21 October 2003

ENGLISH ONLY

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

SUBSIDIARY BODY FOR IMPLEMENTATION
Nineteenth session
Milan, 1–9 December 2003
Item 10 (b) of the provisional agenda

OTHER MATTERS

SPECIAL CIRCUMSTANCES OF CROATIA UNDER ARTICLE 4, PARAGRAPH 6, OF THE CONVENTION

Submission from a Party

1. The Subsidiary Body for Implementation (SBI), at its eighteenth session, invited Croatia to submit, by 30 September 2003, inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not covered by the Montreal Protocol, by year, including data from 1990 or an earlier year to the latest inventory year available. The SBI also invited Croatia to submit projections of its greenhouse gas emissions consistent with inventory data.

2. The secretariat has received a submission in response to the invitation above. In accordance with the procedure for miscellaneous documents, the submission is attached and reproduced* in the language in which it was received and without formal editing.

3. In this document only the executive summary of the inventory report and the full report of the projections are included. The full submission, including the full text of the inventory report and the projections report, is available at http://unfccc.int/resource/docs/natc/cronc1add.pdf

---

* This submission has been electronically imported in order to make it available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the text as submitted.

CONTENTS

SUBMISSION FROM CROATIA

Zagreb, 30 September 2003

SUBJECT: Submission by Croatia related to the matter of the special circumstances of Croatia under Article 4, paragraph 6 of the UNFCCC Convention

Enclosed, please find Croatia's inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, by year, including data from 1990 to 2001, as well as projections of its greenhouse gas emissions, consistent with inventory data in accordance with Decision FCCC/SBI/2003/L.7 related to the matter of the special circumstances of Croatia under Article 4, paragraph 6 of the UNFCCC Convention.

The provided data and information are based on the requirements of Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories as well as the "UNFCCC guidelines for the preparation of national communication by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories" contained in the annex to decision 3/CP.5 and presented in formats as those specified in document FCCC/CP/1999/7.

The submitted documents do not include Croatian special circumstances related to gaining of independence after the dissolution of the former Yugoslavia, as already described in the First National Communication of the Republic of Croatia to the UNFCCC as well as in the Croatian request for base year determination referring to Article 4, para 6 of the Convention, submitted on COP 7 in Marrakech.

Minister
Ivo Banac

EXECUTIVE SUMMARY

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

In 1996 the Republic of Croatia became a party to the United Nations Framework Convention on Climate Change (UNFCCC) pursuant to the Parliament's decision on its ratification (Gazette 55/1966). By this decision and the Article 22 of the Convention and as a country undergoing the process of transformation to the market economy, the Republic of Croatia has assumed the scope of its commitments under the Annex I to the Convention. Among other obligations, Croatia undertook to maintain the emission of greenhouse gases to the 1990 level.

The Republic of Croatia has signed the Kyoto Protocol according to which, when it becomes operative and is ratified by the Parliament, it will have to reduce the greenhouse gas emission by 5 per cent in the 2008-2012 period as compared to the base year. The Kyoto Protocol provides the possibility for the countries to meet their commitments by “domestic” measures and, additionally, by applying the joint implementation (JI) mechanism, clean development mechanism (CDM), or emission trading (ET).

One of the essential steps in a systematic consideration of the climate change issues and their solving is the development of a greenhouse gas emission inventory. Even before the First National Communication made in compliance with the United Nation Framework Convention on Climate Change (hereinafter referred to as the Convention), the inventories of the pollutant emissions to air had been systematically made in Croatia for the most important greenhouse gases (CO2, CH4 and N2O) and other pollutants (SO2, NOx, CO, NMVOC, NH3, heavy metals and persistent organic compounds). Since 1995, the Ministry of Environmental Protection and Physical Planning has been regularly preparing its annual reports of the pollutant emissions. The experience and the know-how in GHG inventory preparation of EKONERG’s experts gained during the development of the First National Communication has played an important role in making the inventory and this report.

This inventory report comprises greenhouse gas emissions in the Republic of Croatia for the period 1990-2001. The structure of inventory report is in line with Annex I of the Guidelines for the preparation of national communication by parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (FCCC/CP/2002/8). The methodology used for emissions calculation is in line with the Revised 1996 IPCC Guidelines for National GHG Inventories (IPCC/UNEP/OECD/IEA) and Good Practice Guidance and Uncertainty Management in National GHG Inventories, 2000 (IPCC/NGGIP), recommended by the UNFCCC. The available methodology and a systematic approach insure that the principles of transparency, consistency, comparability, completeness and accuracy of calculations could be achieved. The methodology additionally requires uncertainty assessments of input data and the results of calculations and verification in order to improve the quality and reliability of the inventory.

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

The emissions of individual greenhouse gases can be expressed in an aggregated form taking into consideration their different radiation properties. The global warming potential (GWP) values were used for comparison. The reference gas CO2 (GWP=1) and 100 year time horizon is used.

Overall decline of economic activities and energy consumption in the period 1991-1995, 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, which was considerably reflected in GHG emissions. Emissions have started to increase in the period 1996-2001 in average of 3.2 per cent per year, because of revitalisation of economy.

The shares of emission by greenhouse gases have not significantly changed during entire period. The CO_2 is the largest anthropogenic contributor to total national GHG emissions. In 2001 the shares of GHG emissions were as follows: 75.9 per cent CO_2, 12.4 per cent CH_4, 11.5 per cent N_2O and 0.2 per cent HFCs. The trend of aggregated emissions/removals, for the period 1990-2001, is shown in tables ES.2-1 and ES.2-2 and the figure ES.2-1.

Table ES.2-1: *Aggregated emissions and removals of GHG by sectors (1990-2001)*

Source	Emissions and removals of GHG (eq-CO_2)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Energy	22463	16568	15467	16526	15499	16353	17076	18037	18872	19256	18817	19875
Industrial Processes	3892	2976	2653	2066	2317	2021	2095	2365	2002	2454	2815	2785
Agriculture	4321	4344	4060	3277	3109	2891	3192	3479	3186	3282	3303	3036
Waste	933	917	901	913	937	995	983	1034	1082	1160	1162	1163
Total	**31609**	**24804**	**23082**	**22783**	**21862**	**22259**	**23347**	**24915**	**25142**	**26151**	**26097**	**26859**
Removals (LUCF)	-6505	-6505	-6505	-6505	-6505	-6505	-8069	-8069	-8069	-8069	-8069	-8069
NET EMISSION	**25104**	**18299**	**16577**	**16278**	**15357**	**15754**	**15278**	**16845**	**17073**	**18082**	**18028**	**18790**

Table ES.2-2: *Aggregated emissions and removals of GHG by gases (1990-2001)*

Gas	Emissions and removals of GHG (eq-CO_2)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Carbon dioxide (CO_2)	22970	16702	15764	16399	15674	16251	16976	18057	18956	19678	19379	20390
Methane (CH_4)	3815	3611	3419	3291	3099	3104	3146	3243	3099	3179	3210	3332
Nitrous oxide (N_2O)	3886	3843	3898	3093	3089	2896	3165	3523	3070	3285	3484	3088
HFCs, PFCs and SF_6	939	648	0	0	0	8	60	91	18	9	23	49
Total	**31609**	**24804**	**23082**	**22783**	**21862**	**22259**	**23347**	**24915**	**25142**	**26151**	**26097**	**26859**
Removals (CO_2)	-6505	-6505	-6505	-6505	-6505	-6505	-8069	-8069	-8069	-8069	-8069	-8069
NET EMISSION	**25104**	**18299**	**16577**	**16278**	**15357**	**15754**	**15278**	**16845**	**17073**	**18082**	**18028**	**18790**

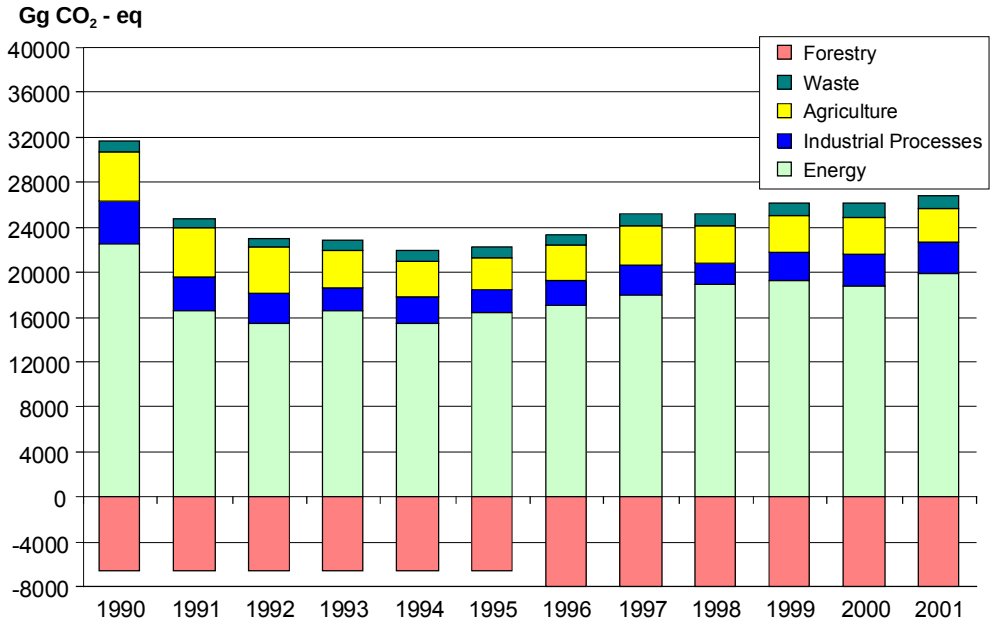


Figure ES.2-1: Trend of total emissions/removals of GHGs from 1990 to 2001

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

ES.3.1. CARBON DIOXIDE EMISSIONS

The most significant anthropogenic source of CO_2 is the energy sector (mainly fossil fuel combustion) and some industrial processes (e.g. cement production). The results of CO_2 emission estimates in the period 1990-2001 are shown in table ES.3-1. More detailed information on CO_2 emissions from various sectors (according to IPCC methodology) are given in the text below.

Table ES.3-1: Total CO_2 emissions and removals in the period 1990-2001

Source	CO_2 emissions and removals (Gg)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Energy	20959	15201	14187	15146	14235	15082	15727	16607	17594	17966	17448	18379
Industrial Processes	2011	1501	1578	1253	1439	1170	1250	1450	1362	1713	1932	2011
Forest (sink)	-6505	-6505	-6505	-6505	-6505	-6505	-8069	-8069	-8069	-8069	-8069	-8069
Total	22970	16702	15765	16399	15674	16251	16976	18057	18956	19679	19379	20390
NET EMISSION	16465	10197	9259	9894	9169	9746	8907	9988	10887	11610	11310	12321

Energy

This sector covers all activities that involve fuel consumption (fuel combustion and non–energy use of fuel) and fugitive emissions from fuels. The fuel fugitive emissions are generated during production, transport, processing, storing, and distribution of fossil fuels. Emissions from fossil

fuel combustion comprise the majority (more then 90 per cent) of energy-related emissions. The results of CO2 emission estimates for energy subsectors in the period 1990-2001 are shown in table ES.3-2.

Table ES.3-2: CO_2 emission estimates for energy subsectors in the period 1990-2001

Energy	CO_2 emissions (Gg)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Energy Industries	5897	3847	4514	5185	3925	4460	4310	4875	5531	5699	5156	5650
Manufacturing Industries and Construction	6546	4732	3730	3658	3815	3617	3763	3714	4008	3729	3805	3903
Transport (Road & Off-Road)	4046	2917	2781	2949	3124	3337	3668	4013	4163	4394	4396	4459
Other sectors (Comm./Inst.,	3616	3003	2495	2484	2568	2778	3136	3180	3107	3513	3359	3576
Other (non-energy fuel consumption)	439	246	189	194	199	193	206	225	196	105	99	102
Total	**20543**	**14745**	**13709**	**14470**	**13630**	**14385**	**15083**	**16007**	**17005**	**17441**	**16814**	**17691**

The methodology used for estimating CO2 emissions follows the Revised 1996 IPCC Guidelines. Emission estimates are based on fuel consumption data given in National Energy Balance (Energy Institute "Hrvoje Požar"), where energy demand and supply is given at sufficiently detailed level, what allows emissions estimation by sectors and subsectors (IPCC Methodology, Sectoral approach). Also, the CO2 emission is estimated by Reference approach, which considered only total energy balance, without subsectors analyses. Comparison between these approaches was made, and the difference is not greater than 5.2 per cent (Table ES.3-3 and table A2-6 in Annex 2).

- ***Table ES.3-3: CO_2 emission comparison due to fuel combustion***

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Reference Approach (Tg)	19.94	14.19	13.23	13.72	13.59	14.06	14.83	15.37	16.59	17.28	16.62	17.51
Sectoral Approach (Tg)	20.54	14.74	13.71	14.47	13.63	14.38	15.08	16.01	17.00	17.44	16.81	17.69
Relative Difference (per cent)	2.92	3.78	3.46	5.18	0.33	2.29	1.66	3.97	2.35	0.87	1.17	1.03

According to calculation results there are two emission intensive subsectors in Energy sector i.e. Energy Industries and Manufacturing Industries and Construction.

Energy Industries comprise emissions from fuel combustion in thermal power and district heating plants, petroleum refining plants, solid transformation plants, oil and gas extraction and coal mining. It should be point out that a large part of the electrical energy is generated without CO2 emission (hydroelectric power plants, nuclear power plant Krško and import), therefore the emission from this sector is relatively small, 23-32 per cent of emission from Energy sector. The largest part (60 to 80 per cent) of the emissions is a consequence of fuel combustion in thermal power plants, following by the combustion in oil refineries 16-28 per cent.

Manufacturing industries and construction include the emissions from fuel combustion in different industries, such as industry of building materials (22-37 per cent), iron and steel industries, industries of non-ferrous metals, chemicals, pulp and paper, food processing, beverages, tobacco and others. This sector also includes the emissions from fuel used for the generation of electricity and heat in industry (industrial cogeneration and heating plants) with sectoral contribution of 43-57 per cent

Transport is also one of the important emission sources of CO2. The most of emission comes from road transport (86-94 per cent, depending on the year), then from rail transport and domestic air and marine transport. The emission of international aircraft or marine transport is excluded from the national total but is reported separately (Table A2-8 in Annex 2).

The emissions due to non-energy fuel consumption (fuels used as feedstock) 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 (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 CO2 emission because all carbon is bound to the product. In order to avoid double counting, CO2 emission in non-energy consumption of natural gases in ammonia production was estimated in sector Industrial processes. Detailed information about non-energy fuel consumption is presented in the table A2-11 in Annex 2.

CO2 emissions from biomass combustion are not included in total national GHG emission because emitted CO2 has been previously absorbed from the atmosphere for growth and development of biomass, as proposed by Revised 1996 IPCC Guidelines. Removal or emission of CO2 due to the changes in the forest biomass is estimated in the sector Land Use Change and Forestry.

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 (more for methane), specifically in Croatia emission of CO_2 from natural gas scrubbing is assigned here. Natural gas produced in Croatian gas fields has a large amount of CO_2, more than 15 per cent, and before coming to commercial pipeline (max. 3 per cent of CO_2) has to be cleaned (scrubbed). Emission estimation from natural gas scrubbing is done by material balance method and it is up to 5 per cent of CO_2 emission in Energy sector (tables 2.5-2 and 2.6-1).

Industrial processes

Greenhouse gas emissions are produced as by-products of non-energy industrial processes in which raw materials are chemically transformed to final products. Industrial processes whose contribution to CO2 emissions is identified as significant are production of cement, lime, ammonia, ferroalloy, as well as use of limestone and soda ash in different industrial activities.

The general methodology applied to estimate emissions associated with each industrial process, recommended by Revised 1996 IPCC Guidelines, involves the product of amount of material produced or consumed, and an associated emission factor per unit of consumption/production. The activity data on consumption/production for particular industrial processes were, in most cases, extracted from Monthly Industrial Reports, published by Central Bureau of Statistics, Department of Manufacturing and Mining. Certain activity data were collected from voluntary survey of manufacturers and cross-checked with statistical data. The results of CO2 emission estimates for industrial processes in the period 1990-2001 are shown in table ES.3-4.

Table ES.3-4: CO_2 emission estimates for industrial processes in the period 1990-2001

Industrial Processes	CO_2 emissions (Gg)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Cement production	1022.	647.5	774.7	648.5	793.8	584.9	634.0	753.5	811.4	1072.	1242.	1419.
Lime production	145.1	86.9	54.5	60.3	59.7	62.3	79.3	101.8	105.9	102.7	124.5	143.7
Limestone and dol. use	18.9	15.7	10.5	9.6	15.5	11.2	8.5	7.3	8.6	8.0	8.4	9.2
Soda ash prod. and use	25.7	21.8	14.7	12.5	15.2	14.4	11.4	9.7	11.5	10.6	11.0	12.4
Ammonia production	491.6	471.5	606.8	471.3	474.7	462.9	502.7	546.2	409.7	519.1	525.3	425.9
Ferroalloys production	194.9	181.4	116.7	50.9	79.9	33.9	13.7	31.5	15.4	0.0	20.5	0.5
Aluminium production	111.4	76.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**2011**	**1501**	**1578**	**1253**	**1439**	**1170**	**1250**	**1450**	**1362**	**1713**	**1932**	**2011**

Most significant CO2 industrial processes emission source is cement production (with 40 to 70 per cent of total CO2 emissions in sector) and ammonia production (with 20 to 40 per cent of total CO2 emissions in sector). Generally, CO2 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 1996-2001 emissions were approached to emission in 1990. Some productions, such as iron, steel and aluminium were halted in 1992.

The quantity of the CO2 emitted during cement production is directly proportional to the lime content of the clinker. Therefore, estimation of CO2 emissions is accomplished by applying an emission factor, in tonnes of CO2 released per tonne of clinker produced, to the annual clinker output corrected with the fraction of clinker that is lost from the kiln in the form of Cement Kiln Dust (CKD). The emission factor and correction factor for CKD is determined according to Revised 1996 IPCC Guidelines and Good Practice Guidance. The activity data for clinker production were collected from voluntary 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.

Emissions of CO2 from ammonia production were calculated by multiplying annual consumption of natural gas used as a feedstock in process by carbon content of natural gas. Data on consumption and composition of natural gas used as a feedstock in a process were collected from voluntary survey of ammonia manufacturer and cross-checked with statistical data. CO2 which was produced as a by-product during the production of ammonia was used as a feedstock in the production of urea. Emissions of intermediately bound CO2 occurred during the use of urea as a fertilizer in agriculture and should be reported perhaps under agriculture sector. According to Revised 1996 IPCC Guidelines no account should consequently be taken for intermediate binding of CO2 in production of urea, dry ice and fertilizer. Therefore, total CO2 emissions of natural gas used as a feedstock in ammonia production were reported here.

Removals

According to General Forest Management Plan of the Republic of Croatia forests and forest land in Croatia cover 43.5 per cent of the whole area. In Croatia forests were formed by natural regeneration over 95 per cent of the area and 5 per cent of the forests are grown artificially. Of all forested area and forest land, 2,061,609 ha (84 per cent) is under forests, 315,166 ha (13 per cent) is non – forest productive land, and 80,973 ha (3 per cent) is bare unproductive and infertile soil.

Only changes in forest and other woody biomass stocks are included in the estimates of CO_2 emissions here, because insufficient data were available to estimate emission from forest and grassland conversion, abandonment of croplands, pastures, plantation forests and changes in soil carbon.

Annual increment in Croatian forests is 9,643,000 m3 of wood. Increment is an increase in forest wood stock over a certain time period. It is calculated as annual, periodical and average increment. Different methods have been developed in forest management to identify the forest increment. The methods mostly used in Croatia are a check method and a method of bore-spills. Different methods of forest cultivation can make the increment larger both in terms of their quantity and quality. A described cut is a part of the forest wood stock planned for commercial cutting over a time period (1 year, 10 years, 20 years) expressed in wood stock (m3, m3/ha) or in an area (ha). In order to satisfy the basic principal of forest management and a principle of sustainability the described cut shall not be larger than the increment value.

The methodology used for estimating net uptake of CO2 follows the Revised 1996 IPCC Guidelines, based on annual increment of biomass in forests and wood harvest. The net carbon uptake due to these two sources was then calculated and expressed as CO2. Due to long term nature of changes in forestry same annual emission estimate was given for the period 1990-1995 (6505 Gg CO2) and for the period 1996-2001 (8069 Gg CO2).

The most important human activity that affects forest carbon fluxes is deforestation. In Croatia, the problem of deforestation does not exist. According to the current data, the total forest area has not been reduced in the last 100 years.

ES.3.2. METHANE EMISSIONS

In Croatia, the major sources of methane are agriculture, municipal solid waste disposal on land and fugitive emission from fuel production, processing, transportation and using activities. The results of CH4 emission estimates in the period 1990-2001 are shown in table ES.3-5.

Livestock farming in agriculture is the major anthropogenic source of methane emissions in Croatia. CH4 is formed as a direct product of the metabolism of herbivorous animals (enteric fermentation) and as the product of organic degradation of animal waste (manure management). The methods presented in Revised 1996 IPCC Guidelines were used and form the basis of the methane emissions estimates for each animal type. General decrease of economic activities during the period from 1990 to 1995 influenced decreasing of animal's number and thus CH4 emissions decreased considerably as well.

Table ES.3-5: CH_4 emission estimates in the period 1990-2001

Source	CH_4 emissions (Gg)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Energy	67.8	62.5	58.7	63.4	57.9	58.2	61.2	64.3	56.4	56.1	58.7	63.9
Industrial processes	0.8	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3
Agriculture	75.3	71.9	67.1	55.6	50.8	48.1	45.3	44.5	43.1	43.9	42.6	43.1
Waste	37.8	37.0	36.6	37.2	38.4	41.2	42.9	45.3	47.8	51.1	51.3	51.3
Total	**182**	**172**	**163**	**157**	**148**	**148**	**150**	**154**	**148**	**151**	**153**	**159**

Methane (CH4) emissions from solid waste disposal sites (SWDSs) result from anaerobic decomposition of organic wastes by methanogenic bacteria. The default methodology was used for estimating CH4 emissions according to Revised 1996 IPCC Guidelines. The quantity of the CH4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste. DOC was estimated by using country-specific data and according to that data fraction of DOC in municipal solid waste (MSW) was estimated to be 0.17. In wastewater treatment aerobic biological processes are used mostly. According to national wastewater experts anaerobic treatment is applied in some wastewater treatment. Total amount of gas is flared in these treatments, and therefore all methane from gas is oxidized to carbon dioxide and water vapour.

The fugitive emission estimates were calculated by proposed IPCC methodology. The fugitive emission of methane is mainly (about 97 per cent) the consequence of production, transmission and distribution of natural gas. The fugitive emission from oil accounts for about 1 per cent and venting and flaring of gas/oil production accounts for approximately 2 per cent (table A2-19 in Annex 2). The fugitive CH4 emissions based on mining and processing of coal are reduced significantly after closing the underground coal mines in Istria in 1999.

ES.3.3. NITROUS OXIDE EMISSIONS

The most important sources of N2O emission in Croatia are agriculture and nitric acid production. The results of N2O emission estimates in the period 1990-2001 are shown in table ES.3-6.

Table ES.3-6: N_2O *emission estimates in the period 1990-2001*

Source	N_2O emissions (Gg)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Energy	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5
Industrial processes	3.0	2.6	3.4	2.6	2.8	2.7	2.5	2.6	2.0	2.3	2.8	2.3
Agriculture	8.8	9.1	8.6	6.8	6.6	6.1	7.2	8.2	7.4	7.6	7.8	6.9
Waste	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Total	**12.5**	**12.4**	**12.6**	**10.0**	**10.0**	**9.3**	**10.2**	**11.4**	**9.9**	**10.6**	**11.2**	**10.0**

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 N2O emitted. Three sources of N2O are distinguished in the methodology we used: direct emissions from agricultural soils, direct soil emissions from animal production and N2O emissions indirectly induced by agricultural activities. Direct emissions N2O from agricultural soils, with largest emission between mentioned sources, includes total amount of nitrogen to soils through cropping practices. These practices includes application of synthetic fertilizer, nitrogen from animal waste, production of nitrogen – fixing crops, nitrogen from crop residue mineralisation and soil nitrogen mineralisation due to cultivation of histosols. Annual synthetic fertilizer consumption data were taken from Croatian Statistical Reports and appropriate methodology and emission factor (default values) to give direct soil emission from synthetic fertilizer, are taken from Revised 1996 IPCC Guidelines.

In Industrial processes N2O is only generated as a by-product in nitric acid production. Emissions were calculated by proposed IPCC methodology (by multiplying annual nitric acid production with emission factor which reflects the process type, i.e. dual pressure type, according to Good Practice Guidance).

Concerning Waste sector indirect N2O emissions from human sewage, using the Revised 1996 IPCC Guidelines, are calculated based on population data and annual per capita protein consumption.

Emissions in energy sector were calculated on the basis of the fossil fuel consumption balance, applying emission factors from the Revised 1996 IPCC Guidelines.

ES.3.4. HALOGENATED CARBONS (HFCs, PFCs) AND SF_6 EMISSIONS

Synthetic greenhouse gases include halogenated carbons (HFCs and PFCs) and sulphur hexafluoride (SF6). 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.

PFC (CF4 and C2F6) emissions are generated in the production of primary aluminium. The Croatian aluminium industry was still operational in 1990/1991, but production was stopped in 1992. Activity data (production of primary aluminium) and adequate emission factors (proposed by Revised 1996 IPCC Guidelines) were used to calculate emissions.

A certain amount of SF6 is contained in electrical equipment used in the facilities of Croatian National Electricity (Hrvatska elektroprivreda). Equipment manufacturers guarantee annual leakage of less than 1 per cent, so this information could be used to determine the SF6 emissions. However, it is still not included in the inventory because the input data are not reliable.

Also, some emissions are released by the handling and consumption of synthetic greenhouse gases. HFCs and PFCs are used as substitutes for cooling gases in refrigerating and air-conditioning systems that deplete the ozone layer. The survey carried out among the major agents, users and consumers of these gases and information related to import and export of HFCs in the period 1995-2001, provided by Ministry of Environmental Protection and Physical Planning, was used to calculate emissions. According to this information potential HFCs emissions (proposed by Revised 1996 IPCC Guidelines) were calculated by difference of import and export of these gases.

ES.4. OTHER RELEVANT INFORMATION

ES.4.1. EMISSIONS OF INDIRECT GREENHOUSE GASES

Although they are not considered as greenhouse gases, photochemical active gases such as carbon monoxide (CO), oxides of nitrogen (NOx) 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 effect the creation and degradation of O3 as one of the GHGs. Sulphur dioxide (SO2), as a precursor of sulphate and aerosols, is believed to contribute negatively to the greenhouse effect. The calculation aggregate results for the emissions of indirect gases in the period 1990-2001 are given in table ES.4-1.

Table ES.4-1: Emissions of indirect GHG by different sectors in the period 1990-2001

Gas	Emissions (Gg)											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
NO_x Emission	**91.8**	**67.9**	**64.5**	**67.5**	**66.1**	**68.1**	**74.8**	**77.9**	**81.7**	**85.6**	**86.2**	**87.9**
Energy Industries	16.4	10.9	12.7	14.5	10.8	12.1	11.6	13.4	15.1	15.5	14.6	16.0
Manuf. Ind. & Constr.	18.0	13.3	10.6	10.4	10.8	10.1	10.5	10.5	11.2	10.3	10.6	10.8
Transport	38.8	29.2	28.7	29.8	31.0	33.1	37.4	40.4	41.3	43.5	43.5	44.5
Other Energy	17.9	14.1	12.2	12.6	13.2	12.5	15.0	13.3	13.9	16.0	17.2	16.3
Industrial Processes	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3
Agriculture*	0.2											
CO Emission	**486.7**	**348.7**	**298.7**	**298.5**	**317.5**	**331.8**	**332.0**	**352.8**	**364.5**	**380.2**	**391.4**	**365.7**
Energy Industries	1.4	1.0	1.1	1.3	1.0	1.0	1.1	1.2	1.3	1.3	1.3	1.4
Manuf. Ind. & Constr.	11.1	9.5	7.7	7.6	6.4	6.6	6.5	7.9	7.6	5.9	6.0	5.5
Transport	290.5	219.3	193.2	191.0	208.6	219.6	240.8	262.3	283.1	298.3	300.1	292.0
Other Energy	166.2	109.1	93.2	95.7	98.5	101.3	80.4	78.0	69.9	71.4	80.7	64.0
Industrial Processes	13.1	9.8	3.5	2.9	3.0	3.3	3.2	3.4	2.6	3.2	3.3	2.7
Agriculture*	4.3											
NMVOC Emission	**561.2**	**508.0**	**428.4**	**416.8**	**320.3**	**323.0**	**205.4**	**260.0**	**257.6**	**271.5**	**258.5**	**219.1**
Energy Industries	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Manuf. Ind. & Constr.	0.9	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4
Transport	54.8	41.3	36.4	36.1	39.4	41.5	45.6	49.6	53.5	56.4	56.7	55.2
Other Energy	55.3	36.7	31.7	37.3	38.4	40.4	10.4	9.9	9.0	9.3	10.5	8.5
Industrial Processes	419.4	396.8	335.6	317.3	214.3	212.9	118.4	172.4	168.8	183.2	165.3	130.6
Solvent Use	30.4	32.3	23.9	25.2	27.5	27.4	30.3	25.2	25.3	21.8	25.2	23.9
SO_2 Emission	**185.9**	**112.1**	**111.6**	**117.2**	**93.8**	**76.4**	**69.9**	**83.4**	**91.9**	**93.4**	**61.0**	**64.3**
Energy Industries	86.9	48.8	61.3	59.0	35.9	36.1	31.8	45.9	59.8	61.5	29.6	23.3
Manuf. Ind. & Constr.	62.7	34.3	30.5	37.5	40.3	26.0	17.9	18.1	15.2	14.5	12.5	26.6
Transport	5.8	9.5	5.6	6.3	4.6	3.6	9.4	8.2	7.1	7.1	8.7	4.9
Other Energy	24.1	14.9	8.7	10.7	8.7	6.0	6.4	7.0	6.2	6.1	5.8	6.2
Industrial Processes	6.3	4.6	5.5	3.7	4.3	4.7	4.5	4.2	3.6	4.2	4.4	3.3

* - Field burning of agricultural residues (data existed only for 1990)

ES.4.2. UNCERTAINTY EVALUATION AND VERIFICATION

Uncertainty evaluation

The uncertainty assessment of the calculation is one of the key elements of the national emission inventory. The information about the uncertainty does not dispute the calculation validity but helps with the identification of the priority measures for higher accuracy of the calculation and for selection of the methodological options. There are several reasons why the actual emissions and sinks are different in comparison with the figures obtained by the calculation. Totally quantified uncertainty of the emission from certain sources is a combination of some uncertainties of the emission estimate elements:
uncertainty related to the emission factors
uncertainty related to the activity data

The experts involved in making this GHG emissions/removals inventory have assessed for the first time the total uncertainty of the entire inventory for 2001 and the uncertainty of emission trend for the period from 1990 to 2001 following the guidelines given in the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. The approach used was the simpler Tier 1 Level approach.

The quantitative assessment of uncertainty is presented in the Annex 3 (Table A3-1). The total uncertainty of GHG emission estimate for 2001 has been assessed at 37 per cent whereas the trend uncertainty at 8 per cent. The higher reliability of trend is easy to understand and results from the calculation consistency, one of the basic principles of the IPCC methodology.

The uncertainty of the calculation of certain emissions from some sectors/sub-sectors is quantified and presented in Table ES.4-2 and categorized at three levels: to ±10 per cent high reliability level, from ±10 to ±50 per cent medium reliability level, and above ±50 per cent low reliability level.

Table ES.4-2: Qualitative analysis of uncertainty

High reliability level
• CO_2 Emissions from Fuel Combustion • CO_2 Emissions from Natural Gas Scrubbing • CO_2 Emissions from Industrial Processes (Cement and Ammonia Production)
Medium reliability level
• CH_4 Emissions from Fuel Combustion • CO_2 Emissions from Industrial Processes (Lime Production, Limestone and Dolomite Use, Soda Ash Production and Use, Iron and Steal Production, Ferroalloys Production, Aluminium Production) • CH_4 Emissions from Industrial Processes (Other Chemical Production) • N_2O Emissions from Industrial Processes (Nitric Acid Production) • N_2O Emissions from Human Sewage
Low reliability level
• N_2O Emissions from Fuel Combustion • CH_4 Fugitive Emissions from Coal Mining and Handling • CH_4 Fugitive Emissions from Oil and Natural Gas • HFC Emissions from HFC Consumption • CH_4 Emissions from Enteric Fermentation in Domestic Livestock • CH_4 and N_2O Emissions from Manure Management • N_2O Emissions from Agricultural Soils • CH_4 Emissions from Solid Waste Disposal Sites

Verification

The verification process of calculation is aimed at the improvement of the input quality and identification of the calculation reliability. The IPCC Guidelines recommends 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 CO2 emissions from fuel combustion calculated using national methods with the IPCC Reference Approach. Further verification checks may be done through an international co-operation and comparison with other national inventory calculation data. In the development of the Croatian inventory certain steps and some of these checks were performed:

- Two National Workshops on Emissions were organized with the participation of numerous experts and representatives from the relevant institutions and industry, where discussion and cross-checking on data from different sectors were performed and recommendations for improving of the quality of data and emissions inventory were given.
- Comparison with the national inventory data of other countries was conducted by comparing communications or through a direct communication.
- 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). The difference between them is not greater than 5.2 per cent (Tables ES.3-3 and A2-6 in Annex 2).
- The CO_2 emissions from road transport were estimated by the IPCC Tier 1 approach. Also, the rough estimate was done by using COPERT package methodology. The difference between estimated emissions is less than 2.5 per cent.

Also, Croatian interim and final communications on inventory calculations were submitted for a technical review organized by UNDP-National Communications Support Program (NCSP). The overall communication assessment was positive, and the detail technical comments have been accepted and appropriate corrections were made in this final inventory communication.

In March 2002, Croatia organized an In-depth review of the First National Communication, which also included the review of greenhouse gas inventory for the period 1990-1995. Generally, review team's opinion of the inventory quality was good. A comments and recommendations for the inventory improvement have been taken into account when making the inventory and this report.

ES.4.3. KEY SOURCES

The Annex I Parties to the Convention should identify their key emission sources for the base year, for the last year of inventory and for the emission trend. The key emission sources are the sources that substantially contribute to the total GHG emissions (95 per cent) with all the emissions presented as equivalent emission of CO2. The emissions from each source are summed up starting with the most significant to the less significant sources thus excluding from the emission key sources the least significant sources whose emissions cover the remaining 5 per cent.

Table ES.4-3 shows the emissions of key sources in Croatia obtained by analysing the total emission of the last year inventory (Level Assessment) and the trend analysis (Trend Assessment) according to the methodology given in the Good Practice Guidance and

Uncertainty Management in National Greenhouse Gas Inventories. A detailed outline of the emission key sources analysis is given in the Annex 3.

Table ES.4-3: Key sources of GHG emission in Croatia

IPCC Category Source	GHG	Level/Trend
ENERGY		
Stationary Sources - Coal	CO_2	Level, Trend
Stationary Sources – Liquid Fuel	CO_2	Level, Trend
Stationary Sources – Natural Gas	CO_2	Level, Trend
Stationary Sources – All Fuel	CH_4	Trend
Mobile Sources – Road Transport	CO_2	Level, Trend
Mobile Sources – Domestic Aviation Transport	CO_2	Trend
Mobile Sources – Agriculture/Forestry/Fishing	CO_2	Level, Trend
Mobile Sources – Road Transport	N_2O	Trend
Fugitive Sources – Natural Gas and Oil	CH_4	Level, Trend
Natural Gas Scrubbing* - CPS Molve	CO_2	Level, Trend
INDUSTRIAL PROCESSES		
Cement Production	CO_2	Level, Trend
Ammonia Production	CO_2	Level
Ferroalloys Production	CO_2	Trend
Nitric Acid Production	N_2O	Level, Trend
AGRICULTURE		
Enteric Fermentation	CH_4	Level, Trend
Manure Management	N_2O	Level
Direct N_2O Emission from Agricultural Soils	N_2O	Level, Trend
Indirect N_2O Emission from Nitrogen Used in Agriculture	N_2O	Level
WASTE		
Managed Waste Disposal on Land	CH_4	Level, Trend

*** CO_2 Emission from Natural Gas Scrubbing** – 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 per cent. The maximum volume content CO_2 in commercial natural gas is 3 per cent 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.

ANNEX 1

GREENHOUSE GAS EMISSION TREND

Table A1-1: Greenhouse gas emission in 1990, Croatia

Croatia	CO_2	CH_4		N_2O		HFC,PFC and SF_6		TOTAL	Share
Year 1990	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
Energy	**20959.42**	**67.81**	**1423.94**	**0.26**	**79.58**	**0.00**	**0.00**	**22462.9**	**71.07**
Energy Industries	5896.55	0.18	3.86	0.04	13.84			5914.2	18.71
Manufacturing Industries and Constr.	6545.89	0.51	10.66	0.07	20.40			6576.9	20.81
Transport	4046.04	0.78	16.32	0.04	12.54			4074.9	12.89
Domestic Aviation	*295.61*	*0.00*	*0.04*	*0.01*	*2.59*			*298.2*	*0.94*
Road	*3479.92*	*0.76*	*15.87*	*0.03*	*9.22*			*3505.0*	*11.09*
Railways	*137.53*	*0.01*	*0.21*	*0.00*	*0.39*			*138.1*	*0.44*
National Navigation	*132.98*	*0.01*	*0.19*	*0.00*	*0.34*			*133.5*	*0.42*
Other Sectors	3616.10	7.52	157.90	0.11	32.73			3806.7	12.04
Commercial/Institutional	*782.14*	*0.09*	*1.97*	*0.01*	*1.77*			*785.9*	*2.49*
Residential	*1994.78*	*7.36*	*154.63*	*0.09*	*28.92*			*2178.3*	*6.89*
Agriculture / Forestry/Fishing	*839.19*	*0.06*	*1.30*	*0.01*	*2.04*			*842.5*	*2.67*
Other *	438.89	0.01	0.18	0.00	0.07			439.2	1.39
Fugitive	415.95	58.81	1235.02					1651.0	5.22
Coal		*2.32*	*48.76*					*48.8*	*0.15*
Oil & Natural gas	*415.95*	*56.49*	*1186.26*					*1602.2*	*5.07*
Industrial Processes	**2010.47**	**0.75**	**15.80**	**2.99**	**927.56**	**0.14**	**938.60**	**3892.4**	**12.31**
Cement production	1022.90							1022.9	3.24
Lime production	145.07							145.1	0.46
Limestone and dolomite use	18.91							18.9	0.06
Soda ash production and use	25.74							25.7	0.08
Ammonia production	491.55							491.6	1.56
Nitric acid production				2.99	927.56			927.6	2.93
Product. of other chemicals		0.75	15.80					15.8	0.05
Iron and steel production								0.0	0.00
Ferroalloys production	194.93							194.9	0.62
Aluminium production	111.37							111.4	0.35
HFC, PFC and SF_6 **						0.14	938.60	938.6	2.97
Agriculture	**0.00**	**75.32**	**1581.76**	**8.83**	**2738.84**	**0.00**	**0.00**	**4320.6**	**13.67**
Enteric fermentation		64.06	1345.34		0.00			1345.3	4.26
Manure management		11.05	232.08	1.21	376.52			608.6	1.93
Agricultural soils management				7.62	2361.08			2361.1	7.47
Agricultural residue burning		0.21	4.34	0.00	1.24			5.6	0.02
Land-use Change & Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
Forest and other woody biomass stocks (sink)	-6505.13							-6505.1	-20.58
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**37.77**	**793.25**	**0.45**	**139.65**	**0.00**	**0.00**	**932.9**	**2.95**
Land Disposal of Solid Waste		37.77	793.25					793.3	2.51
Human Sewage				0.45	139.65			139.7	0.44
Other	**0.00**		**0.00**		**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**22969.89**	**181.65**	**3814.75**	**12.53**	**3885.63**	**0.14**	**938.60**	**31608.9**	**100.00**
NET EMISSIONS (Sources and Sinks)	**16464.76**	**181.65**	**3814.75**	**12.53**	**3885.63**	**0.14**	**938.60**	**25103.7**	
Share of Gases in Total Emissions (%)	**72.67**		**12.07**		**12.29**		**2.97**	**100.0**	
Share of Gases in Net Emissions (%)	**65.59**		**15.20**		**15.48**		**3.74**	**100.0**	
International aviation bunkers * **	**202.26**	**0.00**	**0.03**	**0.01**	**1.77**			**204.1**	
International marine bunkers * **	**108.54**	**0.01**	**0.15**	**0.00**	**0.27**			**109.0**	

* - non-energy fuel cons. and statistical difference

** - PFC: 0.13 CF_4 + 0.013 C_2F_6

*** - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-2: Greenhouse gas emission in 1991, Croatia

Croatia	CO_2	CH_4		N_2O		HFC,PFC and SF_6		TOTAL	Share
Year 1991	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
Energy	**15200.46**	**62.49**	**1312.35**	**0.18**	**54.83**	**0.00**	**0.00**	**16567.6**	**66.79**
Energy Industries	3846.95	0.12	2.51	0.03	9.29			3858.7	15.56
Manufacturing Industries and Constr.	4732.07	0.39	8.24	0.05	15.25			4755.6	19.17
Transport	2916.56	0.59	12.30	0.03	8.21			2937.1	11.84
Domestic Aviation	*80.90*	*0.00*	*0.01*	*0.00*	*0.71*			*81.6*	*0.33*
Road	*2581.14*	*0.57*	*11.92*	*0.02*	*6.84*			*2599.9*	*10.48*
Railways	*146.65*	*0.01*	*0.22*	*0.00*	*0.39*			*147.3*	*0.59*
National Navigation	*107.86*	*0.01*	0.15	*0.00*	*0.27*			*108.3*	*0.44*
Other Sectors	3003.32	4.92	103.22	0.07	22.08			3128.6	12.61
Commercial/Institutional	*539.80*	*0.07*	*1.37*	*0.00*	*1.18*			*542.3*	*2.19*
Residential	*1735.55*	*4.79*	*100.66*	*0.06*	*19.13*			*1855.3*	*7.48*
Agriculture / Forestry/Fishing	*727.97*	*0.06*	*1.19*	*0.01*	*1.76*			*730.9*	*2.95*
Other (non-energy fuel consumption)	245.73							245.7	0.99
Fugitive	455.83	56.48	1186.08					1641.9	6.62
Coal		*4.88*	*102.40*					*102.4*	*0.41*
Oil & Natural gas	*455.83*	*51.60*	*1083.68*					*1539.5*	*6.21*
Industrial Processes	**1501.16**	**0.55**	**11.49**	**2.63**	**814.67**	**0.10**	**648.30**	**2975.6**	**12.00**
Cement production	647.46							647.5	2.61
Lime production	86.93							86.9	0.35
Limestone and dolomite use	15.69							15.7	0.06
Soda ash production and use	21.75							21.8	0.09
Ammonia production	471.50							471.5	1.90
Nitric acid production				2.63	814.67			814.7	3.28
Product. of other chemicals		0.55	11.49					11.5	0.05
Iron and steel production								0.0	0.00
Ferroalloys production	181.42							181.4	0.73
Aluminium production	76.40							76.4	0.31
HFC, PFC and SF6 *						0.10	648.30	648.3	2.61
Agriculture	**0.00**	**71.91**	**1510.13**	**9.14**	**2833.80**	**0.00**	**0.00**	**4343.9**	**17.51**
Enteric fermentation		61.06	1282.29		0.00			1282.3	5.17
Manure management		10.85	227.84	1.17	361.27			589.1	2.38
Agricultural soils management				7.98	2472.52			2472.5	9.97
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
Forest and other woody biomass stocks (sink)	-6505.13							-6505.1	-26.23
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**37.02**	**777.52**	**0.45**	**139.39**	**0.00**	**0.00**	**916.9**	**3.70**
Land Disposal of Solid Waste		37.02	777.52					777.5	3.13
Human Sewage				0.45	139.39			139.4	0.56
Other	**0.00**		**0.00**		**0.00**			**0.0**	**0.00**
TOTAL EMISSIONS	**16701.61**	**171.98**	**3611.50**	**12.40**	**3842.68**	**0.10**	**648.30**	**24804.1**	**100.00**
NET EMISSIONS (Sources and Sinks)	**10196.48**	**171.98**	**3611.50**	**12.40**	**3842.68**	**0.10**	**648.30**	**18299.0**	
Share of Gases in Total Emissions (%)	**67.33**		**14.56**		**15.49**		**2.61**	**100.0**	
Share of Gases in Net Emissions (%)	**55.72**		**19.74**		**21.00**		**3.54**	**100.0**	
International aviation bunkers **	**17.11**	**0.00**	**0.00**	**0.00**	**0.15**			**17.3**	
International marine bunkers **	**71.34**	**0.00**	**0.10**	**0.00**	**0.18**			**71.6**	

*- PFC: 0.087 CF_4 + 0.009 C_2F_6

** - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-3: Greenhouse gas emission in 1992, Croatia

Croatia Year 1992	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO2eq)	N_2O (Gg)	N_2O (Gg CO2eq)	HFC, PFC and SF_6 (Gg)	HFC, PFC and SF_6 (Gg CO2eq)	TOTAL (Gg CO2eq)	Share %
Energy	**14186.64**	**58.69**	**1232.51**	**0.16**	**48.55**	**0.00**	**0.00**	**15467.7**	**67.01**
Energy Industries	4514.10	0.14	2.86	0.03	10.79			4527.7	19.62
Manufacturing Industries and Constr.	3730.07	0.32	6.68	0.04	11.74			3748.5	16.24
Transport	2781.33	0.52	11.01	0.02	7.44			2799.8	12.13
Domestic Aviation	*32.05*	*0.00*	*0.00*	*0.00*	*0.28*			*32.3*	*0.14*
Road	*2485.77*	*0.51*	*10.62*	*0.02*	*6.49*			*2502.9*	*10.84*
Railways	*96.72*	*0.01*	*0.14*	*0.00*	*0.25*			*97.1*	*0.42*
National Navigation	*166.79*	*0.01*	*0.24*	*0.00*	*0.42*			*167.5*	*0.73*
Other Sectors	2494.70	3.88	81.53	0.06	18.58			2594.8	11.24
Commercial/Institutional	*393.71*	*0.05*	*0.98*	*0.00*	*0.76*			*395.4*	*1.71*
Residential	*1463.01*	*3.79*	*79.53*	*0.05*	*16.33*			*1558.9*	*6.75*
Agriculture / Forestry/Fishing	*637.98*	*0.05*	*1.02*	*0.00*	*1.50*			*640.5*	*2.77*
Other (non-energy fuel consumption)	189.10							189.1	0.82
Fugitive	477.33	53.83	1130.44					1607.8	6.97
Coal		*1.61*	*33.77*					*33.8*	*0.15*
Oil & Natural gas	*477.33*	*52.22*	*1096.68*					*1574.0*	*6.82*
Industrial Processes	**1577.88**	**0.46**	**9.74**	**3.44**	**1065.21**	**0.00**	**0.00**	**2652.8**	**11.49**
Cement production	774.68							774.7	3.36
Lime production	54.49							54.5	0.24
Limestone and dolomite use	10.54							10.5	0.05
Soda ash production and use	14.68							14.7	0.06
Ammonia production	606.76							606.8	2.63
Nitric acid production				3.44	1065.21			1065.2	4.61
Product. of other chemicals		0.46	9.74					9.7	0.04
Iron and steel production	0.00							0.0	0.00
Ferroalloys production	116.73							116.7	0.51
Aluminium production	0.00							0.0	0.00
						0.00			
HFC, PFC and SF_6							0.00	0.0	0.00
Agriculture	**0.00**	**67.08**	**1408.69**	**8.55**	**2651.88**	**0.00**	**0.00**	**4060.6**	**17.59**
Enteric fermentation		56.59	1188.34		0.00			1188.3	5.15
Manure management		10.49	220.35	1.09	338.01			558.4	2.42
Agricultural soils management				7.46	2313.87			2313.9	10.02
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
Forest and other woody biomass stocks (sink)	-6505.13							-6505.1	-28.18
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**36.59**	**768.45**	**0.43**	**132.83**	**0.00**	**0.00**	**901.3**	**3.90**
Land Disposal of Solid Waste		36.59	768.45					768.4	3.33
Human Sewage				0.43	132.83			132.8	0.58
Other	**0.00**		**0.00**		**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**15764.52**	**162.83**	**3419.39**	**12.58**	**3898.47**	**0.00**	**0.00**	**23082.4**	**100.00**
NET EMISSIONS (Sources and Sinks)	**9259.39**	**162.83**	**3419.39**	**12.58**	**3898.47**	**0.00**	**0.00**	**16577.2**	
Share of Gases in Total Emissions (%)	**68.30**		**14.81**		**16.89**		**0.00**	**100.0**	
Share of Gases in Net Emissions (%)	**55.86**		**20.63**		**23.52**		**0.00**	**100.0**	
International aviation bunkers *	**46.36**	**0.00**	**0.01**	**0.00**	**0.41**			**46.8**	
International marine bunkers *	**80.62**	**0.01**	**0.11**	**0.00**	**0.20**			**80.9**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-4: Greenhouse gas emission in 1993, Croatia

Croatia Year 1993	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2eq)	N_2O (Gg)	N_2O (Gg CO2eq)	HFC, PFC and SF_6 (Gg)	HFC, PFC and SF_6 (Gg CO2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**15146.11**	**63.45**	**1332.40**	**0.15**	**47.88**	**0.00**	**0.00**	**16526.4**	**72.54**
Energy Industries	5184.89	0.16	3.26	0.04	11.10			5199.3	22.82
Manufacturing Industries and Constr	3657.88	0.31	6.50	0.04	11.32			3675.7	16.13
Transport	2948.63	0.52	11.01	0.03	8.03			2967.7	13.03
Domestic Aviation	*64.41*	*0.00*	*0.01*	*0.00*	*0.56*			*65.0*	*0.29*
Road	*2661.91*	*0.51*	*10.68*	*0.02*	*6.91*			*2679.5*	*11.76*
Railways	*101.08*	*0.01*	*0.14*	*0.00*	*0.26*			*101.5*	*0.45*
National Navigation	*121.24*	*0.01*	*0.17*	*0.00*	*0.30*			*121.7*	*0.53*
Other Sectors	2484.26	3.52	73.99	0.06	17.43			2575.7	11.31
Commercial/Institutional	*489.32*	*0.06*	*1.16*	*0.00*	*0.96*			*491.4*	*2.16*
Residential	*1356.90*	*3.42*	*71.84*	*0.05*	*14.93*			*1443.7*	*6.34*
Agriculture / Forestry/Fishing	*638.04*	*0.05*	*0.99*	*0.00*	*1.54*			*640.6*	*2.81*
Other (non-energy fuel consumption)	194.34							194.3	0.85
Fugitive	676.12	58.94	1237.64					1913.8	8.40
Coal		*1.54*	*32.31*					*32.3*	*0.14*
Oil & Natural gas	*676.12*	*57.40*	*1205.33*					*1881.5*	*8.26*
Industrial Processes	**1253.10**	**0.50**	**10.48**	**2.59**	**802.98**	**0.00**	**0.00**	**2066.6**	**9.07**
Cement production	648.49							648.5	2.85
Lime production	60.25							60.3	0.26
Limestone and dolomite use	9.60							9.6	0.04
Soda ash production and use	12.53							12.5	0.06
Ammonia production	471.34							471.3	2.07
Nitric acid production				2.59	802.98			803.0	3.52
Product. of other chemicals		0.50	10.48					10.5	0.05
Iron and steel production	0.00							0.0	0.00
Ferroalloys production	50.88							50.9	0.22
Aluminium production	0.00							0.0	0.00
HFC, PFC and SF_6						0.00	0.00	0.0	0.00
Agriculture	**0.00**	**55.57**	**1166.96**	**6.81**	**2110.53**	**0.00**	**0.00**	**3277.5**	**14.39**
Enteric fermentation		47.14	990.00		0.00			990.0	4.35
Manure management		8.43	176.96	0.91	281.22			458.2	2.01
Agricultural soils management				5.90	1829.31			1829.3	8.03
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
Forest and other woody biomass stocks (sink)	-6505.13							-6505.1	-28.55
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**37.18**	**780.88**	**0.42**	**131.48**	**0.00**	**0.00**	**912.4**	**4.00**
Land Disposal of Solid Waste		37.18	780.88					780.9	3.43
Human Sewage				0.42	131.48			131.5	0.58
Other	**0.00**		**0.00**		**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**16399.21**	**156.70**	**3290.73**	**9.98**	**3092.88**	**0.00**	**0.00**	**22782.8**	**100.00**
NET EMISSIONS (Sources and Sinks)	**9894.08**	**156.70**	**3290.73**	**9.98**	**3092.88**	**0.00**	**0.00**	**16277.7**	
Share of Gases in Total Emissions (%)	**71.98**		**14.44**		**13.58**		**0.00**	**100.0**	
Share of Gases in Net Emissions (%)	**60.78**		**20.22**		**19.00**		**0.00**	**100.0**	
International aviation bunkers *	**130.69**	**0.00**	**0.02**	**0.00**	**1.14**			**131.9**	
International marine bunkers *	**114.54**	**0.01**	**0.16**	**0.00**	**0.28**			**115.0**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-5: Greenhouse gas emission in 1994, Croatia

Croatia Year 1994	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2eq)	N_2O (Gg)	N_2O (Gg CO_2eq)	HFC, PFC and SF_6 (Gg)	HFC, PFC and SF_6 (Gg CO2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**14235.12**	**57.80**	**1213.74**	**0.15**	**45.53**	**0.00**	**0.00**	**15494.4**	**70.89**
Energy Industries	3924.56	0.12	2.61	0.02	7.71			3934.9	18.00
Manufacturing Industries and Constr.	3814.87	0.30	6.33	0.03	10.80			3832.0	17.53
Transport	3124.04	0.57	11.95	0.03	8.50			3144.5	14.39
Domestic Aviation	*64.41*	*0.00*	*0.01*	*0.00*	*0.56*			*65.0*	*0.30*
Road	*2878.22*	*0.56*	*11.68*	*0.02*	*7.48*			*2897.4*	*13.26*
Railways	*94.21*	*0.01*	*0.13*	*0.00*	*0.24*			*94.6*	*0.43*
National Navigation	*87.20*	*0.01*	*0.12*	*0.00*	*0.22*			*87.5*	*0.40*
Other Sectors	2567.65	3.67	77.01	0.06	18.52			2663.2	12.18
Commercial/Institutional	*552.40*	*0.06*	*1.36*	*0.00*	*1.04*			*554.8*	*2.54*
Residential	*1372.24*	*3.56*	*74.67*	*0.05*	*15.90*			*1462.8*	*6.69*
Agriculture / Forestry/Fishing	*643.00*	*0.05*	*0.98*	*0.01*	*1.58*			*645.6*	*2.95*
Other (non-energy fuel consumption)	199.13							199.1	0.91
Fugitive	604.87	53.14	1115.84					1720.7	7.87
Coal		*1.38*	*28.97*					*29.0*	*0.13*
Oil & Natural gas	*604.87*	*51.76*	*1086.87*					*1691.7*	*7.74*
Industrial Processes	**1438.78**	**0.48**	**10.06**	**2.80**	**868.35**	**0.00**	**0.00**	**2317.2**	**10.60**
Cement production	793.81							793.8	3.63
Lime production	59.65							59.7	0.27
Limestone and dolomite use	15.50							15.5	0.07
Soda ash production and use	15.21							15.2	0.07
Ammonia production	474.73							474.7	2.17
Nitric acid production				2.80	868.35			868.3	3.97
Product. of other chemicals		0.48	10.06					10.1	0.05
Iron and steel production	0.00							0.0	0.00
Ferroalloys production	79.88							79.9	0.37
Aluminium production	0.00							0.0	0.00
HFC, PFC and SF_6						0.00	0.00	0.0	0.00
Agriculture	**0.00**	**50.78**	**1066.37**	**6.59**	**2042.72**	**0.00**	**0.00**	**3109.1**	**14.22**
Enteric fermentation		42.36	889.51		0.00			889.5	4.07
Manure management		8.42	176.86	0.84	259.10			436.0	1.99
Agricultural soils management				5.75	1783.62			1783.6	8.16
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
Forest and other woody biomass stocks (sink)	-6505.13							-6505.1	-29.76
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**38.41**	**806.63**	**0.42**	**130.66**	**0.00**	**0.00**	**937.3**	**4.29**
Land Disposal of Solid Waste		38.41	806.63					806.6	3.69
Human Sewage				0.42	130.66			130.7	0.60
Other	**0.00**		**0.00**		**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
NET EMISSIONS (Sources and Sinks)	**15673.90**	**147.47**	**3096.79**	**9.96**	**3087.26**	**0.00**	**0.00**	**21857.9**	**100.00**
Share of Gases in Total Emissions (%)	**9168.77**	**147.47**	**3096.79**	**9.96**	**3087.26**	**0.00**	**0.00**	**15352.8**	
Share of Gases in Net Emissions (%)	**71.71**		**14.17**		**14.12**		**0.00**	**100.0**	
Udjel plinova u neto emisiji (%)	**59.72**		**20.17**		**20.11**		**0.00**	**100.0**	
International aviation bunkers *	**199.46**	**0.00**	**0.03**	**0.01**	**1.75**			**201.2**	
International marine bunkers *	**138.33**	**0.01**	**0.19**	**0.00**	**0.34**			**138.9**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-6: Greenhouse gas emission in 1995, Croatia

Croatia Year 1995	CO_2 (Gg)	CH_4 (Gg)	 (Gg CO_2eq)	N_2O (Gg)	 (Gg CO_2eq)	HFC, PFC and SF_6 (Gg)	 (Gg CO_2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**15081.87**	**58.19**	**1222.05**	**0.16**	**48.83**	**0.00**	**0.00**	**16352.7**	**73.47**
Energy Industries	4459.92	0.16	3.26	0.03	10.07			4473.2	20.10
Manufacturing Industries and Constr.	3617.02	0.28	5.97	0.03	10.54			3633.5	16.32
Transport	3337.20	0.60	12.60	0.03	9.19			3359.0	15.09
Domestic Aviation	*88.68*	*0.00*	*0.01*	*0.00*	*0.78*			*89.5*	*0.40*
Road	*3044.16*	*0.59*	*12.30*	*0.03*	*7.90*			*3064.4*	*13.77*
Railways	*106.09*	*0.01*	*0.15*	*0.00*	*0.27*			*106.5*	*0.48*
National Navigation	*98.28*	*0.01*	*0.14*	*0.00*	*0.25*			*98.7*	*0.44*
Other Sectors	2777.69	3.76	79.02	0.06	19.03			2875.7	12.92
Commercial/Institutional	*601.40*	*0.07*	*1.46*	*0.00*	*1.08*			*603.9*	*2.71*
Residential	*1595.98*	*3.65*	*76.66*	*0.05*	*16.53*			*1689.2*	*7.59*
Agriculture / Forestry/Fishing	*580.31*	*0.04*	*0.89*	*0.00*	*1.42*			*582.6*	*2.62*
Other (non-energy fuel consumption)	193.10							193.1	0.87
Fugitive	696.92	53.39	1121.20					1818.1	8.17
Coal		*1.10*	*23.07*					*23.1*	*0.10*
Oil & Natural gas	*696.92*	*52.29*	*1098.13*					*1795.1*	*8.06*
Industrial Processes	**1169.49**	**0.40**	**8.41**	**2.69**	**835.04**	**0.01**	**7.80**	**2020.7**	**9.08**
Cement production	584.89							584.9	2.63
Lime production	62.27							62.3	0.28
Limestone and dolomite use	11.19							11.2	0.05
Soda ash production and use	14.39							14.4	0.06
Ammonia production	462.85							462.9	2.08
Nitric acid production				2.69	835.04			835.0	3.75
Product. of other chemicals		0.40	8.41					8.4	0.04
Iron and steel production	0.00							0.0	0.00
Ferroalloys production	33.91							33.9	0.15
Aluminum production	0.00							0.0	0.00
HFC, PFC and SF_6 *						0.01	7.80	7.8	0.04
Agriculture	**0.00**	**48.06**	**1009.28**	**6.07**	**1881.37**	**0.00**	**0.00**	**2890.7**	**12.99**
Enteric fermentation		40.44	849.30		0.00			849.3	3.82
Manure management		7.62	159.98	0.80	246.87			406.8	1.83
Agricultural soils management				5.27	1634.50			1634.5	7.34
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
Forest and other woody biomass stocks (sink)	-6505.13							-6505.1	-29.23
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**41.15**	**864.11**	**0.42**	**130.51**	**0.00**	**0.00**	**994.6**	**4.47**
Land Disposal of Solid Waste		41.15	864.11					864.1	3.88
Human Sewage				0.42	130.51			130.5	0.59
Other	**0.00**		**0.00**		**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**16251.36**	**147.80**	**3103.85**	**9.34**	**2895.75**	**0.01**	**7.80**	**22258.8**	**100.00**
NET EMISSIONS (Sources and Sinks)	**9746.23**	**147.80**	**3103.85**	**9.34**	**2895.75**	**0.01**	**7.80**	**15753.6**	
Share of Gases in Total Emissions (%)	**73.01**		**13.94**		**13.01**		**0.04**	**100.0**	
Share of Gases in Net Emissions (%)	**61.87**		**19.70**		**18.38**		**0.05**	**100.0**	
International aviation bunkers **	**175.19**	**0.00**	**0.03**	**0.00**	**1.53**			**176.7**	
International marine bunkers **	**102.01**	**0.01**	**0.14**	**0.00**	**0.25**			**102.4**	

* - HFC_3 consumption
** - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-7: Greenhouse gas emission in 1996, Croatia

Croatia Year 1996	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2eq)	N_2O (Gg)	N_2O (Gg CO_2eq)	HFC, PFC and SF_6 (Gg)	HFC, PFC and SF_6 (Gg CO_2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**15726.64**	**61.22**	**1285.63**	**0.21**	**63.93**	**0.00**	**0.00**	**17076.2**	**73.14**
Energy Industries	4310.04	0.14	3.00	0.03	8.76			4321.8	18.51
Manufacturing Industries and Constr.	3762.87	0.29	6.05	0.03	10.74			3779.7	16.19
Transport	3668.07	0.67	14.03	0.07	21.56			3703.7	15.86
Domestic Aviation	*106.73*	*0.00*	0.02	*0.00*	0.93			*107.7*	*0.46*
Road	*3312.91*	*0.65*	13.66	*0.06*	20.00			*3346.6*	*14.33*
Railways	*99.59*	*0.01*	0.14	*0.00*	0.25			*100.0*	*0.43*
National Navigation	*148.84*	*0.01*	0.21	*0.00*	0.37			*149.4*	*0.64*
Other Sectors	3135.86	4.59	96.29	0.07	22.87			3255.0	13.94
Commercial/Institutional	*608.13*	*0.07*	1.50	*0.00*	1.13			*610.8*	*2.62*
Residential	*1779.25*	*4.46*	93.64	*0.06*	19.93			*1892.8*	*8.11*
Agriculture/ Forestry/Fishing	*748.48*	*0.06*	1.16	*0.01*	1.81			*751.4*	*3.22*
Other (non-energy fuel consumption)	205.76							205.8	0.88
Fugitive	644.04	55.54	1166.26					1810.3	7.75
Coal		*0.89*	18.61					*18.6*	*0.08*
Oil & Natural gas	*644.04*	*54.65*	1147.65					*1791.7*	*7.67*
Industrial Processes	**1249.49**	**0.38**	**7.94**	**2.51**	**777.53**	**0.19**	**60.15**	**2095.1**	**8.97**
Cement production	634.01							634.0	2.72
Lime production	79.15							79.2	0.34
Limestone and dolomite use	8.50							8.5	0.04
Soda ash production and use	11.41							11.4	0.05
Ammonia production	502.68							502.7	2.15
Nitric acid production				2.51	777.53			777.5	3.33
Product. of other chemicals		0.38	7.94					7.9	0.03
Iron and steel production								0.0	0.00
Ferroalloys production	13.73							13.7	0.06
Aluminium production								0.0	0.00
HFC, PFC and SF_6						0.19	60.15	60.2	0.26
Agriculture	**0.00**	**45.34**	**952.05**	**7.23**	**2240.33**	**0.00**	**0.00**	**3192.4**	**13.67**
Enteric fermentation		37.86	795.06					795.1	3.41
Manure management		7.48	156.99	1.21	374.93			531.9	2.28
Agricultural soils management				6.02	1865.41			1865.4	7.99
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**-8069.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-8069.2**	**-34.56**
Forest and other woody biomass stocks (sink)	-8069.18							-8069.2	-34.56
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**42.89**	**900.62**	**0.27**	**83.23**	**0.00**	**0.00**	**983.8**	**4.21**
Land Disposal of Solid Waste		42.89	900.62					900.6	3.86
Human Sewage				0.27	83.23			83.2	0.36
Other	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**16976.13**	**149.82**	**3146.25**	**10.21**	**3165.02**	**0.19**	**60.15**	**23347.5**	**100.00**
NET EMISSIONS (Sources and Sinks)	**8906.95**	**149.82**	**3146.25**	**10.21**	**3165.02**	**0.19**	**60.15**	**15278.4**	
Share of Gases in Total Emissions (%)	**72.71**		**13.48**		**13.56**		**0.26**	**100.0**	
Share of Gases in Net Emissions (%)	**58.30**		**20.59**		**20.72**		**0.39**	**100.0**	
International aviation bunkers *	**114.91**	**0.01**	**0.16**	**0.00**	**0.28**			**175.5**	
International marine bunkers *	**173.94**	**0.00**	**0.03**	**0.00**	**1.52**			**115.4**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-8: Greenhouse gas emission in 1997, Croatia

Croatia Year 1997	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2eq)	N_2O (Gg)	N_2O (Gg CO_2eq)	HFC, PFC and SF_6 (Gg)	HFC, PFC and SF_6 (Gg CO_2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**16607.11**	**64.30**	**1350.24**	**0.26**	**79.57**	**0.00**	**0.00**	**18036.9**	**72.39**
Energy Industries	4874.87	0.15	3.22	0.04	11.21			4889.3	19.62
Manufacturing Industries and Constr.	3714.10	0.31	6.55	0.04	11.21			3731.9	14.98
Transport	4013.22	0.73	15.27	0.11	34.61			4063.1	16.31
Domestic Aviation	*110.14*	*0.00*	0.02	*0.00*	0.96			*111.1*	*0.45*
Road	*3689.48*	*0.71*	14.95	*0.11*	33.11			*3737.5*	*15.00*
Railways	*95.52*	*0.01*	0.14	*0.00*	0.22			*95.9*	*0.38*
National Navigation	*118.07*	*0.01*	0.17	*0.00*	0.30			*118.5*	*0.48*
Other Sectors	3179.94	4.55	95.48	0.07	22.76			3298.2	13.24
Commercial/Institutional	*646.59*	*0.08*	1.63	*0.00*	1.26			*649.5*	*2.61*
Residential	*1939.19*	*4.43*	92.96	*0.06*	20.08			*2052.2*	*8.24*
Agriculture/ Forestry/Fishing	*594.16*	*0.04*	0.89	*0.00*	1.43			*596.5*	*2.39*
Other (non-energy fuel consumption)	225.21							225.2	0.90
Fugitive	599.78	58.56	1229.73					1829.5	7.34
Coal		*0.65*	13.61					*13.6*	*0.05*
Oil & Natural gas	*599.78*	*57.91*	1216.11					*1815.9*	*7.29*
Industrial Processes	**1449.75**	**0.34**	**7.15**	**2.64**	**817.17**	**0.04**	**91.18**	**2365.3**	**9.49**
Cement production	753.47							753.5	3.02
Lime production	101.63							101.6	0.41
Limestone and dolomite use	7.25							7.2	0.03
Soda ash production and use	9.68							9.7	0.04
Ammonia production	546.23							546.2	2.19
Nitric acid production				2.64	817.17			817.2	3.28
Product. of other chemicals		0.34	7.15					7.1	0.03
Iron and steel production								0.0	0.00
Ferroalloys production	31.50							31.5	0.13
Aluminium production								0.0	0.00
HFC, PFC and SF_6						0.04	91.18	91.2	0.37
Agriculture	**0.00**	**44.50**	**934.57**	**8.21**	**2543.96**	**0.00**	**0.00**	**3478.5**	**13.96**
Enteric fermentation		37.17	780.53					780.5	3.13
Manure management		7.34	154.04	1.20	371.36			525.4	2.11
Agricultural soils management				7.01	2172.60			2172.6	8.72
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**-8069.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-8069.2**	**-32.39**
Forest and other woody biomass stocks (sink)	-8069.18							-8069.2	-32.39
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**45.33**	**952.02**	**0.27**	**82.47**	**0.00**	**0.00**	**1034.5**	**4.15**
Land Disposal of Solid Waste		45.33	952.02					952.0	3.82
Human Sewage				0.27	82.47			82.5	0.33
Other	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**18056.87**	**154.48**	**3243.98**	**11.37**	**3523.17**	**0.04**	**91.18**	**24915.2**	**100.00**
NET EMISSIONS (Sources and Sinks)	**9987.69**	**154.48**	**3243.98**	**11.37**	**3523.17**	**0.04**	**91.18**	**16846.0**	
Share of Gases in Total Emissions (%)	**72.47**		**13.02**		**14.14**		**0.4**	**100.0**	
Share of Gases in Net Emissions (%)	**59.29**		**19.26**		**20.91**		**0.5**	**100.0**	
International aviation bunkers *	**73.63**	**0.00**	**0.10**	**0.00**	**0.18**			**146.3**	
International marine bunkers *	**145.01**	**0.00**	**0.03**	**0.00**	**1.52**			**73.9**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-9: Greenhouse gas emission in 1998, Croatia

Croatia Year 1998	CO_2 (Gg)	CH_4 (Gg)	 (Gg CO_2eq)	N_2O (Gg)	 (Gg CO_2eq)	HFC, PFC and SF_6 (Gg)	 (Gg CO_2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**17593.74**	**56.37**	**1183.68**	**0.31**	**94.87**	**0.00**	**0.00**	**18872.3**	**75.06**
Energy Industries	5530.92	0.18	3.78	0.04	12.71			5547.4	22.06
Manufacturing Industries and Constr.	4008.26	0.32	6.64	0.04	11.44			4026.3	16.01
Transport	4162.63	0.78	16.30	0.16	50.48			4229.4	16.82
Domestic Aviation	*126.95*	*0.00*	0.02	*0.00*	1.11			*128.1*	*0.51*
Road	*3847.35*	*0.76*	16.02	*0.16*	48.89			*3912.3*	*15.56*
Railways	*98.02*	*0.01*	0.14	*0.00*	0.25			*98.4*	*0.39*
National Navigation	*90.31*	*0.01*	0.13	*0.00*	0.23			*90.7*	*0.36*
Other Sectors	3107.25	4.00	84.08	0.07	20.24			3211.6	12.77
Commercial/Institutional	*614.74*	*0.07*	1.52	*0.00*	1.19			*617.5*	*2.46*
Residential	*1841.45*	*3.88*	81.58	*0.06*	17.46			*1940.5*	*7.72*
Agriculture/ Forestry/Fishing	*651.06*	*0.05*	0.98	*0.01*	1.59			*653.6*	*2.60*
Other (non-energy fuel consumption)	195.50							195.5	0.78
Fugitive	589.17	51.09	1072.88					1662.0	6.61
Coal		*0.68*	14.26					*14.3*	*0.06*
Oil & Natural gas	*589.17*	*50.41*	1058.62					*1647.8*	*6.55*
Industrial Processes	**1362.41**	**0.32**	**6.65**	**1.98**	**615.22**	**0.01**	**17.57**	**2001.8**	**7.96**
Cement production	811.39							811.4	3.23
Lime production	105.77							105.8	0.42
Limestone and dolomite use	8.60							8.6	0.03
Soda ash production and use	11.49							11.5	0.05
Ammonia production	409.73							409.7	1.63
Nitric acid production				1.98	615.22			615.2	2.45
Product. of other chemicals		0.32	6.65					6.6	0.03
Iron and steel production								0.0	0.00
Ferroalloys production	15.42							15.4	0.06
Aluminium production								0.0	0.00
HFC, PFC and SF_6						0.01	17.57	17.6	0.07
Agriculture	**0.00**	**43.11**	**905.37**	**7.36**	**2280.81**	**0.00**	**0.00**	**3186.2**	**12.67**
Enteric fermentation		35.90	753.84					753.8	3.00
Manure management		7.22	151.53	1.17	362.23			513.8	2.04
Agricultural soils management				6.19	1918.58			1918.6	7.63
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**-8069.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-8069.2**	**-32.09**
Forest and other woody biomass stocks (sink)	-8069.18							-8069.2	-32.09
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**47.75**	**1002.69**	**0.26**	**79.15**	**0.00**	**0.00**	**1081.8**	**4.30**
Land Disposal of Solid Waste		47.75	1002.69					1002.7	3.99
Human Sewage				0.26	79.15			79.1	0.31
Other	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**18956.14**	**147.54**	**3098.38**	**9.90**	**3070.05**	**0.01**	**17.57**	**25142.1**	**100.0**
NET EMISSIONS (Sources and Sinks)	**10886.97**	**147.54**	**3098.38**	**9.90**	**3070.05**	**0.01**	**17.57**	**17073.0**	
Share of Gases in Total Emissions (%)	**75.40**		**12.32**		**12.21**		**0.07**	**100.0**	
Share of Gases in Net Emissions (%)	**63.77**		**18.15**		**17.98**		**0.10**	**100.0**	
International aviation bunkers *	**81.00**	**0.01**	**0.11**	**0.00**	**0.20**			**149.7**	
International marine bunkers *	**148.43**	**0.00**	**0.02**	**0.00**	**1.30**			**81.3**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-10: Greenhouse gas emission in 1999, Croatia

Croatia Year 1999	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2eq)	N_2O (Gg)	N_2O (Gg CO_2eq)	HFC, PFC and SF_6 (Gg)	HFC, PFC and SF_6 (Gg CO_2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**17965.86**	**56.10**	**1178.03**	**0.36**	**111.92**	**0.00**	**0.00**	**19255.8**	**73.63**
Energy Industries	5698.76	0.19	3.96	0.04	13.07			5715.8	21.86
Manufacturing Industries and Constr.	3729.40	0.27	5.69	0.03	10.04			3745.1	14.32
Transport	4394.36	0.82	17.17	0.22	67.83			4479.4	17.13
Domestic Aviation	*130.63*	*0.00*	0.02	*0.00*	1.15			*131.8*	*0.50*
Road	*4083.79*	*0.80*	16.89	*0.21*	66.23			*4166.9*	*15.93*
Railways	*92.39*	*0.01*	0.13	*0.00*	0.23			*92.8*	*0.35*
National Navigation	*87.55*	*0.01*	0.13	*0.00*	0.22			*87.9*	*0.34*
Other Sectors	3513.27	4.07	85.52	0.07	20.99			3619.8	13.84
Commercial/Institutional	*639.60*	*0.08*	1.59	*0.00*	1.20			*642.4*	*2.46*
Residential	*2032.85*	*3.93*	82.56	*0.06*	17.71			*2133.1*	*8.16*
Agriculture/ Forestry/Fishing	*840.81*	*0.07*	1.37	*0.01*	2.08			*844.3*	*3.23*
Other (non-energy fuel consumption)	104.83							104.8	0.40
Fugitive	525.25	50.75	1065.70					1590.9	6.08
Coal		*0.20*	4.29					*4.3*	*0.02*
Oil & Natural gas	*525.25*	*50.54*	1061.40					*1586.6*	*6.07*
Industrial Processes	**1712.78**	**0.27**	**5.73**	**2.34**	**725.95**	**0.00**	**9.09**	**2453.6**	**9.38**
Cement production	1072.55							1072.5	4.10
Lime production	102.57							102.6	0.39
Limestone and dolomite use	7.95							7.9	0.03
Soda ash production and use	10.60							10.6	0.04
Ammonia production	519.12							519.1	1.98
Nitric acid production				2.34	725.95			726.0	2.78
Product. of other chemicals		0.27	5.73					5.7	0.02
Iron and steel production								0.0	0.00
Ferroalloys production								0.0	0.00
Aluminium production								0.0	0.00
HFC, PFC and SF_6						0.00	9.09	9.1	0.03
Agriculture	**0.00**	**43.95**	**922.94**	**7.61**	**2359.05**	**0.00**	**0.00**	**3282.0**	**12.55**
Enteric fermentation		35.96	755.24					755.2	2.89
Manure management		7.99	167.70	1.24	382.89			550.6	2.11
Agricultural soils management				6.37	1976.15			1976.2	7.56
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**-8069.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-8069.2**	**-30.85**
Forest and other woody biomass stocks (sink)	-8069.18							-8069.2	-30.85
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**51.10**	**1073.08**	**0.28**	**87.71**	**0.00**	**0.00**	**1160.8**	**4.44**
Land Disposal of Solid Waste		51.10	1073.08					1073.1	4.10
Human Sewage				0.28	87.71			87.7	0.34
Other	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**19678.64**	**151.42**	**3179.78**	**10.60**	**3284.63**	**0.00**	**9.09**	**26152.1**	**100.00**
NET EMISSIONS (Sources and Sinks)	**11609.46**	**151.42**	**3179.78**	**10.60**	**3284.63**	**0.00**	**9.09**	**18083.0**	
Share of Gases in Total Emissions (%)	**75.25**		**12.16**		**12.56**		**0.03**	**100.0**	
Share of Gases in Net Emissions (%)	**64.20**		**17.58**		**18.16**		**0.05**	**100.0**	
International aviation bunkers *	**65.68**	**0.00**	**0.09**	**0.00**	**0.16**			**138.4**	
International marine bunkers *	**137.23**	**0.00**	**0.02**	**0.00**	**1.20**			**65.9**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-11: Greenhouse gas emission in 2000, Croatia

Croatia Year 2000	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2eq)	N_2O (Gg)	N_2O (Gg CO_2eq)	HFC, PFC and SF_6 (Gg)	HFC, PFC and SF_6 (Gg CO_2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**17447.46**	**58.69**	**1232.54**	**0.44**	**137.35**	**0.00**	**0.00**	**18817.3**	**72.11**
Energy Industries	5155.94	0.14	2.87	0.04	13.28			5172.1	19.82
Manufacturing Industries and Constr.	3804.63	0.28	5.83	0.03	10.31			3820.8	14.64
Transport	4396.02	0.82	17.27	0.29	90.66			4503.9	17.26
Domestic Aviation	*110.46*	*0.00*	0.02	*0.00*	0.97			*111.4*	*0.43*
Road	*4114.35*	*0.81*	17.01	*0.29*	89.26			*4220.6*	*16.17*
Railways	*85.49*	*0.01*	0.12	*0.00*	0.22			*85.8*	*0.33*
National Navigation	*85.71*	*0.01*	0.12	*0.00*	0.22			*86.1*	*0.33*
Other Sectors	3358.97	4.55	95.47	0.07	23.10			3477.5	13.33
Commercial/Institutional	*605.13*	*0.07*	1.54	*0.00*	1.21			*607.9*	*2.33*
Residential	*1896.34*	*4.41*	92.62	*0.06*	19.77			*2008.7*	*7.70*
Agriculture/ Forestry/Fishing	*857.50*	*0.06*	1.31	*0.01*	2.13			*860.9*	*3.30*
Other (non-energy fuel consumption)	98.90							98.9	0.38
Fugitive	633.02	52.91	1111.10					1744.1	6.68
Coal								*0.0*	*0.00*
Oil & Natural gas	*633.02*	*52.91*	1111.10					*1744.1*	*6.68*
Industrial Processes	**1931.65**	**0.29**	**6.04**	**2.76**	**854.30**	**0.01**	**23.10**	**2815.1**	**10.79**
Cement production	1242.25							1242.2	4.76
Lime production	124.25							124.3	0.48
Limestone and dolomite use	8.41							8.4	0.03
Soda ash production and use	11.01							11.0	0.04
Ammonia production	525.25							525.2	2.01
Nitric acid production				2.76	854.30			854.3	3.27
Product. of other chemicals		0.29	6.04					6.0	0.02
Iron and steel production								0.0	0.00
Ferroalloys production	20.48							20.5	0.08
Aluminium production								0.0	0.00
HFC, PFC and SF_6						0.01	23.10	23.1	0.09
Agriculture	**0.00**	**42.57**	**894.01**	**7.77**	**2408.74**	**0.00**	**0.00**	**3302.8**	**12.66**
Enteric fermentation		35.16	738.32					738.3	2.83
Manure management		7.41	155.69	1.20	372.39			528.1	2.02
Agricultural soils management				6.57	2036.35			2036.4	7.80
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**-8069.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-8069.2**	**-30.92**
Forest and other woody biomass stocks (sink)	-8069.18							-8069.2	-30.92
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**51.33**	**1077.89**	**0.27**	**84.00**	**0.00**	**0.00**	**1161.9**	**4.45**
Land Disposal of Solid Waste		51.33	1077.89					1077.9	4.13
Human Sewage				0.27	84.00			84.0	0.32
Other	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**19379.11**	**152.88**	**3210.49**	**11.24**	**3484.39**	**0.01**	**23.10**	**26097.1**	**100.00**
NET EMISSIONS (Sources and Sinks)	**11309.93**	**152.88**	**3210.49**	**11.24**	**3484.39**	**0.01**	**23.10**	**18027.9**	
Share of Gases in Total Emissions (%)	**74.26**		**12.30**		**13.35**		**0.09**	**100.0**	
Share of Gases in Net Emissions (%)	**62.74**		**17.81**		**19.33**		**0.13**	**100.0**	
International aviation bunkers *	**57.02**	**0.00**	**0.08**	**0.00**	**0.14**			**115.8**	
International marine bunkers *	**114.82**	**0.00**	**0.02**	**0.00**	**1.01**			**57.2**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

Table A1-12: Greenhouse gas emission in 2001, Croatia

Croatia Year 2001	CO_2 (Gg)	CH_4 (Gg)	 (Gg CO_2eq)	N_2O (Gg)	 (Gg CO_2eq)	HFC, PFC i SF_6 (Gg)	 (Gg CO_2eq)	TOTAL (Gg CO_2eq)	Share %
Energy	**18378.69**	**63.92**	**1342.35**	**0.50**	**153.86**	**0.00**	**0.00**	**19874.9**	**74.00**
Energy Industries	5650.32	0.15	3.14	0.05	14.48			5667.9	21.10
Manufacturing Industries and Constr.	3903.14	0.27	5.77	0.03	10.19			3919.1	14.59
Transport	4459.15	0.81	16.98	0.35	109.89			4586.0	17.07
Domestic Aviation	*110.78*	*0.00*	0.02	*0.00*	0.97			*111.8*	*0.42*
Road	*4168.82*	*0.80*	16.71	*0.35*	108.47			*4294.0*	*15.99*
Railways	*87.69*	*0.01*	0.13	*0.00*	0.22			*88.0*	*0.33*
National Navigation	*91.86*	*0.01*	0.13	*0.00*	0.23			*92.2*	*0.34*
Other Sectors	3576.41	3.56	74.85	0.06	19.30			3670.6	13.67
Commercial/Institutional	*709.66*	*0.08*	1.78	*0.00*	1.34			*712.8*	*2.65*
Residential	*2068.47*	*3.42*	71.88	*0.05*	16.02			*2156.4*	*8.03*
Agriculture/ Forestry/Fishing	*798.29*	*0.06*	1.20	*0.01*	1.94			*801.4*	*2.98*
Other (non-energy fuel consumption)	102.03							102.0	0.38
Fugitive	687.64	59.12	1241.59					1929.2	7.18
Coal								*0.0*	*0.00*
Oil & Natural gas	*687.64*	*59.12*	1241.59					*1929.2*	*7.18*
Industrial Processes	**2010.99**	**0.31**	**6.41**	**2.32**	**718.52**	**0.02**	**48.99**	**2784.9**	**10.37**
Cement production	1419.61							1419.6	5.29
Lime production	143.48							143.5	0.53
Limestone and dolomite use	9.24							9.2	0.03
Soda ash production and use	12.37							12.4	0.05
Ammonia production	425.83							425.8	1.59
Nitric acid production				2.32	718.52			718.5	2.68
Product. of other chemicals		0.31	6.41					6.4	0.02
Iron and steel production								0.0	0.00
Ferroalloys production	0.47							0.5	0.00
Aluminium production								0.0	0.00
HFC, PFC and SF_6						0.02	48.99	49.0	0.18
Agriculture	**0.00**	**43.09**	**904.91**	**6.87**	**2130.66**	**0.00**	**0.00**	**3035.6**	**11.30**
Enteric fermentation		35.64	748.38					748.4	2.79
Manure management		7.45	156.53	1.21	375.11			531.6	1.98
Agricultural soils management				5.66	1755.56			1755.6	6.54
Agricultural residue burning								0.0	0.00
Land-use Change & Forestry	**-8069.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-8069.2**	**-30.04**
Forest and other woody biomass stocks (sink)	-8069.18							-8069.2	-30.04
Changes in soil carbon								0.0	0.00
Waste	**0.00**	**51.33**	**1077.89**	**0.28**	**85.29**	**0.00**	**0.00**	**1163.2**	**4.33**
Land Disposal of Solid Waste		51.33	1077.89					1077.9	4.01
Human Sewage				0.28	85.29			85.3	0.32
Other	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**
TOTAL EMISSIONS	**20389.68**	**158.65**	**3331.56**	**9.96**	**3088.34**	**0.02**	**48.99**	**26858.6**	**100.00**
NET EMISSIONS (Sources and Sinks)	**12320.51**	**158.65**	**3331.56**	**9.96**	**3088.34**	**0.02**	**48.99**	**18789.4**	
Share of Gases in Total Emissions (%)	**75.91**		**12.40**		**11.50**		**0.18**	**100.0**	
Share of Gases in Net Emissions (%)	**65.57**		**17.73**		**16.44**		**0.26**	**100.0**	
International aviation bunkers *	**89.37**	**0.01**	**0.13**	**0.00**	**0.22**			**115.5**	
International marine bunkers *	**114.51**	**0.00**	**0.02**	**0.00**	**1.00**			**89.7**	

* - Emissions from International Marine and Aviation Bunkers are not included in nationals totals.

REPUBLIC OF CROATIA

PROJECTIONS OF GREENHOUSE GAS EMISSIONS

Ordered by:
Ministry of Environmental Protection and Physical Planning
Ulica grada Vukovara 78, Zagreb, Republic of Croatia

Prepared by:
EKONERG – Energy Research and Environmental Protection Institute
Atmospheric Protection Department

Team Leader: Davor Vešligaj

Authors:
Željko Jurić, Jasmina Burek (Energy Sector),
Davor Vešligaj, Andrea Hublin (Industrial Processes, Waste),
Snježana Fijan-Parlov (Agriculture, Land Use Change and Forestry)

External authors:
Vladimir Jelavić, Goran Slipac, Damir Pešut

Zagreb, Septembre 2003

CONTENT:

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTORY NOTES

The purpose of this report is to give evaluation of future trends in greenhouse gas emissions and removals in Croatia in a form of projections for scenarios "Without measures", "With measures", and "With additional measures", as well as historical emissions data, for the period 1990-2020, according to document FCCC/CP/1999/7. For evaluating the future trends there are three scenarios which represent different assumptions with respect to implemented, adopted or planned policies and measures.

- **"Without measures" scenario** – is based on the presumption of delayed introduction of new technologies into the business sector and insufficient support of the state to the reforms and restructuring in energy and other sectors. It implies lesser government involvement in institutional and organizational reform, lack of support for energy efficiency, renewable resources, changes in industry, agriculture and forestry, and environmental protection. However, this scenario does not represent a completely "frozen" status and an intention to continue the business-as-usual scenario. It also includes the improvements that are to happen regardless of the climate change mitigation program requirements.

- **"With measures" scenario** – is based on the most feasible scenario from Energy Sector Development Strategy *(Ref.1.)*. The key assumptions are equivalent to "Without measures" scenario, except one which is related to subsequent introduction of renewable energy sources and efficiency increase. The Energy Sector Development Strategy is adopted policy document and there are approximately 30 regulatory documents which support its implementation, of which five will regulate use of renewable energy and energy efficiency. This secondary regulation is currently in the process of drafting and/or adoption. Apart from Energy, other sectors do not have developed strategic or regulatory documents which address climate change mitigation measures.

- **"With additional measures" scenario** – assumes that the climate change and sustainable development concept shall cause significant change in orientation of the overall Croatian industry and economy. This scenario takes into account the highest possible potential of analyzed measures for GHG emissions reduction. Considerable effects of these measures are expected beyond the year 2010.

There are two strategic objectives with respect to Croatian long-term social and economical development which play important role in analyzing future developments:

- Political stabilization in the region and
- Accession to European Union

These three above scenarios are different than those described in the First National Communication of Republic Croatia, submitted to the UNFCCC in the year 2001. Scenarios in the First National Communication have been developed on the basis of the projection vision existed in the year 1995, which has optimistic trend for years immediately after 1995. Unfortunately, economic development in the period from 1995 to 1999 was slower than predicted, and expected forecast figures were moved for few years in future.

In the year 2001 the new Energy Strategy was adopted under framework of comprehensive policy document named 'Economic Strategy – Croatia for the 21 Century'. Here described scenarios derivate from the most feasible Energy Strategy's scenario, called S1. Scenario 'With measures' corresponds to S1 scenario and it is hereafter described in details. Other scenarios, 'Without measures' and 'With additional measures' are analytically developed by subtracting or adding GHG reduction potentials of different mitigation measures

For development of abovementioned scenarios, macroeconomic parameters were taken from Macro economical development strategy (Ref.2.). It is expected that growth of GDP will be approximately 5.2 percent in the period 2001-2004, 3.9 percent in the period 2005-2010, and 4.8 percent in the period 2011-2015. The future trends of GDP and number of population is presented in table 1-1.

Table 1-1: Historical and future trends of GDP and number of population in Croatia

	1990	1995	2000	2005	2010	2015	2020
GDP (USD/capita)	5106	3873	4669	5942	7535	9355	11521
Number of population (mil.)	4.778	4.669	4.437	4.560	4.627	4.700	4.756

2. ENERGY SECTOR

Energy sector development depends on large number of significant factors among which the most important are:

- economic development,
- energy sector reform and government measures,
- international energy market development and international influence,
- technological development,
- global environmental protection limitations

Each of these factors has its influence dimension and the consequences will be different energy consumption levels and energy generation structures. In Energy sector three different scenarios are analysed: “With measures”, “Without measures” and “With additional measures”, which is generally described in previous chapter.

2.1. SCENARIO “WITH MEASURES”

2.1.1. ENERGY CONSUMPTION DATA FOR SCENARIO “WITH MEASURES”

The projection of energy sector development scenario is presented through following energy indicators:

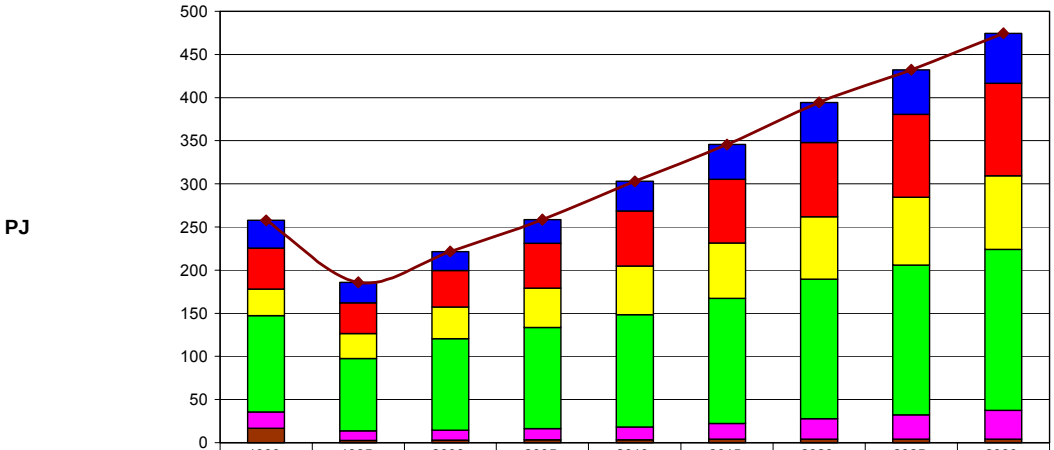
- final energy demand by energy carriers
- final energy demand in different sectors
- electricity generation structure
- energy source structure for the electric utility demand
- total energy consumption divided by fuels
- renewable energy resource structure
- energy import and domestic production structure

2.1.1.1. Final energy demand by energy carriers

The analysis was carried out with expected increase of final energy consumption by average annual growth rate of 2.6 percent. The consumption of all energy sources will increase unequally which will lead to certain changes in energy source structure (Figure 2.1-1).

The steam and hot water consumption will be from 9.9 percent in 2000 to 11.7 percent in 2020. Electric energy participation will grow gradually because of electricity non-heat consumption increase. Gas fuel participation will increase and stabilise on the level of 18 percent. However,

the liquid fuel participation and coal will decrease. The renewable resource participation will rise a little and remain on the level of 7 percent.

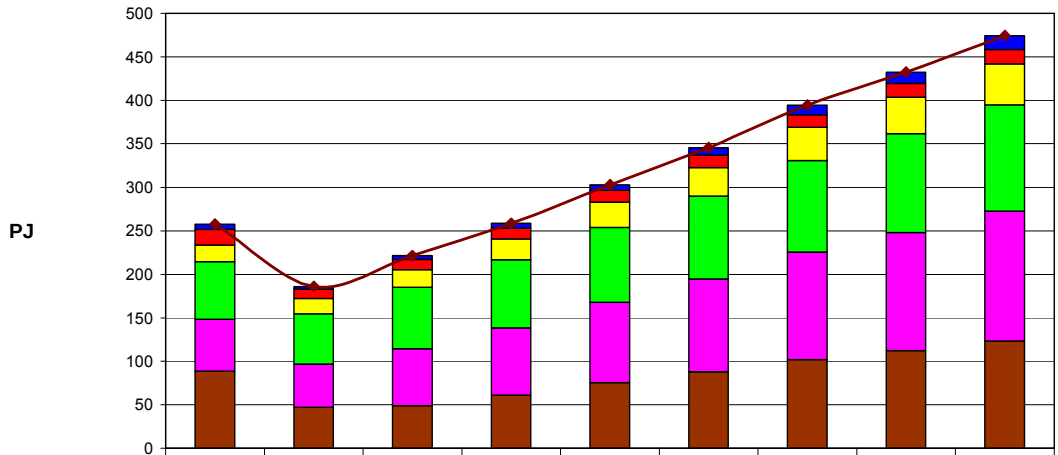


	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Steam&hot water	31.93	23.61	22.01	27.63	34.67	40.06	46.29	51.78	57.93
Electricity	47.76	35.74	42.12	51.79	63.69	74.17	86.37	96.16	107.05
Natural gas	30.80	28.82	36.85	45.56	56.31	63.76	72.19	78.42	85.19
Liquid fuel	111.48	83.78	105.67	117.14	129.86	144.87	161.62	173.68	186.64
Renewable resources	19.08	11.07	11.66	13.09	14.71	18.74	23.89	28.34	33.63
Coal	16.68	2.95	3.21	3.52	3.85	3.95	4.04	4.02	4.00
Total	257.74	185.96	221.52	258.73	303.10	345.55	394.40	432.41	474.45

Figure 2.1-1: Final energy demand by energy carriers, PJ

2.1.1.2. Final energy demand in different sectors

In some sectors there will be no other important energy consumption changes because the most important changes have already happened partially because of the war consequences and partially for the economic reasons. Economic activities of intense energy consumption in industry have been considerably reduced, thus in the future major technological promotions can be expected, but with no energy consumption increase of the intensive energy consumers. Transport participation will increase to the level of 31 percent in 2020 while the household share will decrease to fewer than 30 percent after 2010. Gradual agriculture share will decrease owing to an efficient economy organisation and expected technological improvement. In construction and services the gradual increase of energy consumption is expected (Figure 2.1-2).



	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Construction	5.91	3.01	4.36	5.43	6.76	8.54	10.78	13.15	16.05
Agriculture	18.03	10.58	11.80	12.53	13.32	13.99	14.70	15.59	16.54
Services	19.42	17.65	19.89	23.96	28.88	33.17	38.12	42.20	46.73
Households	66.21	57.82	71.05	78.28	86.30	95.22	105.09	113.38	122.36
Transport	59.24	49.59	65.05	77.44	92.24	106.77	123.61	135.78	149.21
Industry	88.93	47.30	49.36	61.07	75.60	87.85	102.10	112.30	123.56
Total	257.74	185.96	221.52	258.73	303.10	345.55	394.40	432.41	474.45

Figure 2.1-2: Final energy demand in different sectors, PJ

2.1.1.3. Power Supply System

The Croatian power supply system has total installed capacity of around 4019 MW. There are 17 hydro power plants with 2063 MW that share 51.3 percent of total power supply and 6 thermal power plants with 1618 MW that share 40.3 percent of total power supply. One nuclear power plant of 680 MW capacity situated in Slovenia, delivers 50 percent of its production to the Croatia grid.

Table 2.1-1: Net Power in Croatian Electricity Utility

Power plants	Net Power (MW)
HPP	2063
TPP coal fired	290
TPP on liquid fuel	303
TPP - nat. gas+liquid fuel	479
CHP TPP	469
Gas turbine	48
Diesel engine	29
NPP Krško (50%)	338
Total	**4019**

At present there is no plan on revitalisation of existing thermal power plants, except for NPP Krško which has permanent modernisation programme to operate till the year 2023, with possible extension in years after. Therefore, all scenarios assumes closing down the existing thermal power plants, after their life time expire in average 35 to 40 years

Regarding the hydro power plants, the assumption is that all existing hydro power plants will, with some necessary renewal of some of its parts, operate at least until the end of the planning period (2030). The dynamics of closing down of existing thermal power plants shows that up to

year 2020 around 1220 MW of thermal power plants will be closed as it is shown in Figure 2.1-3.

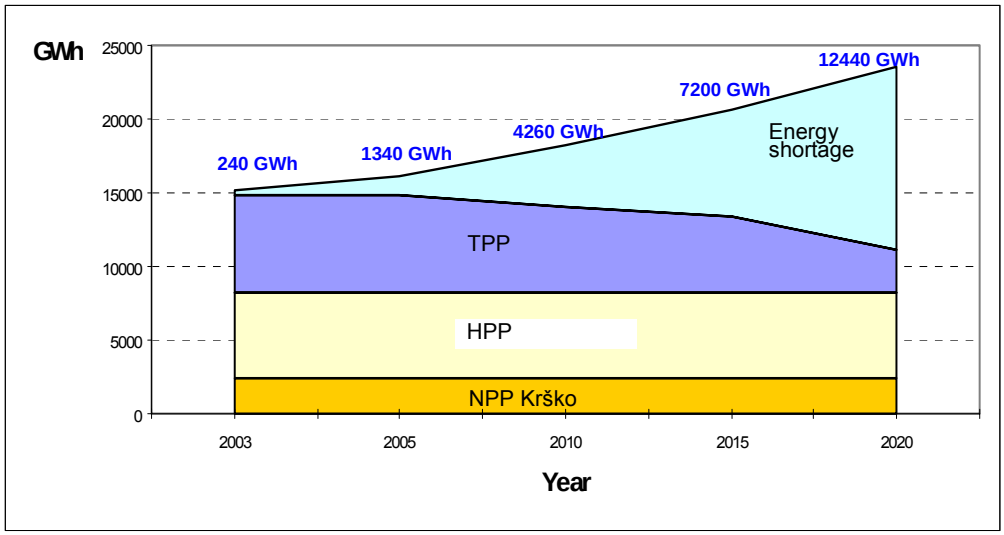
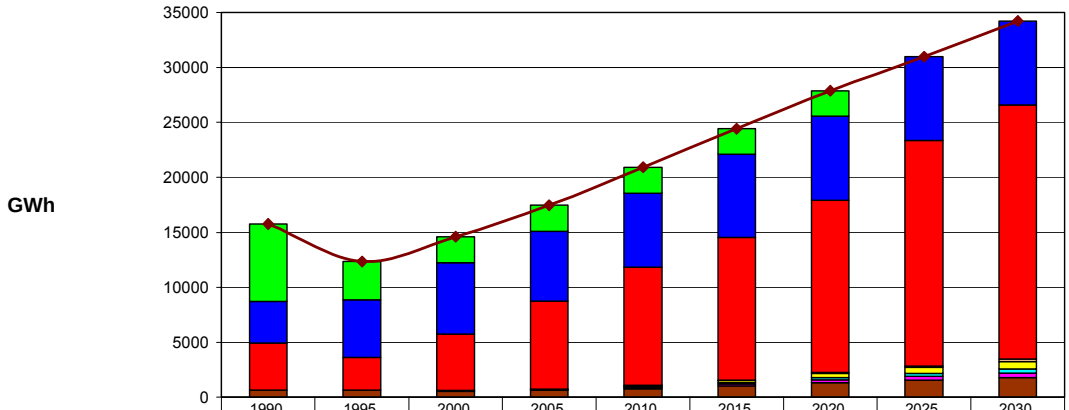


Figure 2.1-3: The dynamics of closing down the existing thermal power plants

Electric energy generation will be performed on the public network level. A small part of the public network participates in decentralized generation plants e.g. combine heat and power generation, renewable resource and small consumer part (hydrogen in future). Electric energy generation structure is presented in Figure 2.1-4.



	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
NPP Krsko&import	7061.9	3495.9	2360.4	2400.8	2336.2	2337.0	2337.1	0.0	0.0
HPP in Utility	3748.0	5264.5	6509.4	6350.6	6747.9	7577.9	7622.5	7617.2	7616.9
TPP in Utility	4315.8	2965.3	5108.0	7977.8	10735.7	12965.6	15670.2	20499.6	23106.4
Fuel cells	0.0	0.0	0.0	0.0	17.8	36.2	73.7	140.0	233.0
Renewable sources	0.0	0.0	0.0	18.5	109.3	201.1	416.9	558.1	697.1
Small hydro PP	0.0	0.0	82.7	62.0	81.9	124.0	189.0	266.0	372.0
Small cogen.	0.0	0.0	0.0	33.0	94.0	167.0	263.0	351.0	430.0
Industrial cogen.	628.8	632.3	541.4	630.0	785.0	1025.0	1306.0	1537.0	1764.0
Total	15754.5	12358.0	14601.9	17472.7	20908.0	24433.9	27878.4	30968.9	34219.4

Figure 2.1-4: Electric energy generation structure

The fundamental act governing country's energy policy and energy system planning is Energy Sector Development Strategy which outlines major guidelines for power system development. Among others, the most important outlines are:
The strategic interest of the Republic of Croatia is to construct networked energy systems, i.e. natural gas system and power system that have to complement each other.
Intensive construction of hydro power plants, in line with the National Hydro Construction Program, as multipurpose plants that stimulate the development of national building construction and electro-mechanical industry
Diversification of electricity resources (natural gas, coal)
Multidirectional natural gas & electricity supply is required

When considering hydro power plants, use of remainder of the Croatian hydro potentials will be the top priority. According to that, several HPP are planned to be build in the planning period 2003-2020.

The first power plant which could enter into operation at the earliest by 2008 is HPP Lešće, 40 MW. After that in 2009 HPP Podsused, 44 MW should enter into operation followed by HPP Drenje, 39 MW in 2011, Acumulation&HPP Kosinj, 52 MW should enter into operation in 2012 and in the period 2013 - 2020 around 70 MW in HPP should enter into operation.

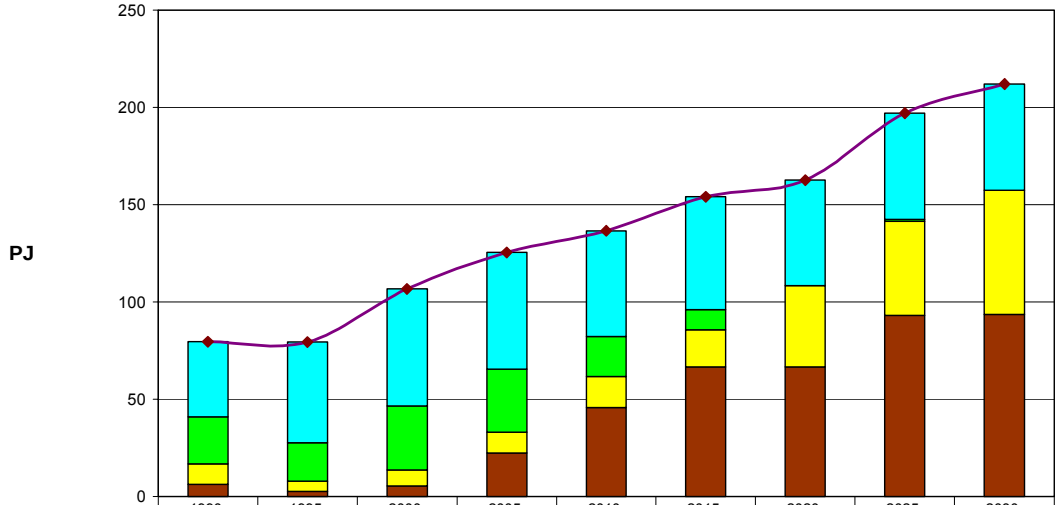
Regarding TPP units, the most favourable option is the construction of gas-fired power plants. In techno-economical competition with coal fired plants, this option is in favour by lower environmental impact and positive public attitude towards them. The first candidate plant is a 300 MW gas-fired combined-cycle thermal unit which should enter into operation in 2007. As it was explained earlier, mainly because of diversification criteria, the next TPP should be coal fired 500 MW power plant which should enter into operation in 2010. In 2010 some existing power plants will stop operating. This, together with the rise of the electricity consumption could be compensated with one thermal power plant with the capacity of 500 MW. From 2010 to 2020 one 500 MW coal fired thermal power plant should enter into operation, followed by four gas power plants of 300 MW each. In this planned period (2003 – 2020) 2500 MW of new TPP units should enter into operation and around 200 MW of HPP. The structure of production units in 2010 and 2020 are shown in Table 2.1-2.

Table 2.1-2: Structure of production units in 2010 and 2020

Power plants	2010 (MW)	2010 (%)	2020 (MW)	2010 (%)
HPP	2147	46.2	2308	41.7
TPP coal fired	790	17.0	1192	21.5
TPP on liquid fuel	303	6.5	-	
TPP - nat. gas + liquid fuel	479	10.3	-	
CHP TPP- nat. gas + liquid fuel	243	5.2	201	3.6
CCGT	300	6.5	1500	27.1
Gas turbines	48	1.0	-	
Diesel engine	-		-	
NPP Krško (50%)	338	7.3	338	6.1
Total	**4648**	**100.0**	**5539**	**100.0**

After the decommissioning of fuel oil burned thermal power plants (TPP Sisak 1 and 2 – 2x210 MW, TPP Rijeka – 320 MW), the fuel oil will not be used in electricity generation. According to this scenario, the fuel oil will be replaced with gas and coal power plants which will satisfy all the needs for electricity. At the end of the observed period the energy from coal and gas will be used equally, however the share of coal will be somewhat bigger.

The structure of fuel used for electricity production is shown in Figure 2.1-4.



	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Hydro	38.55	51.75	60.10	59.80	54.27	57.94	54.34	54.62	54.61
Liquid fuel	24.30	19.64	32.90	32.50	20.50	10.39	0.00	1.00	0.00
Natural gas	10.38	5.29	8.25	10.77	16.04	19.10	41.71	48.39	63.74
Coal	6.37	2.66	5.39	22.36	45.69	66.58	66.62	93.00	93.64
Total	79.60	79.34	106.65	125.43	136.50	154.00	162.67	197.01	211.99

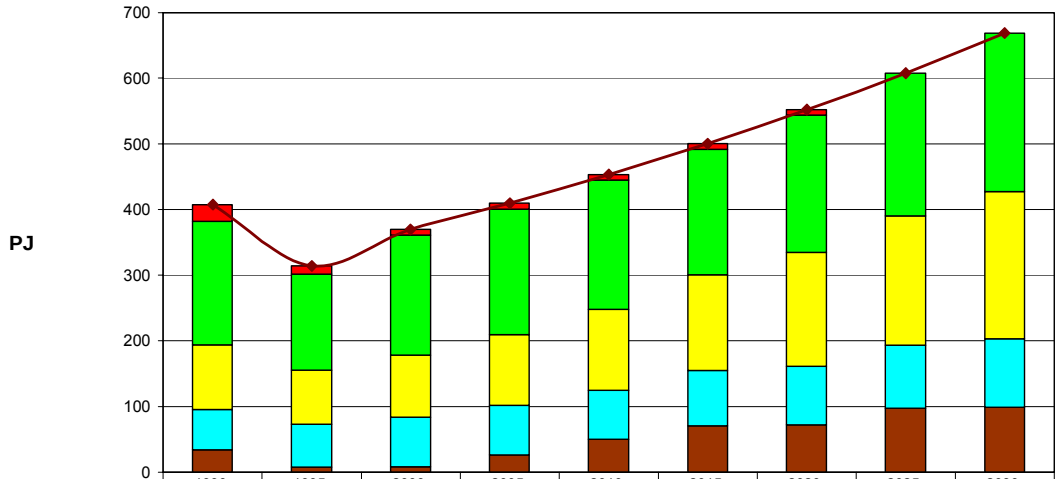
Figure 2.1-5: Structure of fuel used for electricity production

It should be noted, this scenario emphasizes diversification and security of electric-power supply system. In a period by year 2010 the emphasis is given to gas because the gas is more economical than coal, and also it is ecologically more acceptable. After realisation of project GEA (Gas Energy Adria), and liberalization and more opened trade in Europe it is expected that it will be possible to provide enough gas.

2.1.1.4. Energy source structure in total energy demand

Complete energy demands depend on economic improvement, technological development, energy efficiency and electric energy import.

According to this scenario in the period between 2000 and 2020, total energy demand will increase with the rate of 2 percent (Figure 2.1-4). The increase rates will be different and the structure will change. Equally, liquid fuel decrease will continue from 49.6 percent in 2000 to 37.9 percent in 2020. Natural gas as a second energy source will continue increasing with the end participation of gas demand of approximately 31.3 percent.

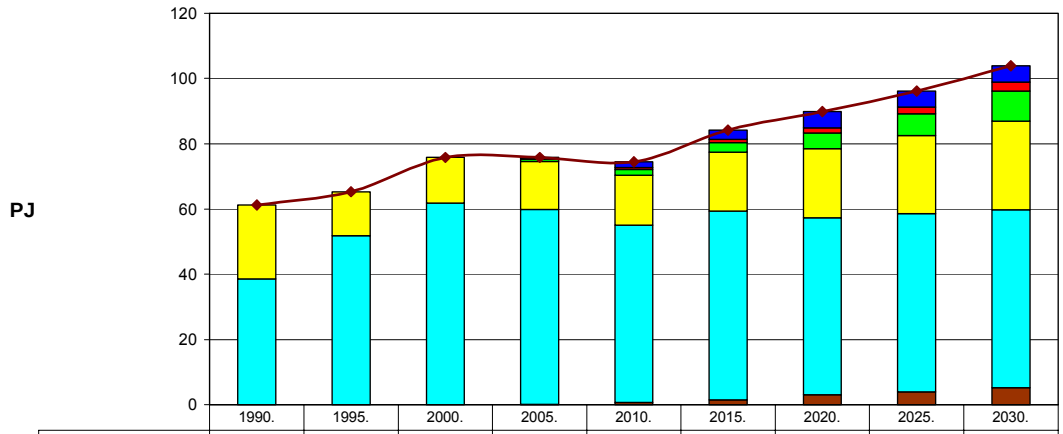


	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Electricity	25.42	12.59	8.50	8.64	8.41	8.41	8.41	0.00	0.00
Liquid fuel	188.57	146.03	183.40	191.43	196.86	191.24	209.27	217.36	241.19
Natural gas	98.22	82.77	94.05	107.57	123.05	145.89	172.98	196.98	224.31
Renewables	61.23	65.27	75.79	75.84	74.47	84.23	89.80	96.22	103.90
Coal	34.07	7.42	8.04	25.88	50.42	70.52	71.83	97.02	99.02
Total	407.51	314.08	369.77	409.37	453.21	500.30	552.29	607.59	668.43

Figure 2.1-6: Energy source structure in total energy demand, PJ

2.1.1.5. Renewable energy resource structure

In this scenario based on present-day technologies and experiences, new technology contribution in the field of energy efficiency and renewable resource utilisation is planned to increase. It is related to two traditional sources used until now: hydro power plant and biomass (wood for heating). This scenario structure anticipates the increase of geothermal energy after the 2000 with the end at 5.5 percent in total renewable energy consumption. Wind energy utilisation increases in period after the 2000 and it is expected to be 1.7 percent in 2020. In this scenario solar energy will reach 5.4 percent. At the end of the period renewable resource share should be approximately 23.6 percent. Hydro potential should absolutely increase. Hydro potential should decrease from more than 80 percent in 2000 to 60.5 percent in 2020. Biofuel utilisation is expected to begin around 2010 and in 2020 its share is expected to be approximately 3.3 percent (Figure 2.1-5).



	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Geothermal energy			0.00	0.34	1.75	2.93	4.90	4.96	5.02
Wind energy			0.00	0.15	0.50	0.88	1.55	2.06	2.74
Solar energy			0.00	0.77	1.78	2.93	4.82	6.65	9.16
Biomass	22.68	13.52	13.92	14.67	15.48	18.13	21.22	24.00	27.15
Hydro power	38.55	51.75	61.86	59.80	54.27	57.94	54.34	54.62	54.61
Biodiesel			0.00	0.10	0.69	1.43	2.97	3.94	5.22
Total	61.23	65.27	75.79	75.84	74.47	84.23	89.80	96.22	103.90

Figure 2.1-7: Renewable energy resource structure, PJ

2.1.1.6. Import and domestic energy

Domestic energy sources were used in energy sector development of the Republic of Croatia. In the past 5 years period share of domestic sources decreased from 63.4 percent to little bit more than 50.4 percent in 2000. According to this scenario, by the year 2010 the import will increase to 64 percent and at the end of the observed period the share in total demand will be 74 percent (Table 2.1-3).

Table 2.1-3: Import and domestic energy, PJ

	Past			Projected	
	1990	1995	2000	2010	2020
Imported energy	40.1	36.6	49.6	64.0	73.8
Domestic energy	59.9	63.4	50.4	36.0	26.2

2.1.2. GHG EMISSION FOR SCENARIO "WITH MEASURES"

2.1.2.1. Measures

The scenario "With measures" outlines total energy demand, assuming the implementation of a variety of measures, such as the use of renewable energy resources and the implementation of energy efficiency measures.

The following measures are included in "With measures" scenario:

- Wind Power Plants
- Small Hydro Power Plants
- Biomass Use in Cogeneration Plants
- Fuel Cells
- Biodiesel and Hydrogen
- Solar Energy
- Geothermal Energy
- Heat Generation Efficiency Increase

The table 2.1-4 shows GHG emission reduction potential of the mentioned measures for the years 2010 and 2020. More detailed information about GHG emission reduction potential of listed measures is presented in Annex 1. The mentioned measures cannot be implemented without special incentives and an adequate energy policy. Implementation of concerned measures is adopted through Energy Sector Development Strategy (policy document adopted by Parliament). There are approximately 30 regulatory documents which support its implementation, of which five will regulate use of renewable energy and energy efficiency. This secondary regulation is currently in the process of drafting and/or adoption.

The secondary regulation for introduction of renewable energy sources (wind, small hydro, bioenergy and geothermal) will stipulate connections of these sources to the grid by providing energy subsidies. Every power supplier will be obliged to have certain proportion of renewable energy in its portfolio, and revenue for subsidies will be collected through energy taxation.

Table 2.1-4: Potential of GHG mitigation measures (Gg) in Energy sector

	2010				**2020**			
	CO_2	**CH_4**	**N_2O**	**CO_2-eq**	**CO_2**	**CH_4**	**N_2O**	**CO_2-eq**
Wind Power Plants	108.9	2.1	1.3	**109.4**	285.1	3.6	3.4	**286.3**
Small Hydro Power Plants	64.2	1.2	0.8	**64.4**	125.1	1.6	1.5	**125.6**
Biomass Use in Cogeneration Plants	44.1	1.1	0.2	**44.2**	204.9	5.1	0.8	**205.2**
Fuel Cells	14.0	0.3	0.2	**14.0**	48.8	0.6	0.6	**49.0**
Biodiesel and Hydrogen	53.8	4.4	0.4	**54.1**	261.7	27.7	2.2	**263.0**
Solar Energy	311.6	15.4	3.4	**313.0**	624.8	32.7	6.0	**627.3**
Geothermal Energy	239.1	11.0	2.6	**240.1**	539.2	25.8	5.3	**541.4**
Heat Generation Efficiency Increase	33.7	2.7	0.5	**33.9**	78.6	6.5	1.2	**79.1**
Total	**869.4**	**38.2**	**9.4**	**873.1**	**2168.2**	**103.6**	**21.0**	**2176.9**

2.1.2.2. Projections

The fossil fuels consumption projections and the adequate emission factors recommended by IPCC method, enable the determination of greenhouse gas emissions. The CO_2 emission will increase, according to "With measure" scenario. The highest increase is expected in the power

generation sector as a result of two new coal-fired thermal power plants in operation, and in transport due to increase of vehicles and mobility (Table 2.1-5).

Table 2.1-5: CO_2 emission from Energy subsectors

CO_2 Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	5896.5	4459.9	5650.3	7152.5	8691.5	9403.2	10131.1
Man. Ind. & Constr.	6545.9	3617.0	3903.1	4486.3	5095.8	5843.1	6590.3
Transport	4046.0	3337.2	4459.1	5452.4	6345.2	7329.2	8313.1
Residential	1994.8	1596.0	2068.5	2332.9	2572.8	2789.0	3005.2
Commercial/Institutional	782.1	601.4	709.7	698.7	688.3	716.3	744.4
Agriculture and Other	1278.1	773.4	900.3	868.0	877.6	905.8	917.8
Natural Gas Scrubbing	415.9	696.9	687.6	687.6	687.6	687.6	687.6
Total Energy Sector	**20959.4**	**15081.9**	**18378.7**	**21678.4**	**24958.9**	**27674.2**	**30389.6**

In addition, the total emissions of individual greenhouse gases from Energy Sector are presented (Table 2.1-6). According to scenario ”With measures”, the increase in greenhouse gas emission will occur so that in 2010 the emission will be 34 percent larger than emission in 2001, or 19 percent larger than emission in 1990.

Table 2.1-6: Total GHG emission from Energy sector

GHG Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
CO_2 Emission	20959.4	15081.9	18378.7	21678.4	24958.9	27674.2	30389.6
CH_4 Emission	67.806	58.193	63.921	64.702	65.296	66.187	67.077
N_2O Emission	0.257	0.158	0.496	0.792	1.039	1.191	1.343
CO_2-eq Emission	**22462.9**	**16352.7**	**19874.9**	**23282.6**	**26652.0**	**29433.2**	**32214.4**

More detailed information about GHG emissions for “With measures” scenario is shown in Annex 1.

2.1.2.3. Analysis of “With measures” scenario

The expected increase of gross domestic product, total energy demand, electricity consumption and CO_2 emission, for “With measure” scenario, is presented in the Table 2.1-7.

Table 2.1-7: Expected increase of main indicators, “With measure” scenario

	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
GDP/capita, $/cap.	5106	3873	4669	5942	7535	9355	11521
Total energy demand, PJ	408	314	370	411	453	503	552
CO_2 emission - "With measure", Gg	20959	15082	17447	21678	24959	27674	30390
Electricity consumption, GWh	14749	11404	13836	16048	19127	22103	24865

According to expected values of main indicators for the period from 2000 to 2020, GDP will annually increase by 4.6 percent on average, total energy demand by 3.0 percent, CO_2 emission by 2.8 percent and electricity consumption by 2.0 percent. Indexes of abovementioned indicators, normalized on 1990 values (100% in 1990), are shown in the Figure 2.1-6.

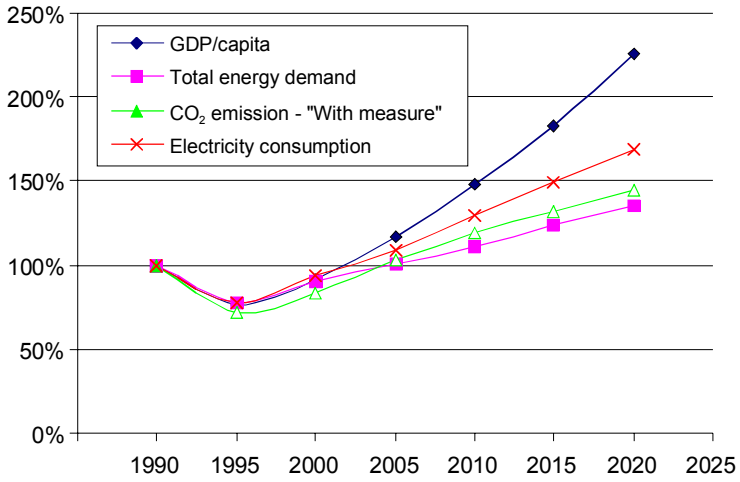


Figure 2.1-8: Indexes of main indicators for "With measure" scenario

2.2. SCENARIO "WITHOUT MEASURES"

As it was noted in introductory chapter this scenario is constructed from the 'With Measures' scenarios by subtracting the GHG reduction potentials of selected measures that belongs to the category of 'Climate Change' driven measures.

Although a number of measures were simulated under the scenario "With measures", only some of them, more significant in terms of their respective potential, were selected for the creation of the scenario "Without measures" (Table 2.1-4). Therefore, the scenario "Without measures" does not represent a frozen scenario, i.e. energy demand projections based on the present state of energy technologies. In addition to the mentioned measures, a gradual improvement in energy efficiency without special incentives was also simulated. This suggests that the energy demand under the scenario "Without measures" would be slightly lower than that under the straight frozen scenario. At the same time, the GHG emission would be higher under the frozen scenario than under the analyzed scenario "Without measures".

2.3. SCENARIO "WITH ADDITIONAL MEASURES"

Additional mitigation measures is analysed in official development strategy of Energy sector and First National Communication to the UNFCCC. According to above-mentioned documents, potential of measures for Power sector and Energy consumption sectors is developed (Table 2.3-1). More detailed information about additional measures is presented in Annex.

Table 2.3-1: Potential of additional GHG mitigation measures (Gg) in Energy sector

	2010				2020			
	CO_2	CH_4	N_2O	CO_2-eq	CO_2	CH_4	N_2O	CO_2-eq
Power Generation Sector	**727.3**	**13.9**	**8.5**	**730.2**	**1225.4**	**15.3**	**14.5**	**1230.2**
Savings in power trans. and distrib.	39.6	0.8	0.5	39.8	99.2	1.2	1.2	99.6
Wind Power Plants	451.1	8.6	5.3	452.9	762.1	9.5	9.0	765.1
Small Hydro Power Plants	62.7	1.2	0.7	62.9	105.9	1.3	1.3	106.3
Biomass in Cogeneration	174.0	3.3	2.0	174.7	258.2	3.2	3.1	259.2
Industry	**258.8**	**12.6**	**3.4**	**260.1**	**795.6**	**19.0**	**12.2**	**799.8**
Motor Drives Regulation	12.2	0.2	0.2	12.3	470.7	5.9	7.4	473.1
Cogeneration Plants	52.8	0.9	0.9	53.1	150.1	2.7	2.7	151.0
Low-temp. heat gener. effic. increase	115.2	5.4	1.1	115.7	102.1	4.8	1.0	102.5
High-temp. heat gener. effic. increase	78.5	6.0	1.2	79.0	72.7	5.6	1.1	73.1
Transport	**59.4**	**4.1**	**0.5**	**59.6**	**910.2**	**70.4**	**34.5**	**922.3**
Interurban passenger transport	0.0	0.0	0.0	0.0	93.0	21.5	16.6	98.6
Urban passenger transport	0.0	0.0	0.0	0.0	77.0	15.4	11.9	81.0
Freight transport	0.0	0.0	0.0	0.0	458.5	14.4	3.7	460.0
Increase in biodiesel use	59.4	4.1	0.5	59.6	281.6	19.2	2.3	282.7
Services	**406.8**	**21.4**	**4.4**	**408.6**	**835.5**	**44.3**	**7.9**	**838.8**
DSM measures	14.4	0.3	0.2	14.5	32.1	0.4	0.4	32.2
Solar energy use increase	78.5	3.9	0.8	78.8	140.2	7.3	1.3	140.7
Geothermal energy use increase	16.4	0.8	0.2	16.4	27.9	1.3	0.3	28.0
Distr. heating and cogen.use increase	66.8	3.6	0.7	67.1	145.6	8.0	1.4	146.2
Insulation improvement	230.8	12.8	2.5	231.8	489.6	27.2	4.6	491.6
Residential	**586.8**	**22.4**	**4.4**	**588.6**	**1789.2**	**87.0**	**13.9**	**1795.3**
Solar energy use increase	28.4	1.8	0.2	28.5	286.7	21.3	1.9	287.7
DSM measures	12.4	0.2	0.1	12.5	192.3	2.4	2.3	193.0
District heating use increase	20.7	2.2	0.1	20.8	156.8	17.2	1.1	157.5
Insulation improvement	73.0	2.5	0.7	73.2	376.4	18.7	3.1	377.8
Biomass in cogen. and boiler plants	452.2	15.6	3.1	453.5	777.0	27.4	5.5	779.3
Total potential	**2039.1**	**74.3**	**21.2**	**2047.2**	**5555.8**	**236.1**	**83.1**	**5586.5**

2.3.1. POWER SECTOR

One of the main characteristic of Croatian Power sector is that more than 65 percent of electricity supply is provided without direct GHG emissions, by hydro power plants, nuclear power plant Krško and import. Import of electricity is very large in last few years, i.e. in 2000 the import (4037 GWh) was more than production in all thermal power plants in Croatia (3958 GWh). According to Power sector development scenarios, all electricity demands should be supplied from Croatian power plants.

In "With additional measures" scenarios, about 300 MW installed capacity of renewable power plants in wind power plants, small hydro plants and biomass cogeneration plants is assumed. Those plants should produce 878 GWh of electricity in 2010. Accordingly, 690 Gg of equivalent CO_2 emissions will be avoided (Table 2.3-1).

This scenario assumes 576 GWh of electricity production from wind turbines, in 2010. Using wind-electricity, appropriate fossil fuels consumption will be reduced, because of decrease of thermal power electricity production.

The construction of small hydro-electric plants was considered. There are records of 699 possible stretches for waterpower harnessing in small hydro plants on 63 streams in Croatia. Approximate total potential installed capacity could be 177 MW, and the power generation potential is about 570 GWh. If the stretches at small gradients are excluded, it is realistically assumed that about 350 technically feasible stretches are available. This number will further reduce because of the local town-planning and environmental requirements. If only 100 stretches will be used in 2010, and about 80 GWh of power generated, the GHG emission would be reduced by 63 Gg.

The biomass-fired cogeneration plants should contribute to reduction of the CO_2 emission from power generation in the amount of equal to the generated power, and the reduction in the energy consumption sectors equal to the generated heat quantity. In calculation is assumed 222 GWh of electricity production from biomass-fired cogeneration plants in 2010.

Additionally, distribution efficiency improvement is also analysed. The technical losses from the distribution network are evaluated at 5 to 5.5 percent. The loses in distribution network could be reduced to approximately 1 percent till 2020. These measures demand high additional investment, for reduction of losses from the existing network, which is usually not cost-effective.

2.3.2. ENERGY CONSUMPTION SECTORS

2.3.2.1. Measures in Industry

This scenario expects faster replacement of production machinery in the Croatian industry with more efficient technologies so that, in a long run, the heat consumption rate would be twice as low as today and the electricity consumption intensity would fall by 15 percent. Enhanced introduction of renewable resources and cogeneration in the energy market is also expected, which would enable that, in the long term, the share of electricity in heat demand falls below 10 percent.

In Industry is analysed heat generation efficiency increase, electromotor drive regulation and industrial cogenerations. Expected GHG emission reduction potential of planned measures is about 260 Gg in 2010 (Table 2.3-1).

2.3.2.2. Measures in Transport

In this scenario the transport undergoes significant changes. It is presumed that an adequate transport policy would essentially change the freight transport structure. Namely, the so-called integral goods transport would allow the increase of railway traffic against the road traffic. In the passenger traffic, public transport would have bigger share in the cities, and in the interurban traffic. The structure of used energy sources would also be changed. In that way the share of electricity in this scenario would be the highest. The shares of motor gasoline and diesel fuels would notably decline. Additionally, in this sector increase of biodiesel use ia also analysed.

The estimated potential of reducing energy consumption in transport sector is calculated with the equal efficiency and equal level of passenger and freight transport effects. The GHG emission reduction potential of planned mitigation measures in Transport sector is presented in the Table 2.3-1.

2.3.2.3. Measures in Services

Unlike the scenarios “With measures” and “Without measures”, this scenario expects the improving of thermal insulation of sector’s premises and the long-term reduction of thermal energy demand. The share of renewable resources and cogeneration would increase. So, the solar energy will participate with 13.4 percent and geothermal energy with 4.5 percent in 2020, which is higher than in the “With measures” scenario. An even faster introduction of heat generated in small cogeneration plants and of district heating is expected.

In this sector is recognized few types of measures, as follow: demand side measures, increase usage of solar and geothermal energy, increase usage of district heating plants and cogenerations and thermal insulation improvement. The GHG reduction potential of these measures is presented in the Table 2.3-1.

2.3.2.4. Measures in Residential sector

In relation to the other scenarios, faster decline in coal and oil derivatives use is expected, slower growth of natural gas use, and a more intensive application of new technologies (solar collectors, biomass-fired boiler plants, solar boiler plants and heat produced in small district heating and cogeneration plants). Improvements of thermal insulation of existing households and electricity savings for non-heat purposes is also analysed in this “With additional measures” scenario (Table 2.3-1).

2.4. GHG EMISSION PROJECTION OF ENERGY SECTOR

The greenhouse gases emission for previously mentioned scenarios of energy sector development, so called “With measures”, “Without measures” and “With additional measures” scenarios, are presented in the Figure 2.4.1. The projection of fuel combustion sectors is based on Energy sector development strategy, while fugitive emission projection is not determined. In projections, the fugitive emission from the year 2001 is used.

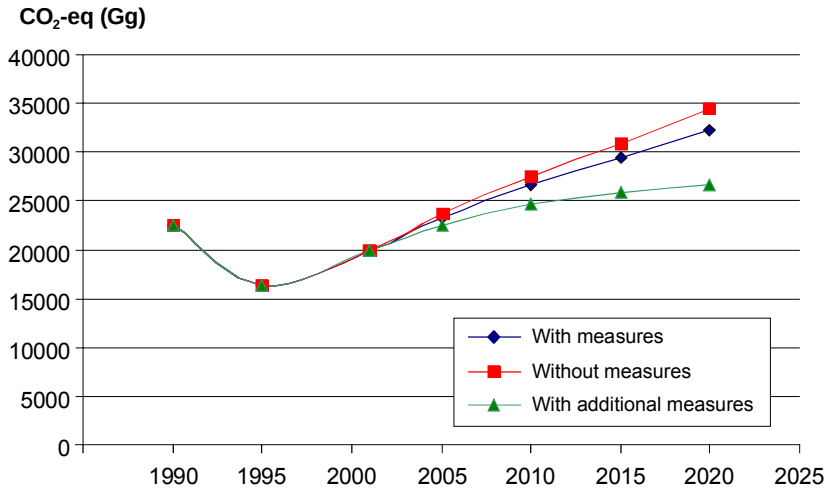


Figure 2.4-1: GHG emission projection for Energy sector

According to all analysed scenarios, the increase of GHG emission will occur. For scenario “With additional measures” in 2010, the GHG emission will be 10.5 percent larger than emission 1990, while the scenario “Without measures“ even 22.5 percent. It is important to stress, that in scenario “With additional measures”, about 300 MW installed capacity in renewable power plants (wind power plants, small hydro plants and biomass cogeneration plants) is involved.

3. INDUSTRIAL PROCESSES

The projections of emission from industrial processes assume that Croatia is not going to install additional capacities of the energy-intensive industry, and that there will be no revival of iron and primary aluminium production which were closed down in 1991. The industrial processes analyzed here have the major share in the total sector emission (around 92 per cent) and have prepared medium or long-term bussines strategies. These are production of cement, ammonia and nitric acid. The projections does not encompass the closed down processes and ones for which there are no developed medium or long-term bussiness plans/strategies as well as those that have negligible contribution to total emission from this sector.

In respect to classification of measures ("With measures" and "With additional measures") it should be stressed that there are no currently implemented and adopted policies and mitigation measures in industrial processes in Croatia, and therefore it is not possible to report "With measures" projections. Only "Without measures" and "With additional measures" projections are reported.

3.1. "WITHOUT MEASURES" PROJECTIONS

The "Without measures" projections of emission from industrial processes assumes that production of selected processes (cement, ammonia and nitric acid) in the period 2005-2020 will reach its planned capacities, and that no measure for reduction of greenhouse gases will be implemented. The emissions of CO2 and N2O for "Without measure" scenario are presented in tables 3-1 and 3-2.

3.1.1. CO_2 EMISSION

Table 3.1-1: CO_2 emissions from Industrial processes (Gg)

Industrial processes	1990	1995	2001	2005	2010	2015	2020
Cement production	1022	585	1420	1557	1557	1557	1557
Lime production	145	62	144	NE	NE	NE	NE
Limestone use	19	11	9	NE	NE	NE	NE
Soda ash use	26	14	12	NE	NE	NE	NE
Ammonia production	492	463	426	509	542	542	542
Metal production[1]	641	34	0.5	NE	NE	NE	NE
Total	**2345**	**1169**	**2012**	**2066**	**2099**	**2099**	**2099**

[1] Includes: iron and steel production, ferroalloys production and aluminium production
NE – Not estimated

3.1.2. N_2O EMISSION

Table 3.1-2: N_2O emissions from Industrial processes (Gg)

Industrial processes	1990	1995	2001	2005	2010	2015	2020
Nitric acid production	2,99	2,69	2,32	2,92	3,11	3,11	3,11
Total	**2,99**	**2,69**	**2,32**	**2,92**	**3,11**	**3,11**	**3,11**

3.2. "WITH ADDITIONAL MEASURES" PROJECTIONS

The only mitigation measure in industrial processes which is considered as "additional measure" in this analysis is installation of NSCR (Non-Selective Catalytic Reduction) in the nitric acid production plant. This measure is included in manufacturer's business strategy as medium term objective if N_2O fee will be in place (not planned at the moment), or to achieve allocated greenhouse gas emission limit according to national emission allocation scheme (still not developed). For this purpose it is assumed that this measure will be implemented in 2010, and that NSCR has 85 per cent efficiency.

Table 3.2-1: N_2O emissions from nitric acid production "With additional measures"(Gg)

Industrial processes	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Nitric acid production	2.99	2.69	2.32	2.92	0.47	0.47	0.47
Total	**2.99**	**2.69**	**2.32**	**2.92**	**0.47**	**0.47**	**0.47**

Table 3.2-2 presents difference between "Without measure" and "With additional measure" scenario.

Table 3.2-2: CO_2-eq emissions from Industrial processes (Gg)

Industrial processes	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
"Without measures"	3272.6	2004.0	2730.0	2972.0	3063.6	3063.6	3063.6
"With add. measures"	3272.6	2004.0	2730.0	2972.0	2243.7	2243.7	2243.7
Mitigation	**0**	**0**	**0**	**0**	**819.9**	**819.9**	**819.9**

4. AGRICULTURE

The projection is made on the basis of the current situation in agricultural production, and pre- and post-war trends. It is assumed that the present population increase trend (1 percent a year) will be sustained, that the GDP increase rate will be lower (2 percent beyond 2001), and that the consumption of agricultural products will increase according to the results of the research conducted by the Agricultural Economics Department (1986-1990).

For consumption forecast, the econometric model was used based on the consumer people income projection (€ 6,000 per capita), increase in present population/consumers (4,400,000) at an average annual rate of 2 percent, and coefficients of income-based elasticity of consumption known from the earlier research of the Agricultural Economics Department of the Agricultural College of the University of Zagreb. The forecast does not account for unexpected events that might cause significant disturbances in offer and demand of the agricultural products. It is assumed that in 2005 the tourist consumption will reach 150,000 conditional inhabitants or an occupancy level of about 55 million of foreign tourists, and this trend is seemly to be maintained until the end of the analyzed period.

As regards production of forage, and partly corn and cereals intended for animal feed, the animal feed demand has been calculated as per the feed units. The yield increment in the plant production by the year 2020 is accounted for as a 30 percent increase of the present standards for cattle, pig and poultry gain.

The calculation is made on the basis of an estimate that 56 to 85 percent of arable land shall be included in high-input agriculture by the year 2020.

It is assumed that the domestic agricultural production will, in the best case, remain at the present level of the self-sufficiency, which is measured as the ratio of domestic production and quantity available for overall consumption. According to the present trends and expected conditions in the future international economic integration Croatia will take part in, no significant increase in export is envisaged. It is certain that the import/export balance for the agricultural product will be relatively uniform beyond 2010, and no significant deviations are expected. The strategic objective of the domestic production in the period until 2010 is increase in self-sufficiency until the said values are achieved, followed by stabilization or small increase in the reached level.

4.1. BASELINE SCENARIO

The production is oriented towards meeting of the lower demand level, which will be reached under the conditions of the slower increase in purchasing power and a particularly slow development of agriculture. A 25-38 percent lower technical advancement is planned measured by the plant production yield. The animal husbandry production rate, measured by the live weight gain, is about 30 percent lower. The milk production per head is relatively high, since considerable increase is assumed in larger farms share without any additional incentives (2.672 kg/year in 2020 on average).

4.2. ECONOMIC EFFICIENCY

At the very best, a significant consolidation of farm land is planned, application of modern technology on 70-85 percent of arable land and over 50 percent participation of large farms in animal husbandry. As said, the increase in plant production yield is also anticipated. In animal

husbandry, an expected average increase in milkiness to about 3,360 kg milk a year from about 55 percent of milking cows on larger farms. An average increase in animal breeding productivity measured by the live weight gain is about 30 percent (pork, beef and eggs production). With such structure, a well-organized production could meet a maximum domestic demand (increased by tourist demand). All major agricultural projects (plantations, farms, processing facilities) will be highly environmentally oriented, with considerable use of sound practices for removal of the potentially harmful substances.

4.3. MOST PROBABLE SCENARIO

The most probable agricultural production development is based on realization of 60-70 percent of presumptions from the economically efficient case. The production is focused on meeting a moderate demand to be achieved under the conditions of the slower increase in purchasing power and medium agricultural development efficiency. A 12-23 percent lower technical advancement is planned, measured by the plant production yield, animal husbandry productivity measured by the live weight gain and milk production per head (2,704 kg/year in 2020 on average).

5. LAND USE CHANGE AND FORESTRY

The “without measures” or baseline scenario for forestry does not envisage any changes in surfaces under the forests and their structure, so the carbon sequestration remains at the present level of 8.069 million tons per year.

Measures for increase of carbon sequestration with forest biomass with the highest contribution are reforestation and better use of biomass in power generation, or use of waste wood. Reforestation does not bring short-term results and the procedure for determination of the GHG emission and sinks is very complex if the entire cycle is to be covered. That is the reason that within the Convention this issue is still undergoing the methodological analyses and discussion. For better understanding of the problem, Croatia has for a number of years participated in the international IEA program Bioenergy – Task 38 “GHG Emission Balances of Bioenergy Systems”.

No significant effects of the measures are expected in this sector until the year 2010. So far, allowed level for sinks are limited by Kyoto rules and for Croatia the limitations have not yet been established. It is only highlighted that the reforestation of the free forestland on the surface area of 331000 ha could result in an increase in the annual increment of 2.2 million m^3, which means the emission sink increase by 2 million tons.

6. WASTE

The projections of emissions from waste sector includes only municipal solid waste disposal on land since there are no realistic plans for anaerobic wastewater treatment and waste incineration without energy recovery in Croatia in the future period.

In respect to classification of measures ("With measures" and "With additional measures") it should be stressed that there are no currently implemented and adopted policies and mitigation measures in waste sector in Croatia, and therefore it is not possible to report "With measures" projections. Only "Without measures" and "With additional measures" projections are reported.

6.1. "WITHOUT MEASURES" PROJECTIONS

The "Without measures" projections of emission from solid waste disposal assume continuous increase of municipal solid waste caused by increase in the standard of living and size of population, and subsequent decrease with time due to waste avoidance/minimization and recycling measures. In the period 1990-2000, the estimated annual waste increase was 2.7 percent. The estimated increase for the period 2001-2010 is in the range of 1.5 to 2.5 percent, and for the period 2011-2020 from 1.0 to 2.0 percent.

At such increase rates, the average annual municipal waste production shall grow from 1 million tonnes in 1990 to approximately 1.6 million tonnes in 2010 and 1.8 million tonnes in 2020. IPCC default methodology was used to estimate methane emissions from solid waste disposal sites (table 6.1-1).

Table 6.1-1: CH_4 emissions from Waste "Without measures" (Gg)

Waste	1990	1995	2001	2005	2010	2015	2020
Solid waste disposal	37.77	41.16	51.33	62.57	69.89	65.37	57.57

6.2. "WITH ADDITIONAL MEASURES" PROJECTIONS

The "With additional measures" projections include implementation of "waste-to-energy" plants for municipal solid waste instead of waste disposal to land. According to actual plans for building of the first waste incineration plant it is assumed that approximately 20 percent of total municipal solid waste generated in Croatia will be incinerated in 2010 and 40 percent in 2020.

Table 6.2-1: CH_4 emissions from Waste "With additional measures" (Gg)

Waste	1990	1995	2001	2005	2010	2015	2020
Solid waste disposal	37.77	41.16	51.33	54.26	53.36	42.29	31.25

Table 6.2.2 presents difference between "Without measure" and "With additional measure" scenario.

Table 6.2-2: CO_2-eq emissions from waste (Gg)

Waste	1990	1995	2001	2005	2010	2015	2020
"Without measures"	793	864	1078	1314	1468	1373	1209
"With add. measures"	793	864	1078	1139	1120	888	662
Mitigation	**0**	**0**	**0**	**175**	**348**	**485**	**547**

7. SUMMARY OF SCENARIOS

Total greenhouse gas emissions in the "Without measures" scenario, and contribution of individual sectors, are shown in Figure 7-1. It must be noted that this projection has not been considered for some individual sub-sectors, such as: fugitive emission from fuels, some less important industrial processes, and human sewage. Their contribution to the total emission was about 8.3 percent in 2001, and all scenarios assume that the emissions from these sub-sectors remain at the 2001 level.

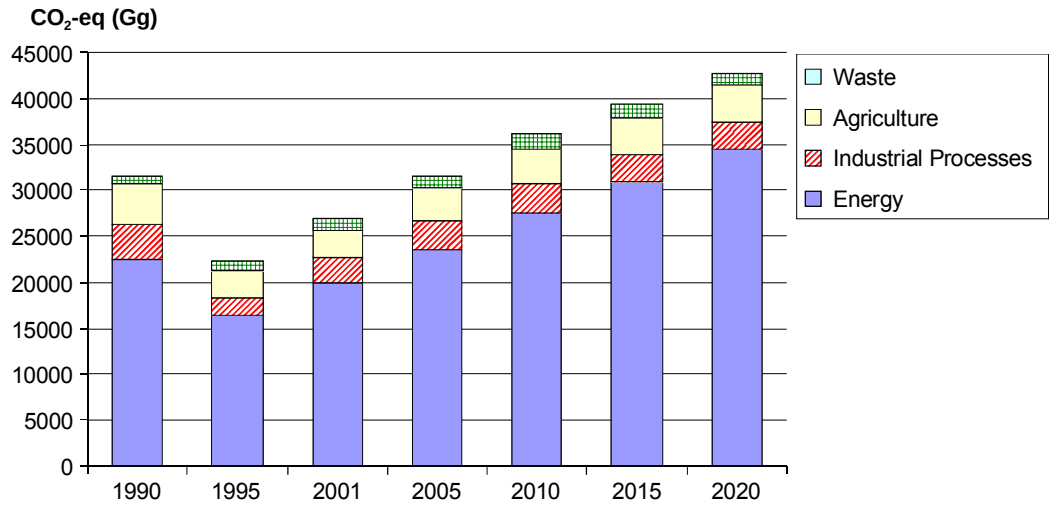


Figure 7-1: Total GHG emission according to "Without measure" scenario

Figure 7.2 presents cumulative GHG emission reduction potential, including both "with measures" and "with additional measures".

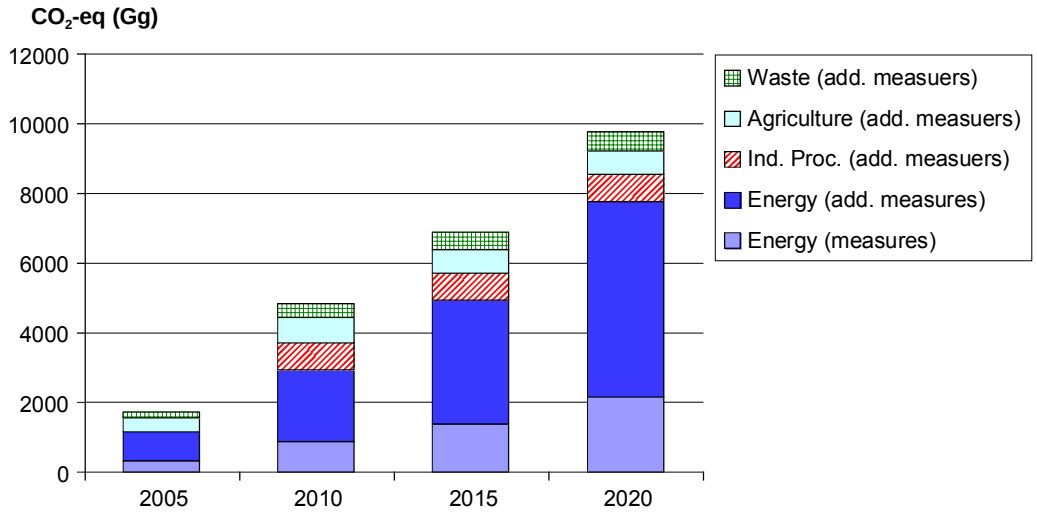


Figure 7-2: Total GHG emission reduction potential of analysed measures

Total GHG emission projections for “Without measures”, “With measures” and “With additional measures” scenarios are shown in Figure 7-3. Kyoto protocol target presented on figure 7-3 is on the level which does not involve Proposal of the Croatian under article 4.6 (7.4 million of tons of CO_2-eq above standard approach for defining base year emission).

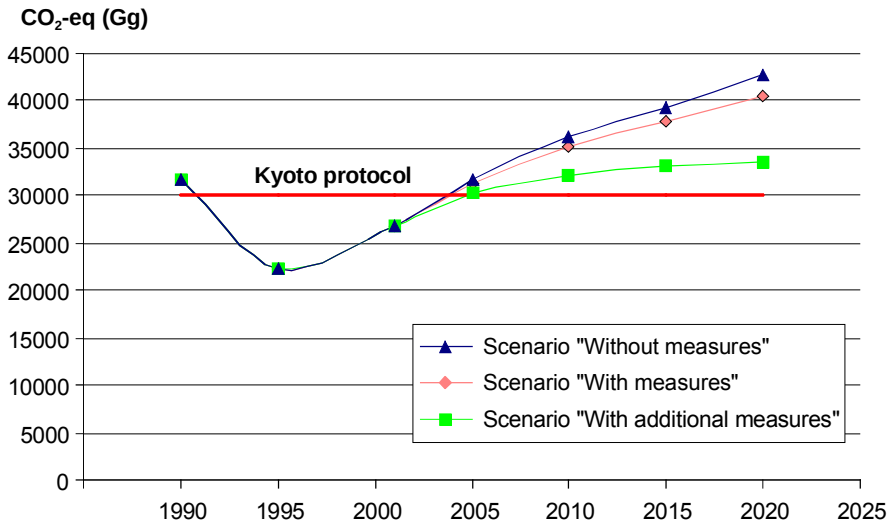


Figure 7-3: Greenhouse gases emission projection for Croatia

In assessing projection scenarios from figure 7-3 it is important to have on mind the following:

- Projection scenarios assume realistic growth rates in energy sector. The total energy growth rate is 3 percent and for the electricity consumption is 2 percent, less than growth of GDP (Figure 2.1-8). With this growth rates which are already in place, Croatia will have in the year 2010 per capita energy and electricity consumption lower than each country of the enlarged EU. Emission intensity (t CO_2/GDP) will decrease in the year 2010 for 16.7 percent comparing to year 1990, for the scenario “With measures”.
- The share of fossil fuel consumption in all sectors, including power production, will be still relatively low, much less then in many other EU countries, particularly less than in EIT countries.
- Croatia has to build new power plant not only for covering the new growing demands but also to substitute capacities that have been available, on long term basis, from another republics of former Yugoslavia.
- Croatia is still suffering the consequences of the war and instability in region for the period until the end of the first commitment period. For Croatia, the main priority was recovering the life in war effected areas, the great part of public expenses, including the National Electricity Company investments, is going on recovering of war destroyed grid and transmition facilities (for example the greatest power switch yard in this part of the Europe destroyed in the war, named Ernestinovo, has needed ten years to be re-build).
- In the year 2010 imported energy will have share of 64 percent. To enable secure energy supply, Croatia needs to have diversified fuel sources.
- Potential for renewable energy are quite limited, location for the wind farms are not close to consumers and often in areas where visible landscape impact is problematic because of tourism. Croatian hydro potentials are explored and new capacities could be built with high costs and great environmental impact. Share of biomass use is currently quite high, in rural settlements where there is no natural gas, fuel wood is dominant fuel. In total energy supply, fuel wood share is 4.3 percent in the year 2000.

- Currently 14.4 percent (in 2000) of electricity is produced in cogeneration plants. There is no public or industrial consume available for big new electricity cogeneration units.
- Energy intensity in Croatia is about 310 toe/mill.US$90 which is on the level of some very developed countries like USA. This shows that there is no great potential in industry restructuring.
- Since the great part of industrial and service sector is struggling with survival and with transition to open market, it is not possible to use benefits of energy efficiency implementation.
- Policy priority in energy sector is to build regulatory and institutional basis for new energy open market system. Significant penetration of renewable electricity will be possible when Energy Regulating Agency and Independed Operator of the Energy Market will have instruments in place for absorbing this energy in the system. Process of deregulation of energy market is slow and current situations about shortage of electricity and black outs in Europe calls for very careful change steps which will definitely slow down the whole restructuring process.
- Some important projects, like “Removing Barriers for Energy Efficiency in Service and domestic Sector”, “Croatian Energy Efficiency Project” and “Croatian Renewable Project”, all supported by the GEF with total budget of 56 million US$, show that barrier for implementation of energy efficiency and renewables are still large.

Figure 7-3 shows that even with implementation of all additional measures, Croatia is not able to achieve the GHG emission stabilization on the level of the base year emission and Kyoto target. It should be emphasised that “With additional measures” scenario could be hardly achieved. This scenario assumes full utilisation of reduction potentials, presently estimated on aggregated analysis and data, with an approach which usually gives more optimistic figures than the collection of individual project potentials, by bottom-up approach. Current Government initiative to collect candidate project for JI under Kyoto protocol shows that project base level potential of GHG reduction is considerable lower than aggregate scenario figures give.

Even with “Without measure” scenario Croatia will have per capita GHG emission on the level between the lowest of EU and EIT countries. Feasible scenario “With measures” gives 5.2 million tons of CO_2-eq above the Kyoto protocol target. Including forest sink (976 Gg CO_2), which is 15 percent of total removal of forestry management activities, the emission of Croatia in the year 2010 will be 4.2 million tons above Kyoto target.

Scenario “With additional measures”, exceeds Kyoto emission target by 2 million tons CO_2-eq. This scenario assumes reduction of emission by 5.2 million of tons comparing to “Without measures” (business as usual) scenario in the year 2010, in 2020 reduction needs to be 10 million tons. National cost calculation curve of mitigation measures shows that in energy sector with approach above 1.5 million of tons reduction, costs reach 30 – 40 US$ per ton of CO_2 *(Ref.3.).* This means that scenario “With additional measures” will have a considerable socio-economic impact, which is not in proportion to the Croatian economic capabilities and its priorities.

8. REFERENCES

Ref 1: Government of the Republic of Croatia (2002): *Croatia in 21st century,* Energy Sector Development Strategy, Zagreb

Ref 2: Government of the Republic of Croatia (2002): *Croatia in 21st century,* Macro-economical development strategy, Zagreb

Ref 3: Ministry of Environmental Protection and Physical Planning (2001): *The First National Communication of the Republic of Croatia to the United Nations Framework Convention on Climate Change (UNFCCC),* Zagreb

Ref 4: EKONERG (2003): *Croatian Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of all Greenhouse Gases not Controlled by the Montreal Protocol for the Period 1990-2001*, Zagreb

Ref 5: Energy Institute "Hrvoje Požar" (1998): *National Energy Programs*, Renewable Energy Sources and Energy Efficiency, Zagreb

Ref 6: EKONERG (2001): *Analysis of possible measures for greenhouse gas emissions reduction of Croatian Electric Utility*, Zagreb

ANNEX

GHG EMISSION PROJECTION OF ENERGY SECTOR

Table A-1: Projection of CO_2 emission for Energy - "With measures" scenario

CO_2 Emission (Gg)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
Energy Industries	5897	3847	4514	5185	3925	4460	4310	4875	5531	5699	5156	5650	7152	8691	9403	10131
Manufact. Ind. and Constr.	6546	4732	3730	3658	3815	3617	3763	3714	4008	3729	3805	3903	4486	5096	5843	6590
Transport	4046	2917	2781	2949	3124	3337	3668	4013	4163	4394	4396	4459	5452	6345	7329	8313
Residential	1995	1736	1463	1357	1372	1596	1779	1939	1841	2033	1896	2068	2333	2573	2789	3005
Commercial/Institutional	782	540	394	489	552	601	608	647	615	640	605	710	699	688	716	744
Agriculture and Other	1278	974	827	832	842	773	954	819	847	946	956	900	868	878	906	918
Fugitive emission	416	456	477	676	605	697	644	600	589	525	633	688	688	688	688	688
Total	**20959**	**15200**	**14187**	**15146**	**14235**	**15082**	**15727**	**16607**	**17594**	**17966**	**17447**	**18379**	**21678**	**24959**	**27674**	**30390**

Table A-2: Projection of CH4 emission for Energy - "With measures" scenario

CH_4 Emission (Gg)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
Energy Industries	0.18	0.12	0.14	0.16	0.12	0.16	0.14	0.15	0.18	0.19	0.14	0.15	0.17	0.19	0.17	0.16
Manufact. Ind. and Constr.	0.51	0.39	0.32	0.31	0.30	0.28	0.29	0.31	0.32	0.27	0.28	0.27	0.38	0.47	0.55	0.63
Transport	0.78	0.59	0.52	0.52	0.57	0.60	0.67	0.73	0.78	0.82	0.82	0.81	1.08	1.26	1.46	1.65
Residential	7.36	4.79	3.79	3.42	3.56	3.65	4.46	4.43	3.88	3.93	4.41	3.42	3.70	3.98	4.59	5.20
Commercial/Institutional	0.09	0.07	0.05	0.06	0.06	0.07	0.07	0.08	0.07	0.08	0.07	0.08	0.08	0.08	0.08	0.09
Agriculture and Other	0.07	0.06	0.05	0.05	0.05	0.04	0.06	0.04	0.05	0.07	0.06	0.06	0.16	0.20	0.21	0.22
Fugitive emission	58.81	56.48	53.83	58.94	53.14	53.39	55.54	58.56	51.09	50.75	52.91	59.12	59.12	59.12	59.12	59.12
Total	**67.81**	**62.49**	**58.69**	**63.45**	**57.80**	**58.19**	**61.22**	**64.30**	**56.37**	**56.10**	**58.69**	**63.92**	**64.70**	**65.30**	**66.19**	**67.08**

Table A-3: Projection of N2O emission for Energy - "With measures" scenario

N_2O Emission (Gg)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
Energy Industries	0.04	0.03	0.03	0.04	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.07	0.09	0.10	0.11
Manufact. Ind. and Constr.	0.07	0.05	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.05	0.05
Transport	0.04	0.03	0.02	0.03	0.03	0.03	0.07	0.11	0.16	0.22	0.29	0.35	0.62	0.84	0.97	1.10
Residential	0.09	0.06	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.06	0.07	0.07
Commercial/Institutional	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture and Other	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fugitive emission																
Total	**0.26**	**0.18**	**0.16**	**0.15**	**0.15**	**0.16**	**0.21**	**0.26**	**0.31**	**0.36**	**0.44**	**0.50**	**0.79**	**1.04**	**1.19**	**1.34**

Table A-4: Projection of CO2-eq emission for Energy - "With measures" scenario

CO_2-eq Emission (Gg)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
Energy Industries	5914	3859	4528	5199	3935	4473	4322	4889	5547	5716	5172	5668	7177	8723	9437	10167
Manufact. Ind. and Constr.	6577	4756	3748	3676	3832	3634	3780	3732	4026	3745	3821	3919	4506	5119	5869	6620
Transport	4075	2937	2800	2968	3144	3359	3704	4063	4229	4479	4504	4586	5667	6631	7659	8688
Residential	2178	1855	1559	1444	1463	1689	1893	2052	1940	2133	2009	2156	2428	2674	2906	3138
Commercial/Institutional	786	542	395	491	555	604	611	649	617	642	608	713	702	691	719	748
Agriculture and Other	1282	977	830	835	845	776	957	822	849	949	960	903	874	884	913	925
Fugitive emission	1651	1642	1608	1914	1721	1818	1810	1830	1662	1591	1744	1929	1929	1929	1929	1929
Total	**22463**	**16568**	**15468**	**16526**	**15494**	**16353**	**17076**	**18037**	**18872**	**19256**	**18817**	**19875**	**23283**	**26652**	**29433**	**32214**

Table A-5: GHG mitigation measures involved in scenario "With measures"

GHG emission reduction (Gg)	2005				2010				2015				2020			
	CO_2	CH_4	N_2O	CO_2-eq	CO_2	CH_4	N_2O	CO_2-eq	CO_2	CH_4	N_2O	CO_2-eq	CO_2	CH_4	N_2O	CO_2-eq
Wind Power Plants	33.5	0.8	0.4	33.6	108.9	2.1	1.3	109.4	175.9	2.8	2.1	176.6	285.1	3.6	3.4	286.3
Small Hydro Power Plants	49.8	1.2	0.5	50	64.2	1.2	0.8	64.4	89.1	1.4	1	89.5	125.1	1.6	1.5	125.6
Biomass in Cogeneration	21.6	0.6	0.1	21.6	44.1	1.1	0.2	44.2	118.4	3	0.5	118.6	204.9	5.1	0.8	205.2
Fuel Cells	0	0	0	0	14	0.3	0.2	14	26	0.4	0.3	26.1	48.8	0.6	0.6	49
Biodiesel and Hydrogen	7.3	0.5	0.1	7.4	53.8	4.4	0.4	54.1	121.7	12	1	122.3	261.7	27.7	2.2	263
Solar Energy	160	6.6	1.6	160.6	311.6	15.4	3.4	313	436.9	22.3	4.4	438.7	624.8	32.7	6	627.3
Geothermal Energy	50.7	2	0.5	50.9	239.1	11	2.6	240.1	354.4	16.7	3.6	355.9	539.2	25.8	5.3	541.4
Heat Gen. Eff. Increase	15.2	1.2	0.2	15.3	33.7	2.7	0.5	33.9	55.2	4.5	0.8	55.6	78.6	6.5	1.2	79.1
Total	**338.1**	**12.9**	**3.4**	**339.4**	**869.4**	**38.2**	**9.4**	**873.1**	**1378**	**63.1**	**13.7**	**1383.3**	**2168**	**103.6**	**21**	**2176.9**

Table A-6: Additional measures

GHG emission reduction measures	2005				2010			
	CO_2	CH_4	N_2O	CO_2-eq	CO_2	CH_4	N_2O	CO_2-eq
Power Generation Sector	**373.0**	**8.9**	**3.9**	**374.3**	**727.3**	**13.9**	**8.5**	**730.2**
Savings in power trans. and distrib.	20.3	0.5	0.2	20.4	39.6	0.8	0.5	39.8
Wind Power Plants	231.3	5.5	2.4	232.2	451.1	8.6	5.3	452.9
Small Hydro Power Plants	32.1	0.8	0.3	32.3	62.7	1.2	0.7	62.9
Biomass in Cogeneration	89.2	2.1	0.9	89.5	174.0	3.3	2.0	174.7
Industry	**174.8**	**10.2**	**2.1**	**175.7**	**258.8**	**12.6**	**3.4**	**260.1**
Motor Drives Regulation	0.0	0.0	0.0	0.0	12.2	0.2	0.2	12.3
Cogeneration Plants	0.0	0.0	0.0	0.0	52.8	0.9	0.9	53.1
Low-temp. heat gener. efficiency increase	104.6	5.0	1.0	105.0	115.2	5.4	1.1	115.7
High-temp. heat gener. efficiency increase	70.2	5.2	1.0	70.6	78.5	6.0	1.2	79.0
Transport	**0.0**	**0.0**	**0.0**	**0.0**	**59.4**	**4.1**	**0.5**	**59.6**
Interurban passenger transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Urban passenger transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Freight transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Increase in biodiesel use	0.0	0.0	0.0	0.0	59.4	4.1	0.5	59.6
Services	**60.0**	**2.6**	**0.6**	**60.3**	**406.8**	**21.4**	**4.4**	**408.6**
DSM measures	0.0	0.0	0.0	0.0	14.4	0.3	0.2	14.5
Solar energy use increase	32.6	1.3	0.3	32.7	78.5	3.9	0.8	78.8
Geothermal energy use increase	7.8	0.3	0.1	7.8	16.4	0.8	0.2	16.4
Distr. heating and cogen.use increase	19.6	0.9	0.2	19.7	66.8	3.6	0.7	67.1
Thermal insulation improvement	0.0	0.0	0.0	0.0	230.8	12.8	2.5	231.8
Residential	**226.1**	**7.8**	**1.6**	**226.8**	**586.8**	**22.4**	**4.4**	**588.6**
Solar energy use increase	0.0	0.0	0.0	0.0	28.4	1.8	0.2	28.5
DSM measures	0.0	0.0	0.0	0.0	12.4	0.2	0.1	12.5
District heating use increase	0.0	0.0	0.0	0.0	20.7	2.2	0.1	20.8
Thermal insulation improvement	0.0	0.0	0.0	0.0	73.0	2.5	0.7	73.2
Biomass in cogen. and boiler plants	226.1	7.8	1.6	226.8	452.2	15.6	3.1	453.5
Total potential	**833.9**	**29.5**	**8.2**	**837.1**	**2039.1**	**74.3**	**21.2**	**2047.2**

Table A-6: Additional measures (continue)

GHG emission reduction measures	2015				2020			
	CO_2	CH_4	N_2O	CO_2-eq	CO_2	CH_4	N_2O	CO_2-eq
Power Generation Sector	**999.2**	**15.6**	**11.8**	**1003.2**	**1225.4**	**15.3**	**14.5**	**1230.2**
Savings in power trans. and distrib.	72.0	1.1	0.8	72.3	99.2	1.2	1.2	99.6
Wind Power Plants	620.9	9.7	7.3	623.3	762.1	9.5	9.0	765.1
Small Hydro Power Plants	86.3	1.3	1.0	86.6	105.9	1.3	1.3	106.3
Biomass in Cogeneration	220.0	3.4	2.6	220.9	258.2	3.2	3.1	259.2
Industry	**474.3**	**16.1**	**6.8**	**476.8**	**795.6**	**19.0**	**12.2**	**799.8**
Motor Drives Regulation	164.8	2.6	2.4	165.6	470.7	5.9	7.4	473.1
Cogeneration Plants	115.2	2.1	2.1	115.9	150.1	2.7	2.7	151.0
Low-temp. heat gener. efficiency increase	114.3	5.4	1.1	114.8	102.1	4.8	1.0	102.5
High-temp. heat gener. efficiency increase	80.0	6.1	1.2	80.5	72.7	5.6	1.1	73.1
Transport	**342.1**	**29.6**	**14.0**	**347.1**	**910.2**	**70.4**	**34.5**	**922.3**
Interurban passenger transport	42.1	9.8	7.7	44.6	93.0	21.5	16.6	98.6
Urban passenger transport	26.6	5.3	4.1	28.0	77.0	15.4	11.9	81.0
Freight transport	103.0	2.9	0.8	103.3	458.5	14.4	3.7	460.0
Increase in biodiesel use	170.5	11.6	1.4	171.2	281.6	19.2	2.3	282.7
Services	**662.7**	**35.4**	**6.6**	**665.5**	**835.5**	**44.3**	**7.9**	**838.8**
DSM measures	22.1	0.3	0.3	22.2	32.1	0.4	0.4	32.2
Solar energy use increase	112.0	5.7	1.1	112.5	140.2	7.3	1.3	140.7
Geothermal energy use increase	22.0	1.0	0.2	22.1	27.9	1.3	0.3	28.0
Distr. heating and cogen.use increase	113.9	6.3	1.1	114.3	145.6	8.0	1.4	146.2
Thermal insulation improvement	392.7	22.0	3.9	394.3	489.6	27.2	4.6	491.6
Residential	**1045.2**	**43.9**	**8.2**	**1048.7**	**1789.2**	**87.0**	**13.9**	**1795.3**
Solar energy use increase	107.4	7.9	0.8	107.8	286.7	21.3	1.9	287.7
DSM measures	88.2	1.4	1.0	88.5	192.3	2.4	2.3	193.0
District heating use increase	55.2	5.8	0.4	55.5	156.8	17.2	1.1	157.5
Thermal insulation improvement	179.8	7.4	1.7	180.5	376.4	18.7	3.1	377.8
Biomass in cogen. and boiler plants	614.6	21.5	4.3	616.4	777.0	27.4	5.5	779.3
Total potential	**3523.5**	**140.7**	**47.5**	**3541.1**	**5555.8**	**236.1**	**83.1**	**5586.5**

Table A-7: "With measures" scenario

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
CO_2 Emission (Gg)	20959.4	15200.5	14186.6	15146.1	14235.1	15081.9	15726.6	16607.1	17593.7	17965.9	17447.5	18378.7	21678.4	24958.9	27674.2	30389.6
CH_4 Emission (Gg)	67.806	62.493	58.691	63.448	57.797	58.193	61.220	64.297	56.366	56.097	58.693	63.921	64.702	65.296	66.187	67.077
N_2O Emission (Gg)	0.257	0.177	0.157	0.154	0.147	0.158	0.206	0.257	0.306	0.361	0.443	0.496	0.792	1.039	1.191	1.343
CO_2-eq Emission (Gg)	22462.9	16567.6	15467.7	16526.4	15494.4	16352.7	17076.2	18036.9	18872.3	19255.8	18817.3	19874.9	23282.6	26652.0	29433.2	32214.4

Table A-8: "Without measures" scenario

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
CO_2 Emission (Gg)	20959.4	15200.5	14186.6	15146.1	14235.1	15081.9	15726.6	16607.1	17593.7	17965.9	17447.5	18378.7	22016.6	25828.3	29052.0	32557.8
CH_4 Emission (Gg)	67.806	62.493	58.691	63.448	57.797	58.193	61.220	64.297	56.366	56.097	58.693	63.921	64.715	65.334	66.250	67.181
N_2O Emission (Gg)	0.257	0.177	0.157	0.154	0.147	0.158	0.206	0.257	0.306	0.361	0.443	0.496	0.795	1.048	1.204	1.363
CO_2-eq Emission (Gg)	22462.9	16567.6	15467.7	16526.4	15494.4	16352.7	17076.2	18036.9	18872.3	19255.8	18817.3	19874.9	23622.1	27525.1	30816.6	34391.2

Table A-9: "With additional measures" scenario

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
CO_2 Emission (Gg)	20959.4	15200.5	14186.6	15146.1	14235.1	15081.9	15726.6	16607.1	17593.7	17965.9	17447.5	18378.7	21678.4	24958.9	27674.2	30389.6
CH_4 Emission (Gg)	67.806	62.493	58.691	63.448	57.797	58.193	61.220	64.297	56.366	56.097	58.693	63.921	64.702	65.296	66.187	67.077
N_2O Emission (Gg)	0.257	0.177	0.157	0.154	0.147	0.158	0.206	0.257	0.306	0.361	0.443	0.496	0.792	1.039	1.191	1.343
CO_2-eq Emission (Gg)	22462.9	16567.6	15467.7	16526.4	15494.4	16352.7	17076.2	18036.9	18872.3	19255.8	18817.3	19874.9	23282.6	26652.0	29433.2	32214.4

- - - - -