emissions from Nitric Acid Production | $N_2O$ | Yes | Yes | Yes/No* | Yes |
| HFC Emissions from Consumption of HFCs | HFC | Yes | Yes | Yes | No |
| **SOLVENT AND OTHER PRODUCT USE** | | | | | |
| $CO_2$ Emissions from solvent and other product use | $CO_2$ | No | No | Yes | No |
| **AGRICULTURE SECTOR** | | | | | |
| $CH_4$ Emissions from Enteric Fermentation in Domestic Livestock | $CH_4$ | Yes | Yes | Yes/No* | Yes |
| $N_2O$ Emissions from Manure Management | $N_2O$ | Yes | No/Yes* | No | No |
| Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | Yes | Yes | No | Yes |
| Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture | $N_2O$ | Yes/No* | Yes | No | 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 |

*Not Key category for excluding 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 |
|---|---|---|---|---|---|---|
| Fuel consumption | | | | | | |
| Hard coal (1000 t) | 253.7 | 96.2 | 569.9 | 915.0 | 835.9 | 895.8 |
| NCV for hard coal (MJ/kg) | 25.1 | 25.7 | 26.2 | 24.2 | 24.6 | 24.5 |
| Fuel oil (1000 t) | 570.4 | 325.4 | 283.4 | 284.0 | 311.4 | 423.9 |
| NCV for fuel oil (MJ/kg) | 40.4 | 40.8 | 40.5 | 40.3 | 40.4 | 40.2 |
| Extra light oil (1000 t) | 0.7 | 2.6 | 7.5 | 3.0 | 1.0 | 1.4 |
| NCV for ex. light oil (MJ/kg) | 42.3 | 42.0 | 42.0 | 42.3 | 42.3 | 28.3 |
| Natural gas (1000000 $m^3$) | 194.6 | 114.5 | 155.7 | 48.2 | 128.4 | 296.8 |
| NCV for nat. gas (MJ/$m^3$) | 33.4 | 33.4 | 33.4 | 33.4 | 33.4 | 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 |
| Emissions | | | | | | |
| EF $CO_2$ – hard coal (t/TJ) | 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 |
| EF $CO_2$ – extra light oil (t/TJ) | 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 |
| EF $CO_2$ – coke gas (t/TJ) | 47.4 | | | | | |
| $CO_2$ emission (Gg) | 2739 | 1464 | 2577 | 3030 | 3113 | 3896 |
| EF $CH_4$ – hard coal (kg/TJ) | 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 |
| EF $CH_4$ – extra light oil (kg/TJ) | 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 |
| 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 |
| EF $N_2O$ – hard coal (kg/TJ) | 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 |
| EF $N_2O$ – extra light oil (kg/TJ) | 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 |
| 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 |

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

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Fuel consumption | | | | | | |
| Fuel oil (1000 t) | 117.7 | 336.2 | 108.6 | 162.0 | 156.1 | 93.8 |
| NCV for fuel oil (MJ/kg) | 40.5 | 40.5 | 40.7 | 40.7 | 38.4 | 40.2 |
| Extra light oil (1000 t) | 0.0 | 1.0 | 0.9 | 0.0 | 0.0 | 0.0 |
| NCV for extra light oil (MJ/kg) | 0.0 | 21.3 | 21.4 | 21.4 | 0.0 | 0.0 |
| Natural gas (1000000 $m^3$) | 312.7 | 103.3 | 357.7 | 479.0 | 458.8 | 550.6 |
| NCV for natural gas (MJ/$m^3$) | 33.3 | 33.4 | 33.4 | 33.4 | 33.6 | 33.3 |
| Total fuel consumption (TJ) | 15196 | 17170 | 16399 | 22567 | 21411 | 22124 |
| Emissions | | | | | | |
| EF $CO_2$ – fuel oil (t/TJ) | 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 |
| EF $CO_2$ – natural gas (t/TJ) | 55.8 | 55.8 | 55.8 | 55.8 | 55.8 | 55.8 |
| $CO_2$ emission (Gg) | 2739 | 1240 | 1005 | 1397 | 1322 | 1313 |

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

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

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

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Fuel oil (1000 t) | 0.0 | 35.6 | 37.0 | 39 | 33.5 | 28.6 |
| NCV for fuel oil (MJ/kg) | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| Light heating oil (1000 t) | 0.0 | 6.0 | 4.4 | 6.7 | 5.3 | 4.2 |
| NCV for light heating oil (MJ/kg) | 42.7 | 42.7 | 42.7 | 42.7 | 42.7 | 42.7 |
| Natural gas (1000000 $m^3$) | 0.0 | 36.2 | 53.0 | 71.3 | 62.1 | 66.3 |
| NCV for natural gas (MJ/$m^3$) | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 |
| LPG (1000 t) | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| NCV for LPG (MJ/kg) | 46.9 | 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/$m^3$) | 18.6 | | | 21.5 | 30.4 | 27.8 |
| Total fuel cunsumption (TJ) | 0.0 | 2988.2 | 3477.0 | 4309.1 | 3737.5 | 3628.6 |
| **Emissions** | | | | | | |
| EF $CO_2$ - fuel oil (t/TJ) | 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 |
| EF $CO_2$ - natural gas (t/TJ) | 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 |
| EF $CO_2$ - gas work gas (t/TJ) | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 |
| $CO_2$ Emission (Gg) | 0.0 | 201.5 | 228.3 | 277.8 | 240.1 | 229.2 |
| EF $CH_4$ - fuel oil (kg/TJ) | 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 |
| EF $CH_4$ - natural gas (kg/TJ) | 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 |
| EF $CH_4$ - gas work gas (t/TJ) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| $CH_4$ Emission (Mg) | 0.0 | 7.0 | 6.8 | 8.0 | 6.9 | 6.3 |
| EF $N_2O$ - fuel oil (kg/TJ) | 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 |
| EF $N_2O$ - natural gas (kg/TJ) | 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 |
| EF $N_2O$ - gas work gas (t/TJ) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| $N_2O$ Emission (Mg) | 0.0 | 1.2 | 1.2 | 1.4 | 1.2 | 1.0 |

The GHG emissions from thermal power plants and public cogeneration plants. for the whole period (1990-2006). 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 and last two years, on aggregated level. The GHG emissions on plant level, for the year 2007, are given in the Table A2-5.

*Table A2-4: The GHG emissions from TPPs and PCPs (Tier 2). year 2006*

| | TE Plomin | TE Rijeka | TE Sisak | TE-TO Zagreb | EL-TO Zagreb | TE-TO Osijek | KTE Jertovec |
|---|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | | |
| Hard coal (1000 t) | 895.8 | | | | | | |
| NCV for hard coal (MJ/kg) | 24.5 | | | | | | |
| Fuel oil (1000 t) | | 296.5 | 127.4 | 56.6 | 24.5 | 12.7 | |
| NCV for fuel oil (MJ/kg) | | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 | |
| Extra light oil (1000 t) | 1.2 | 0.2 | | | | | |
| NCV for ELLU (MJ/kg) | 42.7 | 42.1 | | | | | |
| Natural gas (1000000 $m^3$) | | | 243.6 | 351.9 | 148.3 | 50.4 | 53.2 |
| NCV for nat. gas (MJ/$m^3$) | | | 33.3 | 33.3 | 33.3 | 33.3 | 33.3 |
| Total fuel consumption (TJ) | 21999.5 | 11923.9 | 13240.4 | 14004.9 | 5929.1 | 2190.3 | 1774.1 |
| **Emissions** | | | | | | | |
| EF $CO_2$ – hard coal (t/TJ) | 92.7 | | | | | | |
| EF $CO_2$ – fuel oil (t/TJ) | | 76.6 | 76.6 | 76.6 | 76.6 | 76.6 | |
| EF $CO_2$ – extra light oil (t/TJ) | 73.3 | 73.3 | | | | | 73.3 |
| EF $CO_2$ – natural gas (t/TJ) | | | 55.8 | 55.8 | 55.8 | 55.8 | 55.8 |
| $CO_2$ emission (Gg) | 2038.5 | 913.3 | 845.4 | 829.0 | 351.4 | 132.9 | 99.0 |
| 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 | 5.4 | 4.7 | 1.3 | 6.0 |
| $CH_4$ emission (Mg) | 15.4 | 10.7 | 5.4 | 65.2 | 24.1 | 2.6 | 10.6 |
| EF $N_2O$ – hard coal (kg/TJ) | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| EF $N_2O$ – fuel oil (kg/TJ) | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| EF $N_2O$ – extra light oil (kg/TJ) | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| EF $N_2O$ – natural gas (kg/TJ) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| $N_2O$ emission (Mg) | 35.1 | 3.6 | 2.3 | 1.9 | 0.8 | 0.3 | 0.2 |

*Table A2-5: The GHG emissions from Petroleum refining – own use of energy*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Fuel oil (1000 t) | 127.7 | 101.2 | 47.8 | 70.8 | 58.1 | 82.4 |
| NCV for fuel oil (MJ/kg) | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| LPG (1000 t) | | 35.0 | 2.2 | 6.6 | 5.5 | 7.3 |
| NCV for LPG (MJ/kg) | | 46.9 | 46.9 | 46.9 | 46.9 | 46.9 |
| Petroleum coke (1000 t) | 53.7 | 42.6 | 63.0 | 64.2 | 195.2 | 67.8 |
| NCV for petroleum coke (MJ/kg) | 29.31 | 29.31 | 31.00 | 31.00 | 31.00 | 31.00 |
| Refinery gas (1000 t) | 347.5 | 196.5 | 221.7 | 222.0 | 55.0 | 199.8 |
| NCV for refinery gas (MJ/kg) | 48.6 | 48.6 | 48.6 | 48.6 | 48.6 | 48.6 |
| Natural gas (1000000 $m^3$) | | | | 1.2 | 0.4 | 12.4 |
| NCV for natural gas (MJ/$m^3$) | | | | 34.0 | 34.0 | 34.0 |
| Total fuel consumption (TJ) | 23584.3 | 16501.0 | 14745.2 | 15968.5 | 11329.1 | 15881.6 |
| **Emissions** | | | | | | |
| EF $CO_2$ – fuel oil (t/TJ) | 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 |
| EF $CO_2$ – petroleum coke (t/TJ) | 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 |
| EF $CO_2$ – natural gas (t/TJ) | 55.8 | 55.8 | 55.8 | 55.8 | 55.8 | 55.8 |
| $CO_2$ emission (Gg) | 1665.3 | 1169.2 | 1059.9 | 1150.6 | 976.3 | 1149.5 |
| EF $CH_4$ – fuel oil (kg/TJ) | 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 |
| EF $CH_4$ – petroleum coke (kg/TJ) | 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 |
| EF $CH_4$ – natural gas (kg/TJ) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| $CH_4$ emission (Mg) | 70.8 | 49.5 | 44.2 | 47.8 | 34.0 | 46.8 |
| EF $N_2O$ – fuel oil (kg/TJ) | 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 |
| EF $N_2O$ – petroleum coke (kg/TJ) | 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 |
| EF $N_2O$ – natural gas (kg/TJ) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| $N_2O$ emission (Mg) | 14.2 | 9.9 | 8.8 | 9.6 | 6.8 | 9.3 |

*Table A2-6: The GHG emissions from Petroleum refining – heating/cogeneration plants**

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Fuel oil (1000 t) | 227.2 | 199.5 | 193.4 | 183.2 | 191.8 | 199.6 |
| NCV for fuel oil (MJ/kg) | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| LPG (1000 t) | 0.0 | 0.0 | 0.0 | 2.9 | 4.2 | 3.6 |
| NCV for LPG (MJ/kg) | 46.9 | 46.9 | 46.9 | 46.9 | 46.9 | 46.9 |
| Petroleum coke (1000 t) | 0.0 | 0.0 | 0.0 | 6.5 | 6.9 | 0.0 |
| NCV for petroleum coke (MJ/kg) | 33.6 | 29.3 | 31.0 | 31.0 | 31.0 | 31.0 |
| Refinery gas (1000 t) | 58.4 | 27.7 | 40.7 | 19.1 | 15.2 | 17.6 |
| NCV for refinery gas (MJ/kg) | 48.6 | 48.6 | 48.6 | 48.6 | 48.6 | 48.6 |
| Natural gas (1000000 $m^3$) | 7.3 | 7.1 | 0.2 | 0.0 | 0.0 | 0.0 |
| NCV for natural gas (MJ/$m^3$) | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 |
| Total fuel consumption (TJ) | 12216 | 9605 | 9756 | 8628 | 8858 | 9046 |
| **Emissions** | | | | | | |
| EF $CO_2$ – fuel oil (t/TJ) | 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 |
| EF $CO_2$ – petroleum coke (t/TJ) | 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 |
| EF $CO_2$ – natural gas (t/TJ) | 55.8 | 55.8 | 55.8 | 55.8 | 55.8 | 55.8 |
| $CO_2$ emission (Gg) | 900.6 | 716.5 | 726.3 | 653.8 | 672.8 | 681.4 |
| EF $CH_4$ – fuel oil (kg/TJ) | 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 |
| EF $CH_4$ – petroleum coke (kg/TJ) | 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 |
| EF $CH_4$ – natural gas (kg/TJ) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| $CH_4$ emission (Mg) | 36.2 | 28.3 | 29.3 | 25.9 | 26.6 | 27.1 |
| EF $N_2O$ – fuel oil (kg/TJ) | 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 |
| EF $N_2O$ – petroleum coke (kg/TJ) | 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 |
| EF $N_2O$ – natural gas (kg/TJ) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| $N_2O$ emission (Mg) | 7.2 | 5.6 | 5.9 | 5.2 | 5.3 | 5.4 |

*Table A2-7: The GHG emissions from manufacturing of solid fuels and other energy industries*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| LPG (1000 t) | 11.9 | | 1 | | | |
| 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 | 158.3 | 190.4 |
| NCV for nat. gas (MJ/$m^3$) | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 |
| Total fuel consumpt. (TJ) | 15869.3 | 7048.5 | 5144.2 | 6201.9 | 5489.0 | 6473.6 |
| **Emissions** | | | | | | |
| EF $CO_2$ – LPG (t/TJ) | 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 |
| EF $CO_2$ – ex.light oil (t/TJ) | 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 |
| $CO_2$ emission (Gg) | 874.4 | 394.3 | 293.1 | 350.3 | 308.3 | 361.4 |
| EF $CH_4$ – hard coal (kg/TJ) | 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 |
| EF $CH_4$ – ex.ligh oil (kg/TJ) | 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 |
| $CH_4$ emission (Mg) | 16.0 | 7.2 | 5.8 | 6.7 | 5.7 | 6.5 |
| EF $N_2O$ – hard coal (kg/TJ) | 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 |
| EF $N_2O$ – ex.ligh oil (kg/TJ) | 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 |
| $N_2O$ emission (Mg) | 2.3 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 |

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

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Gasoline (1000 t) | 0.2 | 8.5 | 7.6 | 6.9 | 7.3 | 7.6 |
| NCV for gasoline (MJ/kg) | 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 | 110.6 | 124.2 | 177.4 |
| NCV for gas/diesel o.(MJ/kg) | 42.7 | 42.7 | 42.7 | 42.7 | 42.7 | 42.7 |
| Fuel oil (1000 t) | 419.2 | 269.7 | 302.2 | 198.6 | 195.7 | 43.3 |
| NCV for fuel oil (MJ/kg) | 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 | 28.0 |
| NCV for LPG (MJ/kg) | 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 |
| NCV for petroleum coke (MJ/kg) | 29.3 | | | 31.0 | 31.0 | 31.0 |
| Total fuel consumpt. (TJ) | 28498 | 16383 | 19056 | 21513 | 23273 | 21139 |

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

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Emissions** | | | | | | |
| EF $CO_2$ – gasoline (t/TJ) | 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 |
| EF $CO_2$ – gas/diesel oil (t/TJ) | 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 |
| EF $CO_2$ – LPG (t/TJ) | 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 |
| EF $CO_2$ – petroleum coke (t/TJ) | 99.8 | 99.8 | 99.8 | 99.8 | 99.8 | 99.8 |
| $CO_2$ emission (Gg) | 2135.5 | 1225.9 | 1424.6 | 1732.4 | 1892.3 | 1717.4 |
| EF $CH_4$ – gasoline (kg/TJ) | 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 |
| EF $CH_4$ – gas/diesel oil (kg/TJ) | 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 |
| EF $CH_4$ – LPG (kg/TJ) | 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 |
| EF $CH_4$ – petroleum coke (kg/TJ) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| $CH_4$ emission (Mg) | 0.057 | 0.033 | 0.038 | 0.0430 | 0.0465 | 0.0423 |
| EF $N_2O$ – gasoline (kg/TJ) | 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 |
| EF $N_2O$ – gas/diesel oil (kg/TJ) | 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 |
| EF $N_2O$ – LPG (kg/TJ) | 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 |
| EF $N_2O$ – petroleum coke (kg/TJ) | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| $N_2O$ emission (Mg) | 0.017 | 0.010 | 0.011 | 0.0129 | 0.0140 | 0.0127 |

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

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Anthracite (1000 t) | 107.2 | 5.0 | | | 0.1 | 0.3 |
| NCV for anthracite (MJ/kg) | 29.3 | 29.3 | 29.3 | | 29.3 | 29.3 |
| Hard coal (1000 t) | 42.0 | 41.9 | 53.2 | 68.8 | 151.0 | 185.1 |
| NCV for hard coal (MJ/kg) | 25.1 | 28.1 | 26.2 | 25.8 | 24.9 | 24.9 |
| Brown Coal (1000 t) | 261.2 | 95.8 | 28.2 | 42.3 | 61.3 | 53.2 |
| NCV for brown coal (MJ/kg) | 16.7 | 17.8 | 17.8 | 18.2 | 17.7 | 19.0 |
| Lignite (1000 t) | 73.2 | 56.3 | 14.4 | 20.2 | 0.2 | 0.4 |
| NCV for lignite (MJ/kg) | 10.9 | 12.0 | 12.0 | 12.2 | 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 | 18.3 | 20.6 | 27.9 |
| NCV for coke oven coke (MJ/kg) | 29.3 | 29.3 | 29.3 | 29.3 | 29.3 | 29.3 |
| Total fuel consumpt. (TJ) | 16784 | 4626 | 3171 | 5957.2 | 5448.4 | 6374.4 |

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

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Emissions** | | | | | | |
| EF $CO_2$ – anthracite (t/TJ) | 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 |
| EF $CO_2$ – brown coal (t/TJ) | 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 |
| EF $CO_2$ – briquettes (t/TJ) | 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 |
| $CO_2$ emission (Gg) | 1676.8 | 448.4 | 310.5 | 562.6 | 514.7 | 603.3 |
| EF $CH_4$ – anthracite (kg/TJ) | 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 |
| EF $CH_4$ – brown coal (kg/TJ) | 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 |
| EF $CH_4$ – briquettes (kg/TJ) | 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 |
| $CH_4$ emission (Mg) | 0.168 | 0.046 | 0.032 | 0.0596 | 0.0545 | 0.0637 |
| EF $N_2O$ – anthracite (kg/TJ) | 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 |
| EF $N_2O$ – brown coal (kg/TJ) | 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 |
| EF $N_2O$ – briquettes (kg/TJ) | 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 |
| $N_2O$ emission (Mg) | 0.003 | 0.002 | 0.002 | 0.0083 | 0.0076 | 0.0089 |

*Table A2-10: The GHG emissions from Manufacturing Industries and Construction –gaseous fuels*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Natural gas (1000000 m3) | 845.7 | 656.8 | 703.8 | 712.2 | 703.4 | 763.8 |
| NCV for natural gas (MJ/m3) | 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 |
| NCV for gas work gas (MJ/kg) | 15.8 | 15.8 | 15.8 | 21.5 | 30.4 | 27.8 |
| 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 | 24291.0 | 24007.8 | 26045.9 |
| Emissions | | | | | | |
| EF $CO_2$ - natural gas (t/TJ) | 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 |
| EF $CO_2$ - coke oven gas (t/TJ) | 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 |
| $CO_2$ Emission (Gg) | 1992.5 | 1253.8 | 1341.6 | 1355.3 | 1339.3 | 1453.2 |
| EF $CH_4$ - natural gas (kg/TJ) | 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 |
| EF $CH_4$- coke ov. gas (kg/TJ) | 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 |
| $CH_4$ Emission (Mg) | 0.1652 | 0.1132 | 0.1209 | 0.121 | 0.1200 | 0.1302 |

*Table A2-10: The GHG emissions from Manufacturing Industries and Construction –gaseous fuels (cont.)*

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

*Table A2-11: The number of road motor vehicles in Croatia*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Mopeds | 18025 | 21561 | 46345 | 82185 | 89583 | 96769 |
| Motorcycles | 12455 | 15317 | 24717 | 46313 | 51758 | 56523 |
| Passenger Cars | 1120974 | 820071 | 1140964 | 1379737 | 1422784 | 1450009 |
| Buses | 6482 | 4497 | 4650 | 4798 | 4728 | 4695 |
| Light and Heavy Duty Vehicles | 80017 | 90204 | 128848 | 168771 | 171106 | 170932 |
| Total | 1237953 | 951650 | 1345524 | 1681804 | 1739959 | 1778928 |

*Table A2-12: GHG emissions from Road Transport*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Gasoline (1000 t) | 759.5 | 557.9 | 764.2 | 693.5 | 694.5 | 708.2 |
| NCV for gasoline (MJ/kg) | 44.59 | 44.59 | 44.59 | 44.59 | 44.59 | 44.59 |
| Diesel (1000 t) | 364.5 | 406.2 | 557.8 | 955.6 | 1048.3 | 1,152.8 |
| NCV for diesel (MJ/kg) | 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 |
| NCV for LPG (MJ/kg) | 46.89 | 46.89 | 46.89 | 46.89 | 46.89 | 46.89 |
| Total fuel consumption (TJ) | 49434 | 42868 | 58359 | 72773 | 77471 | |
| **Emissions** | | | | | | |
| $CO_2$ emission (Gg) | 3561.4 | 3100.7 | 4218.8 | 5286.9 | 5635.2 | 6059.4 |
| $CH_4$ emission (Mg) | 1.530 | 1.164 | 1.478 | 1.530 | 1.533 | 1.533 |
| $N_2O$ emission (Mg) | 0.155 | 0.158 | 0.311 | 0.483 | 0.544 | 0.61632 |

*Table A2-13: The GHG emissions from Domestic Air Transport*

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

*Table A2-14: The GHG emissions from National Navigation*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **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 |
| NCV for diesel (MJ/kg) | 42.7 | 42.7 | 42.7 | 42.7 | 42.7 | 42.7 |
| Fuel oil (1000 t) | 2.1 | 6.2 | 1.4 | | | |
| NCV for fuel oil (MJ/kg) | 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 |
| **Emissions** | | | | | | |
| EF $CO_2$ - gasoline (t/TJ) | 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 |
| EF $CO_2$ - fuel oil (t/TJ) | 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 |
| $CO_2$ Emission (Gg) | 133.0 | 98.3 | 85.7 | 99.6 | 103.7 | 107.7 |
| EF $CH_4$ - gasoline (kg/TJ) | 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 |
| EF $CH_4$ - fuel oil (kg/TJ) | 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 |
| $CH_4$ Emission (Mg) | 9.1 | 6.7 | 5.8 | 6.8 | 7.1 | 7.3 |
| EF $N_2O$ - gasoline (kg/TJ) | 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 |
| EF $N_2O$ - fuel oil (kg/TJ) | 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 |
| $N_2O$ Emission (Mg) | 1.0 | 0.8 | 0.7 | 0.8 | 0.8 | 0.9 |

*Table A2-15: The GHG emissions from Railways*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **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 |
| NCV for diesel (MJ/kg) | 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 |
| **Emissions** | | | | | | |
| EF $CO_2$ - gasoline (t/TJ) | 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 |
| EF $CO_2$ - fuel oil (t/TJ) | 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 |
| EF $CO_2$ - brown coal (t/TJ) | 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 |
| EF $CO_2$ - jet kerosene (t/TJ) | 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 |
| $CO_2$ Emission (Gg) | 138.1 | 106.4 | 85.5 | 95.5 | 101.2 | 102.1 |
| EF $CH_4$ - gasoline (kg/TJ) | 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 |
| EF $CH_4$ - fuel oil (kg/TJ) | 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 |
| EF $CH_4$ - brown coal (kg/TJ) | 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 |
| EF $CH_4$ - jet kerosene (t/TJ) | 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 |
| $CH_4$ Emission (Mg) | 10.2 | 7.2 | 5.8 | 6.5 | 6.9 | 7.0 |
| EF $N_2O$ - gasoline (kg/TJ) | 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 |
| EF $N_2O$ - fuel oil (kg/TJ) | 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 |
| EF $N_2O$ - brown coal (kg/TJ) | 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 |
| EF $N_2O$ - jet kerosene (t/TJ) | 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 |
| $N_2O$ Emission (Mg) | 1.3 | 0.9 | 0.7 | 0.8 | 0.8 | 0.8 |

*Table A2-16: The GHG emissions from Commercial/Institutional*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **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 |
| NCV for light heating oil (MJ/kg) | 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 |
| NCV for fuel oil (MJ/kg) | 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 |
| NCV for LPG (MJ/kg) | 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 |
| NCV for brown coal (MJ/kg) | 16.74 | 17.30 | 17.80 | 18.50 | 17.73 | 19.03 |
| Lignite (1000 t) | 40.0 | 1.6 | 1.2 | 0.6 | 0.2 | 0.1 |
| NCV for lignite (MJ/kg) | 10.9 | 10.1 | 12.0 | 12.1 | 12.3 | 11.7 |
| Briquettes (1000 t) | 2.9 | | | | | |
| NCV for briquettes (MJ/kg) | 16.7 | | | | | |
| Gas work gas (1000000 m3) | 4.9 | 1.4 | 1.5 | 3.4 | 3.3 | 2.9 |
| NCV for gas work gas (MJ/m3) | 15.8 | 15.9 | 19.5 | 21.5 | 30.4 | 27.8 |
| Natural gas (1000000 m3) | 82.0 | 132.6 | 98.2 | 151.2 | 147.0 | 144.2 |
| NCV for natural gas (MJ/m3) | 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 | | | | | |
| Total fuel cunsumption (TJ) | 10819 | 9969 | 9507 | 12054 | 11157 | 9527 |
| **Emissions** | | | | | | |
| EF $CO_2$ - petroleum (t/TJ) | 73.3 | 73.3 | 73.3 | 73.3 | 73.3 | 74.3 |
| EF $CO_2$ - diesel (t/TJ) | 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 |
| EF $CO_2$ - LPG (t/TJ) | 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 |
| EF $CO_2$ - brown coal (t/TJ) | 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 |
| EF $CO_2$ - briquettes (t/TJ) | 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 |
| EF $CO_2$ - natural gas (t/TJ) | 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 |
| EF $CO_2$ – petroleum coke (t/TJ) | 99.8 | 99.8 | 99.8 | 99.8 | 99.8 | 99.8 |
| $CO_2$ Emission (Gg) | 771.2 | 649.3 | 635.2 | 782.8 | 719.5 | 607.4 |

*Table A2-16: The GHG emissions from Commercial/Institutional (cont.)*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| EF $CH_4$ - petroleum (kg/TJ) | 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 |
| EF $CH_4$ - fuel oil (kg/TJ) | 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 |
| EF $CH_4$ - anthracite (kg/TJ) | 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 |
| EF $CH_4$ - lignite (kg/TJ) | 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 |
| EF $CH_4$ - gas work gas (kg/TJ) | 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 |
| EF $CH_4$ - gasoline (kg/TJ) | 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 |
| $CH_4$ Emission (Mg) | 93.6 | 77.0 | 78.2 | 94.5 | 86.1 | 70.4 |
| EF $N_2O$ - petroleum (kg/TJ) | 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 |
| EF $N_2O$ - fuel oil (kg/TJ) | 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 |
| EF $N_2O$ - anthracite (kg/TJ) | 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 |
| EF $N_2O$ - lignite (kg/TJ) | 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 |
| EF $N_2O$ - gas work gas (kg/TJ) | 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 |
| EF $N_2O$ - gasoline (kg/TJ) | 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 |
| $N_2O$ Emission (Mg) | 5.8 | 3.9 | 4.2 | 4.6 | 4.2 | 3.3 |

*Table A2-17: The GHG emissions from Residential sector*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Petroleum (1000 t) | | 7.9 | 1.6 | 1 | 0.9 | 1.2 |
| NCV for petroleum (MJ/kg) | | 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 |
| NCV for light heating oil (MJ/kg) | 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 |
| NCV for fuel oil (MJ/kg) | 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 |
| NCV for LPG (MJ/kg) | 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 |
| NCV for brown coal (MJ/kg) | 16.7 | 17.3 | 17.8 | 18.5 | 17.7 | 19.0 |
| Lignite (1000 t) | 207.3 | 10.8 | 15.0 | 11.7 | 10.6 | 5 |
| NCV for lignite (MJ/kg) | 10.9 | 10.1 | 12.0 | 12.1 | 12.3 | 11.7 |
| Briquettes (1000 t) | 6.1 | | | | | |
| NCV for briquettes (MJ/kg) | 16.7 | | | | | |
| Gas work gas (1000000 $m^3$) | 24.4 | 11.8 | 9.9 | 10.24 | 8.979 | 7.693 |
| NCV for gas work gas ($MJ/m^3$) | 15.8 | 15.9 | 19.5 | 21.5 | 30.4 | 27.8 |
| Natural gas (1000000 $m^3$) | 230.0 | 381.3 | 496.6 | 687.8 | 651.7 | 622.5 |
| NCV for natural gas ($MJ/m^3$) | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 |

*Table A2-17: The GHG emissions from Residential sector (cont.)*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Biomass (TJ) | 19080 | 11070 | 13410 | 12510 | 12600 | 10620 |
| Total fuel consumption (TJ) | 47477 | 36301 | 43598 | 50831 | 48069 | 43019 |
| **Emissions** | | | | | | |
| EF $CO_2$ - petroleum (t/TJ) | 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 |
| EF $CO_2$ - fuel oil (t/TJ) | 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 |
| EF $CO_2$ - brown coal (t/TJ) | 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 |
| EF $CO_2$ - briquettes (t/TJ) | 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 |
| EF $CO_2$ - natural gas (t/TJ) | 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 |
| $CO_2$ Emission (Gg) | 4045.3 | 2785.3 | 3337.3 | 3718.8 | 3534.7 | 3113.2 |
| EF $CH_4$ - petroleum (k/TJ) | 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 |
| EF $CH_4$ - fuel oil (kg/TJ) | 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 |
| EF $CH_4$ - brown coal (kg/TJ) | 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 |
| EF $CH_4$ - briquettes (kg/TJ) | 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 |
| EF $CH_4$ - natural gas (kg/TJ) | 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 |
| $CH_4$ Emission (Mg) | 7247.9 | 3594.1 | 4352.9 | 4133.5 | 4097.9 | 3441.3 |
| EF $N_2O$ - petroleum (k/TJ) | 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 |
| EF $N_2O$ - fuel oil (kg/TJ) | 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 |
| EF $N_2O$ - brown coal (kg/TJ) | 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 |
| EF $N_2O$ - briquettes (kg/TJ) | 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 |
| EF $N_2O$ - natural gas (kg/TJ) | 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 |
| $N_2O$ Emission (Mg) | 92.8 | 53.1 | 63.5 | 61.6 | 60.7 | 51.3 |

*Table A2-18: The GHG emissions from Agriculture/Forestry/Fishing*

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

*Table A2-18: The GHG emissions from Agriculture/Forestry/Fishing (cont.)*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| **Fuel consumption** | | | | | | |
| Fuel oil (1000 t) | 12.3 | 6.2 | 13.4 | 4.7 | 4.5 | 4.5 |
| NCV for fuel oil (MJ/kg) | 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 |
| NCV for LPG (MJ/kg) | 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 |
| NCV for natural gas (MJ/m3) | 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 |
| Total fuel consumption (TJ) | 11668 | 8074 | 11841 | 9896 | 10146 | 10025 |
| **Emissions** | **850** | | | | | |
| EF $CO_2$ - gasoline (t/TJ) | 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 |
| EF $CO_2$ - diesel (t/TJ) | 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 |
| EF $CO_2$ - fuel oil (t/TJ) | 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 |
| EF $CO_2$ - gas work gas (t/TJ) | 47.4 | | | | | 47.4 |
| EF $CO_2$ - natural gas (t/TJ) | 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 |
| Total $CO_2$ emission (Gg) | 839.2 | 580.3 | 857.5 | 709.4 | 729.5 | 721.9 |
| EF $CH_4$ - gasoline (kg/TJ) | 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 |
| EF $CH_4$ - diesel (kg/TJ) | 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 |
| EF $CH_4$ - fuel oil (kg/TJ) | 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 |
| EF $CH_4$ - gas work gas (kg/TJ) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| EF $CH_4$ - natural gas (kg/TJ) | 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 |
| Total $CH_4$ emission (Mg) | 61.8 | 42.4 | 62.5 | 51.1 | 52.3 | 51.7 |
| EF $N_2O$ - gasoline (kg/TJ) | 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 |
| EF $N_2O$ - diesel (kg/TJ) | 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 |
| EF $N_2O$ - fuel oil (kg/TJ) | 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 |
| EF $N_2O$ - gas work gas (kg/TJ) | 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 |
| $N_2O$ emission (Mg) - stationary | 0.5 | 0.3 | 0.4 | 0.3 | 0.3 | 0.2 |
| Total $N_2O$ emission (Mg) | 6.6 | 4.6 | 6.9 | 5.5 | 5.8 | 5.7 |

*Table A2-19: 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 A2-20: Methane emissions from Oil and Gas Activities. years 1990, 1995, 2000, 2007*

| 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 2007** | | | | | |
| **1B 2a** | Oil | | | **0.42** | |
| | | Production | 37.27 | 0.10 | 2650 |
| | | Transport | 178.01 | 0.13 | 745 |
| | | Refining | 214.80 | 0.03 | 135 |
| | | Storage | 214.80 | 0.16 | 135 |
| **1B 2b** | Natural Gas | | | **74.82** | |
| | | Prod./Process./Trans./Distrib. | 100.12 | 45.85 [1)] | 458000 |
| | | Other Leakage(non-residential) | 93.05 | 26.01 [2)] | 279500 |
| | | Other Leakage (residential) | 21.17 | 2.95 [3)] | 139500 |
| **1B 2c** | Venting and Flaring | | | **1.4** | |
| | | Gas | 100.12 | 1.80 | 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 | 181.19 | 13,255.62 | 0.55 | -3.10 |
| | Solid Fuels | 34.27 | 3,102.87 | 29.10 | 2,821.32 | 17.77 | 9.98 |
| | Gaseous Fuels | 76.47 | 5,255.62 | 75.23 | 4,089.90 | 1.64 | 28.50 |
| | **Total** | ***292.93*** | ***21,203.76*** | ***285.52*** | ***20,166.84*** | ***2.59*** | ***5.14*** |
| **1991** | Liquid Fuels | 125.85 | 9,007.48 | 129.24 | 9,465.32 | -2.62 | -4.84 |
| | Solid Fuels | 21.07 | 1,850.52 | 17.74 | 1,708.70 | 18.76 | 8.30 |
| | Gaseous Fuels | 69.29 | 4,875.40 | 62.76 | 3,449.39 | 10.40 | 41.34 |
| | **Total** | ***216.21*** | ***15,733.40*** | ***209.74*** | ***14,623.41*** | ***3.09*** | ***7.59*** |
| **1992** | Liquid Fuels | 119.35 | 8,509.32 | 122.50 | 9,016.09 | -2.56 | -5.62 |
| | Solid Fuels | 17.25 | 1,476.32 | 13.77 | 1,298.84 | 25.34 | 13.66 |
| | Gaseous Fuels | 67.53 | 5,036.19 | 62.93 | 3,488.73 | 7.32 | 44.36 |
| | **Total** | ***204.14*** | ***15,021.84*** | ***199.19*** | ***13,803.66*** | ***2.49*** | ***8.83*** |
| **1993** | Liquid Fuels | 117.56 | 8,510.98 | 125.74 | 9,239.24 | -6.51 | -7.88 |
| | Solid Fuels | 14.71 | 1,225.37 | 11.14 | 1,051.06 | 32.09 | 16.58 |
| | Gaseous Fuels | 83.90 | 5,736.68 | 73.29 | 4,068.61 | 14.47 | 41.00 |
| | **Total** | ***216.18*** | ***15,473.03*** | ***210.18*** | ***14,358.91*** | ***2.85*** | ***7.76*** |
| **1994** | Liquid Fuels | 121.93 | 9,050.93 | 126.22 | 9,241.82 | -3.40 | -2.07 |
| | Solid Fuels | 9.20 | 771.63 | 6.84 | 661.08 | 34.49 | 16.72 |
| | Gaseous Fuels | 70.00 | 4,945.77 | 68.14 | 3,787.64 | 2.73 | 30.58 |
| | **Total** | ***201.12*** | ***14,768.33*** | ***201.20*** | ***13,690.54*** | ***-0.04*** | ***7.87*** |
| **1995** | Liquid Fuels | 136.27 | 9,987.52 | 142.40 | 10,446.82 | -4.30 | -4.40 |
| | Solid Fuels | 7.71 | 735.29 | 7.63 | 728.68 | 1.04 | 0.91 |
| | Gaseous Fuels | 62.06 | 4,504.93 | 56.45 | 3,148.09 | 9.93 | 43.10 |
| | **Total** | ***206.04*** | ***15,227.73*** | ***206.48*** | ***14,323.59*** | ***-0.22*** | ***6.31*** |
| **1996** | Liquid Fuels | 147.34 | 10,607.65 | 146.24 | 10,728.26 | 0.75 | -1.12 |
| | Solid Fuels | 6.21 | 591.97 | 6.18 | 589.91 | 0.42 | 0.35 |
| | Gaseous Fuels | 72.48 | 5,047.32 | 65.45 | 3,650.40 | 10.73 | 38.27 |
| | **Total** | ***226.03*** | ***16,246.94*** | ***217.88*** | ***14,968.57*** | ***3.74*** | ***8.54*** |
| **1997** | Liquid Fuels | 147.43 | 10,576.41 | 151.24 | 11,079.84 | -2.52 | -4.54 |
| | Solid Fuels | 10.17 | 960.12 | 10.19 | 962.07 | -0.17 | -0.20 |
| | Gaseous Fuels | 74.01 | 5,232.81 | 68.38 | 3,813.72 | 8.24 | 37.21 |
| | **Total** | ***231.62*** | ***16,769.35*** | ***229.81*** | ***15,855.63*** | ***0.79*** | ***5.76*** |
| **1998** | Liquid Fuels | 163.14 | 11,749.54 | 164.41 | 12,081.85 | -0.77 | -2.75 |
| | Solid Fuels | 9.87 | 929.44 | 9.86 | 928.38 | 0.11 | 0.11 |
| | Gaseous Fuels | 74.70 | 5,030.95 | 69.61 | 3,884.51 | 7.31 | 29.51 |
| | **Total** | ***247.71*** | ***17,709.94*** | ***243.88*** | ***16,894.74*** | ***1.57*** | ***4.83*** |
| **1999** | Liquid Fuels | 171.92 | 12,720.47 | 173.58 | 12,785.19 | -0.96 | -0.51 |
| | Solid Fuels | 8.63 | 810.25 | 8.52 | 800.49 | 1.23 | 1.22 |
| | Gaseous Fuels | 72.95 | 5,102.44 | 67.97 | 3,791.78 | 7.33 | 34.57 |
| | **Total** | ***253.49*** | ***18,633.15*** | ***250.07*** | ***17,377.46*** | ***1.37*** | ***7.23*** |
| **2000** | Liquid Fuels | 148.90 | 11,055.21 | 153.34 | 11,217.36 | -2.89 | -1.45 |
| | Solid Fuels | 18.65 | 1,747.47 | 18.68 | 1,750.18 | -0.16 | -0.16 |
| | Gaseous Fuels | 73.77 | 5,145.03 | 68.72 | 3,832.94 | 7.35 | 34.23 |
| | **Total** | ***241.32*** | ***17,947.71*** | ***240.74*** | ***16,800.49*** | ***0.24*** | ***6.83*** |
| **2001** | Liquid Fuels | 155.14 | 11,508.51 | 158.03 | 11,599.13 | -1.83 | -0.78 |
| | Solid Fuels | 19.83 | 1,849.61 | 19.69 | 1,836.26 | 0.74 | 0.73 |
| | Gaseous Fuels | 81.58 | 5,391.17 | 75.29 | 4,202.31 | 8.35 | 28.29 |
| | **Total** | ***256.54*** | ***18,749.29*** | ***253.00*** | ***17,637.70*** | ***1.40*** | ***6.30*** |

*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 | 163.72 | 12,017.86 | 3.28 | 4.29 |
| | Solid Fuels | 24.43 | 2,277.22 | 24.03 | 2,244.66 | 1.66 | 1.45 |
| | Gaseous Fuels | 85.37 | 5,522.98 | 79.72 | 4,447.56 | 7.09 | 24.18 |
| | **Total** | ***278.89*** | ***20,333.90*** | ***267.46*** | ***18,710.08*** | ***4.27*** | ***8.68*** |
| **2003** | Liquid Fuels | 179.28 | 13,302.49 | 181.14 | 13,300.99 | -1.03 | 0.01 |
| | Solid Fuels | 27.20 | 2,532.94 | 27.03 | 2,523.04 | 0.64 | 0.39 |
| | Gaseous Fuels | 82.90 | 5,492.44 | 77.66 | 4,332.77 | 6.75 | 26.77 |
| | **Total** | ***289.38*** | ***21,327.86*** | ***285.83*** | ***20,156.80*** | ***1.24*** | ***5.81*** |
| **2004** | Liquid Fuels | 166.44 | 12,383.85 | 166.90 | 12,261.19 | -0.27 | 1.00 |
| | Solid Fuels | 28.88 | 2,687.52 | 29.01 | 2,705.38 | -0.46 | -0.66 |
| | Gaseous Fuels | 86.27 | 5,724.39 | 82.25 | 4,589.67 | 4.88 | 24.72 |
| | **Total** | ***281.59*** | ***20,795.76*** | ***278.16*** | ***19,556.24*** | ***1.23*** | ***6.34*** |
| **2005** | Liquid Fuels | 173.51 | 12,962.09 | 172.94 | 12,809.04 | 0.32 | 1.19 |
| | Solid Fuels | 28.64 | 2,667.30 | 28.53 | 2,662.57 | 0.41 | 0.18 |
| | Gaseous Fuels | 83.10 | 5,535.24 | 79.95 | 4,461.05 | 3.95 | 24.08 |
| | **Total** | ***285.25*** | ***21,164.62*** | ***281.42*** | ***19,932.66*** | ***1.36*** | ***6.18*** |
| **2006** | Liquid Fuels | 174.83 | 13,053.17 | 173.37 | 13,040.42 | 0.84 | 0.10 |
| | Solid Fuels | 26.56 | 2,389.29 | 26.39 | 2,463.52 | 0.64 | -3.01 |
| | Gaseous Fuels | 82.65 | 5,480.15 | 79.34 | 4,427.45 | 4.17 | 23.78 |
| | **Total** | ***284.04*** | ***20,922.61*** | ***279.10*** | ***19,931.39*** | ***1.77*** | ***4.97*** |
| **2007** | Liquid Fuels | 179.52 | 13,418.46 | 179.80 | 13,350.29 | -0.16 | 0.51 |
| | Solid Fuels | 28.96 | 2,695.65 | 28.50 | 2,660.44 | 1.59 | 1.32 |
| | Gaseous Fuels | 95.58 | 6,288.32 | 92.57 | 5,148.98 | 3.24 | 22.13 |
| | **Total** | ***304.05*** | ***22,402.43*** | ***300.87*** | ***21,159.72*** | ***1.06*** | ***5.87*** |

*Table A3-2: Net calorific values for different fossil fuels from 1990 to 2007*

| | | | Net calorific values 1990- 2007 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 2007*

| National energy balance 2007 | Anthracite | | Hard coal | | Brown coal | | Lignite | |
|---|---|---|---|---|---|---|---|---|
| | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ |
| Import | 1 | 0.03 | 1100.9 | 27.41 | 59.6 | 1.13 | 5.5 | 0.06 |
| Export | 0.7 | 0.02 | | | | | | |
| Stock change | | | -20.1 | -0.50 | | | | |
| Energy supplied | 0.3 | 0.01 | 1080.8 | 26.91 | 59.6 | 1.13 | 5.5 | 0.06 |
| | | | | | | | | |
| Total transformation sector | | | | | | | | |
| Power plants | | | 895.7 | 22.30 | | | | |
| Indust. cogeneration plants | | | | | 48.7 | 0.93 | | |
| Industrial heating plants | | | | | | | | |
| Total transformation sector | | | 895.7 | 22.30 | 48.7 | 0.93 | | |
| | | | | | | | | |
| Available for final consumption | 0.3 | 0.01 | 185.1 | 4.61 | 10.9 | 0.21 | 5.5 | 0.06 |
| | | | | | | | | |
| Final energy demand | 0.3 | 0.01 | 185.1 | 4.61 | 10.9 | 0.21 | 5.5 | 0.06 |
| | | | | | | | | |
| Industry | 0.3 | 0.01 | 185.1 | 4.61 | 4.5 | 0.09 | 0.4 | 0.00 |
| Iron and steel | 0.3 | 0.01 | 1.6 | 0.04 | | | | |
| Chemical | | | 3.6 | 0.09 | | | | |
| Construction materials | | | 179.5 | 4.47 | 1.4 | 0.03 | 0.3 | 0.00 |
| Other | | | 0.4 | 0.01 | 3.1 | 0.06 | 0.1 | 0.00 |
| | | | | | | | | |
| Other sectors | | | | | 6.4 | 0.12 | 5.1 | 0.06 |
| Households | | | | | 4 | 0.08 | 5 | 0.06 |
| Services | | | | | 2.4 | 0.05 | 0.1 | 0.00 |

*Table A3-3: National energy balance for 2007 (continue)*

| ENERGETSKA BILANCA 2007 | Crude oil $10^3$ t | PJ | Natural gas $10^6$ $m^3$ | PJ | Hydro energy TJ | Fuel wood $10^3$ $m^3$ | PJ | Wind energy TJ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| Production | 879.1 | 37.27 | 2892.1 | 100.12 | 42213.1 | 1450.6 | 13.06 | 334.8 |
| Import | 4198.3 | 178.01 | 1055.1 | 35.87 | | 3.4 | 0.03 | |
| Export | | | 751.7 | 25.56 | | 203.4 | 1.83 | |
| Stock change | -11.2 | -0.47 | 111.2 | 3.78 | | | | |
| Energy supplied | 5066.2 | 214.81 | 3306.7 | 114.22 | 42213.1 | 1250.6 | 11.26 | 334.8 |
| | | | | | | | | |
| Transformation sector | | | | | | | | |
| hydro power plants | | | | | 42213.1 | | | |
| – small HPP | | | | | 796.3 | | | |
| thermal power plants | | | 301 | 10.23 | | | | 334.8 |
| public cogeneration plants | | | 572.6 | 19.47 | | | | |
| public heating plants | | | 66.3 | 2.25 | | | | |
| industrial cogeneration plants | | | 329.1 | 11.19 | | | | |
| – in gas production | | | 53.1 | 1.81 | | | | |
| Industrial heating plants | | | 88.4 | 3.01 | | | | |
| Petroleum refineries | 4955.3 | 210.10 | 32.5 | 1.11 | | | | |
| NGL-plant | 110.9 | 4.70 | 24.2 | 2.61 | | | | |
| Total transformation sector | 5066.2 | 214.81 | 1414.1 | 49.87 | 42213.1 | | | 334.8 |
| | | | | | | | | |
| Energy sector own use | | | | | | | | |
| Oil and gas extraction | | | 133.1 | 4.53 | | | | |
| Petroleum refineries | | | 12.4 | 0.42 | | | | |
| NGL-plant | | | 4.2 | 0.14 | | | | |
| Energy sector own use total | | | 149.7 | 5.09 | | | | |
| | | | | | | | | |
| Losses | | | 51.1 | 1.74 | | | | |
| | | | | | | | | |
| Final energy demand | | | 1691.8 | 57.52 | | 1250.6 | 11.26 | |
| | | | | | | | | |
| Non energy use | | | 507.8 | 17.27 | | | | |
| Petrochemical industry | | | 507.8 | 17.27 | | | | |
| | | | | | | | | |
| Energy consumption | | | 1184 | 40.26 | | 1250.6 | 11.26 | |
| | | | | | | | | |
| Industry | | | 399.4 | 13.58 | | 60.6 | 0.55 | |
| Iron and steel | | | 27.3 | 0.93 | | 0.1 | 0.001 | |
| Non-ferrous metals | | | 1.7 | 0.06 | | 0.7 | 0.01 | |
| Non-metallic minerals | | | 61.1 | 2.08 | | | | |
| Chemical | | | 72.5 | 2.47 | | 0.2 | 0.002 | |
| Construction materials | | | 129.4 | 4.40 | | 0.2 | 0.002 | |
| Pulp and paper | | | 6.4 | 0.22 | | | | |
| Food production | | | 51.4 | 1.75 | | 0.2 | 0.002 | |
| Not elsewhere specified | | | 49.6 | 1.69 | | 59.2 | 0.53 | |
| | | | | | | | | |
| Other sectors | | | 784.6 | 26.68 | | 1190 | 10.71 | |
| Households | | | 622.5 | 21.17 | | 1180 | 10.62 | |
| Services | | | 144.2 | 4.90 | | 10 | 0.09 | |
| Agriculture | | | 17.9 | 0.61 | | | | |

*Table A3-3: National energy balance for 2007 (continue)*

| ENERGETSKA BILANCA 2007 | Industrial waste TJ | Solar energy TJ | Geothermal energy TJ | Landfill gas $10^3$ $m^3$ | Landfill gas PJ | Biofuels $10^3$ t | Biofuels PJ |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Production | 2058.9 | 26.1 | 139.5 | 3864 | 0.07 | 4 | 0.15 |
| Import | | | | | | | |
| Export | | | | | | 0.7 | 0.03 |
| Stock change | | | | | | | |
| Energy supplied | 2058.9 | 26.1 | 139.5 | 3864 | 0.07 | 3.3 | 0.12 |
| | | | | | | | |
| Transformation sector | | | | | | | |
| hydro power plants | | | | | | | |
| – small HPP | | | | | | | |
| thermal power plants | | | | 3864 | 0.07 | | |
| public cogeneration plants | | | | | | | |
| public heating plants | | | | | | | |
| industrial cogeneration plants | 67.5 | | | | | | |
| – in gas production | | | | | | | |
| Industrial heating plants | 1991.4 | | | | | | |
| Petroleum refineries | | | | | | | |
| NGL-plant | | | | | | | |
| Total transformation sector | 2058.9 | | | 3864 | 0.07 | | |
| | | | | | | | |
| Energy sector own use | | | | | | | |
| Oil and gas extraction | | | | | | | |
| Petroleum refineries | | | | | | | |
| NGL-plant | | | | | | | |
| Energy sector own use total | | | | | | | |
| | | | | | | | |
| Losses | | | | | | | |
| | | | | | | | |
| Final energy demand | | 26.1 | 139.5 | | | 3.3 | 0.12 |
| | | | | | | | |
| Non energy use | | | | | | | |
| Petrochemical industry | | | | | | | |
| | | | | | | | |
| Energy consumption | | 26.1 | 139.5 | | | 3.3 | 0.12 |
| | | | | | | | |
| Industry | | | | | | | |
| Iron and steel | | | | | | | |
| Non-ferrous metals | | | | | | | |
| Non-metallic minerals | | | | | | | |
| Chemical | | | | | | | |
| Construction materials | | | | | | | |
| Pulp and paper | | | | | | | |
| Food production | | | | | | | |
| Not elsewhere specified | | | | | | | |
| | | | | | | | |
| Other sectors | | 26.1 | 139.5 | | | | |
| Households | | 26.1 | | | | | |
| Services | | | 139.5 | | | | |
| Agriculture | | | | | | | |

Table A3-3: National energy balance for 2007 (continue)

| ENERGETSKA BILANCA 2007 | Coke oven coke | | Liquefied petroleum gases | | Unleaded motor gasoline | | Standard motor gasoline | |
|---|---|---|---|---|---|---|---|---|
| | 103 t | PJ | 103 t | PJ | 103 t | PJ | 103 t | PJ |
| Production | | | 372.4 | 17.46 | 1052.4 | 46.93 | 150.0 | 6.69 |
| Petroleum refineries | | | 307.5 | 14.42 | 1052.4 | 46.93 | 150.0 | 6.69 |
| NGL-plant | | | 64.9 | 3.04 | | | | |
| Import | 28.6 | 0.84 | 2.0 | 0.09 | 254 | 11.33 | 1.0 | 0.04 |
| Export | | | 198.8 | 9.32 | 575.1 | 25.64 | 142.2 | 6.34 |
| Stock change | -0.7 | -0.02 | -2.4 | -0.11 | -7.1 | -0.32 | -7.7 | -0.34 |
| Energy supplied | 27.9 | 0.82 | 173.2 | 8.12 | 724.2 | 32.29 | 1.1 | 0.05 |
| | | | | | | | | |
| Transformation sector | | | | | | | | |
| industrial cogeneration plants | | | 3.6 | 0.17 | | | | |
| – in rafineries | | | 3.6 | 0.17 | | | | |
| Industrial heating plants | | | 0.2 | 0.01 | | | | |
| gas works | | | 9.3 | 0.44 | | | | |
| Total transformation sector | | | 13.1 | 0.62 | | | | |
| | | | | | | | | |
| Energy sector own use | | | | | | | | |
| Petroleum refineries | | | 7.3 | 0.34 | | | | |
| Energy sector own use total | | | 7.3 | 0.34 | | | | |
| | | | | | | | | |
| Available for final consumption | 27.9 | 0.82 | 152.8 | 7.16 | 724.2 | 32.29 | 1.1 | 0.05 |
| | | | | | | | | |
| Final energy demand | 27.9 | 0.82 | 152.8 | 7.16 | 724.2 | 32.29 | 1.1 | 0.05 |
| | | | | | | | | |
| Industry | 27.9 | 0.82 | 25.5 | 1.20 | | | | |
| Iron and steel | 5.4 | 0.16 | 5.7 | 0.27 | | | | |
| Non-ferrous metals | | | 2.7 | 0.13 | | | | |
| Non-metallic minerals | 3.6 | 0.11 | 2.2 | 0.10 | | | | |
| Chemical | | | | | | | | |
| Construction materials | 10.3 | 0.30 | 8.9 | 0.42 | | | | |
| Pulp and paper | | | 0.1 | 0.00 | | | | |
| Food production | 8.4 | 0.25 | 1.0 | 0.05 | | | | |
| Not elsewhere specified | 0.2 | 0.01 | 4.9 | 0.23 | | | | |
| | | | | | | | | |
| Transport | | | 51.3 | 2.41 | 708.2 | 31.58 | 1.1 | 0.05 |
| Rail | | | | | | | | |
| Road | | | 51.3 | 2.41 | 708.2 | 31.58 | | |
| Air | | | | | | | 1.1 | 0.05 |
| – international | | | | | | | | |
| – domestic | | | | | | | 1.1 | 0.05 |
| Sea and River | | | | | | | | |
| | | | | | | | | |
| Other sectors | | | 76.0 | 3.56 | 16 | 0.71 | | |
| Households | | | 61.8 | 2.90 | | | | |
| Services | | | 9.0 | 0.42 | | | | |
| Agriculture | | | 2.7 | 0.13 | 8.4 | 0.37 | | |
| Construction | | | 2.5 | 0.12 | 7.6 | 0.34 | | |

Table A3-3: National energy balance for 2007 (continue)

| ENERGETSKA BILANCA 2007 | Petroleum | | Jet fuel | | Diesel oil | | Light heating oil | |
|---|---|---|---|---|---|---|---|---|
| | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ |
| | | | | | | | | |
| Production | | | 96.5 | 4.24 | 1286.4 | 54.94 | 390.1 | 16.66 |
| Petroleum refineries | | | 96.5 | 4.24 | 1286.4 | 54.94 | 390.1 | 16.66 |
| NGL-plant | 1.1 | 0.05 | 2.9 | 0.13 | 653.5 | 27.91 | 67 | 2.86 |
| Import | | | 0.2 | 0.01 | 403.5 | 17.23 | 109.7 | 4.69 |
| Export | 0.1 | 0.00 | 0.4 | 0.02 | 12.1 | 0.52 | -14.7 | -0.63 |
| Stock change | | | | | 4.4 | 0.19 | | |
| Energy supplied | 1.2 | 0.05 | 99.6 | 4.38 | 1544.1 | 65.95 | 332.7 | 14.21 |
| | | | | | | | | |
| Transformation sector | | | | | | | | |
| Power plants | | | | | | | 1.6 | 0.07 |
| public cogeneration plants | | | | | | | | |
| public heating plants | | | | | | | 4.2 | 0.18 |
| industrial cogeneration plants | | | | | | | 1.3 | 0.06 |
| Total transformation sector | | | | | | | 7.1 | 0.30 |
| | | | | | | | | |
| Energy sector own use | | | | | | | | |
| Oil and natural gas production | | | | | | | | |
| Energy sector own use total | | | | | | | | |
| | | | | | | | | |
| Available for final consumption | 1.2 | 0.05 | 99.6 | 4.38 | 1544.1 | 65.95 | 325.6 | 13.91 |
| | | | | | | | | |
| Final energy demand | 1.2 | 0.05 | 99.6 | 4.38 | 1544.1 | 65.95 | 325.6 | 13.91 |
| | | | | | | | | |
| Industry | | | | | | | 29.3 | 1.25 |
| Iron and steel | | | | | | | 1.2 | 0.05 |
| Non-ferrous metals | | | | | | | 0.3 | 0.01 |
| Non-metallic minerals | | | | | | | 1.9 | 0.08 |
| Chemical | | | | | | | 0.5 | 0.02 |
| Construction materials | | | | | | | 6.1 | 0.26 |
| Pulp and paper | | | | | | | | |
| Food production | | | | | | | 10.7 | 0.46 |
| Not elsewhere specified | | | | | | | 8.6 | 0.37 |
| | | | | | | | | |
| Transport | | | 99.6 | 4.38 | 1219.8 | 52.10 | | |
| Rail | | | | | 32.6 | 1.39 | | |
| Road | | | | | 1127 | 48.13 | | |
| Air | | | 99.6 | 4.38 | | | | |
| – international | | | 42.8 | 1.88 | | | | |
| – domestic | | | 56.8 | 2.50 | | | | |
| Sea and River | | | | | 34.4 | 1.47 | | |
| public city | | | | | 25.8 | 1.10 | | |
| | | | | | | | | |
| Other sectors | 1.2 | 0.05 | | | 324.3 | 13.85 | 296.3 | 12.65 |
| Households | 1.2 | 0.05 | | | | | 177.7 | 7.59 |
| Services | | | | | | | 91.6 | 3.91 |
| Agriculture | | | | | 190.2 | 8.12 | 14.3 | 0.61 |
| Construction | | | | | 134.1 | 5.73 | 12.7 | 0.54 |

*Table A3-3: National energy balance for 2007 (continue)*

| ENERGETSKA BILANCA 2007 | Low sulphur fuel oil | | Standard fuel oil | | Naphta | | White spirit | |
|---|---|---|---|---|---|---|---|---|
| | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ |
| Production | | | 1180.4 | 47.44 | 220.0 | 9.81 | | |
| Petroleum refineries | | | 1180.4 | 47.44 | 187.9 | 8.38 | | |
| NGL-plant | | | | | 32.1 | 1.43 | | |
| Import | 72.0 | 2.89 | 24.8 | 1.00 | | | 4.8 | 0.16 |
| Export | 0.1 | 0.004 | 215.3 | 8.65 | 188.9 | 8.42 | | |
| Stock change | | | -46.6 | -1.87 | 0.5 | 0.02 | | |
| Bunkers | | | 20.1 | 0.81 | | | | |
| Energy supplied | 71.9 | 2.89 | 923.2 | 37.10 | 31.6 | 1.41 | 4.8 | 0.16 |
| | | | | | | | | |
| Transformation sector | | | | | | | | |
| Power plants | 0.7 | 0.03 | 423.2 | 17.01 | | | | |
| public cogeneration plants | 57.0 | 2.29 | 45.1 | 1.81 | | | | |
| public heating plants | | | 28.6 | 1.15 | | | | |
| industrial cogeneration plants | | | 213.9 | 8.60 | | | | |
| – in rafineries | | | 199.6 | 8.02 | | | | |
| Industrial heating plants | 0.7 | 0.03 | 38.3 | 1.54 | | | | |
| Rafineries | | | | | 31.6 | 1.41 | | |
| Total transformation sector | 58.4 | 2.35 | 749.1 | 30.11 | 31.6 | 1.41 | | |
| | | | | | | | | |
| Energy sector own use | | | | | | | | |
| Oil and natural gas production | | | 82.4 | 3.31 | | | | |
| Energy sector own use total | | | 82.4 | 3.31 | | | | |
| | | | | | | | | |
| Available for final consumption | 13.5 | 0.54 | 91.7 | 3.69 | | | 4.8 | 0.16 |
| | | | | | | | | |
| Non energy use | | | | | | | 4.8 | 0.16 |
| | | | | | | | | |
| Final energy demand | 13.5 | 0.54 | 91.7 | 3.69 | | | | |
| | | | | | | | | |
| Industry | 13.5 | 0.54 | 75.0 | 3.01 | | | | |
| Iron and steel | 0.1 | 0.00 | 0.2 | 0.01 | | | | |
| Non-ferrous metals | 3.0 | 0.12 | | | | | | |
| Non-metallic minerals | 2.6 | 0.10 | | | | | | |
| Chemical | | | 40.2 | 1.62 | | | | |
| Construction materials | 1.8 | 0.07 | 25.1 | 1.01 | | | | |
| Pulp and paper | | | 1.8 | 0.07 | | | | |
| Food production | 3.8 | 0.15 | 4.3 | 0.17 | | | | |
| Not elsewhere specified | 2.2 | 0.09 | 3.4 | 0.14 | | | | |
| | | | | | | | | |
| Other sectors | | | 16.7 | 0.67 | | | | |
| Households | | | 8.6 | 0.35 | | | | |
| Services | | | 3.6 | 0.14 | | | | |
| Agriculture | | | 4.5 | 0.18 | | | | |

*Table A3-3: National energy balance for 2007 (continue)*

| ENERGETSKA BILANCA 2007 | Bitumen | | Lubricants | | Paraffin and wax | | Petroleum coke | |
|---|---|---|---|---|---|---|---|---|
| | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ |
| Production | 189.5 | 6.35 | 64.8 | 2.17 | 8.7 | 0.29 | 113.2 | 3.51 |
| Petroleum refineries | 189.5 | 6.35 | 64.8 | 2.17 | 8.7 | 0.29 | 113.2 | 3.51 |
| Import | 96.3 | 3.23 | 29.8 | 1.00 | 5.2 | 0.17 | 200.4 | 6.21 |
| Export | 56.6 | 1.90 | 51 | 1.71 | 2.8 | 0.09 | 40.9 | 1.27 |
| Stock change | -2.4 | -0.08 | 1.5 | 0.05 | -0.2 | -0.01 | -4.5 | -0.14 |
| Energy supplied | 226.8 | 7.60 | 45.1 | 1.51 | 10.9 | 0.37 | 268.2 | 8.31 |
| | | | | | | | | |
| Transformation sector | | | | | | | | |
| industrial cogeneration plants | | | | | | | | |
| – in rafineries | | | | | | | | |
| Total transformation sector | | | | | | | | |
| | | | | | | | | |
| Energy sector own use | | | | | | | | |
| Petroleum refineries | | | | | | | 67.8 | 2.10 |
| Energy sector own use total | | | | | | | 67.8 | 2.10 |
| | | | | | | | | |
| Available for final consumption | 226.8 | 7.60 | 45.1 | 1.51 | 10.9 | 0.37 | 200.4 | 6.21 |
| | | | | | | | | |
| Non energy use | 226.8 | 7.60 | 45.1 | 1.51 | 10.9 | 0.37 | | |
| | | | | | | | | |
| Final energy demand | | | | | | | 200.4 | 6.21 |
| | | | | | | | | |
| Industry | | | | | | | 200.4 | 6.21 |
| Iron and steel | | | | | | | 2.7 | 0.08 |
| Non-metallic minerals | | | | | | | 4.6 | 0.14 |
| Construction materials | | | | | | | 186.2 | 5.77 |
| Not elsewhere specified | | | | | | | 6.9 | 0.21 |

*Table A3-3: National energy balance for 2007 (continue)*

| ENERGETSKA BILANCA 2007 | Ethane | | Other derivates | | Refinery gas | | Refinery semiproducts | | Aditives | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ | $10^3$ t | PJ |
| Production | 59.7 | 2.82 | 67.1 | 2.70 | 217.4 | 10.56 | | | | |
| Petroleum refineries | | | 67.1 | 2.70 | 217.4 | 10.56 | | | | |
| NGL-plant | 59.7 | 2.82 | | | | | | | | |
| Import | | | | | | | 275.7 | 11.69 | 38.0 | 1.61 |
| Export | | | 35.1 | 1.41 | | | | | | |
| Stock change | | | -25.3 | -1.02 | | | 24.7 | 1.05 | -3.1 | -0.13 |
| Energy supplied | 59.7 | 2.82 | 6.7 | 0.27 | 217.4 | 10.56 | 300.4 | 12.74 | 34.9 | 1.48 |
| | | | | | | | | | | |
| Transformation sector | | | | | | | | | | |
| industrial cogeneration plants | | | 6.0 | 0.24 | 17.6 | 0.85 | | | | |
| – in rafineries | | | 6.0 | 0.24 | 17.6 | 0.85 | | | | |
| Rafineries | | | | | | | 300.4 | 12.74 | 34.9 | 1.48 |
| Total transformation sector | | | 6.0 | 0.24 | 17.6 | 0.85 | 300.4 | 12.74 | 34.9 | 1.48 |
| | | | | | | | | | | |
| Energy sector own use | | | | | | | | | | |
| Oil and natural gas production | | | | | 199.8 | 9.70 | | | | |
| Energy sector own use total | | | | | 199.8 | 9.70 | | | | |
| | | | | | | | | | | |
| Available for final consumption | 59.7 | 2.82 | 0.7 | 0.03 | | | | | | |
| | | | | | | | | | | |
| Non energy use | 59.7 | 2.82 | 0.7 | 0.03 | | | | | | |

*Table A3-3: National energy balance for 2007 (continue)*

| ENERGETSKA BILANCA 2007 | Gas works gas $10^3$ $m^3$ | Gas works gas PJ | Electricity GWh | Electricity PJ | Steam and hot water TJ |
|---|---|---|---|---|---|
| Production | 15129.5 | 0.420 | 12245.1 | 44.08 | 32446.6 |
| hydro power plants | | | 4400.2 | 15.84 | |
| – small HPP | | | 83.0 | 0.30 | |
| thermal power plants | | | 5216.3 | 18.78 | |
| public cogeneration plants | | | 2115.5 | 7.62 | 8675.9 |
| public heating plants | | | | | 2987.6 |
| industrial cogeneration plants | | | 513.1 | 1.85 | 15398.4 |
| – in rafineries | | | 136.5 | 0.49 | 7548.4 |
| – in gas production | | | 61.9 | 0.22 | 700.9 |
| Industrial heating plants | | | | | 5384.7 |
| Gas works | 15129.5 | 0.420 | | | |
| Import | | | 7811.8 | 28.12 | |
| Export | | | 1450.7 | 5.22 | |
| Stock change | | | | | |
| Bunkers | | | | | |
| Energy supplied | 15129.5 | 0.420 | 18606.2 | 66.98 | 32446.6 |
| Transformation sector | | | | | |
| hydro power plants | | | | | |
| – small HPP | | | | | |
| thermal power plants | | | | | |
| public cogeneration plants | | | | | |
| public heating plants | 1642 | 0.046 | | | |
| industrial cogeneration plants | | | | | |
| – in rafineries | | | | | |
| – in gas production | | | | | |
| Industrial heating plants | | | | | |
| Petroleum refineries | | | | | |
| NGL-plant | | | | | |
| Gas works | | | | | |
| Total transformation sector | 1642 | 0.046 | | | |
| Energy sector own use | | | | | |
| Oil and natural gas production | | | 115.9 | 0.42 | 230.9 |
| Electric energy supply industry | | | 34.0 | 0.12 | |
| Hydro power plants | | | 264.6 | 0.95 | |
| Thermal power plants | | | 390.2 | 1.40 | |
| Public cogeneration plants | | | 94.5 | 0.34 | 798 |
| Oil refineries | | | 304.0 | 1.09 | 7548.4 |
| NGL plant | | | 10.2 | 0.04 | 470 |
| Energy sector own use total | | | 1213.4 | 4.37 | 9047.3 |
| Losses | 380.8 | 0.011 | 2026.8 | 7.30 | 1746.2 |
| Final energy demand | 13106.7 | 0.364 | 15366.0 | 55.32 | 21653.1 |
| Non energy use | | | | | |
| Available for final consumption | 13106.7 | 0.364 | 15366.0 | 55.32 | 21653.1 |
| Industry | 2526.7 | 0.070 | 3690.6 | 13.29 | 14377.1 |
| Iron and steel | | | 310.1 | 1.12 | 10.1 |
| Non-ferrous metals | | | 96.0 | 0.35 | |
| Non-metallic minerals | 989.3 | 0.027 | 138.6 | 0.50 | 184.7 |
| Chemical | | | 600.0 | 2.16 | 4775.6 |
| Construction materials | | | 652.8 | 2.35 | 18.7 |
| Pulp and paper | 24 | 0.001 | 259.4 | 0.93 | 1747.6 |
| Food production | 45.7 | 0.001 | 575.6 | 2.07 | 4739.7 |
| Not elsewhere specified | 1467.7 | 0.041 | 1058.1 | 3.81 | 2900.7 |
| Transport | | | 322.3 | 1.16 | |
| Rail | | | 189.4 | 0.68 | |
| Road | | | | | |
| Air | | | 19.6 | 0.07 | |
| – international | | | | | |
| – domestic | | | 19.6 | 0.07 | |
| Sea and River | | | 25.5 | 0.09 | |
| public city | | | 61.2 | 0.22 | |
| Other | | | 26.6 | 0.10 | |
| Other sectors | 10580 | 0.294 | 11353.1 | 40.87 | 7276 |
| Households | 7693 | 0.214 | 6392.5 | 23.01 | 5784.6 |
| Services | 2887 | 0.080 | 4625.7 | 16.65 | 1491.4 |
| Agriculture | | | 67.6 | 0.24 | |
| Construction | | | 267.3 | 0.96 | |

# 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.2.1 6.B.2.1 Domestic and Commercial (w/o human sewage) | CH4 emissions from Wastewater Handling (Domestic and Commercial Wastewater) are not 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 CH4 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. IPCC 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 Guidelines 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 |
| $N_2O$ | 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 | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.A.1 5.A.1 Forest Land remaining Forest Land | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.1 5.B.1 Cropland remaining Cropland | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.2.1 Forest Land converted to Cropland | Dificulties in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.2.1 Forest Land converted to Cropland | Dificulties in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.2.2 Grassland converted to Cropland | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.2.2 Grassland converted to Cropland | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.2.3 Wetlands converted to Cropland | Dificulties in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.2.3 Wetlands converted to Cropland | Dificulties in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.B.2.5 Other Land converted to Cropland | Dificulties in collecting adequate activity data. |

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

| GHG | Sector | Source/sink category | Explanation |
|---|---|---|---|
| $N_2O$ | 5 LULUCF | 5.B.2.5 Other Land converted to Cropland | Dificulties in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.C.1 5.C.1 Grassland remaining Grassland | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.D.1 5.D.1 Wetlands remaining Wetlands | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.E.1 Settlements remaining Settlements | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.E.2 Land converted to Settlements | Dificulies in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.F.2 Land converted to Other Land | Dificulties in collecting adequate activity data. |
| $N_2O$ | 5 LULUCF | 5.G Harvested Wood Products | Dificulies in collecting adequate activity data. |
| $N_2O$ | 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 | $CO_2$ | 2,800.9 | 2,660.4 | 5 | 5 | 7.07 | 0.58 | -0.01 | 0.08 | -0.04 | 0.42 | 0.43 |
| 1A | $CO_2$ Emissions from Stationary Combustion - Oil | $CO_2$ | 8,497.0 | 6,317.1 | 5 | 5 | 7.07 | 1.38 | -0.08 | 0.20 | -0.39 | 1.01 | 1.08 |
| 1A | $CO_2$ Emissions from Stationary Combustion - Gas | $CO_2$ | 4,042.5 | 5,115.0 | 5 | 5 | 7.07 | 1.12 | 0.03 | 0.16 | 0.15 | 0.82 | 0.83 |
| 1A | Mobile Combustion - Road Vehicles | $CO_2$ | 3,561.4 | 6,059.4 | 5 | 5 | 7.07 | 1.32 | 0.08 | 0.19 | 0.38 | 0.97 | 1.04 |
| 1A | Mobile Combustion: Water-borne Navigation | $CO_2$ | 133.0 | 107.7 | 5 | 5 | 7.07 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 |
| 1A | Mobile Combustion: Aircraft | $CO_2$ | 154.7 | 76.0 | 5 | 5 | 7.07 | 0.02 | -0.00267 | 0.00 | -0.01 | 0.01 | 0.02 |
| 1A | Mobile Combustion: Railways | $CO_2$ | 138.1 | 102.1 | 5 | 5 | 7.07 | 0.02 | -0.00129 | 0.003 | -0.01 | 0.02 | 0.02 |
| 1A | Mobile Combustion - Agriculture/Forestry/Fishing | $CO_2$ | 839.2 | 721.9 | 5 | 5 | 7.07 | 0.16 | -0.00460 | 0.02 | -0.02 | 0.12 | 0.12 |
| 1B | $CO_2$ Emissions from Natural Gas Scrubbing* | $CO_2$ | 415.9 | 665.0 | 10 | 3 | 10.44 | 0.21 | 0.00751 | 0.02 | 0.02 | 0.21 | 0.21 |
| 2A | $CO_2$ Emissions from Cement Production | $CO_2$ | 1,085.8 | 1,612.0 | 3 | 3 | 4.24 | 0.21 | 0.02 | 0.05 | 0.05 | 0.15 | 0.16 |
| 2A | $CO_2$ Emissions from Lime Production | $CO_2$ | 160.6 | 254.5 | 3 | 3 | 4.24 | 0.03 | 0.00 | 0.01 | 0.01 | 0.02 | 0.03 |
| 2A | $CO_2$ Emissions from Limestone and Dolomite Use | $CO_2$ | 51.5 | 16.8 | 7.5 | 30 | 30.92 | 0.02 | 0.00 | 0.00 | -0.03 | 0.00 | 0.03 |
| 2A | $CO_2$ Emissions from Soda Ash Production and Use | $CO_2$ | 25.7 | 13.4 | 7.5 | 30 | 30.92 | 0.0128 | -0.0004 | 0.0004 | -0.0126 | 0.0032 | 0.0130 |
| 2C | $CO_2$ Emissions from Iron and Steel Production | $CO_2$ | 0.8 | 0.3 | 7.5 | 30 | 30.92 | 0.0003 | 0.0000 | 0.0000 | -0.0004 | 0.0001 | 0.0004 |
| 2B | $CO_2$ Emissions from Ammonia Production | $CO_2$ | 871.0 | 945.0 | 3 | 5 | 5.83 | 0.1701 | 0.0015 | 0.0301 | 0.0073 | 0.0904 | 0.0907 |
| 2C | $CO_2$ Emissions from Ferroalloys Production | $CO_2$ | 118.8 | 0.0 | 7.5 | 30 | 30.92 | 0.0000 | -0.0039 | 0.0000 | -0.1173 | 0.0000 | 0.1173 |
| 2C | Aluminium Production | $CO_2$ | 111.4 | 0.0 | 3 | 30 | 30.15 | 0.0000 | -0.0037 | 0.0000 | -0.1099 | 0.0000 | 0.1099 |
| 2G | Emissions from Waste Incineration | $CO_2$ | 0.0 | 0.1 | 50 | 30 | 58.31 | 0.000147 | 0.000001 | 0.000003 | 0.000036 | 0.000131 | 0.000135 |
| 3 | Total Solvent and Other Product Use | $CO_2$ | 96.2 | 197.8 | 50 | 50 | 70.71 | 0.431875 | 0.003138 | 0.006305 | 0.156918 | 0.315225 | 0.352122 |
| 6C | Other non-specified NEU | $CO_2$ | | | 5 | 50 | 50.25 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| | **$CO_2$ Total** | | **23,104.7** | **24,864.7** | | | | | | | | | |

*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 | 85.8 | 5 | 50 | 50.25 | 0.1331 | -0.0028 | 0.0027 | -0.1394 | 0.0137 | 0.1401 |
| 1A | Mobile Combustion - Road Vehicles | $CH_4$ | 32.1 | 32.2 | 5 | 40 | 40.31 | 0.0401 | 0.0000 | 0.0010 | -0.0012 | 0.0051 | 0.0053 |
| 1A | Mobile Combustion: Water-borne Navigation | $CH_4$ | 0.2 | 0.2 | 5 | 40 | 40.31 | 0.0002 | 0.0000 | 0.0000 | -0.0001 | 0.0000 | 0.0001 |
| 1A | Mobile Combustion: Aircraft | $CH_4$ | 0.0 | 0.0 | 5 | 40 | 40.31 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1A | Mobile Combustion: Railways | $CH_4$ | 0.2 | 0.1 | 5 | 40 | 40.31 | 0.0002 | 0.0000 | 0.0000 | -0.0001 | 0.0000 | 0.0001 |
| 1A | Mobile Combustion - Agriculture/Forestry/Fishing | $CH_4$ | 1.3 | 1.1 | 5 | 40 | 40.31 | 0.0014 | 0.0000 | 0.0000 | -0.0003 | 0.0002 | 0.0004 |
| 1B | Fugitive Emissions from Coal Mining and Handling | $CH_4$ | 48.8 | 0.0 | 5 | 250 | 250.05 | 0.0000 | -0.0016 | 0.0000 | -0.4010 | 0.0000 | 0.4010 |
| 1B | Fugitive Emissions from Oil and Gas Operations | $CH_4$ | 1,201.2 | 1,617.8 | 5 | 300 | 300.04 | 14.9887 | 0.0120 | 0.0516 | 3.6122 | 0.2578 | 3.6214 |
| 2B | Production of Chemicals | $CH_4$ | 16.5 | 7.1 | 7.5 | 30 | 30.92 | 0.0068 | -0.0003 | 0.0002 | -0.0094 | 0.0017 | 0.0096 |
| 4A | $CH_4$ Emissions from Enteric Fermentation in Domestic Livestock | $CH_4$ | 1,222.4 | 787.9 | 30 | 40 | 50.00 | 1.2165 | -0.0151 | 0.0251 | -0.6039 | 0.7534 | 0.9656 |
| 4B | $CH_4$ Emissions from Manure Management | $CH_4$ | 228.4 | 166.9 | 30 | 40 | 50.00 | 0.2577 | -0.0022 | 0.0053 | -0.0878 | 0.1596 | 0.1822 |
| 6A | Solid Waste Disposal Sites | $CH_4$ | 221.2 | 602.7 | 50 | 50 | 70.71 | 1.3160 | 0.0119 | 0.0192 | 0.5966 | 0.9605 | 1.1307 |
| 6B | Emissions from Waste Water Handling | $CH_4$ | 278.7 | 179.6 | 50 | 30 | 58.31 | 0.3234 | -0.0034 | 0.0057 | -0.1034 | 0.2862 | 0.3043 |
| | **$CH_4$ Total** | | **3,418.9** | **3,481.5** | | | | | | | | | |

*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 | $N_2O$ | 62.3 | 46.6 | 5 | 200 | 200.06 | 0.2881 | -0.0006 | 0.0015 | -0.1127 | 0.0074 | 0.1130 |
| 1A | Mobile Combustion - Road Vehicles | $N_2O$ | 48.1 | 191.1 | 5 | 200 | 200.06 | 1.1803 | 0.0045 | 0.0061 | 0.9015 | 0.0304 | 0.9021 |
| 1A | Mobile Combustion: Water-borne Navigation | $N_2O$ | 0.3 | 0.3 | 5 | 200 | 200.06 | 0.0017 | 0.0000 | 0.0000 | -0.0005 | 0.0000 | 0.0005 |
| 1A | Mobile Combustion: Aircraft | $N_2O$ | 1.4 | 0.7 | 5 | 200 | 200.06 | 0.0041 | 0.0000 | 0.0000 | -0.0047 | 0.0001 | 0.0047 |
| 1A | Mobile Combustion: Railways | $N_2O$ | 0.4 | 0.3 | 5 | 200 | 200.06 | 0.0016 | 0.0000 | 0.0000 | -0.0009 | 0.0000 | 0.0009 |
| 1A | Mobile Combustion - Agriculture/Forestry/Fishing | $N_2O$ | 2.0 | 1.8 | 5 | 200 | 200.06 | 0.0109 | 0.0000 | 0.0001 | -0.0021 | 0.0003 | 0.0021 |
| 2B | Nitric Acid Production | $N_2O$ | 804.1 | 741.6 | 3 | 30 | 30.15 | 0.6904 | -0.0028 | 0.0236 | -0.0845 | 0.0709 | 0.1103 |
| C | Total Solvent and Other Product Use | $N_2O$ | 34.7 | 34.7 | 50 | 50 | 70.71 | 0.075809 | -0.000036 | 0.001107 | -0.001783 | 0.055333 | 0.055362 |
| 4B | $N_2O$ Emissions from Manure Management | $N_2O$ | 378.7 | 222.8 | 30 | 60 | 67.08 | 0.4616 | -0.0054 | 0.0071 | -0.3215 | 0.2131 | 0.3857 |
| 4B | Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | 1,298.0 | 1,203.7 | 30 | 40 | 50.00 | 1.8584 | -0.0043 | 0.0384 | -0.1736 | 1.1510 | 1.1640 |
| 4D | $N_2O$ Emissions from Pasture, Range and Paddock Manure | $N_2O$ | 262.0 | 194.3 | 30 | 40 | 50.00 | 0.3000 | -0.0024 | 0.0062 | -0.0970 | 0.1858 | 0.2096 |
| 4F | Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture | $N_2O$ | 931.8 | 834.0 | 30 | 60 | 67.08 | 1.7275 | -0.0041 | 0.0266 | -0.2445 | 0.7975 | 0.8341 |
| 6B | Emissions from Waste Water Handling | $N_2O$ | 78.7 | 85.2 | 10 | 30 | 31.62 | 0.0832 | 0.0001 | 0.0027 | 0.0038 | 0.0272 | 0.0274 |
| | **$N_2O$ Total** | | **3,902.6** | **3,557.0** | | | | | | | | | |
| 2F | HFC Emiss. from Consumption of HFCs, PFCs and $SF_6$ | HFC | 11.0 | 481.8 | 70 | 70 | 98.99 | 1.4728 | 0.0150 | 0.0154 | 1.0496 | 1.0750 | 1.5024 |
| 2C | PFC Emissions from Aluminium production | PFC | 936.6 | 0.0 | 30 | 50 | 58.31 | 0.0000 | -0.0308 | 0.0000 | -1.5402 | 0.0000 | 1.5402 |
| | **HFC/PFC/$SF_6$ Total** | | **947.6** | **481.8** | | | | | | | | | |
| | **Total GHG Emissions** | $CO_2$-eq | **31,373.7** | **32,384.9** | | | | | | | | | |
| | **Total Uncertainties (Level/Trend)** | | | | | | | **15.64** | | | | | **5.17** |

*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 | $CO_2$ | 2800.9 | 2660.4 | 5 | 5 | 7.07 | 0.49 | -0.01 | 0.07 | -0.05 | 0.37 | 0.38 |
| 1A | $CO_2$ Emissions from Stationary Combustion - Oil | $CO_2$ | 8497.0 | 6317.1 | 5 | 5 | 7.07 | 1.15 | -0.08 | 0.18 | -0.41 | 0.89 | 0.98 |
| 1A | $CO_2$ Emissions from Stationary Combustion - Gas | $CO_2$ | 4042.5 | 5115.0 | 5 | 5 | 7.07 | 0.93 | 0.02 | 0.14 | 0.10 | 0.72 | 0.73 |
| 1A | Mobile Combustion - Road Vehicles | $CO_2$ | 3561.4 | 6059.4 | 5 | 5 | 7.07 | 1.11 | 0.06 | 0.17 | 0.31 | 0.85 | 0.91 |
| 1A | Mobile Combustion: Water-borne Navigation | $CO_2$ | 133.0 | 107.7 | 5 | 5 | 7.07 | 0.02 | 0.00 | 0.00 | -0.01 | 0.02 | 0.02 |
| 1A | Mobile Combustion: Aircraft | $CO_2$ | 154.7 | 76.0 | 5 | 5 | 7.07 | 0.01 | 0.00 | 0.00 | -0.01 | 0.01 | 0.02 |
| 1A | Mobile Combustion: Railways | $CO_2$ | 138.1 | 102.1 | 5 | 5 | 7.07 | 0.02 | 0.00 | 0.00 | -0.01 | 0.01 | 0.02 |
| 1A | Mobile Combustion - Agriculture/Forestry/Fishing | $CO_2$ | 839.2 | 721.9 | 5 | 5 | 7.07 | 0.13 | -0.01 | 0.02 | -0.03 | 0.10 | 0.11 |
| 1B | $CO_2$ Emissions from Natural Gas Scrubbing* | $CO_2$ | 415.9 | 665.0 | 10 | 3 | 10.44 | 0.18 | 0.01 | 0.02 | 0.02 | 0.19 | 0.19 |
| 2A | $CO_2$ Emissions from Cement Production | $CO_2$ | 1085.8 | 1612.0 | 3 | 3 | 4.24 | 0.18 | 0.01 | 0.05 | 0.04 | 0.14 | 0.14 |
| 2A | $CO_2$ Emissions from Lime Production | $CO_2$ | 160.6 | 254.5 | 3 | 3 | 4.24 | 0.03 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 |
| 2A | $CO_2$ Emissions from Limestone and Dolomite Use | $CO_2$ | 51.5 | 16.8 | 7.5 | 30 | 30.92 | 0.01 | 0.00 | 0.00 | -0.03 | 0.00 | 0.03 |
| 2A | $CO_2$ Emissions from Soda Ash Production and Use | $CO_2$ | 25.7 | 13.4 | 7.5 | 30 | 30.92 | 0.0107 | -0.0004 | 0.0004 | -0.0123 | 0.0028 | 0.0126 |
| 2C | $CO_2$ Emissions from Iron and Steel Production | $CO_2$ | 0.8 | 0.3 | 7.5 | 30 | 30.92 | 0.0003 | 0.0000 | 0.0000 | -0.0004 | 0.0001 | 0.0004 |
| 2B | $CO_2$ Emissions from Ammonia Production | $CO_2$ | 871.0 | 945.0 | 3 | 5 | 5.83 | 0.1424 | -0.0001 | 0.0266 | -0.0004 | 0.0797 | 0.0797 |
| 2C | $CO_2$ Emissions from Ferroalloys Production | $CO_2$ | 118.8 | | 7.5 | 30 | 30.92 | 0.0000 | -0.0036 | 0.0000 | -0.1091 | 0.0000 | 0.1091 |
| 2C | Aluminium Production | $CO_2$ | 111.4 | | 3 | 30 | 30.15 | 0.0000 | -0.0034 | 0.0000 | -0.1022 | 0.0000 | 0.1022 |
| 5A | Forest land remaining forest land | $CO_2$ | 4184.9 | 6302.6 | 45 | 30 | 54.08 | 8.8108 | 0.0491 | 0.1772 | 1.4742 | 7.9761 | 8.1112 |
| 2G | Emissions from Waste Incineration | $CO_2$ | 0.0 | 0.1 | 50 | 30 | 58.31 | 0.000123 | 0.000001 | 0.000002 | 0.000029 | 0.000115 | 0.000119 |
| 3 | Total Solvent and Other Product Use | $CO_2$ | 96.2 | 197.8 | 50 | 50 | 70.71 | 0.361518 | 0.002618 | 0.005563 | 0.130906 | 0.278126 | 0.307393 |
| 6C | Other non-specified NEU | $CO_2$ | 0.0 | 0.0 | 5 | 50 | 50.25 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| | **$CO_2$ Total** | | **27289.6** | **31167.3** | | | | | | | | | |

*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 | 85.8 | 5 | 50 | 50.25 | 0.1114 | -0.0027 | 0.0024 | -0.1362 | 0.0121 | 0.1367 |
| 1A | Mobile Combustion - Road Vehicles | $CH_4$ | 32.1 | 32.2 | 5 | 40 | 40.31 | 0.0335 | -0.0001 | 0.0009 | -0.0031 | 0.0045 | 0.0055 |
| 1A | Mobile Combustion: Water-borne Navigation | $CH_4$ | 0.2 | 0.2 | 5 | 40 | 40.31 | 0.0002 | 0.0000 | 0.0000 | -0.0001 | 0.0000 | 0.0001 |
| 1A | Mobile Combustion: Aircraft | $CH_4$ | 0.0 | 0.0 | 5 | 40 | 40.31 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1A | Mobile Combustion: Railways | $CH_4$ | 0.2 | 0.1 | 5 | 40 | 40.31 | 0.0002 | 0.0000 | 0.0000 | -0.0001 | 0.0000 | 0.0001 |
| 1A | Mobile Combustion - Agriculture/Forestry/Fishing | $CH_4$ | 1.3 | 1.1 | 5 | 40 | 40.31 | 0.0011 | 0.0000 | 0.0000 | -0.0004 | 0.0002 | 0.0004 |
| 1B | Fugitive Emissions from Coal Mining and Handling | $CH_4$ | 48.8 | 0.0 | 5 | 250 | 250.05 | 0.0000 | -0.0015 | 0.0000 | -0.3730 | 0.0000 | 0.3730 |
| 1B | Fugitive Emissions from Oil and Gas Operations | $CH_4$ | 1201.2 | 1617.8 | 5 | 300 | 300.04 | 12.5469 | 0.0087 | 0.0455 | 2.6223 | 0.2275 | 2.6322 |
| 2B | Production of Other Chemicals | $CH_4$ | 16.5 | 7.1 | 7.5 | 30 | 30.92 | 0.0057 | -0.0003 | 0.0002 | -0.0091 | 0.0015 | 0.0092 |
| 4A | $CH_4$ Emissions from Enteric Fermentation in Domestic Livestock | $CH_4$ | 1222.4 | 787.9 | 30 | 40 | 50.00 | 1.0183 | -0.0152 | 0.0222 | -0.6095 | 0.6647 | 0.9019 |
| 4B | $CH_4$ Emissions from Manure Management | $CH_4$ | 228.4 | 166.9 | 30 | 40 | 50.00 | 0.2157 | -0.0023 | 0.0047 | -0.0918 | 0.1408 | 0.1681 |
| 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 | 602.7 | 50 | 50 | 70.71 | 1.1016 | 0.0102 | 0.0169 | 0.5090 | 0.8475 | 0.9886 |
| 6B | Emissions from Waste Water Handling | $CH_4$ | 278.7 | 179.6 | 50 | 30 | 58.31 | 0.2707 | -0.0035 | 0.0051 | -0.1043 | 0.2526 | 0.2732 |
| | **$CH_4$ Total** | | **3418.9** | **3481.5** | | | | | | | | | |

*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 | $N_2O$ | 62.3 | 46.6 | 5 | 200 | 200.06 | 0.2412 | -0.0006 | 0.0013 | -0.1190 | 0.0066 | 0.1192 |
| 1A | Mobile Combustion - Road Vehicles | $N_2O$ | 48.1 | 191.1 | 5 | 200 | 200.06 | 0.9880 | 0.0039 | 0.0054 | 0.7804 | 0.0269 | 0.7808 |
| 1A | Mobile Combustion: Water-borne Navigation | $N_2O$ | 0.3 | 0.3 | 5 | 200 | 200.06 | 0.0014 | 0.0000 | 0.0000 | -0.0005 | 0.0000 | 0.0005 |
| 1A | Mobile Combustion: Aircraft | $N_2O$ | 1.4 | 0.7 | 5 | 200 | 200.06 | 0.0034 | 0.0000 | 0.0000 | -0.0045 | 0.0001 | 0.0045 |
| 1A | Mobile Combustion: Railways | $N_2O$ | 0.4 | 0.3 | 5 | 200 | 200.06 | 0.0013 | 0.0000 | 0.0000 | -0.0009 | 0.0000 | 0.0009 |
| 1A | Mobile Combustion - Agriculture/Forestry/Fishing | $N_2O$ | 2.0 | 1.8 | 5 | 200 | 200.06 | 0.0092 | 0.0000 | 0.0000 | -0.0025 | 0.0002 | 0.0025 |
| 2B | Nitric Acid Production | $N_2O$ | 804.1 | 741.6 | 3 | 30 | 30.15 | 0.5779 | -0.0037 | 0.0209 | -0.1124 | 0.0626 | 0.1286 |
| C | Total Solvent and Other Product Use | $N_2O$ | 34.7 | 34.7 | 50 | 50 | 70.71 | 0.0635 | -0.0001 | 0.0010 | -0.0043 | 0.0488 | 0.0490 |
| 4B | $N_2O$ Emissions from Manure Management | $N_2O$ | 378.7 | 222.8 | 30 | 60 | 67.08 | 0.3864 | -0.0053 | 0.0063 | -0.3193 | 0.1880 | 0.3705 |
| 4B | Direct $N_2O$ Emissions from Agricultural Soils | $N_2O$ | 1298.0 | 1203.7 | 30 | 40 | 50.00 | 1.5557 | -0.0059 | 0.0339 | -0.2345 | 1.0155 | 1.0423 |
| 4D | $N_2O$ Emissions from Pasture, Range and Paddock Manure | $N_2O$ | 262.0 | 194.3 | 30 | 40 | 50.00 | 0.2511 | -0.0026 | 0.0055 | -0.1020 | 0.1639 | 0.1931 |
| 4F | Indirect $N_2O$ Emissions from Nitrogen Used in Agriculture | $N_2O$ | 931.8 | 834.0 | 30 | 60 | 67.08 | 1.4461 | -0.0051 | 0.0235 | -0.3034 | 0.7036 | 0.7662 |
| 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 | $N_2O$ | 78.7 | 85.2 | 10 | 30 | 31.62 | 0.0696 | 0.0000 | 0.0024 | -0.0004 | 0.0240 | 0.0240 |
| | **$N_2O$ Total** | | **3902.6** | **3557.0** | | | | | | | | | |
| 2F | HFC Emiss. from Consumption of HFCs, PFCs and $SF_6$ | HFC | 11.0 | 481.8 | 70 | 70 | 98.99 | 1.2328 | 0.0132 | 0.0135 | 0.9249 | 0.9484 | 1.3247 |
| 2C | PFC Emissions from Aluminium production | PFC | 936.6 | | 30 | 50 | 58.31 | 0.0000 | -0.0286 | 0.0000 | -1.4324 | 0.0000 | 1.4324 |
| | **$HFC/PFC/SF_6$ Total** | | **947.6** | **481.8** | | | | | | | | | |
| | **Total GHG Emissions** | $CO_2$-eq | **35558.7** | **38687.6** | | | | | | | | | |
| | **Total Uncertainties (Level/Trend)** | | | | | | | **15.73** | | | | | **9.14** |

# ANNEX 6

# INVENTORY DATA RECORD SHEET

*Table A6-1: An example of Inventory Data Record Sheet for 2007 in Waste*

# INVENTORY DATA RECORD SHEET

**Year**: 2007

| | |
|---|---|
| **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 2007,* 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: 660 Gg

Unmamaged – deep: 760 Gg

Unmanaged – shallow: 190 Gg

Country-specific methane correction factor (MCF): 0.835

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

Recovered methane: 1.99 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:**<br>▪ Equipping the major landfills with automatic weigh-bridges in order to accurately estimate the quantities of delivered MSW<br>▪ Providing methodology to determine country-specific MSW composition<br>▪ Periodic analysis of waste composition at major landfills according to provided methodology<br>▪ Modification of Environmental Pollution Register, ROO Reporting Forms regarding to MSW with additional information on waste quantities and composition<br>▪ Adjustment of country-specific to IPCC SWDSs classification, in order to accurately MCF estimation. | |
| **NOTES:**<br>- | |
| **RESPONSIBILITY:**<br>Andrea Hublin, M.Sc.<br>EKONERG<br>address: Koranska 5, 10000 Zagreb<br>tel.: +385 1 6000 134<br>fax.: +385 1 6171 560<br>e-mail: andrea.hublin@ekonerg.hr | |

# ANNEX 7

# GHG EMISSION TREND

*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 $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **20582.79** | **69.13** | **1451.65** | **0.37** | **114.52** | **NO** | **22148.96** | **70.60** |
| A. Fuel Comb (Sectoral Appr.) | 20166.84 | 9.61 | 201.71 | 0.55 | 114.52 | NO | 20483.07 | 65.29 |
| 1. Energy Industries | 7126.54 | 0.17 | 3.61 | 0.07 | 13.80 | NO | 7143.95 | 22.77 |
| 2. Man. Ind. and Constr. | 5447.30 | 0.48 | 10.08 | 0.09 | 17.96 | NO | 5475.33 | 17.45 |
| 3. Transport | 3987.25 | 1.55 | 32.56 | 0.24 | 50.17 | NO | 4069.97 | 12.97 |
| 4. Comm./Inst, Resid., Agric. | 3605.76 | 7.40 | 155.47 | 0.16 | 32.59 | NO | 3793.82 | 12.09 |
| 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 | 5.31 |
| 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** | **2425.63** | **0.78** | **16.45** | **2.59** | **804.08** | **947.58** | **4193.73** | **13.37** |
| A. Mineral Products | 1323.65 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1323.65 | 4.22 |
| B. Chemical Industry | 870.99 | 16.45 | 16.45 | 2.59 | 804.08 | NO | 1691.52 | 5.39 |
| C. Metal Production | 230.99 | NE,NO | NE,NO | NO | NO | 936.56 | 1167.56 | 3.72 |
| 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** | **69.09** | **1450.81** | **9.26** | **2870.58** | **NO** | **4321.40** | **13.77** |
| A. Enteric Fermentation | NO | 58.21 | 1222.37 | 0.00 | 0.00 | NO | 1222.37 | 3.90 |
| 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 | 2491.84 | NO | 2491.84 | 7.94 |
| 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** | **-13.34** |
| A. Forest Land | -4184.93 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -4184.92 | -13.34 |
| 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** | **0.25** | **78.69** | **NO** | **578.67** | **1.84** |
| 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 | 0.04 | 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** | **18919.76** | **162.80** | **3418.86** | **12.48** | **3867.87** | **947.58** | **27188.79** | **86.66** |
| **Total Emissions without LUCF** | **23104.69** | **162.80** | **3418.86** | **12.48** | **3867.87** | **947.58** | **31373.71** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **69.59** | | **12.57** | | **14.23** | | **100.00** | |
| **Share of Gases in Total Emissions** | **73.64** | | **10.90** | | **12.33** | | **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 A7-2: GHG emission in Croatia, 1991*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1991 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **15079.24** | **62.04** | **1302.75** | **0.26** | **80.97** | **NO** | **16462.96** | **66.50** |
| A. Fuel Comb (Sectoral Appr.) | 14623.41 | 6.31 | 132.56 | 0.39 | 80.97 | NO | 14836.94 | 59.93 |
| 1. Energy Industries | 4768.18 | 0.11 | 2.27 | 0.04 | 9.03 | NO | 4779.47 | 19.31 |
| 2. Man. Ind. and Constr. | 3882.52 | 0.37 | 7.70 | 0.06 | 13.10 | NO | 3903.32 | 15.77 |
| 3. Transport | 2936.85 | 1.18 | 24.78 | 0.18 | 37.07 | NO | 2998.70 | 12.11 |
| 4. Comm./Inst, Resid., Agric. | 3035.86 | 4.66 | 97.82 | 0.10 | 21.77 | NO | 3155.45 | 12.75 |
| 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 | 6.57 |
| 1. Solid Fuels | NO | NO | 43.45 | NO | NO | NO | 43.45 | NO |
| 2. Oil and Natural Gas | 455.83 | 53.65 | 1126.74 | NO | NO | NO | 1582.57 | 6.39 |
| **2. Industrial Processes** | **2015.38** | **0.58** | **12.26** | **2.28** | **706.28** | **653.29** | **3387.20** | **13.68** |
| A. Mineral Products | 870.62 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 870.62 | 3.52 |
| B. Chemical Industry | 928.55 | 12.26 | 12.26 | 2.28 | 706.28 | NO | 1647.08 | 6.65 |
| C. Metal Production | 216.20 | NE,NO | NE,NO | NO | NO | 642.44 | 858.65 | 3.47 |
| 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** | **64.45** | **1353.47** | **9.17** | **2842.28** | **NO** | **4195.75** | **16.95** |
| A. Enteric Fermentation | NO | 53.70 | 1127.78 | 0.00 | 0.00 | NO | 1127.78 | 4.56 |
| B. Manure Management | NO | 10.75 | 225.68 | 1.17 | 361.98 | NO | 587.67 | 2.37 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 8.00 | 2480.30 | NO | 2480.30 | 10.02 |
| 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** | **-35.14** |
| A. Forest Land | -8699.64 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -8699.63 | -35.14 |
| 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** | **0.24** | **75.73** | **NO** | **580.98** | **2.35** |
| 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 | 0.24 | 75.73 | NO | 347.37 | 1.40 |
| 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** | **8488.83** | **151.13** | **3173.69** | **11.95** | **3705.26** | **653.29** | **16055.79** | **64.86** |
| **Total Emissions without LUCF** | **17188.48** | **151.13** | **3173.69** | **11.95** | **3705.26** | **653.29** | **24755.42** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **52.87** | | **19.77** | | **23.08** | | **100.00** | |
| **Share of Gases in Total Emissions** | **69.43** | | **12.82** | | **14.97** | | **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 A7-3: GHG emission in Croatia, 1992*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1992 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **14280.99** | **60.81** | **1276.92** | **0.24** | **75.46** | **NO** | **15633.37** | **67.79** |
| A. Fuel Comb (Sectoral Appr.) | 13803.66 | 5.14 | 107.98 | 0.36 | 75.46 | NO | 13987.10 | 60.65 |
| 1. Energy Industries | 5338.81 | 0.11 | 2.35 | 0.05 | 9.79 | NO | 5350.96 | 23.20 |
| 2. Man. Ind. and Constr. | 3087.45 | 0.30 | 6.26 | 0.05 | 9.97 | NO | 3103.68 | 13.46 |
| 3. Transport | 2828.24 | 1.04 | 21.93 | 0.18 | 37.27 | NO | 2887.45 | 12.52 |
| 4. Comm./Inst, Resid., Agric. | 2549.15 | 3.69 | 77.44 | 0.09 | 18.43 | NO | 2645.02 | 11.47 |
| 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 | 7.14 |
| 1. Solid Fuels | NO | NO | 33.77 | NO | NO | NO | 33.77 | NO |
| 2. Oil and Natural Gas | 477.33 | 54.06 | 1135.18 | NO | NO | NO | 1612.51 | 6.99 |
| **2. Industrial Processes** | **2198.05** | **0.51** | **10.71** | **2.98** | **923.47** | **10.85** | **3143.08** | **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 | 9.18 |
| C. Metal Production | 85.81 | NE,NO | NE,NO | NO | NO | NO | 85.81 | 0.37 |
| 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** | **50.52** | **1060.91** | **8.14** | **2524.09** | **NO** | **3585.00** | **15.55** |
| A. Enteric Fermentation | NO | 42.44 | 891.26 | 0.00 | 0.00 | NO | 891.26 | 3.86 |
| B. Manure Management | NO | 8.08 | 169.65 | 0.91 | 282.80 | NO | 452.45 | 1.96 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 7.23 | 2241.29 | NO | 2241.29 | 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** | **-40.30** |
| A. Forest Land | -9294.33 | 0.00 | 0.00 | 0.00 | 0.00 | NO | -9294.32 | -40.30 |
| 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** | **77.21** | **NO** | **587.63** | **2.55** |
| A. Solid Waste Disp. on Land | NE,NO | 11.71 | 245.84 | 0.00 | 0.00 | NO | 245.84 | 1.07 |
| B. Waste-water Handling | 0.00 | 12.60 | 264.54 | 0.25 | 77.21 | NO | 341.74 | 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** | **7261.48** | **136.14** | **2858.92** | **11.61** | **3600.23** | **10.85** | **13766.20** | **59.70** |
| **Total Emissions without LUCF** | **16555.81** | **136.14** | **2858.92** | **11.61** | **3600.23** | **10.85** | **23060.53** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **52.75** | | **20.77** | | **26.15** | | **100.00** | |
| **Share of Gases in Total Emissions** | **71.79** | | **12.40** | | **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 A7-4: GHG emission in Croatia, 1993*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1993 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **15035.03** | **67.00** | **1407.07** | **0.26** | **81.90** | **NO** | **16524.00** | **71.84** |
| A. Fuel Comb (Sectoral Appr.) | 14358.91 | 4.88 | 102.41 | 0.39 | 81.90 | NO | 14543.22 | 63.23 |
| 1. Energy Industries | 5821.81 | 0.14 | 2.85 | 0.05 | 9.84 | NO | 5834.50 | 25.37 |
| 2. Man. Ind. and Constr. | 3005.87 | 0.29 | 6.09 | 0.05 | 9.54 | NO | 3021.50 | 13.14 |
| 3. Transport | 3000.03 | 1.02 | 21.43 | 0.21 | 45.12 | NO | 3066.59 | 13.33 |
| 4. Comm./Inst, Resid., Agric. | 2531.20 | 3.43 | 72.04 | 0.08 | 17.40 | NO | 2620.63 | 11.39 |
| 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 | 8.61 |
| 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 | 8.47 |
| **2. Industrial Processes** | **1772.76** | **0.54** | **11.30** | **2.25** | **696.15** | **10.92** | **2491.13** | **10.83** |
| A. Mineral Products | 797.98 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 797.98 | 3.47 |
| B. Chemical Industry | 945.15 | 11.30 | 11.30 | 2.25 | 696.15 | NO | 1652.61 | 7.19 |
| C. Metal Production | 29.62 | NE,NO | NE,NO | NO | NO | NO | 29.62 | 0.13 |
| 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** | **0.51** |
| **4. Agriculture** | **NO** | **49.96** | **1049.18** | **7.17** | **2223.89** | **NO** | **3273.08** | **14.23** |
| A. Enteric Fermentation | NO | 41.60 | 873.65 | 0.00 | 0.00 | NO | 873.65 | 3.80 |
| B. Manure Management | NO | 8.36 | 175.54 | 0.91 | 281.23 | NO | 456.77 | 1.99 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.27 | 1942.66 | NO | 1942.66 | 8.45 |
| E. Burning of Savannas | NO | NO | NO | NO | NO | NO | NO | NO |
| F. Field Burning of Agr. Residues | NO | NO | NO | NO | NO | NO | NO | NO |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO |
| **5. Land-Use Change and Forestry** | **-8036.66** | **0.00** | **0.02** | **0.00** | **0.01** | **NO** | **-8036.63** | **-34.94** |
| A. Forest Land | -8036.66 | 0.00 | 0.02 | 0.00 | 0.01 | NO | -8036.63 | -34.94 |
| B. Cropland | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NO | NE,NO | NO |
| C. Grassland | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NO | NE,NO | NO |
| D. Wetlands | NE,NO | NE,NO | NE,NO | NE,NO | NE,NO | NO | NE,NO | NO |
| E. Settlements | 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** | **0.26** | **79.07** | **NO** | **595.28** | **2.59** |
| 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 | 0.26 | 79.07 | NO | 336.52 | 1.46 |
| 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** | **8852.86** | **142.08** | **2983.74** | **9.94** | **3081.03** | **10.92** | **14963.27** | **65.06** |
| **Total Emissions without LUCF** | **16889.51** | **142.08** | **2983.74** | **9.94** | **3081.03** | **10.92** | **22999.89** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **59.16** | | **19.94** | | **20.59** | | **100.00** | |
| **Share of Gases in Total Emissions** | **73.43** | | **12.97** | | **13.40** | | **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 A7-5: GHG emission in Croatia, 1994*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1994 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **14295.41** | **60.63** | **1273.13** | **0.26** | **80.49** | **NO** | **15649.04** | **70.48** |
| A. Fuel Comb (Sectoral Appr.) | 13690.54 | 5.13 | 107.63 | 0.38 | 80.49 | NO | 13878.67 | 62.51 |
| 1. Energy Industries | 4712.78 | 0.12 | 2.49 | 0.04 | 7.45 | NO | 4722.73 | 21.27 |
| 2. Man. Ind. and Constr. | 3175.64 | 0.28 | 5.90 | 0.04 | 8.96 | NO | 3190.50 | 14.37 |
| 3. Transport | 3186.32 | 1.10 | 23.14 | 0.22 | 45.50 | NO | 3254.96 | 14.66 |
| 4. Comm./Inst, Resid., Agric. | 2615.80 | 3.62 | 76.10 | 0.09 | 18.58 | NO | 2710.48 | 12.21 |
| 5. Other | NO | NO | NO | NO | NO | NO | NO | NO |
| B. Fugitive Emissions from Fuels | 604.87 | 55.50 | 1165.50 | NO | NO | NO | 1770.37 | 7.97 |
| 1. Solid Fuels | NO | NO | 28.97 | NO | NO | NO | 28.97 | NO |
| 2. Oil and Natural Gas | 604.87 | 54.12 | 1136.53 | NO | NO | NO | 1741.40 | 7.84 |
| **2. Industrial Processes** | **1957.82** | **0.52** | **10.90** | **2.43** | **752.82** | **11.20** | **2732.74** | **12.31** |
| A. Mineral Products | 963.54 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 963.54 | 4.34 |
| B. Chemical Industry | 964.02 | 10.90 | 10.90 | 2.43 | 752.82 | NO | 1727.74 | 7.78 |
| C. Metal Production | 30.26 | NE,NO | NE,NO | NO | NO | NO | 30.26 | 0.14 |
| 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** | **45.80** | **961.84** | **7.17** | **2222.60** | **NO** | **3184.44** | **14.34** |
| A. Enteric Fermentation | NO | 37.45 | 786.35 | 0.00 | 0.00 | NO | 786.35 | 3.54 |
| B. Manure Management | NO | 8.36 | 175.50 | 0.84 | 259.10 | NO | 434.60 | 1.96 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.33 | 1963.50 | NO | 1963.50 | 8.84 |
| 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** | **-39.00** |
| A. Forest Land | -8658.34 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -8658.32 | -39.00 |
| 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** | **20.43** | **429.02** | **0.27** | **83.20** | **NO** | **512.26** | **2.31** |
| 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 | 0.27 | 83.20 | NO | 239.62 | 1.08 |
| 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** | **7684.16** | **127.38** | **2674.91** | **10.13** | **3139.12** | **11.20** | **13544.10** | **61.00** |
| **Total Emissions without LUCF** | **16342.50** | **127.38** | **2674.91** | **10.13** | **3139.12** | **11.20** | **22202.43** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **56.73** | | **19.75** | | **23.18** | | **100.00** | |
| **Share of Gases in Total Emissions** | **73.61** | | **12.05** | | **14.14** | | **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 A7-6: GHG emission in Croatia, 1995*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1995 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **15020.51** | **61.10** | **1283.08** | **0.28** | **87.55** | **NO** | **16391.15** | **71.69** |
| A. Fuel Comb (Sectoral Appr.) | 14323.59 | 5.29 | 111.16 | 0.42 | 87.55 | NO | 14522.30 | 63.51 |
| 1. Energy Industries | 5185.76 | 0.14 | 2.86 | 0.04 | 9.38 | NO | 5198.01 | 22.73 |
| 2. Man. Ind. and Constr. | 2928.27 | 0.26 | 5.56 | 0.04 | 8.79 | NO | 2942.63 | 12.87 |
| 3. Transport | 3384.01 | 1.18 | 24.75 | 0.24 | 50.30 | NO | 3459.06 | 15.13 |
| 4. Comm./Inst, Resid., Agric. | 2825.55 | 3.71 | 77.98 | 0.09 | 19.09 | NO | 2922.62 | 12.78 |
| 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 | 8.17 |
| 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 | 8.07 |
| **2. Industrial Processes** | **1820.10** | **0.45** | **9.40** | **2.34** | **723.99** | **19.41** | **2572.90** | **11.25** |
| A. Mineral Products | 743.86 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 743.86 | 3.25 |
| B. Chemical Industry | 1044.28 | 9.40 | 9.40 | 2.34 | 723.99 | NO | 1777.67 | 7.77 |
| C. Metal Production | 31.96 | NE,NO | NE,NO | NO | NO | NO | 31.96 | 0.14 |
| 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 | 19.41 | 19.41 | 0.08 |
| 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** | **43.77** | **919.12** | **6.86** | **2125.61** | **NO** | **3044.74** | **13.32** |
| A. Enteric Fermentation | NO | 36.22 | 760.72 | 0.00 | 0.00 | NO | 760.72 | 3.33 |
| B. Manure Management | NO | 7.54 | 158.40 | 0.79 | 245.37 | NO | 403.77 | 1.77 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.07 | 1880.25 | NO | 1880.25 | 8.22 |
| 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** | **-40.04** |
| A. Forest Land | -9154.24 | 0.00 | 0.00 | 0.00 | 0.00 | NO | -9154.24 | -40.04 |
| 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** | **0.29** | **90.98** | **NO** | **732.31** | **3.20** |
| 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 | 0.29 | 90.98 | NO | 443.68 | 1.94 |
| 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** | **7775.48** | **135.85** | **2852.89** | **9.77** | **3028.14** | **19.41** | **13710.64** | **59.96** |
| **Total Emissions without LUCF** | **16929.73** | **135.85** | **2852.89** | **9.77** | **3028.14** | **19.41** | **22864.88** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **56.71** | | **20.81** | | **22.09** | | **100.00** | |
| **Share of Gases in Total Emissions** | **74.04** | | **12.48** | | **13.24** | | **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 A7-7: GHG emission in Croatia, 1996*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1996 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **15612.61** | **61.78** | **1297.34** | **0.31** | **97.16** | **NO** | **17007.1** | **72.44** |
| A. Fuel Comb (Sectoral Appr.) | 14968.57 | 6.24 | 131.04 | 0.46 | 97.16 | NO | 15196.8 | 64.73 |
| 1. Energy Industries | 5113.34 | 0.13 | 2.81 | 0.04 | 8.84 | NO | 5125.0 | 21.83 |
| 2. Man. Ind. and Constr. | 2972.45 | 0.27 | 5.58 | 0.04 | 8.76 | NO | 2986.8 | 12.72 |
| 3. Transport | 3653.74 | 1.30 | 27.25 | 0.27 | 56.52 | NO | 3737.5 | 15.92 |
| 4. Comm./Inst, Resid., Agric. | 3229.04 | 4.54 | 95.40 | 0.11 | 23.03 | NO | 3347.5 | 14.26 |
| 5. Other | NO | NO | NO | NO | NO | NO | NO | NO |
| B. Fugitive Emissions from Fuels | 644.04 | 55.54 | 1166.30 | NO | NO | NO | 1810.3 | 7.71 |
| 1. Solid Fuels | NO | NO | 18.61 | NO | NO | NO | 18.6 | NO |
| 2. Oil and Natural Gas | 644.04 | 54.65 | 1147.69 | NO | NO | NO | 1791.7 | 7.63 |
| **2. Industrial Processes** | **1841.18** | **0.42** | **8.81** | **2.17** | **674.11** | **72.11** | **2596.2** | **11.06** |
| 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 | 13.14 | NE,NO | NE,NO | NO | NO | NO | 13.1 | 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 | 72.11 | 72.1 | 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** | **42.00** | **882.02** | **6.93** | **2149.00** | **NO** | **3031.0** | **12.91** |
| A. Enteric Fermentation | NO | 34.56 | 725.74 | 0.00 | 0.00 | NO | 725.7 | 3.09 |
| B. Manure Management | NO | 7.44 | 156.28 | 0.75 | 230.97 | NO | 387.2 | 1.65 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.19 | 1918.03 | NO | 1918.0 | 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** | **-40.42** |
| A. Forest Land | -9489.96 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -9490.0 | -40.42 |
| 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** | **0.28** | **86.80** | **NO** | **710.9** | **3.03** |
| 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 | 0.28 | 86.80 | NO | 405.0 | 1.72 |
| 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** | **8061.66** | **133.92** | **2812.25** | **9.70** | **3007.07** | **72.11** | **13987.8** | **59.58** |
| **Total Emissions without LUCF** | **17551.63** | **133.92** | **2812.25** | **9.70** | **3007.07** | **72.11** | **23477.8** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **57.63** | | **20.11** | | **21.50** | | **100.0** | |
| **Share of Gases in Total Emissions** | **74.76** | | **11.98** | | **12.81** | | **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 A7-8: GHG emission in Croatia, 1997*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1997 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **16455.41** | **64.87** | **1362.32** | **0.36** | **110.66** | **NO** | **17928.38** | **72.17** |
| A. Fuel Comb (Sectoral Appr.) | 15855.63 | 6.32 | 132.64 | 0.53 | 110.66 | NO | 16098.92 | 64.80 |
| 1. Energy Industries | 5578.19 | 0.12 | 2.61 | 0.05 | 10.62 | NO | 5591.41 | 22.51 |
| 2. Man. Ind. and Constr. | 3000.47 | 0.29 | 6.13 | 0.04 | 9.41 | NO | 3016.02 | 12.14 |
| 3. Transport | 3996.73 | 1.39 | 29.24 | 0.32 | 67.67 | NO | 4093.65 | 16.48 |
| 4. Comm./Inst, Resid., Agric. | 3280.24 | 4.51 | 94.65 | 0.11 | 22.95 | NO | 3397.85 | 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** | **2068.96** | **0.39** | **8.10** | **2.29** | **708.49** | **102.91** | **2888.47** | **11.63** |
| 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 | 40.29 | NE,NO | NE,NO | NO | NO | NO | 40.29 | 0.16 |
| D. Other Production | NE | NO | NO | NO | NO | NO | NE | NE |
| E. Prod. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | NO | NO | NO |
| F. Cons. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | 102.91 | 102.91 | 0.41 |
| 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** | **41.47** | **870.96** | **7.72** | **2393.45** | **NO** | **3264.41** | **13.14** |
| A. Enteric Fermentation | NO | 34.18 | 717.86 | 0.00 | 0.00 | NO | 717.86 | 2.89 |
| B. Manure Management | NO | 7.29 | 153.11 | 0.73 | 226.59 | NO | 379.70 | 1.53 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.99 | 2166.86 | NO | 2166.86 | 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** | **-33.02** |
| A. Forest Land | -8202.94 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -8202.93 | -33.02 |
| 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** | **0.28** | **86.88** | **NO** | **641.51** | **2.58** |
| 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 | 0.28 | 86.88 | NO | 316.30 | 1.27 |
| 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** | **10407.35** | **133.14** | **2795.99** | **10.64** | **3299.48** | **102.91** | **16640.45** | **66.98** |
| **Total Emissions without LUCF** | **18610.30** | **133.14** | **2795.99** | **10.64** | **3299.48** | **102.91** | **24843.38** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **62.54** | | **16.80** | | **19.83** | | **100.00** | |
| **Share of Gases in Total Emissions** | **74.91** | | **11.25** | | **13.28** | | **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 A7-9: GHG emission in Croatia, 1998*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1998 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **17483.91** | **57.22** | **1201.54** | **0.39** | **120.88** | **NO** | **18806.33** | **75.32** |
| A. Fuel Comb (Sectoral Appr.) | 16894.74 | 6.13 | 128.71 | 0.58 | 120.88 | NO | 17144.33 | 68.66 |
| 1. Energy Industries | 6264.48 | 0.14 | 2.87 | 0.06 | 11.65 | NO | 6279.00 | 25.15 |
| 2. Man. Ind. and Constr. | 3286.89 | 0.30 | 6.20 | 0.05 | 9.59 | NO | 3302.68 | 13.23 |
| 3. Transport | 4202.17 | 1.46 | 30.62 | 0.37 | 78.19 | NO | 4310.97 | 17.27 |
| 4. Comm./Inst, Resid., Agric. | 3141.20 | 4.24 | 89.02 | 0.10 | 21.45 | NO | 3251.67 | 13.02 |
| 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** | **1879.34** | **0.35** | **7.42** | **1.72** | **533.42** | **29.90** | **2450.09** | **9.81** |
| 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 | 5.60 |
| C. Metal Production | 17.88 | NE,NO | NE,NO | NO | NO | NO | 17.88 | 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 | 29.90 | 29.90 | 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** | **40.70** | **854.78** | **6.87** | **2129.52** | **NO** | **2984.29** | **11.95** |
| A. Enteric Fermentation | NO | 33.52 | 703.96 | 0.00 | 0.00 | NO | 703.96 | 2.82 |
| B. Manure Management | NO | 7.18 | 150.82 | 0.72 | 221.96 | NO | 372.78 | 1.49 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.15 | 1907.56 | NO | 1907.56 | 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** | **-27.40** |
| A. Forest Land | -6841.15 | 0.00 | 0.02 | 0.00 | 0.01 | NO | -6841.12 | -27.40 |
| 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** | **0.27** | **84.13** | **NO** | **601.65** | **2.41** |
| 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 | 0.27 | 84.13 | NO | 256.24 | 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** | **12613.61** | **122.92** | **2581.25** | **9.25** | **2867.95** | **29.90** | **18127.43** | **72.60** |
| **Total Emissions without LUCF** | **19454.76** | **122.92** | **2581.25** | **9.25** | **2867.95** | **29.90** | **24968.55** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **69.58** | | **14.24** | | **15.82** | | **100.00** | |
| **Share of Gases in Total Emissions** | **77.92** | | **10.34** | | **11.49** | | **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 A7-10: GHG emission in Croatia, 1999*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 1999 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **17902.71** | **56.01** | **1176.17** | **0.42** | **129.38** | **NO** | **19208.25** | **73.60** |
| A. Fuel Comb (Sectoral Appr.) | 17377.46 | 5.90 | 123.98 | 0.62 | 129.38 | NO | 17630.82 | 67.55 |
| 1. Energy Industries | 6437.02 | 0.14 | 2.92 | 0.06 | 11.73 | NO | 6451.67 | 24.72 |
| 2. Man. Ind. and Constr. | 2956.89 | 0.25 | 5.24 | 0.04 | 8.07 | NO | 2970.20 | 11.38 |
| 3. Transport | 4434.37 | 1.51 | 31.66 | 0.42 | 88.58 | NO | 4554.62 | 17.45 |
| 4. Comm./Inst, Resid., Agric. | 3549.17 | 4.01 | 84.17 | 0.10 | 20.99 | NO | 3654.34 | 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** | **2300.41** | **0.31** | **6.61** | **2.03** | **629.42** | **21.45** | **2957.89** | **11.33** |
| 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 | 6.38 |
| C. Metal Production | 20.74 | NE,NO | NE,NO | NO | NO | NO | 20.74 | 0.08 |
| D. Other Production | NE | NO | NO | NO | NO | NO | NE | NE |
| E. Prod. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | NO | NO | NO |
| F. Cons. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | 21.45 | 21.45 | 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** | **41.41** | **869.61** | **7.47** | **2314.70** | **NO** | **3184.31** | **12.20** |
| A. Enteric Fermentation | NO | 33.46 | 702.63 | 0.00 | 0.00 | NO | 702.63 | 2.69 |
| B. Manure Management | NO | 7.95 | 166.97 | 0.73 | 226.32 | NO | 393.29 | 1.51 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.74 | 2088.39 | NO | 2088.39 | 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** | **-31.24** |
| A. Forest Land | -8153.08 | 0.00 | 0.00 | 0.00 | 0.00 | NO | -8153.08 | -31.24 |
| 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** | **25.91** | **544.02** | **0.28** | **88.24** | **NO** | **632.30** | **2.42** |
| 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 | 88.24 | NO | 264.10 | 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** | **12132.17** | **123.64** | **2596.41** | **10.20** | **3161.74** | **21.45** | **17946.50** | **68.76** |
| **Total Emissions without LUCF** | **20285.26** | **123.64** | **2596.41** | **10.20** | **3161.74** | **21.45** | **26099.58** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **67.60** | | **14.47** | | **17.62** | | **100.00** | |
| **Share of Gases in Total Emissions** | **77.72** | | **9.95** | | **12.11** | | **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 A7-11: GHG emission in Croatia, 2000*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2000 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **17433.51** | **59.29** | **1245.17** | **0.46** | **143.36** | **NO** | **18822.03** | **72.52** |
| A. Fuel Comb (Sectoral Appr.) | 16800.49 | 6.38 | 134.05 | 0.68 | 143.36 | NO | 17077.90 | 65.80 |
| 1. Energy Industries | 5889.65 | 0.14 | 3.01 | 0.07 | 14.61 | NO | 5907.27 | 22.76 |
| 2. Man. Ind. and Constr. | 3076.76 | 0.26 | 5.40 | 0.04 | 8.43 | NO | 3090.59 | 11.91 |
| 3. Transport | 4444.93 | 1.49 | 31.28 | 0.46 | 97.20 | NO | 4573.41 | 17.62 |
| 4. Comm./Inst, Resid., Agric. | 3389.15 | 4.49 | 94.37 | 0.11 | 23.11 | NO | 3506.63 | 13.51 |
| 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 | 6.72 |
| 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 | 6.72 |
| **2. Industrial Processes** | **2440.87** | **0.33** | **6.91** | **2.39** | **740.65** | **35.31** | **3223.74** | **12.42** |
| A. Mineral Products | 1406.19 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1406.19 | 5.42 |
| B. Chemical Industry | 1022.14 | 6.91 | 6.91 | 2.39 | 740.65 | NO | 1769.70 | 6.82 |
| C. Metal Production | 12.53 | NE,NO | NE,NO | NO | NO | NO | 12.53 | 0.05 |
| D. Other Production | NE | NO | NO | NO | NO | NO | NE | NE |
| E. Prod. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | NO | NO | NO |
| F. Cons. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | 35.31 | 35.31 | 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** | **0.44** |
| **4. Agriculture** | **NO** | **40.33** | **846.90** | **7.43** | **2303.85** | **NO** | **3150.75** | **12.14** |
| A. Enteric Fermentation | NO | 32.95 | 691.90 | 0.00 | 0.00 | NO | 691.90 | 2.67 |
| B. Manure Management | NO | 7.38 | 155.00 | 0.71 | 219.27 | NO | 374.27 | 1.44 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.72 | 2084.58 | NO | 2084.58 | 8.03 |
| E. Burning of Savannas | NO | NO | NO | NO | NO | NO | NO | NO |
| F. Field Burning of Agr. Residues | NO | NO | NO | NO | NO | NO | NO | NO |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO |
| **5. Land-Use Change and Forestry** | **-5280.74** | **0.00** | **0.04** | **0.00** | **0.01** | **NO** | **-5280.69** | **-20.35** |
| A. Forest Land | -5280.74 | 0.00 | 0.04 | 0.00 | 0.01 | NO | -5280.69 | -20.35 |
| 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** | **84.24** | **NO** | **643.76** | **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 | 84.24 | NO | 252.63 | 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** | **14674.14** | **126.60** | **2658.50** | **10.56** | **3272.11** | **35.31** | **20674.78** | **79.65** |
| **Total Emissions without LUCF** | **19954.88** | **126.59** | **2658.50** | **10.56** | **3272.11** | **35.31** | **25955.47** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **70.98** | | **12.86** | | **15.83** | | **100.00** | |
| **Share of Gases in Total Emissions** | **76.88** | | **10.24** | | **12.61** | | **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 A7-12: GHG emission in Croatia, 2001*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2001 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **18325.34** | **64.44** | **1353.27** | **0.49** | **151.90** | **NO** | **19830.50** | **73.03** |
| A. Fuel Comb (Sectoral Appr.) | 17637.70 | 5.32 | 111.67 | 0.72 | 151.90 | NO | 17901.27 | 65.92 |
| 1. Energy Industries | 6308.87 | 0.16 | 3.39 | 0.07 | 15.17 | NO | 6327.42 | 23.30 |
| 2. Man. Ind. and Constr. | 3217.12 | 0.26 | 5.36 | 0.04 | 8.45 | NO | 3230.93 | 11.90 |
| 3. Transport | 4506.03 | 1.39 | 29.18 | 0.52 | 108.98 | NO | 4644.19 | 17.10 |
| 4. Comm./Inst, Resid., Agric. | 3605.68 | 3.51 | 73.75 | 0.09 | 19.30 | NO | 3698.73 | 13.62 |
| 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 | 7.10 |
| 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 | 7.10 |
| **2. Industrial Processes** | **2459.57** | **0.34** | **7.13** | **2.01** | **622.93** | **61.74** | **3151.36** | **11.61** |
| A. Mineral Products | 1613.96 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1613.96 | 5.94 |
| B. Chemical Industry | 841.32 | 7.13 | 7.13 | 2.01 | 622.93 | NO | 1471.38 | 5.42 |
| C. Metal Production | 4.29 | NE,NO | NE,NO | NO | NO | NO | 4.29 | 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 | 61.74 | 61.74 | 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** | **41.17** | **864.65** | **8.03** | **2488.33** | **NO** | **3352.98** | **12.35** |
| A. Enteric Fermentation | NO | 33.75 | 708.75 | 0.00 | 0.00 | NO | 708.75 | 2.61 |
| B. Manure Management | NO | 7.42 | 155.90 | 0.71 | 221.57 | NO | 377.47 | 1.39 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 7.31 | 2266.76 | NO | 2266.76 | 8.35 |
| 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** | **-30.25** |
| A. Forest Land | -8213.80 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -8213.78 | -30.25 |
| 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** | **0.29** | **90.26** | **NO** | **698.55** | **2.57** |
| 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 | 0.29 | 90.26 | NO | 281.04 | 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** | **12658.09** | **134.92** | **2833.31** | **10.82** | **3353.42** | **61.74** | **18941.27** | **69.75** |
| **Total Emissions without LUCF** | **20871.89** | **134.92** | **2833.31** | **10.82** | **3353.42** | **61.74** | **27155.06** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **66.83** | | **14.96** | | **17.70** | | **100.00** | |
| **Share of Gases in Total Emissions** | **76.86** | | **10.43** | | **12.35** | | **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 A7-13: GHG emission in Croatia, 2002*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2002 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **19375.40** | **66.93** | **1405.55** | **0.54** | **166.78** | **NO** | **20947.73** | **74.46** |
| A. Fuel Comb (Sectoral Appr.) | 18710.08 | 5.38 | 112.93 | 0.79 | 166.78 | NO | 18989.79 | 67.50 |
| 1. Energy Industries | 7211.59 | 0.19 | 3.92 | 0.09 | 17.89 | NO | 7233.40 | 25.71 |
| 2. Man. Ind. and Constr. | 2998.89 | 0.25 | 5.17 | 0.04 | 8.10 | NO | 3012.16 | 10.71 |
| 3. Transport | 4807.67 | 1.36 | 28.54 | 0.58 | 121.04 | NO | 4957.25 | 17.62 |
| 4. Comm./Inst, Resid., Agric. | 3691.92 | 3.59 | 75.31 | 0.09 | 19.75 | NO | 3786.99 | 13.46 |
| 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 | 6.96 |
| 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 | 6.96 |
| **2. Industrial Processes** | **2364.90** | **0.29** | **6.05** | **1.95** | **604.67** | **62.94** | **3038.56** | **10.80** |
| A. Mineral Products | 1601.16 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1601.16 | 5.69 |
| B. Chemical Industry | 763.57 | 6.05 | 6.05 | 1.95 | 604.67 | NO | 1374.29 | 4.89 |
| C. Metal Production | 0.17 | NE,NO | NE,NO | NO | NO | NO | 0.17 | 0.00 |
| 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 | 62.94 | 62.94 | 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** | **40.74** | **855.46** | **7.98** | **2473.63** | **NO** | **3329.09** | **11.83** |
| A. Enteric Fermentation | NO | 33.20 | 697.23 | 0.00 | 0.00 | NO | 697.23 | 2.48 |
| B. Manure Management | NO | 7.53 | 158.22 | 0.70 | 217.22 | NO | 375.45 | 1.33 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 7.28 | 2256.41 | NO | 2256.41 | 8.02 |
| 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** | **-29.17** |
| A. Forest Land | -8205.61 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -8205.61 | -29.17 |
| 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** | **0.31** | **95.30** | **NO** | **672.15** | **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 | 0.31 | 95.30 | NO | 224.97 | 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** | **13644.94** | **135.42** | **2843.87** | **10.78** | **3340.39** | **62.94** | **19926.86** | **70.83** |
| **Total Emissions without LUCF** | **21850.55** | **135.42** | **2843.87** | **10.78** | **3340.39** | **62.94** | **28132.46** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **68.48** | | **14.27** | | **16.76** | | **100.00** | |
| **Share of Gases in Total Emissions** | **77.67** | | **10.11** | | **11.87** | | **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 A7-14: GHG emission in Croatia, 2003*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2003 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **20840.84** | **68.42** | **1436.89** | **0.62** | **190.72** | **NO** | **22468.45** | **75.08** |
| A. Fuel Comb (Sectoral Appr.) | 20156.80 | 6.37 | 133.81 | 0.91 | 190.72 | NO | 20481.33 | 68.44 |
| 1. Energy Industries | 7877.18 | 0.22 | 4.53 | 0.09 | 19.70 | NO | 7901.41 | 26.40 |
| 2. Man. Ind. and Constr. | 3162.62 | 0.27 | 5.77 | 0.04 | 9.33 | NO | 3177.72 | 10.62 |
| 3. Transport | 5196.90 | 1.32 | 27.69 | 0.66 | 137.82 | NO | 5362.41 | 17.92 |
| 4. Comm./Inst, Resid., Agric. | 3920.10 | 4.56 | 95.83 | 0.11 | 23.86 | NO | 4039.79 | 13.50 |
| 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 | 6.64 |
| 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 | 6.64 |
| **2. Industrial Processes** | **2492.91** | **0.31** | **6.59** | **1.84** | **570.01** | **178.00** | **3247.52** | **10.85** |
| A. Mineral Products | 1595.17 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1595.17 | 5.33 |
| B. Chemical Industry | 871.96 | 6.59 | 6.59 | 1.84 | 570.01 | NO | 1448.56 | 4.84 |
| C. Metal Production | 25.78 | NE,NO | NE,NO | NO | NO | NO | 25.78 | 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 | 178.00 | 178.00 | 0.59 |
| 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** | **0.51** |
| **4. Agriculture** | **NO** | **42.69** | **896.58** | **7.41** | **2295.80** | **NO** | **3192.38** | **10.67** |
| A. Enteric Fermentation | NO | 34.80 | 730.72 | 0.00 | 0.00 | NO | 730.72 | 2.44 |
| B. Manure Management | NO | 7.90 | 165.86 | 0.73 | 226.46 | NO | 392.32 | 1.31 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 6.68 | 2069.34 | NO | 2069.34 | 6.91 |
| 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** | **-6276.50** | **0.00** | **0.02** | **0.00** | **0.01** | **NO** | **-6276.47** | **-20.97** |
| A. Forest Land | -6276.50 | 0.00 | 0.02 | 0.00 | 0.01 | NO | -6276.47 | -20.97 |
| 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** | **93.27** | **NO** | **864.08** | **2.89** |
| A. Solid Waste Disp. on Land | NE,NO | 22.86 | 479.97 | 0.00 | 0.00 | NO | 479.97 | 1.60 |
| B. Waste-water Handling | 0.00 | 13.85 | 290.79 | 0.30 | 93.27 | NO | 384.06 | 1.28 |
| 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** | **17176.09** | **148.14** | **3110.85** | **10.16** | **3149.81** | **178.00** | **23649.47** | **79.03** |
| **Total Emissions without LUCF** | **23452.59** | **148.13** | **3110.85** | **10.16** | **3149.81** | **178.00** | **29925.94** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **72.63** | | **13.15** | | **13.32** | | **100.00** | |
| **Share of Gases in Total Emissions** | **78.37** | | **10.40** | | **10.53** | | **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 A7-15: GHG emission in Croatia, 2004*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2004 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **20266.24** | **69.63** | **1462.17** | **0.65** | **201.39** | **NO** | **21929.81** | **73.53** |
| A. Fuel Comb (Sectoral Appr.) | 19556.24 | 6.24 | 131.08 | 0.96 | 201.39 | NO | 19888.72 | 66.68 |
| 1. Energy Industries | 6836.32 | 0.21 | 4.40 | 0.08 | 17.76 | NO | 6858.48 | 23.00 |
| 2. Man. Ind. and Constr. | 3551.93 | 0.32 | 6.76 | 0.05 | 11.12 | NO | 3569.81 | 11.97 |
| 3. Transport | 5334.47 | 1.29 | 27.02 | 0.71 | 149.32 | NO | 5510.81 | 18.48 |
| 4. Comm./Inst, Resid., Agric. | 3833.52 | 4.42 | 92.90 | 0.11 | 23.20 | NO | 3949.62 | 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** | **2602.07** | **0.31** | **6.41** | **2.24** | **695.54** | **203.77** | **3507.78** | **11.76** |
| A. Mineral Products | 1693.35 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1693.35 | 5.68 |
| B. Chemical Industry | 908.33 | 6.41 | 6.41 | 2.24 | 695.54 | NO | 1610.28 | 5.40 |
| C. Metal Production | 0.39 | NE,NO | NE,NO | NO | NO | NO | 0.39 | 0.00 |
| 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 | 203.77 | 203.77 | 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** | **44.35** | **931.41** | **7.92** | **2454.11** | **NO** | **3385.52** | **11.35** |
| A. Enteric Fermentation | NO | 35.84 | 752.59 | 0.00 | 0.00 | NO | 752.59 | 2.52 |
| B. Manure Management | NO | 8.52 | 178.82 | 0.76 | 235.19 | NO | 414.01 | 1.39 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 7.16 | 2218.92 | NO | 2218.92 | 7.44 |
| 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** | **-7899.85** | **0.00** | **0.00** | **0.00** | **0.00** | **NO** | **-7899.85** | **-26.49** |
| A. Forest Land | -7899.85 | 0.00 | 0.00 | 0.00 | 0.00 | NO | -7899.85 | -26.49 |
| 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** | **0.29** | **91.27** | **NO** | **824.12** | **2.76** |
| 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 | 0.29 | 91.27 | NO | 308.32 | 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** | **15111.90** | **149.18** | **3132.80** | **11.10** | **3442.31** | **203.77** | **21925.50** | **73.51** |
| **Total Emissions without LUCF** | **23011.75** | **149.18** | **3132.80** | **11.10** | **3442.31** | **203.77** | **29825.34** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **68.92** | | **14.29** | | **15.70** | | **100.00** | |
| **Share of Gases in Total Emissions** | **77.16** | | **10.50** | | **11.54** | | **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 A7-16: GHG emission in Croatia, 2005*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2005 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **20623.66** | **69.67** | **1463.17** | **0.65** | **201.72** | **NO** | **22288.54** | **73.24** |
| A. Fuel Comb (Sectoral Appr.) | 19932.66 | 6.32 | 132.68 | 0.96 | 201.72 | NO | 20267.05 | 66.60 |
| 1. Energy Industries | 6866.82 | 0.20 | 4.26 | 0.09 | 18.45 | NO | 6889.53 | 22.64 |
| 2. Man. Ind. and Constr. | 3650.27 | 0.29 | 6.13 | 0.05 | 10.14 | NO | 3666.53 | 12.05 |
| 3. Transport | 5548.63 | 1.54 | 32.42 | 0.72 | 150.90 | NO | 5731.95 | 18.83 |
| 4. Comm./Inst, Resid., Agric. | 3866.95 | 4.28 | 89.86 | 0.11 | 22.24 | NO | 3979.04 | 13.07 |
| 5. Other | NO | NO | NO | NO | NO | NO | NO | NO |
| B. Fugitive Emissions from Fuels | 691.00 | 63.36 | 1330.49 | NO | NO | NO | 2021.49 | 6.64 |
| 1. Solid Fuels | NO | NO | NO | NO | NO | NO | NO | NO |
| 2. Oil and Natural Gas | 691.00 | 63.36 | 1330.49 | NO | NO | NO | 2021.49 | 6.64 |
| **2. Industrial Processes** | **2631.83** | **0.29** | **6.01** | **2.19** | **679.04** | **364.91** | **3681.80** | **12.10** |
| A. Mineral Products | 1736.87 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1736.87 | 5.71 |
| B. Chemical Industry | 894.63 | 6.01 | 6.01 | 2.19 | 679.04 | NO | 1579.67 | 5.19 |
| C. Metal Production | 0.34 | NE,NO | NE,NO | NO | NO | NO | 0.34 | 0.00 |
| D. Other Production | NE | NO | NO | NO | NO | NO | NE | NE |
| E. Prod. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | NO | NA,NO | NA,NO |
| F. Cons. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | 364.91 | 364.91 | 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** | **45.19** | **948.98** | **8.11** | **2515.16** | **NO** | **3464.13** | **11.38** |
| A. Enteric Fermentation | NO | 37.77 | 793.14 | 0.00 | 0.00 | NO | 793.14 | 2.61 |
| B. Manure Management | NO | 7.42 | 155.84 | 0.74 | 229.71 | NO | 385.55 | 1.27 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 7.37 | 2285.45 | NO | 2285.45 | 7.51 |
| 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** | **-7726.37** | **0.00** | **0.00** | **0.00** | **0.00** | **NO** | **-7726.37** | **-25.39** |
| A. Forest Land | -7726.37 | 0.00 | 0.00 | 0.00 | 0.00 | NO | -7726.37 | -25.39 |
| 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** | **0.29** | **89.33** | **NO** | **795.35** | **2.61** |
| 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 | 0.29 | 89.33 | NO | 232.25 | 0.76 |
| 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** | **15697.81** | **148.77** | **3124.14** | **11.24** | **3485.24** | **364.91** | **22706.83** | **74.61** |
| **Total Emissions without LUCF** | **23424.18** | **148.77** | **3124.14** | **11.24** | **3485.24** | **364.91** | **30433.20** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **69.13** | | **13.76** | | **15.35** | | **100.00** | |
| **Share of Gases in Total Emissions** | **76.97** | | **10.27** | | **11.45** | | **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 A7-17: GHG emission in Croatia, 2006*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2006 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **20594.39** | **76.34** | **1603.10** | **0.71** | **218.76** | **NO** | **22416.24** | **72.85** |
| A. Fuel Comb (Sectoral Appr.) | 19931.39 | 6.26 | 131.36 | 1.04 | 218.76 | NO | 20281.50 | 65.91 |
| 1. Energy Industries | 6641.98 | 0.19 | 3.90 | 0.08 | 16.86 | NO | 6662.75 | 21.65 |
| 2. Man. Ind. and Constr. | 3746.32 | 0.29 | 6.01 | 0.05 | 10.12 | NO | 3762.45 | 12.23 |
| 3. Transport | 5913.19 | 1.55 | 32.49 | 0.81 | 169.87 | NO | 6115.56 | 19.88 |
| 4. Comm./Inst, Resid., Agric. | 3629.88 | 4.24 | 88.96 | 0.10 | 21.90 | NO | 3740.75 | 12.16 |
| 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 | 6.94 |
| 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 | 6.94 |
| **2. Industrial Processes** | **2737.31** | **0.37** | **7.74** | **2.17** | **671.40** | **447.11** | **3863.56** | **12.56** |
| A. Mineral Products | 1866.54 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1866.54 | 6.07 |
| B. Chemical Industry | 870.40 | 7.74 | 7.74 | 2.17 | 671.40 | NO | 1549.55 | 5.04 |
| C. Metal Production | 0.37 | NE,NO | NE,NO | NO | NO | NO | 0.37 | 0.00 |
| D. Other Production | NE | NO | NO | NO | NO | NO | NE | NE |
| E. Prod. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | NO | NA,NO | NA,NO |
| F. Cons. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | 447.11 | 447.11 | 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** | **46.40** | **974.36** | **7.88** | **2443.79** | **NO** | **3418.15** | **11.11** |
| A. Enteric Fermentation | NO | 38.84 | 815.70 | 0.00 | 0.00 | NO | 815.70 | 2.65 |
| B. Manure Management | NO | 7.56 | 158.66 | 0.73 | 226.34 | NO | 385.00 | 1.25 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 7.15 | 2217.45 | NO | 2217.45 | 7.21 |
| 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** | **-7490.30** | **0.00** | **0.00** | **0.00** | **0.00** | **NO** | **-7490.29** | **-24.34** |
| A. Forest Land | -7490.30 | 0.00 | 0.00 | 0.00 | 0.00 | NO | -7490.29 | -24.34 |
| 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** | **0.28** | **87.28** | **NO** | **839.98** | **2.73** |
| 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 | 0.28 | 87.28 | NO | 279.63 | 0.91 |
| 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** | **16038.01** | **158.95** | **3337.86** | **11.04** | **3421.23** | **447.11** | **23278.93** | **75.66** |
| **Total Emissions without LUCF** | **23528.31** | **158.95** | **3337.86** | **11.04** | **3421.23** | **447.11** | **30769.22** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **68.89** | | **14.34** | | **14.70** | | **100.00** | |
| **Share of Gases in Total Emissions** | **76.47** | | **10.85** | | **11.12** | | **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** | 1,586.18 | NO | NO | NO | NO | NO | 1586.18 | |

*Table A7-18: GHG emission in Croatia, 2007*

| Croatia | $CO_2$ | $CH_4$ | | $N_2O$ | | HFC, PFC,$SF_6$ | Total | Share |
|---|---|---|---|---|---|---|---|---|
| Year 2007 | Gg | Gg | Gg $CO_2$eq | Gg | Gg $CO_2$eq | Gg $CO_2$eq | Gg $CO_2$eq | % |
| **1. Energy** | **21824.72** | **82.72** | **1737.17** | **0.78** | **240.67** | **NO** | **23802.55** | **73.50** |
| A. Fuel Comb (Sectoral Appr.) | 21159.72 | 5.68 | 119.37 | 1.15 | 240.67 | NO | 21519.75 | 66.45 |
| 1. Energy Industries | 7638.81 | 0.22 | 4.64 | 0.09 | 18.79 | NO | 7662.24 | 23.66 |
| 2. Man. Ind. and Constr. | 3874.22 | 0.33 | 6.83 | 0.05 | 10.81 | NO | 3891.86 | 12.02 |
| 3. Transport | 6345.27 | 1.55 | 32.51 | 0.92 | 192.26 | NO | 6570.03 | 20.29 |
| 4. Comm./Inst, Resid., Agric. | 3301.42 | 3.59 | 75.40 | 0.09 | 18.81 | NO | 3395.63 | 10.49 |
| 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 | 7.05 |
| 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 | 7.05 |
| **2. Industrial Processes** | **2842.08** | **0.34** | **7.14** | **2.39** | **741.61** | **481.79** | **4072.62** | **12.58** |
| A. Mineral Products | 1896.72 | NE,NO | NE,NO | NE,NO | NE,NO | NO | 1896.72 | 5.86 |
| B. Chemical Industry | 945.00 | 7.14 | 7.14 | 2.39 | 741.61 | NO | 1693.75 | 5.23 |
| C. Metal Production | 0.35 | NE,NO | NE,NO | NO | NO | NO | 0.35 | 0.00 |
| D. Other Production | NE | NO | NO | NO | NO | NO | NE | NE |
| E. Prod. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | NO | NA,NO | NA,NO |
| F. Cons. of Halocarbons & $SF_6$ | NO | NO | NO | NO | NO | 481.79 | 481.79 | 1.49 |
| G. Other | NO | NO | NO | NO | NO | NO | NA,NO | NA,NO |
| **3. Solvent and Other Product Use** | **197.80** | **NO** | **NO** | **0.11** | **34.72** | **NO** | **232.52** | **0.72** |
| **4. Agriculture** | **NO** | **45.47** | **954.85** | **7.92** | **2454.81** | **NO** | **3409.66** | **10.53** |
| A. Enteric Fermentation | NO | 37.52 | 787.92 | 0.00 | 0.00 | NO | 787.92 | 2.43 |
| B. Manure Management | NO | 7.95 | 166.93 | 0.72 | 222.83 | NO | 389.75 | 1.20 |
| C. Rice Cultivation | NO | NO | NO | 0.00 | 0.00 | NO | NO | NO |
| D. Agricultural Soils | NO | NO | NO | 7.20 | 2231.99 | NO | 2231.99 | 6.89 |
| 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** | **-6302.65** | **0.00** | **0.01** | **0.00** | **0.00** | **NO** | **-6302.63** | **-19.46** |
| A. Forest Land | -6302.65 | 0.00 | 0.01 | 0.00 | 0.00 | NO | -6302.63 | -19.46 |
| 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** | **37.25** | **782.33** | **0.27** | **85.19** | **NO** | **867.60** | **2.68** |
| A. Solid Waste Disp. on Land | NE,NO | 28.70 | 602.71 | 0.00 | 0.00 | NO | 602.71 | 1.86 |
| B. Waste-water Handling | 0.00 | 8.55 | 179.61 | 0.27 | 85.19 | NO | 264.81 | 0.82 |
| 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** | **18562.03** | **165.79** | **3481.49** | **11.36** | **3522.29** | **481.79** | **26082.32** | **80.54** |
| **Total Emissions without LUCF** | **24864.67** | **165.78** | **3481.49** | **11.36** | **3522.29** | **481.79** | **32384.95** | **100.0** |
| **Share of Gases in Total Em./Rem.** | **71.17** | | **13.35** | | **13.50** | | **100.00** | |
| **Share of Gases in Total Emissions** | **76.78** | | **10.75** | | **10.88** | | **100.00** | |
| **Memo Items:** | | | | | | | | |
| **International Bunkers** | 318.34 | 0.01 | 0.21 | 0.01 | 3.37 | NO | 321.92 | |
| Aviation | 242.68 | 0.01 | 0.11 | 0.01 | 3.19 | NO | 245.98 | |
| 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** | 1,430.99 | NO | NO | NO | NO | NO | 1430.99 | |

# ANNEX 8

# DECISION 7/CP.12

## Decision 7/CP.12

## Level of emissions for the base year of Croatia

*The Conference of the Parties,*

*Recalling* Article 4, paragraph 6, of the Convention,

*Responding* to the request of the Government of Croatia that its base year greenhouse gas emissions be considered in accordance with Article 4, paragraph 6, of the Convention,

*Recalling* decisions 9/CP.2, 11/CP.4 and 10/CP.11,

*Taking into account* the submission from Croatia contained in FCCC/SBI/2006/MISC.1,

*Noting* the report of the individual review of the greenhouse gas inventory of Croatia submitted in 2004 and contained in FCCC/WEB/IRI/2004/HRV, which, inter alia, recognized that the greenhouse gas inventory of Croatia does not contain emissions from power plants outside the boundaries of Croatia for 1990 or subsequent years,

*Noting* that this decision has no implications for historical emission levels of any other Party, in particular for Bosnia and Herzegovina, Serbia, and Montenegro,[1]

*Considering* that the flexibility under Article 4, paragraph 6, of the Convention to choose a base year different from 1990, in order to take into account the economic circumstances of countries undergoing the process of transition to a market economy, has previously been invoked by five Parties,

*Considering* the specific circumstances of Croatia with regard to greenhouse gas emissions before and after 1990, and the structure of the electricity generation sector of the former Yugoslavia,

*Noting* the intention that the approach taken should be conservative, and that unduly high flexibility should not be provided,

1. *Notes* that the inventory reported in 2004 showed the total greenhouse gas emissions in 1990 to be 31.7 Mt $CO_2$ equivalent;

2. *Decides* that Croatia, having invoked Article 4, paragraph 6, of the Convention, shall be allowed to add 3.5 Mt $CO_2$ equivalent to its 1990 level of greenhouse gas emissions not controlled by the Montreal Protocol for the purpose of establishing the level of emissions for the base year for implementation of its commitments under Article 4, paragraph 2, of the Convention.

*7th plenary meeting*
*17 November 2006*

[1] Montenegro is currently an observer State to the UNFCCC.