Republic of Croatia

Fifth National Communication of the Republic of Croatia under the United Nation Framework Convention on the Climate Change

Ministry of Environmental Protection, Physical Planning and Construction

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INTRODUCTION

United Nations Framework Convention on Climate Change (hereinafter *Convention*) was adopted at the United Nations Conference on Environment and Development held in Rio de Janeiro in the year 1992. The Convention entered into force on March 21, 1994 and has 194 parties.

The Republic of Croatia became a party to the Convention on 17 January 1996 when the Croatian Parliament passed the law on its ratification (OG, International Treaties 2/96). For the Republic of Croatia the Convention came into force on 7 July 1996. As a country undergoing the process of transition to market economy, Croatia has, pursuant to Article 22, paragraph 3 of the Convention, assumed the commitments of countries included in Annex I. By the amendment that came into force on 13 August 1998 Croatia was listed among Parties included in Annex I to the Convention.

At the session of the Conference of Parties (COP 3) held in Kyoto, the Protocol on the United Nations Framework Convention on Climate Change was adopted on 11 December 1997, pursuant to Decision 1/CP.3. Nowadays the Kyoto Protocol (hereinafter *Protocol*) has 190 parties, including 40 countries as parties of Annex I. The Republic of Croatia ratified the Protocol in April 2007 and entered into force on 28 August 2007. By ratifying the Protocol (OG, International Treaties 5/07), the Republic of Croatia, as the Protocol Annex B party, takes over the obligation of limiting the greenhouse gases emission in the period 2008-2012 to 95% of total emission in the base year, i.e. 1990.

For Croatia the base year was determined pursuant to Decision 7/CP.12 adopted on the 12^{th} session of the Convention Conference of Parties held in Nairobi in November 2006 pursuant to the Article 4.6 of the Convention. Decision 7/CP.12 adopted specificities related to dissolution of former Yugoslavia and electricity generation sector in Croatia. Negotiations determined emission increase by 3.5 Mt CO_2 eq in 1990.

The Republic of Croatia is, pursuant to provisions in Articles 4 and 12 of the Convention, obliged to create a national greenhouse gas inventory and periodically national communication on climate change, according to which it reports on performing the obligations from the United Nations Framework Convention on Climate Change. Form and terms of submitting the national greenhouse gas inventory and national communication are defined by decisions and instructions of the Conference of Parties. The Republic of Croatia has, due to the obligations arising from the EU acquis communaitaire, implemented into its legal system obligations on reporting on implementation of policy and measures regarding the reduction of emissions and emission projections that will be periodically submitted to the authorities upon the Croatian accession to the EU.

The first Croatian National Communication under the Convention was prepared in 2001 as a purpose of the project of the Government of the Republic of Croatia and the UNDP/GEF "*Enabling Croatia to Prepare First National Communication in Response to Commitments under the UNFCCC*" with the financial assistance of the Global Environmental Facility (GEF). The Convention Secretariat received the First National Communication on 7 February 2002 and the in-depth review followed in March 2002.

The Republic of Croatia created a consolidated Second, Third and Fourth National Communication with data for the period from 1996 to 2003. This National Communication was prepared according to Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention (FCCC/CP/1997/7, Part II). -. The same was submitted to the Convention Secretariat on 6 February 2007. In-depth review was performed in May 2009 by an expert team of the Convention Secretariat. The expert team's findings were published in a document FCCC/IDR.4/HRV available on the Convention web-page.

Pursuant to Decision 13/CMP.1 Modalities for the accounting of assigned amounts under Article 7, paragraph 4 of the Kyoto Protocol, Croatia submitted on 27 August 2008 to the Convention Secretariat so called Initial Report, prescribed by paragraph 6 of the Annex of Decision 13/CMP.1. Within the Initial Report Croatia reported on calculations of the assigned amount, commitment period reserve, selection of activities within the Land-use Change and Forestry Sector (LULUCF) under Articles 3.3 and 3.4 of the Kyoto Protocol, establishment of the national inventory system and national register. The review of the Initial Report was performed in October 2008 by an expert team of the Convention Secretariat. The expert team's findings were published in a document *Report of the Review of the initial report of Croatia* (FCCC/IRR/2008/HRV) available on the Convention web-page.

This Fifth National Communication of the Republic of Croatia, as all the previous, was prepared according to Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention (FCCC/CP/1997/7, Part II).-. Instructions prepared by the Convention Secretariat were applied as well, not having a status of the official obligation yet, but help countries to prepare their national communications more professionally, as required by the Convention and the Protocol. In regard to greenhouse gas (GHG) emissions, this Communication covers the period from 2004-2007.[1] Emission projections are based on conditions and projections of macroeconomic parameters from 2007. In the Republic of Croatia, the beginning of economic crisis became visible in the end of 2008.

[1] The Communication was being prepared during the 2009, and the emission calculation was performed 2 years earlier.

1. SUMMARY

1.1. Introduction

The Republic of Croatia became a party to the Convention in 1996, and considering the process of transition to market economy, it assumed the commitments of countries included in Annex I. It signed the Protocol in 1999 and ratified it in 2007, by which it was committed to reduce its greenhouse gas emissions by 5% in the first commitment period between (2008 – 2012) compared to the base year. The first Croatian National Communication under the Convention was submitted to the Convention Secretariat in 2002, while the consolidated second, third and fourth national communication in 2007. The Fifth National Communication was prepared in accordance with instructions of FCCC/CP/1997/7, Part II - *Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention* and includes a period of 1990 - 2007.

Pursuant to Decision 13/CMP.1 Modalities for the accounting of assigned amounts under Article 7, paragraph 4 of the Protocol, Croatia submitted on 27 August 2008 to the Convention Secretariat so called Initial Report, prescribed by paragraph 6 of the Annex of Decision 13/CMP.1. Within the Initial Report Croatia reported on calculations of the assigned amount, commitment period reserve, selection of activities within the Land-use Change and Forestry Sector (LULUCF) under Articles 3.3 and 3.4 of the Protocol, establishment of the national inventory system and national register. The review of the Initial Report was performed in October 2008 by an expert team of the Convention Secretariat. The expert team's findings were published in a document FCCC/IRR/2008/HRV Report of the Review of the initial report of Croatia available on the Convention web-page.

1.2. National circumstances

Government Profile

The Republic of Croatia gained independence in 1991 in a process of dissolution of ex-Yugoslavia. It has become a member of the United Nations organization on 22 May 1992. Upon the Croatian Parliament has adopted the Resolution on Croatia's Integration into the European Union on 18 December 2002, Croatia applied for EU membership on 21 February 2003 in Athens. The European Council assigned to Croatia the status of an EU candidate country on 18 June 2004 and on 3 October 2005 the EU accession negotiations started in Luxembourg. The state authority is organized on the principle of separation of powers in the legislative (Croatian Parliament), the executive (the President of the Republic, the Government) and the judicial. The Croatian Parliament is a representative body of citizens and is vested with the legislative power in the Republic of Croatia. The government bodies comprise 16 ministries, 3 central state administration offices, 9 state bureaus and county offices of government bodies. The territorial and administrative structure of the Republic of Croatia consists of 21 district (regional) self-government units: 20 counties and the City of Zagreb, and 556 local self-government units: 127 towns and 429 municipalities.

Population Profile

According to the 2001 census, the Republic of Croatia is populated with 4,437,460 inhabitants. According to estimation from the middle of 2008, the number of inhabitants is 4,434,508 (out of which 48.2% are males and 51.8% are women). The birth rate (live-born in 1000 inhabitants) was 9.9, the death rate (dead in 1000 inhabitants) was 11.8 and natural population growth was negative and amounted -1.9.

Average population density is 78.4 inhabitants per km^2. Central part of Croatia is the most populated (115 inh./km²), while the least populated is the mountaneous part of Croatia (13 inh./km²). More than 90% of Croatia's population lives in lowland and small hilly areas up to 300 m above sea level. Within total number of inhabitants, 51.1% lives in 124 cities.

Greenhouse gases emission per inhabitant is among the lowest within the countries of the Annex I of the Convention (7.3 t CO_2 eq/capita in 2007).

Geographic Profile and Land Use

Total land area of the Republic of Croatia is 56,594 km^2. The territorial waters and internal marine waters cover an area of 31,067 km^2. By its position, Croatia belongs to the Central-European, Adriatic-Mediterranean and Pannonian-Danube basin group of countries. The total length of land borders of the Republic of Croatia with neighbouring countries is 2,028 km. The national sea border is 948 km long and stretches along the outer edge of the territorial sea. It is followed by protected ecological and fishing zone covering an area of 25,207 km^2 and reaching the continental shelf border between Croatia and Italy. Three large geomorphological sections may be distinguished in Croatia: the Pannonian basin, the mountain range of Dinaric Alps and the Adriatic basin. The highest mountain peak in Croatia is Dinara (1,831 m). The karst area covering 54% of Croatia's territory represents relief specificity. The Nature Protection Act (OG 70/05, 139/08) determines nine categories of area protection. The total surface of Croatia's protected areas is 5,088.161 km^2 or 8.991% of the mainland and 410.25 km^2 of the marine area.

Climate Profile

According to the Köppen clasification for the standard period of 1961-1990, the greatest part of Croatia belongs to the climate type C, moderately warm rainy climate. The mean annual air temperature in the lowland area of the northern Croatia is 10-12°C, at the hights above 400 m is lower than 10°C, while in the highland is 3-4°C. In the coastal area is 12-17°C. The least precipitation in Croatia is recorded in the open part of the central Adriatic (Palagruža, 304 mm) and in the eastern Slavonia and Baranja (Osijek, 650 mm). Central Croatia and the coastal zone have 800-1,200 mm precipitation per year. The precipitation amount in the Pannonian area decreases from the west to the east. The precipitation amount is increased from the coast to the inland. Most of the precipitation is recorded on the slopes and peaks of the coastal Dinarides, from Gorski Kotar (Risnjak, 3,470 m) to the southern Velebit. The coastal zone from Dugi otok to Prevlaka is the fairest part of Croatia; the islands of the central and southern Adriatic (Hvar, Vis, Korčula) have some 2,700 hours of sunshine per year. The majority of mainland area in Croatia has 1,800-2,000 hours of sunshine. The largest annual cloudiness is in Gorski Kotar (6-7/10), which has the least hours of sunshine yearly – about 1,700.

Economic Profile

In 2007, Croatian economy has been rising by an annual rate of 5.5% while the gross domestic product amounted 314.2 billions of kunas (58.6 mil. USD) or 13,207 USD (9,656 EUR) per capita. In 2008, due to a spillover of consequences of the global economic crisis, economic activities were slowed down. Real growth of the gross domestic product was 2.4% which is 3.1 percent point lower than the growth recorded in 2007 and at the same time, the lowest growth rate since 1999. Considering the purchasing power parity, in 2008 Croatian gross domestic product reached 63.0% of the average gross domestic product per capita in the EU 27 countries.

Due to a spillover of consequences of the economic crisis on Croatian economy, gross domestic product's real decline in 2009 is expected to be 5.0%. In 2010, a slow recovery of economic activity and gross domestic product's real growth of 0.5% is expected and a gradual acceleration of economic growth in 2011 , however with a bit slower dynamics than it was in the period before 2008.

Energy

In 2007, the energy consumption in Croatia totalled 416.8 PJ or 2,242 kg of oil equivalent per capita. In the period from 2002 to 2007, the total primary energy supply increased at an average annual rate of 2.1%. Since 1992, the year when the total primary energy supply in Croatia was at its lowest level, until 2007 the total primary energy supply grew by an average of 2.2% per year. The total primary energy supply per capita and the consumption of electricity per capita are among the lowest in Europe (about 4000 kWh/capita).

The major contribution to the final energy demand by sectors in 2007 comes from general consumption (43.7%), with the 34.1% share of transport and 22.2% of industry. As for the structure of total energy consumption in 2007 liquid fuels had the largest share with 45.5%, followed by natural gas with 27.4% and coal 8.1%. In 2007, the total primary energy supply increased by 1.5% with respect to the previous year. Problems with energy supply are linked to the supply of natural gas, which is 40% of imports, with limited contracted amounts. In the winter months leads to reduction in the supply of industrial consumers. In 2005, the share of renewable energy sources in total energy supply was about 12.7% while in electricity generation was 32%. Emissions from electricity generation are 286 g CO_2 eq/kWh, which is significantly below the average of EU25 (370 g CO_2 eq/kWh). The import of electricity is 20-30% of supply. Thermal power plants are at the end of life and should be replaced with new ones.

Transport

The total construction length of railway lines in the Republic of Croatia is 2,722.4 km out of which 984 km are electrified (36%). In 2007, the total length of public roads in the Republic of Croatia was 29,038.0 km. Passenger and goods transport continues to increase, as well as the number of road motor vehicles subsequently and consumption of motor fuels. There are 323 vehicles per 1,000 inhabitants while the EU average is 456 vehicles. The Republic of Croatia has 6 ports of special (international) economic interest in the cities of Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik. The network of inland waterways of the Republic of Croatia is 804.1 km long out of which 539.2 km are international waterways. Inland waterway ports opened for international public transport are: Osijek, Sisak, Slavonski Brod and Vukovar. There are 7 international airports in the Republic of Croatia: Zagreb, Split, Dubrovnik, Zadar, Rijeka, Pula and Osijek, and three national airports: Brač, Mali Lošinj and Osijek intended to accommodate smaller aircrafts. The annual throughput of passengers in Croatia's airports is some 4.9 million.

Industry

Industry accounted for 16.5% of the GDP structure and employed about 284,000 employees in 2007. The most important contribution of 85% related to manufacturing with approximately 253,000 employees. Within manufacturing branches, the manufacture of food products, beverages and tobacco had the largest share of 19.8% and employed about 50,000 workers. Manufacture of pulp, paper and paper products as well as publishing and printing represented 10.3% in the GDP structure, then follows manufacture of basic metals and fabricated metal products (7.7%), manufacture of electrical and optical equipment (7.3%), manufacture of other non-metallic mineral products (6.9%) and manufacture of coke and refined petroleum products (6.0%). Then follow manufacture of chemicals, chemical products and man-made fibres (5.8%), manufacture of transport equipment (4.5%) and manufacture of textiles and textile products (4.3%). Other manufacturing branches such as manufacture of machinery and equipment, wood and wood products, rubber and plastic products, leather and leather products and other manufacturing represented together about 12.7% of the GDP structure. Mining and quarrying accounted for 2.5% of the GDP structure in 2007 whereof 71% concerns mining and quarrying except for energy producing materials. Furthermore, electricity, gas and water supply accounted for 12.2% of the GDP structure in 2007.

Waste

In 2007 a total of 1,723,186 tonnes or 388 kg of municipal waste per inhabitant was generated in the Republic of Croatia. In comparison with a total of 1,172,534 tonnes or 268 kg of municipal waste per inhabitant, which was generated in 2000, this one represents an increasing of approximately 45%. Municipal waste disposed at landfills in 2007 amounted 1,620,000 tonnes. Organised collection of municipal waste covers an average of 90% of the population. During the period from 2005 to 2008, systems for the management of individual waste categories have been established. Management of individual waste categories, forms and amounts of taxations, methods for environment pollution arrestment and the other issues related to management of individual waste categories are prescribed by the Ordinances.

Building Stock and Urban Structure

Positive trends in construction industry started in 2001 and are reflected in a continuous rise in the value of works, number of employees and productivity. The value of construction works completed in 2007 amounts to HRK 24.3 billion. Within this value construction of buildings accounts for 49.7% (residential buildings 19.7%, non-residential buildings 30.1%), traffic infrastructure accounts for 36.4%, pipelines, communication and power supply lines for 11.3% and complex construction on industrial sites 1.8%. The positive trend continues. The 2007 share of the construction industry in the GDP has significantly increased compared to 2000 (6.7% compared to 3.9%).

In 2001, the housing stock of the Republic of Croatia totalled 1,851,580 flats, consisting of 2.4 persons on average. The old residential building has large heat losses, and flats with individual heating have not full comfort heating. Lately, there are more air-conditioning equipment, which on the coast in the new apartments has become almost standard.

Agriculture

According to statistical data, in 2007 there were 1,201,756 ha of utilized agricultural land in Croatia or about 21% of the total mainland area. In 2001, 92% of Croatian territory was classified as rural which was inhabitated with 48% of the population. The share of agricultural in total population decreased from 8.56% in 1991 to 5.54% in 2001 due to rural population ageing. Maize and wheat production dominates on approximately 50% of total arable land. By comparing 2007 and 1990, the total number of livestock has decreased significantly. Mineral fertilizer consumption in 2007 amounted 413,900 tonnes.
In regard to sea fishing, total catch in 2007 was 40,162 tonnes. Total annual production related to mariculture was about 12,000 tonnes and it mostly refers to sea bass, sea bream, tuna, mussels and oysters. The most significant species in freshwater aquaculture are carp, grass carp, tench, sheat-fish, perch, pike and Californian trout. Total production of freshwater fish in 2007 was about 5,800 tonnes.

Forestry

According to the data from the Forest Management Plan 2006-2015, in 2006, forests and forest land covered an area of 2,688,687 ha out of which 78% is owned by the state and managed by the Croatian Forests Ltd. while the remaining 22% are privately owned. The Forest Management Plan 2006-2015 determines growing stock of about 398 millions of m^3 while its yearly increment amounts around 10.5 millions of m^3. According to statistical data, in 2007, the production in forestry has been increased by about 16% compared to 2000. The development of the National Forest Inventory (CRONFI) is being finalized and will be available in 2010.

Inland Waters and Coastal Area

All surface and ground waters are part of either Black Sea or Adriatic catchment area with the watershed running along the mountain and alpine area. Large watercourses dominate the Black Sea catchment area while in the Adriatic catchment area, the abundance and the length of surface watercourses are significantly lower. The majority of large watercourses of the Black Sea catchment area is of interstate significance (boundary or cross-border). The river Danube is the largest and richest in water that flows through the eastern borderland of Croatia while the rivers Sava and Drava represent the longest courses in Croatia.

Croatia has little natural lakes. The largest natural lakes are Vransko Lake near Pakoštane, Prokljansko Lake, Visovačko Lake and Vransko Lake on the island of Cres.

Croatia is also characterized by significant wetland areas. Four locations have been included in the Ramsar list: Kopački rit in the Drava and the Danube cathments, Lonjsko and Mokro polje and Crna Mlaka in the Sava catchment and the lower Neretva part in the Adriatic catchment.

The Adriatic Sea is the northernmost part of the Mediterranean Sea. The total length of Croatia's coast is about 6,000 km out of which 1,800 km belongs to the mainland and 4,200 km to the island coastline. The highest measured depth is 1,233 m. Croatian islands include almost all islands of the Adriatic eastern coast and its central part making the second Mediterranean archipelago by size. There are 1.244 islands which are geographically distinguished as 79 islands, 525 islets, 640 cliffs (top above sea-level) and reefs (top below sea-level).

According to average water balance, Croatia abounds with water but the interannual distribution of water quantities is not favourable due to the significant spatial and time unequality in water resources distribution.

Specific Circumstances of Croatia under Article 4.6 of the Convention

At the session of the Conference of Parties (COP 7) held in Marrakesh in 2001, the Republic of Croatia submitted a request for the recognition of specific circumstances under Article 4.6 of the Convention and requested the increase in emission level of the base year 1990 by 4.46 million t CO_2 eq. At the session of the Conference of Parties (COP 11) held in Montreal in 2005, the Decision 10/CP.11 was adopted considering the request of the Republic of Croatia for recognition of specific circumstances when determing the emission level of the base year. Pursuant to Article 4.6 of the Convention, Croatia was allowed with a certain degree of flexibility with regard to the historical level of anthropogenic emissions of greenhouse gases chosen as a reference. The negotiations about Croatia’s request were completed at the session of the Conference of Parties (COP 12) in Nairobi in 2006. The Decision was adopted to recognize specific circumstances of Croatia with regard to greenhouse gas emissions before and after 1990, and the structure of the electricity generation sector of the former Yugoslavia (Decision 7/CP.12). By the Decision Croatia was allowed to increase the amount of emission in the base year for additional 3.5 million tonnes CO_2 eq. The Republic of Croatia submitted a request for raising the limit of the LULUCF sector (*Land Use, Land Use Change and Forestry*) by which a portion of CO_2 would be withdrawn due to absorption into the forest biomass. By the Decision 22/CP.9 adopted at the session of the Conference of Parties (COP 9) in 2003, Croatia was allowed to use a sink of 0.265 million t carbon (0.972 million t CO_2) per year for the first commitment period. .

The Commission to review the Initial Report under the Kyoto Protocol did not accept the Decision 7/CP.12, by which Croatia is allowed to increase emissions in the 1990 to 3.5 million tonnes CO_2 eq, but the subject of consideration was given to the Committee for compliance with

Kyoto Protocol commitments of the Parties. The Committee confirmed the decision of the Commission to review the Initial Report in December 2009. Considering that this decision discriminates Croatia in relation to other countries in transition which were eligible to use the flexibility under Article 4.6 of the Convention, Croatia submitted an appeal.

1.3. Greenhouse Gas Inventory Information

This National Communication presents the inventory of greenhouse gas emissions and removals in the Republic of Croatia in the period from 1990 to 2007. The inventory includes direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs, PFCs) and sulphur hexafluoride (SF_6), and indirect greenhouse gases: carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). Greenhouse gasses, which are part of Montreal protocol (for example Freon's), are not included in this report. Contributions of individual greenhouse gases to the total 2007 emission were as follows: CO_2 (76.8%), CH_4 (10.8%), N_2O (11.0%), HFC, PFC and SF_6 (0.1%) (Table 1-1).

Table 1-1: Greenhouse gas emissions/removals by gases, 1990-2007 (Gg CO_2 eq)

Source	Emissions and removals of GHG (Gg CO_2-eq)						
	Base Year[2]	1990	1995	2000	2005	2006	2007
Carbon dioxide (CO_2)		23080	16930	19955	23424	23528	24865
Methane (CH_4)		3426	2853	2658	3124	3338	3481
Nitrous oxide (N_20)		3868	3063	3308	3519	3457	3556
HFC, PFC and SF_6		948	19	35	365	447	482
Total emission (excluding net CO_2 from LULUCF)	**34822**[3]	**31322**	**22865**	**25955**	**30433**	**30769**	**32385**
Removals (LULUCF)		-4185	-9154	-5281	-7726	-7490	-6303
Total emission (including LULUCF)		**27137**	**13711**	**20675**	**22707**	**23279**	**26082**

Figure 1-1 shows the contribution of individual sectors to the total greenhouse gas emission and sinks. The major contributor to 2007 greenhouse gas emission was the energy sector with 73.5%, followed by industrial processes (12.6%), agriculture (10.5%), waste management (2.7%) and solvent use (0.7%). With some slight changes, this structure remained during the entire period 1990-2007. The "coverage" of greenhouse gas emissions by carbon dioxide removals in the forestry sectors amounted to 19.5% in 2007.

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

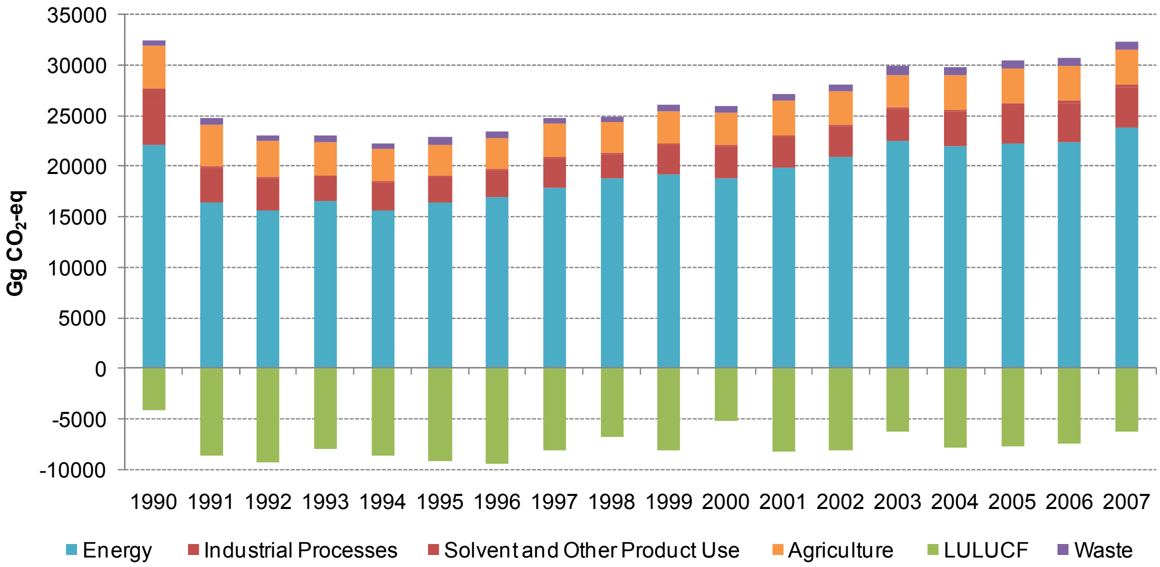


Figure 1-1: Greenhouse gas emissions and removals in Croatia by sectors, 1990-2007 (Gg CO_2 eq)

The largest contribution to the greenhouse gas emission in 2007 has the Energy Sector. The CO_2 emission from Energy industries sector was 7,662 Gg in 2007, representing 23.6% in total greenhouse emission in the Republic of Croatia. In Industrial Processes sector the key emission sources are Cement Production, Lime Production, Ammonia Production, Nitric Acid Production and Consumption of HFCs in Refrigeration and Air Conditioning Equipment, which all together contributed with 99% in total sectoral emission in 2007. The iron production in blast furnaces and aluminium production were ended in 1992, while ferroalloys production ended in 2003. Emission of CH_4 and N_2O in the Agricultural sector is conditioned by different agricultural activities. For the emission of CH_4, the most important source is livestock farming (Enteric Fermentation). The number of cattle showed continuous decrease in the period from 1990 to 2000. As a consequence, this led to CH_4 emission reduction. In 2000, the number of cattle has started increasing and this trend was retained until 2006. However, in 2007, the number of cattle decreased by 3.5% when compared with the previous year. Direct N_2O emission from cultivation of agricultural soils, emission from animal manure (Manure Management) and indirect emission have been more or less stable for the past ten years.

1.4. Policy and measures

The policy and measures for mitigation of climate change cannot be effectively implemented if isolated from the general and development political framework, primarily due to their marked cross-sector impact. The basic policy elements are:

- Croatia has become a candidate country for the EU membership in 2004, accession negotiations are near the end, which means that Croatia has harmonized its legislation with the EU acquis communautaire, including the one referred to mitigation of climate change. Accession to the EU is expected by 2012.
- Regarding the development, Croatia had, within the last years prior to economical-financial crisis, high GDP growth rate, at the level of 3.8-5.5% (from 2001-2007). On such bases, with a purpose to come closer to the EU average, regarding that GDP is at this moment less than 50% of the EU average, Croatia was planning its development until 2020 with GDP growth rate of 5% per year. In line with such goal and assumption, the Energy Development Strategy of the Republic of Croatia (OG 130/2009) has been

prepared, defining the goals and suggesting measures until 2020, with a view to 2030. The Strategy provides a framework for development without pretension to strictly define fuel structure and penetration of certain types of technology, except for renewable energy sources and energy efficiency.
- Climate change mitigation measures are determined by the Air Quality Protection and Improvement Plan of the Republic of Croatia for the period 2008-2011. Majority of measures has a long-term character and their implementation and effect will be clearly seen within the period after 2011.

Air Quality Protection and Improvement Plan determines 33 basic measures that are in a phase of implementation, while some of them in a phase of preparation, as it follows:

- ➲ MCI-1. Promoting the application of renewable energy sources in electricity generation
- ➲ MCI-2. Promoting the application of cogeneration (simultaneous generation of thermal and electrical energy)
- ➲ MCI-3. Reduction in fossil fuel consumption through utilization of biodegradable municipal wastes in district heating plants or landfill biogas
- ➲ MCI-4. Reduction in fossil fuel consumption through the use of biodegradable municipal wastes in cement industry
- ➲ MCA-5. Loan programme for the preparation of renewable energy sources projects in Croatia through the Croatian Bank for Reconstruction and Development
- ➲ MCA-6. Promoting the use of renewable energy sources and energy efficiency through the Environmental Protection and Energy Efficiency Fund
- ➲ MCA-7. Promoting energy efficiency through implementation of the project "Removal of Barriers to Energy Efficiency in Croatia"
- ➲ MCA-8. HEP ESCO energy efficiency programme
- ➲ MCI-9. Measures of energy efficiency upgrading in building sector
- ➲ MCA-10. Energy efficiency labelling of household appliances
- ➲ MCI-11. Setting up a framework for the establishment of ecological design requirements
- ➲ MCI-12. Raising attractiveness of rail transport
- ➲ MCI-13. Introduction of biofuel
- ➲ MCA-14. Promoting the use of low CO_2 vehicles
- ➲ MCA-15. Promoting the use of gas in vehicles
- ➲ MCA-16. N_2O emission reduction measure in nitric acid production
- ➲ MCI-17. Burning or thermal utilization of methane captured at landfills
- ➲ MCA-18. Action plan for the sector of agriculture from the aspect of adaptation to climate change and reduction of greenhouse gas emissions
- ➲ MCA-19. Decision on taking advantage of Article 3.4 of the Kyoto Protocol
- ➲ MCA-20. Establishment of the system of trading in CO_2 emission allowances
- ➲ MCA-21. Increasing CO_2 charge
- ➲ MCA-22. Reporting under the UNFCCC and the Kyoto Protocol
- ➲ MCA-23. Capacity building program for implementation of the UN Framework Convention on Climate Change and the Kyoto Protocol
- ➲ MCA-24. Active participation in international negotiations about the commitment period after 2012 («Post-Kyoto»)
- ➲ MCA-25. Preparation of plans, programmes and studies for efficient implementation and creation of the climate change policy
- ➲ MCA-26. Establishment of a research and development programme focusing on climate change issues
- ➲ MCA-27. National energy programmes
- ➲ MCA-28. Public education and information programme
- ➲ MCA-29. Support to programmes and projects of the technology and know-how transfer

- MCA-30. Establishment of infrastructure for application of flexible mechanisms under the Kyoto Protocol
- MCI-31. Implementation of JI projects in Croatia
- MCA-32. Facilitating investments in CDM and JI project activities in other countries
- MCA-33. Inclusion of Croatia into the European emission trading scheme

Beside these measures, ten more measures are in preparation or adoption phase. The most important is that the Croatian legislation is harmonized with the EU acquis communautaire and it performs the same climate change policy as other EU member states do. The formal termination of negotiations regarding the EU acquis communautaire is expected by the end of 2010. Strong stimulation of measures began with the establishment of the Environmental Protection and Energy Efficiency Fund in 2003. Long-term the most important measures were defined by new energy strategy from 2009, which determines 20% of renewable energy sources in gross final energy consumption in 2020 and stimulates energy efficiency in accordance with the relevant EU directives.

1.5. Emission projections and effects of policy and measure implementation

Total projections of greenhouse gas emissions for scenarios ''without measures'', ''with measures'' and ''with additional measures'' as well as obligation for Croatia according to Kyoto protocol are shown in Figure 1-2 and Table 1-2.

In 'with measures' +LULUCF scenario emissions are slightly above Kyoto target for the period from 2008 to 2012 (target is defined according to the Base year from 7/CP12 Decision).

Effects of economic crises which are immanent in 2008 are not taken into account. Foreseeable effects of crises will affect the greenhouse gas emission in a way that probability of accomplishment of Kyoto target will be magnified.

In the period from 2012-2025, Croatian emissions will be increased despite implementation of measures. The growth will be immanent till new technologies such as CO_2 capturing and storage will become commercially available.

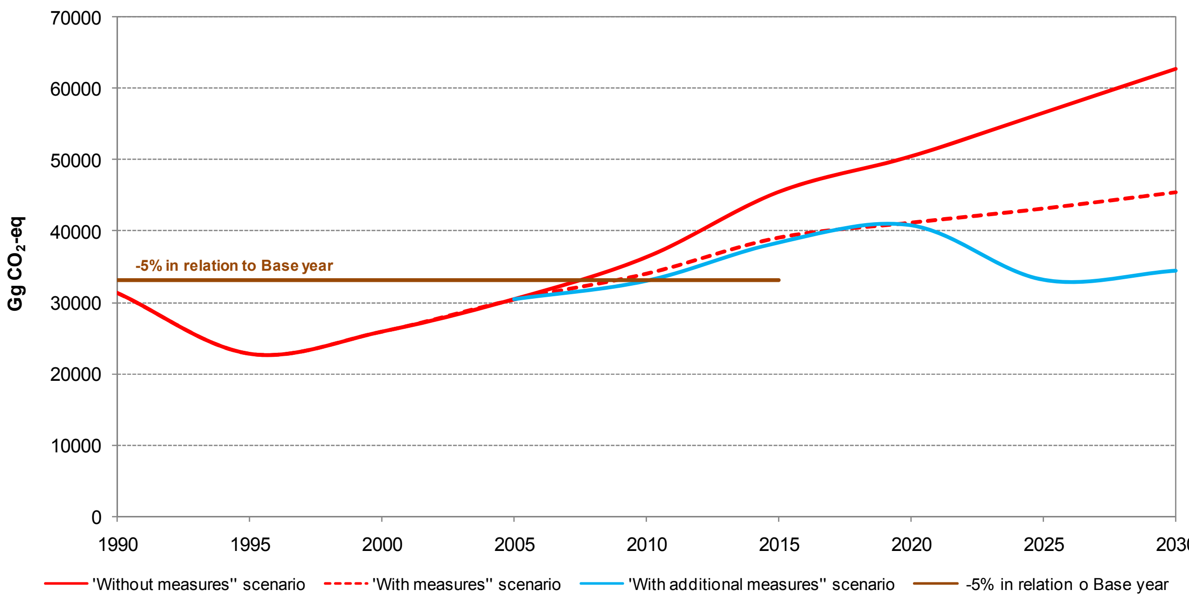


Figure 1-2: Projections of Greenhouse gas emissions in Croatia for the period from 1990 − 2030

Table 1-2: ''With measures'' scenario in relation to Kyoto target (Gg CO_2 eq)

		1990	2008	2009	2010	2011	2012	2008-2012
1	BASE YEAR, according to 7/CP.12 Decision	34822						
2	KYOTO TARGET, 95% from base year	33081	33081	33081	33081	33081	33081	165405
3	''WITH MEASURES'' SCENARIO		32585	33335	34085	35095	36105	171205
4	''WITH MEASURES'' SCENARIO + LULUCF		31613	32363	33113	34123	35133	166345
5	IN RELATION WITH KYOTO TARGET (5-3)		-1468	-718	32	1042	2052	940

1.6. Public awareness

The education system of the Republic of Croatia consists of the pre-school, primary, secondary and university education. It is the view of the Ministry of Science, Education and Sports responsible for institutional education that all school subjects and activities must contribute to the development of ecological awareness and environmental education of students. At the level of the universities, polytechnics, scientific and research institutes and other institutions the area of environmental protection, sustainable development and climate change is addressed through natural, technical, biomedicine, biotechnical, social and humanistic sciences within the framework of numerous compulsory or elective courses of undergraduate and postgraduate studies.

In Croatia daily and weekly press cover various areas of environmental protection such as climate and climate changes, harmful effects of natural disasters (drought, heat, floods, storms), the use of renewable energy sources and biofuel and international commitments and activities of the Republic of Croatia in implementing the Convention and the Protocol. In their news, scientific and educational broadcasts, radio and television stations occasionally provide information on climate changes.

According to the data provided by the Ministry of Environmental Protection, Physical Planning and Construction there are presently 630 non-governmental organizations registered for environmental protection and conservation activities in Croatia.

1.7. Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Global Climate Changes

Meteorological data confirm that the Earth's global temperature has been rising since the beginning of the 20th century. The present climate change is mostly attributed to human activities. The warming observed is connected with the increase in greenhouse gas concentration in the atmosphere. Thus, the carbon dioxide concentration increased by 35% as compared to the pre-industrial era (1750-1850), from 280 ppm in 1750 to 368 ppm in 2003, the concentration of methane by 151% and that of nitrous oxide by 17%.

If the current trend of greenhouse gas emissions into the atmosphere continues, the global temperature is expected to rise between 1.4 and 5.8°C by 2100. To maintain the warming increase up to 2°C as compared to the pre-industrial era, global emissions need to be reduced by 50-85% by 2050 as compared to the 1990 level. In Europe the temperature rise will be 0.1-0.4°C per decade and the greatest warming is predicted in southern and north-eastern Europe.

As a result of warming, the mean global sea-level rises. The scenarios of the 2001 IPCC report predict sea-level rise in a range between 9-88 cm (48 cm in average) from 1990 to year 2100.

The snow line and the upper forest line will move to higher altitudes, which will have an impact on the living world. The reduction in distribution of mountain glaciers in non-polar areas was observed.

Observed Climate Changes in Croatia

Increase of mean annual air temperature, which in the 20th century was between +0.02°C per 10 years (Gospić) up to +0.07°C per 10 years (Zagreb), continued and amplified by the beginning of the 21st century. It has become particularly expressed within the last 50 years, even more within the last 25 years. The positive temperature trends in the continental part of Croatia is mostly due to winter while on the Adriatic to summer trends. Out of ten warmest years since the beginning of the 20th century, since 2000, 7 of them were recorded in Zagreb, 6 in Gospić and Crikvenica, 5 in Hvar and 4 in Osijek. Within the whole analyzed period, a majority of warm temperature indices has a positive trend, while a majority of cold temperature indices has a negative trend. Indices trends are much more expressed at the Adriatic, than in the inland. In the 21st century, temperature indices trends have been amplified while changes in trends of warm temperature indices are greater than changes in trends of cold indices.Warming in Zagreb can be, at least partially, attributed to urban heat island impact.

The decrease of annual precipitation amounts during the 20th century continued and has not significantly changed during the 21st century. It is more expressed over the Adriatic than in the inland. In the area of northern Adriatic (Crikvenica), it is a consequence of the decline of all seasonal precipitation amounts, on Dalmatian islands (Hvar) and in the mountainous hinterland (Gospić on the Lika plateau) the consequence of strongly expressed winter and spring and over the area north of the Sava River of spring and autumn precipitation amounts. In the area of drying such as Croatia, there is no signal of major secular changes in extremes related to the high amounts of precipitation and frequency of wet and very wet days over the larger part of Croatia. The reduction in the annual amounts of precipitation can be attributed to changes in the frequency of low-intensity rain days and significant increase in incidence of dry days all over Croatia.

The frequency of dry spells is more and more expressed by the increase of dry spell durations which is mostly bolded in spring in the north Adriatic and over the northwest Croatia. In autumn months, a negative trend of dry spells is recoreded in entire Croatia.

Climate Change Scenario

The simulation of the future climate for the Croatian area has been performed by applying the regional climate model (RegCM, version 3) which, rescpecting the results of a global model, provides an estimation of significant climate variables under a strong impact of soil configuration and local dynamic processes that a global model ussually does not cover.

Regardless of the season, ground temperature in Croatian area will increase in the future climate. In the colder part of the year, the warming will be somewhat higher over northern (continental) Croatia, while in the warmer period, it will be higher in coastal part of Croatia. The warming within the regional model is in conformity with the global model (whose data were used for the starting and boundary conditions of the regional model); however, the warming amplitude is in general somewhat lower than in the global model. Climate changes, first of all general temperature increase, will cause a decrease in snow precipitation amounts along with the decrease of snow amount on the ground.

A decrease of total precipitation amount is expected over the most part of the year, primarily in the coastal Croatia and the hinterland. Although it is not mostly expressed, this decrease is in relative sense the largest during the summer due to small total amounts of precipitation in this part of Croatia. In winter, there would be a small increase in precipitation, again over the narrow coastal zone, but this increase is not statistically significant. In northern Croatia, a significant change in precipitation in future climate is not expected.

Hydrology and Water Resources

Although the Republic of Croatia belongs to a group of countries for which water issues are not a limiting factor of development, climate changes will cause problems in water supply and meeting the ever-growing drinking water requirements. Researches show that water resources in Croatia are already under challenge of climate change, as certain impacts and changes occur referred to water flow, evapotranspiration, underground water inflow, water level in rivers and lakes, water temperature etc. Results of global and regional models of climate change indicate changes in precipitation in Croatia, the impact could also be manifested due to evapotranspiration increase caused by temperature rise.

Forestry

The assumed climate changes may lead to changes in spatial distribution of forest vegetation reflected in the altered share of current forest types, possible disappearance of the existing or appearance of new types, change in the density of population of certain tree species, productivity of forest ecosystems, ecological stability, forest health condition, and the change in the overall productive and forest value.

Croatian Adriatic coast, particularly islands, is a typical example of area where the common interconnection between water (precipitation) and fire is fully expressed. Generally it can be said that in summer a number of fires and burned areas grow from the north to the south, as well as from the inland to the coat and islands, while in winter and early spring is vice versa. Results of global and regional models indicate that the largest changes could be expected in coastal southern part of the Adriatic.

Agriculture

Effects of climate variability and disasters associated with weather conditions are more and more frequent in the whole world and in Croatia as well. Main issues in agriculture are associated with water availability and increased temperature as it follows:

- increase of water insufficiency in agriculture
- greater frequency of droughts
- heat stresses issue

All natural disasters and climate variability resulted in economical damage. In a period from 2000 to 2007, Croatian counties reported damage on crops caused by extreme weather conditions in amount of EUR 1.4 billions. Therefore, a damage caused by existing climate conditions and climate variability has already an important impact on agriculture in Croatia. The cause may or may not be in climate change, but certainly indicates on current vulnerability.

Little data is available in order to estimate consequences of agriculture practices and climate variables. There is a small number of crops models and economic models of agriculture sector, which could help in understanding the present and future level of sector vulnerability due to climate change.

Biodiversity and Natural Terrestrial Ecosystems

Biodiversity consists of the genetical diversity, speciea diversity and diversity of habitats and ecosystems. In the area of Croatia three various interconnected impacts of climate change on species are expected: phenological, distributional and genetic.

Phenological changes, i.e. seasonally linked biological cycles depend on climate indicators. These changes, recorded in Europe, such as the shift in a period of the freshwater fish spawning and earlier arrival of migratory birds from the wintering grounds, occur in Croatia as well. Phenological data according to which development stages of certain plant species can be monitored, are suitable in research on climate change impacts to plants. Weather conditions of the last years less and less follow known annual and seasonal ranges and there are more and more extreme weather events not following average conditions. Analysis of climate change impacts on plants indicated in all climate zones an earlier flowering of observed plants in spring, which is a result of warmer winter and spring. In autumn there is no such unambiguous delay in colouring and leaves falling in all climate zones, i.e. vegetation period extension is observed in the inland, but not in the mountainous Croatia. These results are in accordance with observed, more expressed mean air temperature rise in spring than in autumn.

Applying the Hopkins' Bioclimate Law saying that a temperature rise of 3°C corresponds to the shift of vegetation by altitude of 500 m, it is predicted that the vegetation of the pre-mountain region of the Dinarides will be replaced by the vegetation of a temperate climate zone.

Species exposed to climate change, regardless whether they are natural or induced, may try to migrate following their life optimum, adapt to newly arisen conditions or become extinct (locally or wider). Adaptation to new conditions presumes a change of populations genetic constitution. Populations of numerous species, especially those on the edges of the areals, are expected to be exposed to fragmentation to smaller subpopulations.

Coast and Coastal Zone

In the long term, the sea level increase could be potentially one of the most expensive climate change impacts on Croatian coast, along with impacts of warmer and dryer climate on tourism and on larger frequency of extreme weather conditions. There are two basic reasons of sea level increase:

- Total sea water volume is increased due to thermal expansion of sea water caused by surface warming.
- The Earth atmosphere warming causes rapid melting of the Earth ice cover and Alps glaciers, which contributes to increase of total sea water volume.

Both factors bring to a global sea level increase, affecting the Adriatic sea as well. The measurements indicate constant sea level increase during the last decade. However, considering the shortness of monitored period, it is difficult to determine with certainty whether the level increase is a result of general sea level increase trend or just 10-year sea level variation.

During the preparation of Human Development Report (UNDP), the area and the type of land which would be covered by sea water or would be at risk of a flood, was analyzed according to two different sea-level rise scenarios – 50 cm and 88 cm. Preliminary results of the analysis for the first scenario (sea-level rise of 50 cm) show that more than 100 km^2 of the mainland will be flooded, and in the case that sea-level rises for 88 cm (second scenario), additional 12.4 km^2 will be under water. Probably the most endangered costal resources are freshwater areas and wetlands.

In regard to of climate change adaptation, the timeframe within sea-level rise is expected, is a very important factor. Considering estimations for gradual sea-level rise, there is enough time to prepare and carry out measures and activities aiming to mitigate negative effects.

Marine Ecosystem and Fish Resources

The impact of climate change on the Croatian fishery sector is complex, as the impacts are both positive and negative. They include changes in the marine environment, changes in the migration patterns of fish in the open sea (including pressure to cold-water species' migration), potential changes in the growing season and rearing time for farmed fish, and the potential increase of invasive species.

Climate change-related warming may have the following implications for the Croatian fishing sector:

- fish depletion in shallow areas of the Adriatic Sea
- better recruitment of species that thrive in warm water
- horizontal or vertical migration of cold water species into colder areas
- introduction of new organisms that transmit disease or exotic or undesired species

Research of the Adriatic Sea have shown the impact of the water inflow from the Mediterranean Sea: changes in phytoplankton and zooplankton species composition, productivity increase of Adriatic, that otherwise has relatively low nutrient levels.

Climate change caused a biodiversity change in Adriatic as well, that can be observed through the expansion of thermophilic fish species areals, i.e. through species movement from south to north. Impacts of new species appearing in Adriatic could be twofold, depending on whether they are observed in economic or ecological sense.

Human Health

Over the last decade, it has become apparent that changes in climate can contribute to disease and premature death throughout the world. The distribution and seasonal appearance of infectious diseases has changed, and the frequency of some has increased. A more frequent occurrence of heat waves will pose a serious threat to human health in future, especially as regards older people and chronic patients. Changes in immune system responses have occurred with the altered seasonal distribution of some allergenic pollen species. More hot and sunny days may also increase the impact of pollution in the future – especially by the increasing formation of ground-level ozone, which harms the lungs and has been linked to asthma. Future climate change, combined with increased pollution, may further alter ground-ozone levels and their corresponding impacts. Climate change stimulate the spread of diseases even outside their natural seats.

1.8. Research and Systematic Observation

Global Climate Observing System (GCOS)

Global Climate Observation System (GCOS) was established in 1992 and the Republic of Croatia, represented by the Meteorological and Hydrological Service, has been its member since. This system includes observation in all parts of the climate system – in the atmosphere, ocean, sea and land.

Global Earth Observation System of Systems (GEOSS) is a new initiative taken with the objective to co-ordinate and enhance all current observing systems on the global level in support of the requirements of user areas: natural disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity. The Republic of Croatia joined the GEOSS in 2004.

Data Collection and Systematic Observations in Croatia

Croatian institutions that maintain observing systems in the climate segments of atmosphere, sea and land are: Meteorological and Hydrological Service, Ministry of Sea, Transport and Infrastructure (airports and road transport), Ministry of Environmental Protection, Physical Planning and Construction, Ministry of Health and Social Welfare, Institute for Medical Research, Public Health Institute, Institute for Oceanography and Fishery, Hydrographic Institute, "Ruđer Bošković" Institute – Marine Research Centre, "Andrija Mohorovičić" Geophysical Institute, College of Science, as well as many other institutions and economic branches which run their own observing systems or individual stations.

Research Into the Climate Change Impact by Areas

In Croatia, it is necessary to initiate a number of research by areas, related to climate change impact and determination of adaptation measures. International cooperation, especially with neighboring countries of similar interests is quite desirable.

2. NATIONAL CIRCUMSTANCES

2.1. Government Profile

The Republic of Croatia gained independence in 1991 in the course of the dissolution of ex-Yugoslavia. On 22 May 1992 the Republic of Croatia became a member of the United Nations organization.

The Constitution of the Republic of Croatia was proclaimed on 22 December 1990. The state authority is organized on the principle of distribution of powers into the legislative (Croatian Parliament), the executive (the President of the Republic, the Government) and the judicial. The Croatian Parliament is the body of elected representatives and is vested with the legislative power in the Republic of Croatia. It is a unicameral parliament with no less than 100 and no more than 160 representatives elected for a term of four years. The working bodies of the Croatian Parliament for individual sectoral issues are committees and commissions, one of them being the Committee for Physical Planning and Environmental Protection.

The President of the Republic of Croatia is vested with the representative and executive function. The President of the Republic is elected on the basis of direct elections for a term of five years and can be re-elected. The President presents and represents the Republic of Croatia in the country and abroad, calls elections for the Croatian Parliament and calls the Parliament into the first session, calls referendums and gives the mandate for the setting up the government to a person enjoying the confidence of the majority of the members of the Parliament. The President of the Republic of Croatia is the commander-in-chief of the armed forces and co-operates with the Government in formulation and implementation of the foreign policy. The President of the Republic of Croatia exercises also other functions as determined by the Constitution.

The Government of the Republic of Croatia exercises the executive power in conformity with the Constitution and the law. The Government consists of the Prime Minister, Deputy Prime Ministers and Ministers and assumes the office when given a vote of confidence by the majority of all members of the Croatian Parliament. The organization, operation and decision-making are regulated by the Law on the Government of the Republic of Croatia and its rules of procedure. The Government of the Republic of Croatia proposes laws, the state budget and other documents to the Croatian Parliament. In accordance with the Constitution it is vested with independent regulatory powers to adopt regulations for the enforcement of laws. It is responsible for implementation of laws and decisions of the Croatian Parliament, conducts the foreign and domestic policy, directs and controls the work, activities and development of the state administration and public services, is responsible for the economic development of the country and conducts other affairs as determined by the Constitution and the law.

The government bodies comprise 16 ministries, 3 central state administration offices, 9 state bureaus and county offices of government bodies. The Ministry of Environmental Protection, Physical Planning and Construction is the central government authority in charge of administrative and expert environmental protection activities relating to the horizontal legislation, air quality, climate and ozone layer protection, soil protection, waste management, protection of the sea and marine environment, industrial pollution control and risk management. Apart from the central government bodies there are other bodies dealing with environmental protection issues such as the Croatian Environment Agency established in 2002, the Environmental Protection and Energy Efficiency Fund established in 2003, the State Institute for Nature Protection and the Croatian Waters.

The local self-government units of the Republic of Croatia are municipalities and towns responsible for issues of local importance that do not fall within the competence of government bodies. Major towns are local self-government units with over 35,000 inhabitants and development centres of a wider region. District (regional) self-government units are counties responsible for activities of the regional importance.

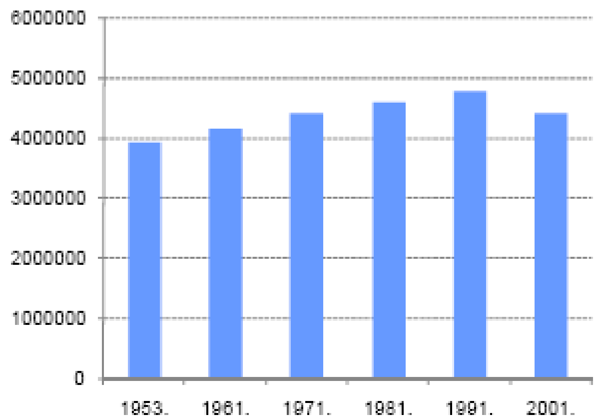
The Republic of Croatia has 21 district (regional) self-government units - 20 counties and the City of Zagreb – and 556 local self-government units – 127 towns and 429 municipalities.

After the adoption of the Resolution on the EU Accession of the Republic of Croatia by the Croatian Parliament on 18 December 2002, Croatia applied for the EU membership in Athens on 21 February 2003. On 18 June 2004 Croatia was granted the status of the EU candidate country and the accession negotiations started in Luxembourg on 3 October 2005. Croatia has almost completely harmonized its legislation with the EU acquis communautaire. The formal termination of negotiations is expected by the middle of 2010, while accession to the EU is expected by 2012.

2.2. Population Profile

According to the 2001 census, the Republic of Croatia is populated with 4,437,460 inhabitants. According to estimation from the middle of 2008, the number of inhabitants is 4,434,508 (out of which 48.2% are males and 51.8% are women). Average age of the population has been constantly increasing, thus in 2008, it was 39.2 years for men and 42.6 years for women. Expected stand was 72.4 years (men) and 79.6 years (women). The birth rate (live-born in 1000 inhabitants) was 9.9, the death rate (dead in 1000 inhabitants) was 11.8 and natural population growth was negative and amounted -1.9.

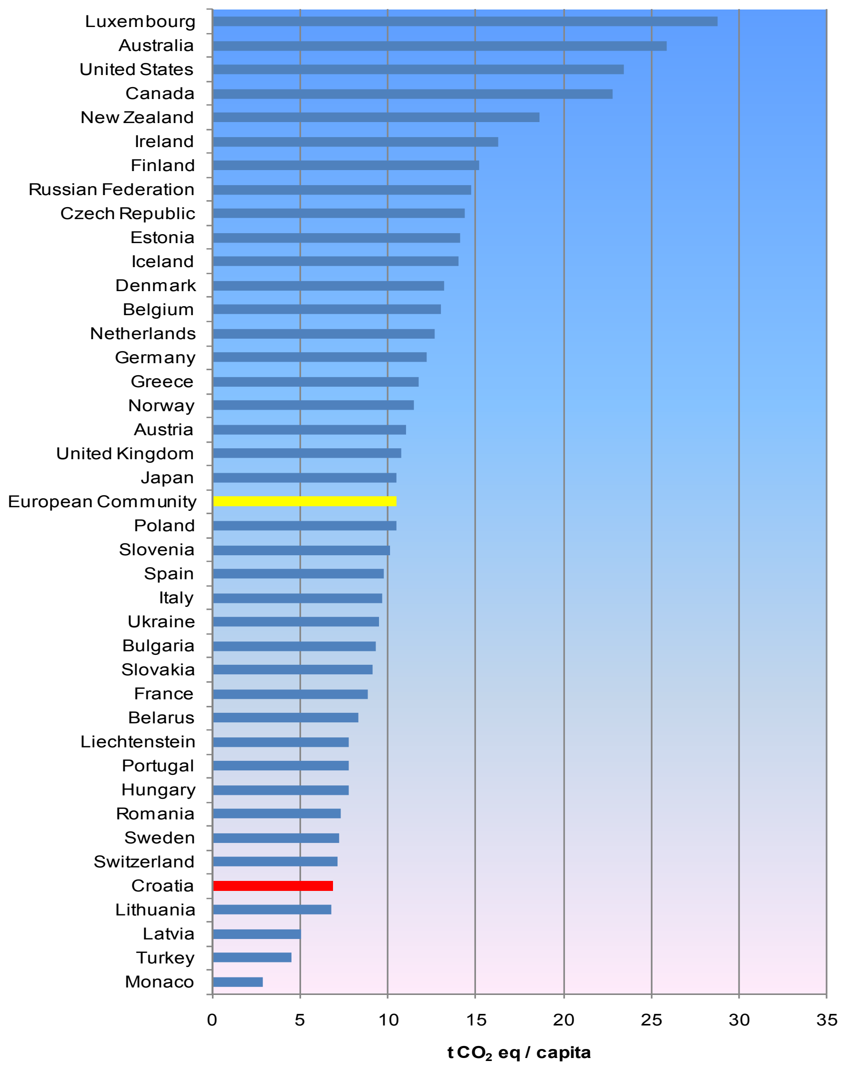
Croatian area is not evenly populated. Average population density is 78.4 inhabitants per km^2. Central part of Croatia is the most populated (115 inh./km^2), while the least populated is the mountaneous part of Croatia (13 inh./km^2). More than 90% of Croatia's population lives in lowland and small hilly areas up to 300 m above sea level. Within total number of inhabitants, 51.1% lives in 124 cities.



(Source: CBS)

Figure 2-1: Population number according to censuses in the period from 1953-2001

Greenhouse gases emission per inhabitant is among the lowest within the countries of the Annex I of the Convention (6.9 t CO_2 eq/capita in 2006). In 2006, emission per capita was by 34% lower than the European Union average and 38% lower than the average of Anex I countries (Figure 2-2).



Source: FCCC/TP/2008/10

Figure 2-2: Greenhouse gas emissions per capita in 2006

2.3. Geographic Profile and Land Use

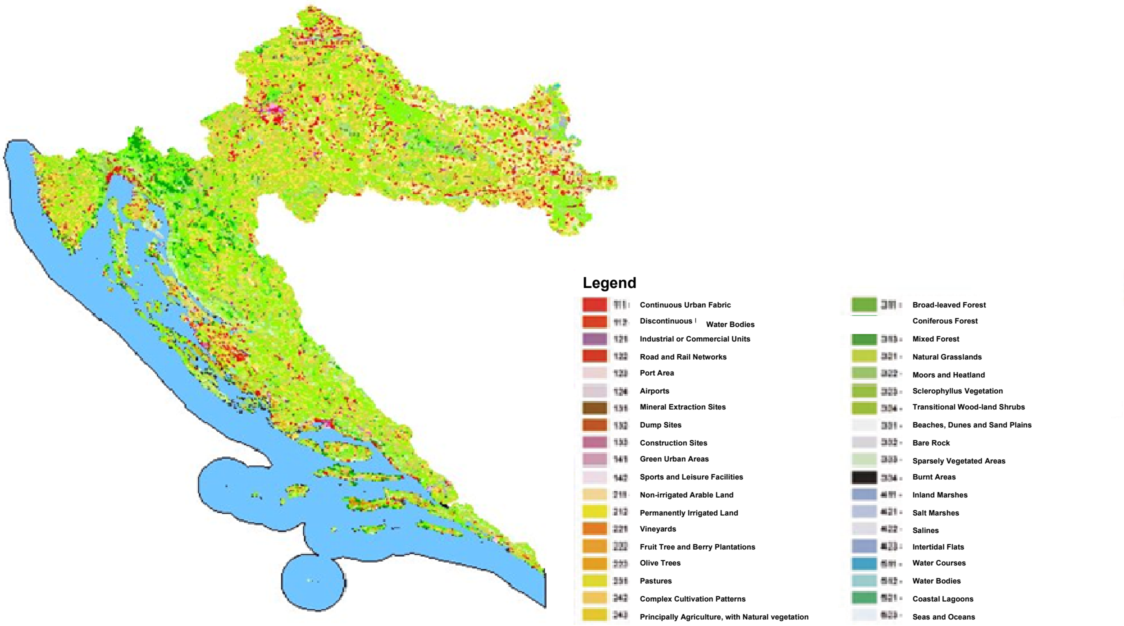
Total land area of the Republic of Croatia is 56,594 km^2. The territorial waters and internal marine waters cover an area of 31,067 km^2. By its position, Croatia belongs to the Central-European, Adriatic-Mediterranean and Pannonian-Danube basin group of countries. The total length of land borders of the Republic of Croatia with neighbouring countries is 2,028 km. It borders Slovenia (501 km) to the northwest, Hungary (329 km) to the north, Serbia (241 km) and Montenegro (25 km) to the northeast and southeast, and has the longest border with Bosnia and Herzegovina (932 km). The national sea border is 948 km long and stretches along the outer edge of the territorial sea. It is followed by protected ecological and fishing zone covering an area of 25,207 km^2 and reaching the continental shelf border between Croatia and Italy.

Three large geomorphological sections may be distinguished in Croatia: the Pannonian basin, the mountain range of Dinaric Alps and the Adriatic basin. Lowland areas up to 200 m above sea level amount 53%, the rolling hills up to 200-500 m 26% and the highland and mountainous areas above 500 m 21% of Croatia's land area.

The highest mountain peak in Croatia is Dinara (1,831 m). The karst area covering 54% of Croatia's territory represents relief specificity. Karst phenomena and forms have developed primarily in limestone of the mountainous and coastal zone of Croatia and also as an isolated phenomena of the Sava and the Danube basin.

In 2007, utilized agricultural land covers the area of about 21%[4], while total area of forest land encompasses 47,5% of Croatia's mainland area.[5]

Land cover, according to CORINE nomenclature, is shown in Figure 2-3.



(Source: CEA CORINE Land Cover 2006 – Croatia)

Figure 2-3: Land cover in the Republic of Croatia

The Nature Protection Act (OG 70/05, 139/08) determines nine categories of area protection. The total surface of Croatia's protected areas is 5,088.161 km^2 or 8.991% of the mainland and 410.25 km^2 of the marine area.[6]

2.4. Climate Profile

According to Köppen classification for a standard period 1961-1990, the largest part of Croatia belongs to the climate type C, a moderately warm rainy climate. The southernmost part of the island of Lošinj, the Dalmatian coast and islands have the Mediterranean climate with dry and hot summers (Csa), whereas the coastal areas of Istria, the Kvarner littoral and the Dalmatia's interior have a moderately warm and humid climate with hot summers (Cfa). The moderately warm and humid climate with warm summers (Cfb) prevails in the major part of Croatia, in the continental Pannonian region and the interior of Istria. Only the regions of Gorski kotar, Lika and the Dinaric Alps above altitude of 1200 m belong to the climate type D, subtype Df, a humid snowy forest climate.

[4] According to Statistical Yearbook 2009
[5] According to Forest Management Plan 2006-2015
[6] Ministry of Culture

The annual mean air temperature in the lowland area of northern Croatia is 10-12°C, at altitudes above 400 m it is under 10 °Clower and in the mountains it is 3-4°C. In the coastal area it is 12-17°C. January is the coldest month on average, with the temperature in the Pannonian region ranging from 0 to -2°C. Along the Adriatic coast winters are milder; January temperatures are 4-6°C. In the north and east of Croatia average July temperatures are 20-22°C and on the Adriatic coast 23-26°C. The absolute minimum temperature of -35.5°C was measured in Čakovec on 3 February 1929 and the absolute maximum of 42.8°C in Ploče on 5 August 1981.

The least precipitation in Croatia is recorded in the open part of the central Adriatic (Palagruža, 304 mm) and in the eastern Slavonia and Baranja (Osijek, 650 mm). Central Croatia and the coastal zone have annual precipitation between 800 and 1,200 mm. The amount of precipitation in the Pannonian region decreases from the west towards the east. From the coast towards the inland the precipitation increases. Most of the precipitation is recorded on the coastal slopes and peaks of the Dinarides (Risnjak, 3,470 m), from Gorski Kotar in the northwest to the southern Velebit in the southeast.

In Croatia's inland the north-easterly winds prevails. Bora (*bura*) is a cold descending wind blowing from the north-eastern direction on the eastern Adriatic coast. It blows in gusts over 110 km/h, which sometimes can exceed 250 km/h. It is more frequent and stronger in winter than in other seasons.

Sirocco (*jugo*) is a warm and wet, moderate or strong south-easterly wind accompanied by cloudy and rainy weather. It is the most frequent and the strongest in the cold half of the year. It is stronger on the open sea, making the waves up to 10 m high.

The duration of sunshine depends directly on the cloudiness. The coastal zone from Dugi otok to Prevlaka is the fairest part of Croatia with the annual cloudiness of 4/10. The islands of the central and southern Adriatic (Hvar, Vis and Korčula) have 2,700 hours of sunshine per year. The majority of inland places in Croatia have 1,800-2,000 hours of sunshine. The annual largest cloudiness is recorded in Gorski kotar (6-7/10), which has the least hours of sunshine yearly – about 1,700.

In the mountaneous part of Croatia the heating season lasts for 8 months, in the continental part for 6, while in the coast for 4 months. In summer in the continental part, as well as in the coastal area, a great number of days needs cooling in order to keep the inside climate pleasant for working. Almost all new hotels, services objects and offices have air conditioning devices.

2.5. Economy Profile

In 2007, Croatian economy has been rising by an annual rate of 5.5% while the gross domestic product amounted 314.2 billions of kunas (58.6 mil. USD) or 13,207 USD (9,656 EUR) per capita. In 2008, due to a spillover of consequences of the global economic crisis, economic activities were slowed down. Real growth of the gross domestic product was 2.4% which is 3.1 percent point lower than the growth recorded in 2007 and at the same time, the lowest growth rate since 1999. Considering the purchasing power parity, in 2008 Croatian gross domestic product reached 63.0% of the average gross domestic product per capita in the EU 27 countries.

Due to a spillover of consequences of the economic crisis on Croatian economy, gross domestic product's real decline in 2009 is expected to be 5.0%. In 2010, a slow recovery of economic activity and gross domestic product's real growth of 0.5% is expected and a gradual acceleration of economic growth in 2011, however with a bit slower dynamics than it was in the period before 2008. In 2011, a real growth of 3.0% is expected and in 2012 its further accelleration to 3.5%.[7]

With its share of 68% in the country's total foreign trade, the European Union is Croatia's major foreign trade partner. The Republic of Croatia has been a member of the World Trade Organization (WTO) since 2000 and a party to the Central European Free Trade Agreement (CEFTA) since 2003.

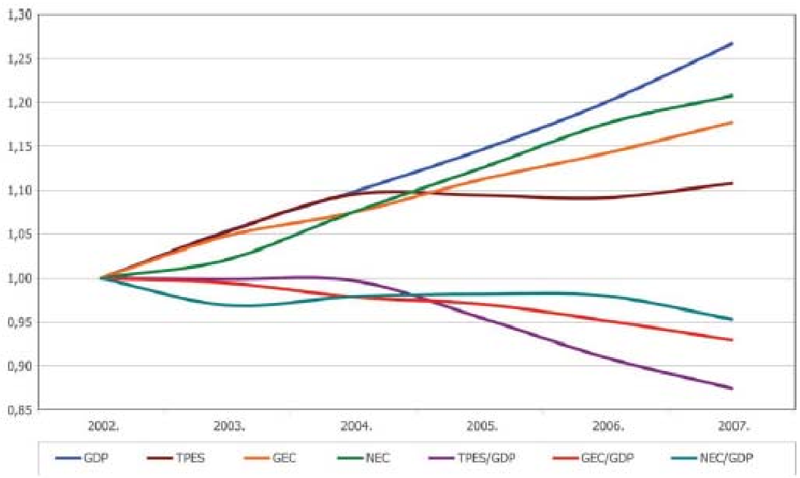
Table 2.1: Selected macro-economic indicators, 2000-2007

	2000	2001	2002	2003	2004	2005	2006	2007
GDP (mil. HRK)	176.7	190.8	208.2	227	245.6	264.4	286.3	314.2
GDP (mil. USD)	21.3	22.9	26.5	33.9	40.7	44.3	49	58.6
GDP per capita (USD)	4,817	5,153	5,957	7,626	9,172	10,003	11,044	13,207
Real GDP-a growth rate (%)	3.03	3.83	5.44	4.96	4.25	4.21	4.7	5.5
Average annual inflation rate (%)	4.6	3.8	1.7	1.8	2.1	3.3	3.2	2.9
Export / %GDP	40.07	42.3	39.6	43.8	43.5	42.8	43.5	42.7
Import / %GDP	45.1	47.4	49.1	50.6	49.4	48.9	50.2	50.1
Gross foreign debt / %GDP	53.0	53.5	53.9	66.3	70.0	72.1	74.9	76.9
Unemployment rate	16.1	15.8	14.8	14.3	13.8	12.7	11.2	9.6

(Source: Central Bureau of Statistics, Ministry of Finance, Croatian National Bank)

2.6. Energy

In 2007, the energy consumption in Croatia totalled 416.8 PJ or 2,242 kg of oil equivalent per capita. In the period from 2002 to 2007, the total primary energy supply increased at an average annual rate of 2.1%. Since 1992, the year when the total primary energy supply in Croatia was at its lowest level, until 2007 the total primary energy supply grew by an average of 2.2% per year. Indicators of development and energy supplyare presented in Figure 2-4.



GDP – Gross Domestic Product, TPES – Total Primary Energy Supply, NEC – Net Electricity Consumption
(Source: Energy in Croatia, 2007)

Figure 2-4: Main indicators of development and energy supply

[7] Guidelines for economic and fiscal policy for the period 2010-2012., Ministry of Finance, September 2009.

The shares of individual energy forms in the total primary energy supply during the period from 1990 to 2007 are given in Table 2-2. As for the structure of total primary energy supply in 2007 liquid fuels had the largest share with 45.5%, followed by natural gas with 27.4% and coal 8.1%. In 2007 the total primary energy supply increased by 1.5% with respect to the previous year. There was an increase in natural gas consumption, imported electricity, liquid fuels, coal and coke and renewable energy sources. The consumption of fuel wood was lower than in the previous year, and unfavourable hydrological conditions were the reason for reduced hydropower utilization, which dropped by 27.4%. The highest increase rate, of 189.8% was recorded in the use of renewable energy sources, but it refers to relatively small amount of energy (0.69 PJ).

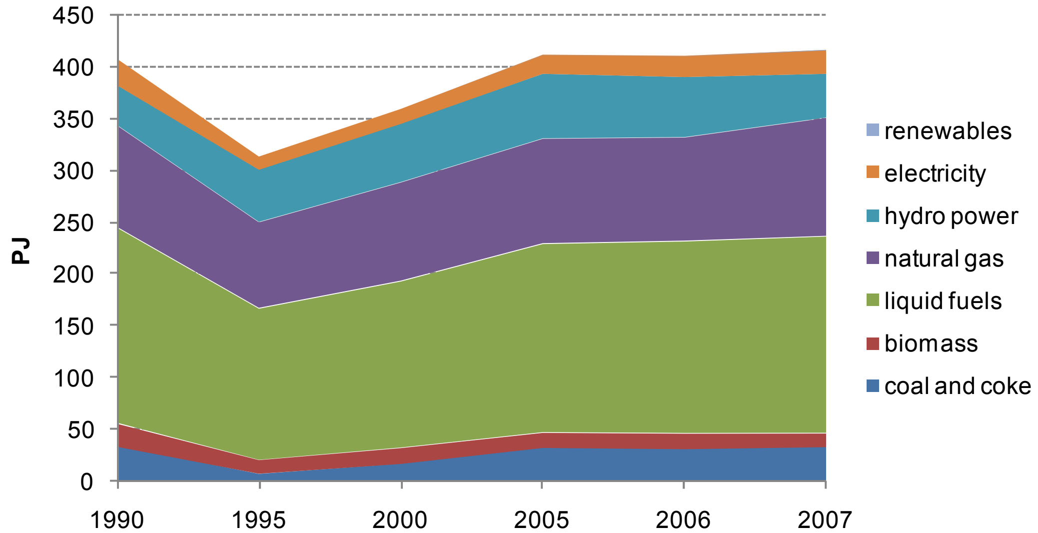
Table 2-2: Total primary energy supply for period 1990 – 2007

	1990	1995	2000	2004	2005	2006	2007
	PJ						
Coal and coke	34.07	7.42	17.15	29.70	32.95	31.61	33.74
Fuel wood	22.68	13.52	15.54	15.86	14.77	15.28	13.31
Liquid fuels	188.57	146.03	160.52	179.62	181.88	185.15	189.70
Natural gas	98.22	82.77	94.98	104.66	101.06	99.86	114.22
Hydro power	38.55	51.75	56.93	69.00	62.40	58.18	42.21
Electricity	25.42	12.59	14.40	13.19	18.41	20.24	22.90
Renewable sources	0.0	0.0	0.0	0.0	0.20	0.24	0.69
TOTAL	**407.51**	**314.08**	**359.62**	**412.04**	**411.66**	**410.56**	**416.78**

(Source: Energy in Croatia, 2007)

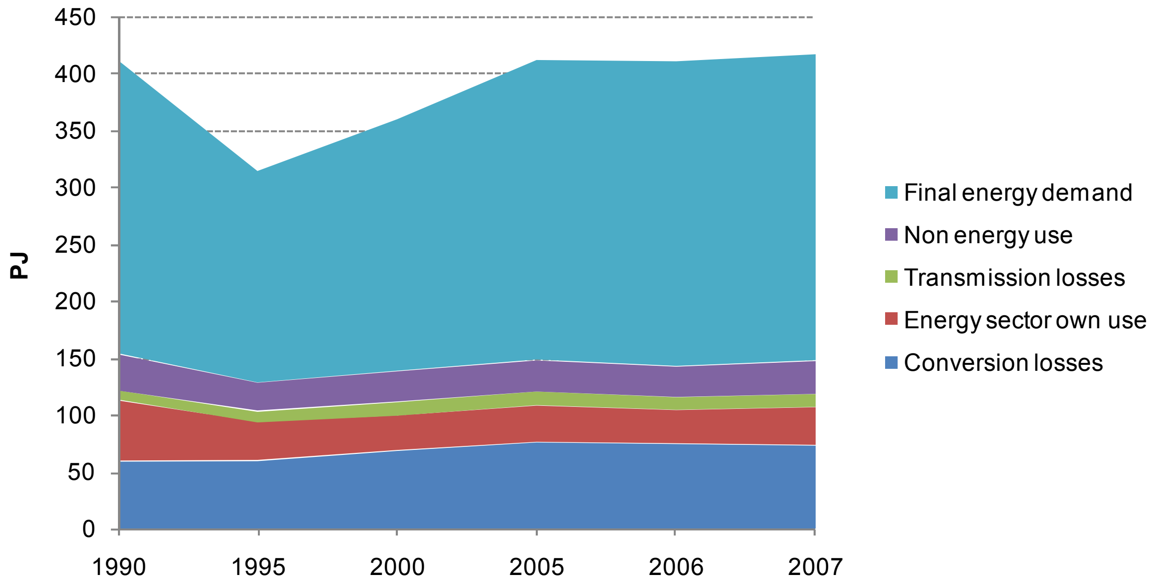
The trends in the total energy supply in last period of seventeen years are showed in Figure 2-5. The structure of the total energy demand in the period from 1990 to 2007 is showed in Figure 2-6.

The major contribution to the final energy demand by sectors in 2007 comes from general consumption (43.7%), with the 34.1% share of transport and 22.2% of industry.



(Source: Energy in Croatia, 2007)

Figure 2-5: Total energy supply in Croatia



(Source: Energy in Croatia, 2007)

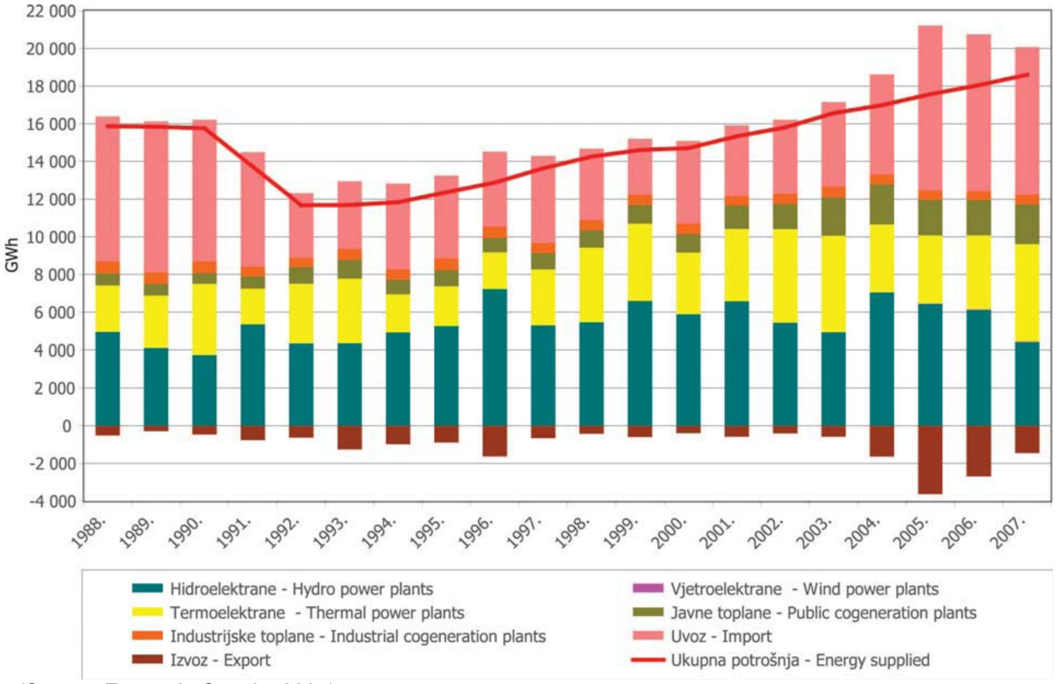
Figure 2-6: The structure of the total energy demand

Among the fossil fuels, Croatia extracts crude oil and natural gas. In 2007 879,100 tonnes of oil were produced on 34 oil fields. The natural gas production from 24 gas fields amounted to 2,892,100,000 m^3 in 2007, covering 71.2% of domestic needs.

From renewable energy sources in Croatia are used hydro power, firewood and waste wood, biomass, biodiesel, wind energy, solar energy, geothermal energy and landfill gas. Although the use of renewable energy sources has increased significantly in recent years, it should be noted that renewable energy sources to total primary energy is very small (0.37% in 2007).

In June 2007, biodiesel production from waste cooking oil has started which makes it the second biodiesel plant operating in Croatia. Its capacity is 9,000 tonnes per year of biodiesel which increases the total Croatian biofuel production capacity to 29,000 tonnes per year. In 2007, 4,334 tonnes of biodiesel was produced in Croatia, out of which 3,583 tonnes were placed at the domestic market.

Electricity generation capacities within the HEP Group consist of 16 locations with hydropower plants, 7 locations with thermal power plants and one half of the installed capacities of the nuclear power plant Krško (located in the territory of Slovenia). Total available capacities of all HEP's power plants in the Republic of Croatia amount to 4,020 MW. Out of this amount, 2,071 MW is placed in hydropower plants, 1,601 MW in thermal power plants and 348 MW in the nuclear unit Krško. Thermal power plants are coal fired, gas-fired and fuel oil-fired. Total installed capacity of industrial power plants amounts to about 210 MW. Beside industrial power plants there is in the Republic of Croatia about 23 MW installed capacity for electricity generation in private ownership. Among them there is one landfill power plant, five small hydro power plants, four solar power plants and two wind power plants (Figure 2-7).



(Source: Energy in Croatia, 2007)

Figure 2-7: Electricity supply in the Republic of Croatia

In the electricity generation sector, significant share of generation is from hydropower, and it varies depending on hydrological conditions (generation 4-6.5 TWh/year). These variations have a significant impact on greenhouse gas emissions because they compensate for differences in the production of thermal power plant production or additional import. The import of electricity is 20-30% of supply. Specific emissions from electricity generation with 286 g CO_2 eq/kWh in 2006, is among the lowest compared to other countries in Europe (Figure 2-8).

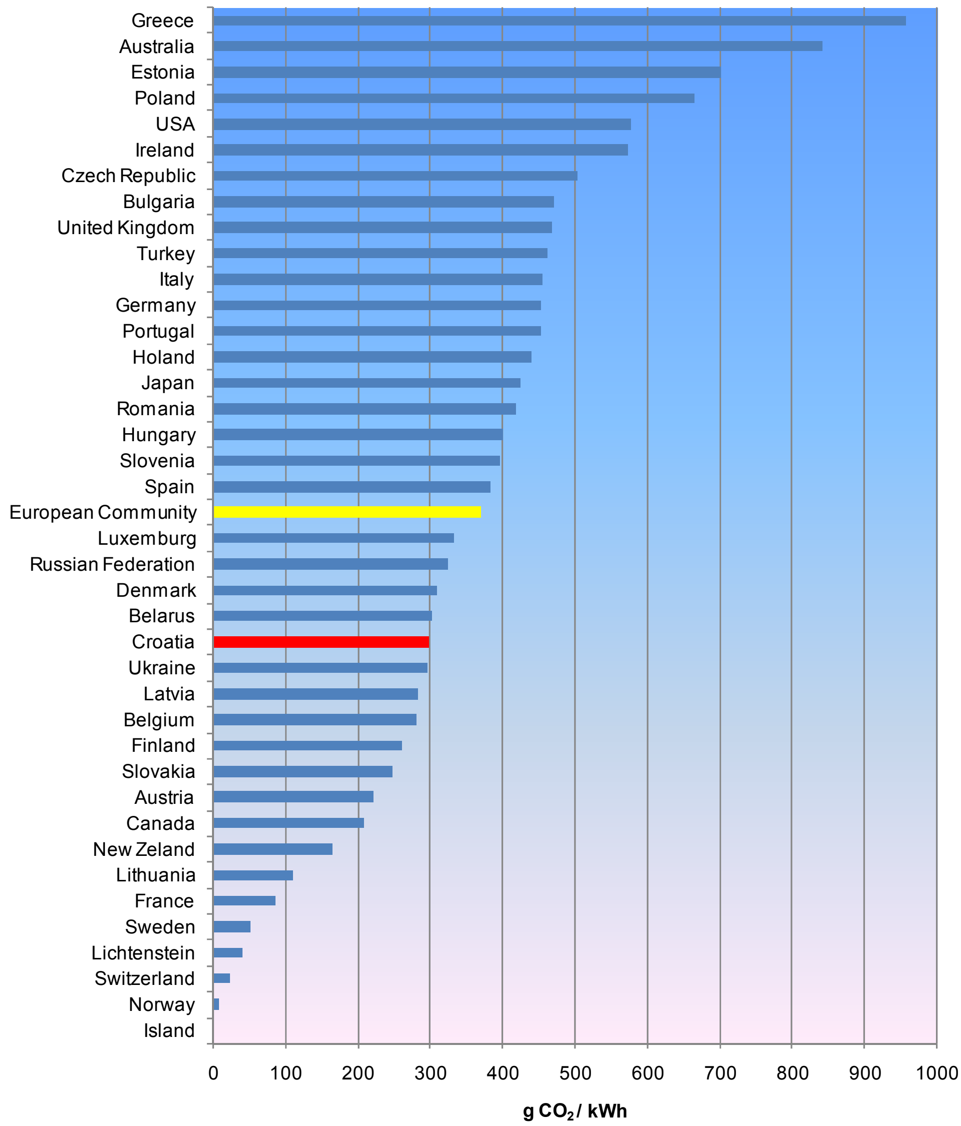
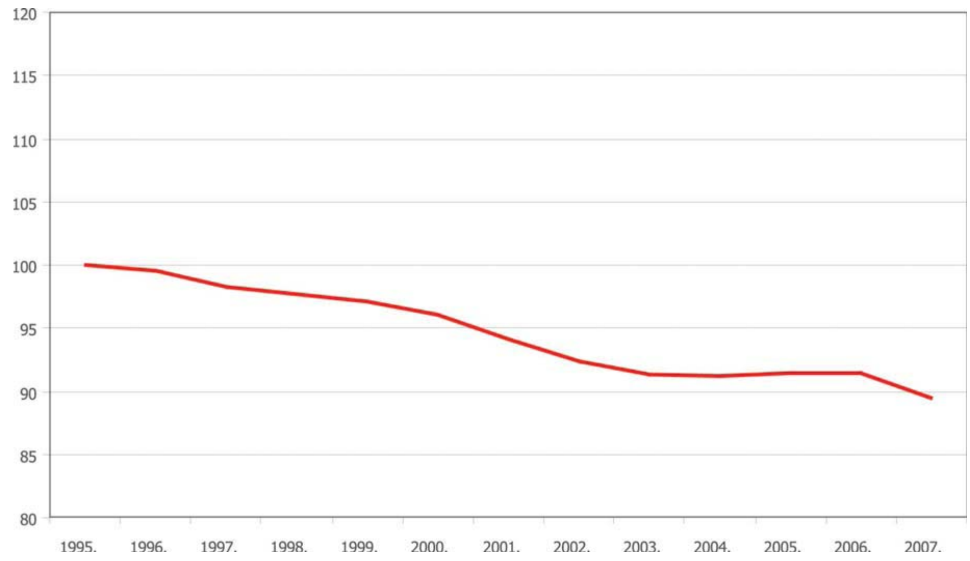


Figure 2-8: Specific emission from electricity generation for European countries (Sector of electricity and heat generation from the public heating plants)[8]

During the period from 1995 to 2007, the energy efficiency index for the whole economy (ODEX) decreased by 10.5 percent in Croatia. The industrial sector (textile) and transport sector (rail) contributed the most to this development. The energy efficiency index (ODEX) for all sectors is given in Figure 2-9.

[8] Source: FCCC/TP/2008/10



(Source: Energy in Croatia, 2007)

Figure 2-9: Energy efficiency index ODEX for all sectors

2.7. Transport

Developed and efficient transport of goods and passengers is a vital element of the foundation of the modern society. At the same time, transport itself is an important economic sector that contributes to tourism, economic growth and employment, strengthening competitiveness and foreign-exchange earnings. The above mentioned positive effects of the transport sector need to be observed against the fact that this sector burdens society in different areas: traffic accidents, air pollution, noise, congestion, and CO_2 emissions.

Road and railway transport of goods and passengers in the Republic of Croatia is the most significant as regards Croatia's geographical and transport-related position. Croatia is located at the crossroads of transit routes between western and south-eastern Europe and between the central Europe and the Mediterranean. The territory of the Republic of Croatia is crossed by three Pan-European traffic corridors:

- Pan-European traffic corridor V (road and railway link): Venice-Trieste/Koper-Ljubljana-Budapest-Lavov, with a V/B branch: Rijeka-Zagreb-Goričan-Budapest and the V/C branch: Ploče-Sarajevo-Osijek-Budapest;
- Pan-European traffic corridor X (road and railway link): Salzburg-Ljubljana-Zagreb-Belgrade-Skopje-Thessalonica with a X/A branch: Graz-Maribor-Macelj-Zagreb;
- Pan-European traffic corridor VII: the Danube river corridor.

The international and interstate freight and passenger transport takes place through 109 permanent border crossings: 57 road, 19 railway, 10 airport, 19 seaport and 4 river port international border crossings.

The total construction length of railway lines in the Republic of Croatia is 2,722 km of which 2,468 km are single-track and 254 km double-track lines. The 984.0 km of railway lines or 36% are electrified.

In 2007, the total length of public roads in the Republic of Croatia was 29,038 km of which 8,119 km were state roads, 10,544 km county roads and 10,375 km local roads. At the end of 2005 the constructed network of motorways in Croatia amounted to 792 km.

The Republic of Croatia has six ports of special (international) economic interest in the cities of Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik.

The network of inland waterways of the Republic of Croatia is 804.1 km long of which 539.2 km are international waterways. Inland waterway ports opened for international public transport are: Osijek, Sisak, Slavonski Brod and Vukovar.

There are seven international airports in the Republic of Croatia: Zagreb, Split, Dubrovnik, Zadar, Rijeka, Pula and Osijek, and three national airports: Brač, Mali Lošinj and Osijek intended to accommodate smaller aircrafts. The annual throughput of passengers in Croatia's airports is some 4.9 million.

In 2007 the transport sector accounted for 26% t of Croatia´s total CO_2 emission and 20% of total greenhouse gas emissions (CO_2 eq)[9], representing a growth of 8, as follows 7 per cent since 1990. Contribution to Croatia´s total greenhouse gas emissions (CO_2 eq) are calculated as a share of the total emissions of greenhouse gases, which include industrial gases, methane, and nitrous oxide.

Passenger and goods transport continued to increase, as well as the number of road motor vehicles subsequently and consumption of motor fuels. In spite of this transport sector has not yet succeeded in decoupling economic growth and greenhouse gases emissions but in step with economic growth, transport performance grows, energy consumption increases and CO_2 emissions is higher. Unlike the transport sector, the energy sector succeeded in reducing greenhouse gas emissions by applied measures, in spite of economic growth. Unfortunately, these measures are not directly available for the transport sector, or associated with high costs of their application.

The developments in passenger and goods transport performances are shown in Tables 2-3 and 2-4 respectively. The number of motor vehicles performance and motor fuel consumption in road transport for the period 1990- 2007 are shown in Figure 2-10.

Table 2-3: Trend in passenger transport performance in billion passenger-kilometres

	1990	1995	2000	2005	2006	2007
Railway transport	3.4	1.1	1.3	1.3	1.4	1.6
Road transport	7.0	4.1	3.3	3.4	3.5	3.8
Sea water and coastal transport	0.2	0.3	0.3	0.4	0.5	0.5
Air transport	0.0	0.4	0.8	2.0	2.0	2.1
Total	**10.6**	**5.9**	**5.7**	**7.1**	**7.4**	**8.0**

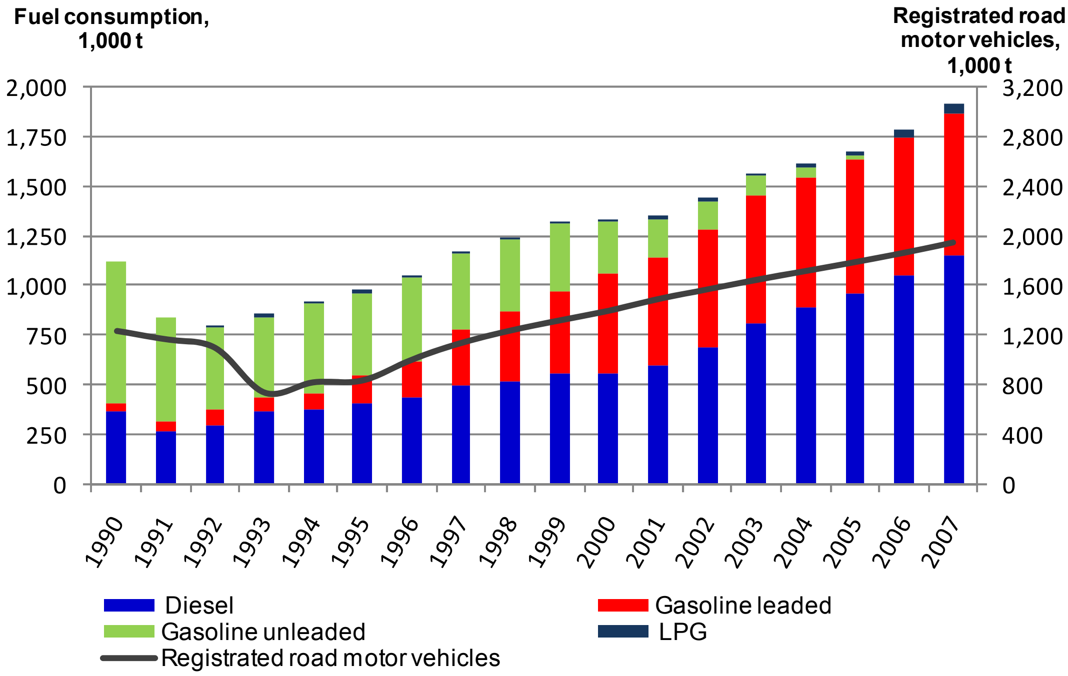
(Source: CBS)

Table 2-4: Trend in goods transport performance, billion tonne-kilometres[10]

	1990	1995	2000	2005	2006	2007
Railway	6.5	2.0	1.8	2.8	3.3	3.6
Road	2.6	1.3	1.1	9.3	10.2	10.5
Pipeline	3.6	0.5	0.7	1.8	1.5	1.8
Sea water and coastal	176.0	196.0	140.1	126.1	137.0	137.5
Inland waterway	0.5	0.0	0.1	0.3	0.3	0.3
Total	**189.2**	**199.8**	**143.8**	**140.3**	**152.3**	**153.7**

[9] It refers to total CO_2 and CO_2 eq emission excluding LULUCF.
[10] Transport of goods by air has a negligible share in total transport of goods.

(Source: CBS)



(Source: EKONERG)

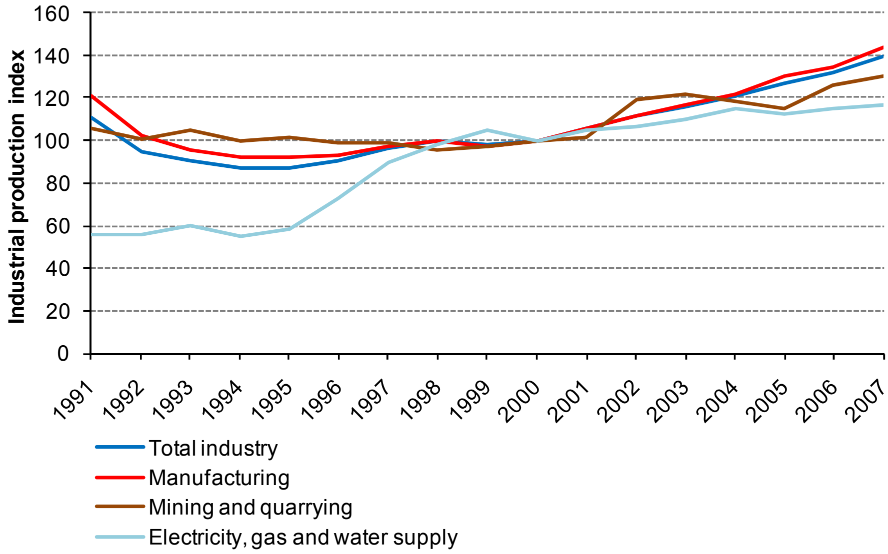
Figure 2-10: Number of vehicles and fuel consumption in road transport, 1990-2007

The number of motor vehicles has continuously been rising since 1995, and amounted to 1,949,936 in 2007, of which 76.5% are passenger cars. While in 1995 there were 164.4 cars per 1,000.0 inhabitants, in 2007 this number was 336.1 (The EU has 466.0 cars /capita).

The consumption of fuel has continuously been increasing since 1992, and consumption of diesel fuel exceeded the petrol consumption for the first time in 2003 (1.1:1 ratio). The rise in the diesel fuel consumption is a result of prices and the specific consumption of diesel fuel. This is, however, an unfavorable trend from the aspect of air pollution due to a higher emission of particulate matter and sulphur dioxide by diesel engines.

2.8. Industry

In the early 1990s the physical volume of industrial production was considerably decreased. A significant increase of industrial production at an annual growth rate of 4.1% has been noted since 1997 (Figure 2-11).



Source: Central Bureau of Statistics, Statistical Yearbooks 1991-2009

Figure 2-11: Industrial production index
(Year 2000 = 100)

Industry accounted for 16.5% of the GDP structure and employed about 284,000 employees in 2007. The most important contribution of 85% related to manufacturing with approximately 253,000 employees. Within manufacturing branches, the manufacture of food products, beverages and tobacco had the largest share of 19.8% and employed about 50,000 workers. Manufacture of pulp, paper and paper products as well as publishing and printing represented 10.3% in the GDP structure, then follows manufacture of basic metals and fabricated metal products (7.7%), manufacture of electrical and optical equipment (7.3%), manufacture of other non-metallic mineral products (6.9%) and manufacture of coke and refined petroleum products (6.0%). Then follow manufacture of chemicals, chemical products and man-made fibres (5.8%), manufacture of transport equipment (4.5%) and manufacture of textiles and textile products (4.3%). Other manufacturing branches such as manufacture of machinery and equipment, wood and wood products, rubber and plastic products, leather and leather products and other manufacturing represented together about 12.7% of the GDP structure.

Mining and quarrying accounted for 2.5% of the GDP structure in 2007 whereof 71% concerns mining and quarrying except for energy producing materials. Furthermore, electricity, gas and water supply accounted for 12.2% of the GDP structure in 2007.

Croatian Chamber of Economy, Industry and Technology Department, through activities of 12 professional associations and 17 communities, consider specific issues associated with particular activities (vertical approach) and coordinate economy attitudes on issues with cross-sectoral, horizontal context.

Industrial processes sector contributes with 12.6% to the total Croatian GHGs emission (CO_2 eq) in 2007. The largest share of 40% sectoral emissions related to the cement production (Portland and Aluminate cement), contributing with 5% to the total Croatian GHGs emission. A significant increase of cement production has been noted since 1997 (Figure 2-12).

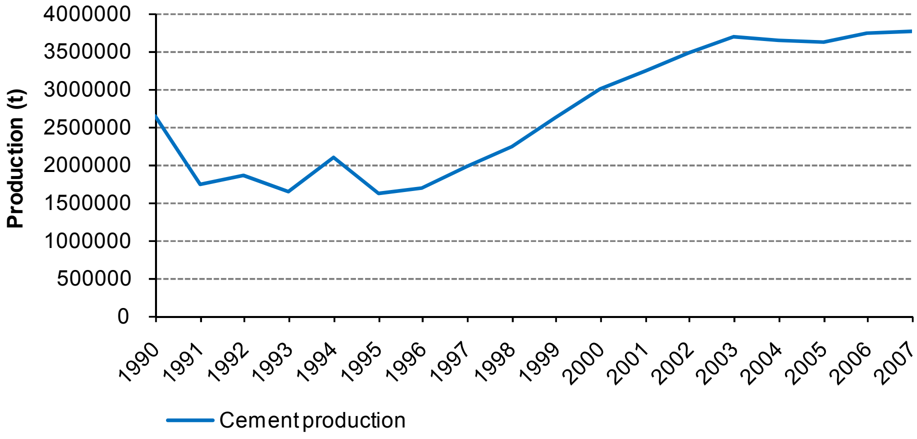


Figure 2-12: Cement production from 1990 to 2007

Fluctuations in ammonia and nitric acid production during the period from 1990 to 2007 (Figure 2-13) mostly depended on consumer demand at the market for different types of mineral fertilizers. Ammonia production contributes with 23% and nitric acid production with 18% to the sectoral GHGs emission in 2007. The abovementioned industrial activities contribute with 3% i.e. 2% to the total Croatian GHGs emission.

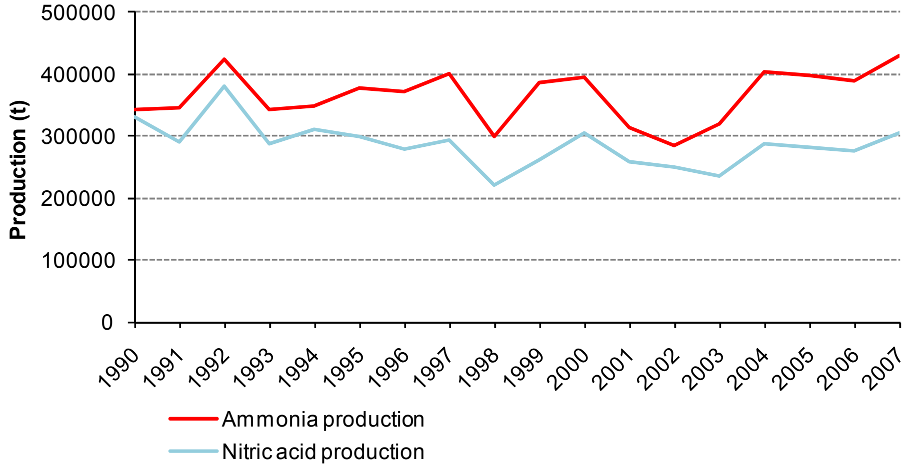


Figure 2-13: Ammonia and nitric acid production from 1990 to 2007

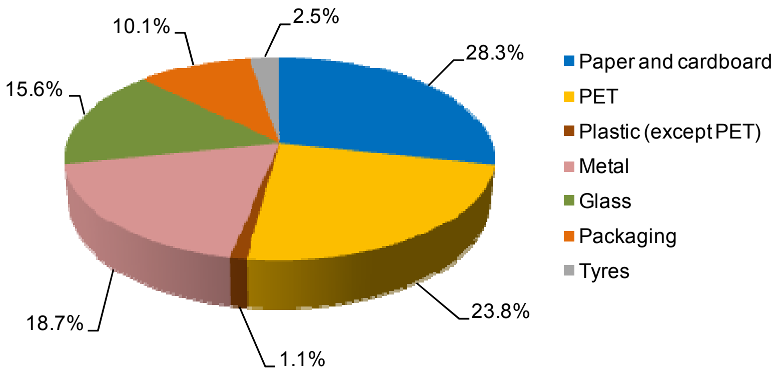
A significant increase in consumption of synthetic GHGs (hydrofluorocarbons, HFCs) has been noted during the last few years. There is no production of HFCs in Croatia; therefore all quantities of HFCs are imported. Minor quantities of some substances are exported. Emissions, which are released by the handling and consumption of HFCs in refrigerating and air-conditioning system, contribute with 12% to the sectoral GHGs emission in 2007 i.e. 1.5% to the total Croatian GHGs emission. In addition to refrigerating and air-conditioning system, HFCs are used for foam blowing and fire extinguishers.

2.9. Waste

Implementation and establishment of the integral waste management system in Croatia are ensured by applying and fulfilling the objectives defined by the Waste Act[11], Strategy[12] and Plan[13]. Management of the different types of waste is arranged by the Strategy and Plan, which are harmonised by objectives of the hierarchical concept of waste management. Three phases of the hierarchical concept, avoiding/reduction - reuse/recovery - disposal, are ordered according to importance. Avoiding and reducing of municipal waste generation has the highest priority and results in reduction of quantity and adversity of produced waste which enters into the next phase. Reuse/recovery of produced waste has the purpose to use material and energy potentials of waste, in the framework of technical, ecological and economic possibilities. The most important elements are separate waste collecting and recycling as well as mechanical, biological, thermal and other categories of waste treatment. Disposal of remaining inert waste at the managed controlled landfills has the lowest rank in the waste management hierarchy. According to the Plan, waste management system will be organized as integral unit of all subjects at the national, regional and local level by predicted establishment of regional and counties' waste management centres.

Environmental Pollution Register/Waste[14] contains data on produced, collected and processed waste against different types of waste. Data on municipal, non-hazardous and hazardous waste are collected by State Administration Offices in counties and City of Zagreb Office. Data collected at the counties' level are integrated at the Croatian Environment Agency.

The Waste Act prescribes the obligation of separate collection and storage of waste whose valuable properties can be used. Hazardous waste must be separated during collecting of municipal waste. Average shares of individual components in separately collected municipal waste in 2005 are shown in Figure 2-14.



Source: Waste Management Plan of the Republic of Croatia for 2007 - 2015

Figure 2-14: Shares of components in separately collected municipal waste *(2005)*

In 2007 a total of 1,723,186 tonnes[15] or 388 kg of municipal waste per inhabitant was generated in the Republic of Croatia. In comparison with a total of 1,172,534 tonnes[16] or 268 kg

[11] Waste Act (OG 178/04, 111/06, 60/08, 87/09)
[12] Waste Management Strategy of the Republic of Croatia (OG 130/05)
[13] Waste Management Plan of the Republic of Croatia for 2007 - 2015 (OG 85/07)
[14] Environmental Pollution Register (ROO) is group of data on sources, type, quantities, methods and places of pollutants and waste exhaust, transfer and disposal into environment, www.azo.hr
[15] Environmental Pollution Register 2007, Municipal solid waste, CEA
[16] Report of Environment Condition 2000, MEPPPC

of municipal waste per inhabitant, which was generated in 2000, this one represents an increasing of approximately 45%.

Municipal waste disposed at landfills in 2007 amounted 1,620,000 tonnes. Organised collection of municipal waste covers an average of 90% of the population.

During the period from 2005 to 2008, systems for the management of individual waste categories have been established - packaging and packaging waste, waste tyres, waste oils, end-of-life vehicles, waste batteries and accumulators, waste electrical and electronic appliances and equipment, waste containing asbestos, medical waste, construction waste, wastewater treatment sludge when used in agriculture, waste from titanium dioxide industry, polychlorinated biphenils and polychlorinated terphenils, waste from research and mining of mineral raw materials. Management of individual waste categories, forms and amounts of taxations, methods for environment pollution arrestment and the other issues related to management of individual waste categories are prescribed by the Ordinances[17].

2.10. Building Stock and Urban Structure

Positive trends in construction industry started in 2001 and are reflected in a continuous rise in the value of works, number of employees and productivity. The value of construction works completed in 2007 amounts to HRK 24.3 billion. Within this value construction of buildings accounts for 49.7% (residential buildings 19.7%, non-residential buildings 30.1%), traffic infrastructure accounts for 36.4%, pipelines, communication and power supply lines for 11.3% and complex construction on industrial sites 1.8%. The positive trend continues, indicating with more than 12,000 building permits issued for buildings and civil engineering works in 2008 with total value of construction works of about HRK 41 billion.

The 2007 share of the construction industry in the GDP has significantly increased compared to 2000 (6.7% compared to 3.9%).

The indicators of positive trends in construction industry are given in Table 2-5.

Table 2-5: Indicators of positive trends in construction industry

	2000.	2005.	2006.	2007.
The share of the construction industry in the GDP	3.9	6.2	6.7	6.7
The value of construction works done, in billion HRK	7,150	17.807	21.430	24.299
The average number of workers on construction sites	39,213	54,682	57,770	62,327

(Source: CBS)

In 2001 the housing stock of the Republic of Croatia totalled 1,851,580 flats, consisting of 2.4 persons on average. In 2007 25,609 flats with a total area of 2,075 thousand m^2 were built, which relates to housing construction of both the construction companies and individual owners (Table 2-6).

[17] Croatian regulations and documents for waste management are available at the internet site of Croatian Environment Agency, www.azo.hr

Table 2-6: Residential construction in the Republic of Croatia

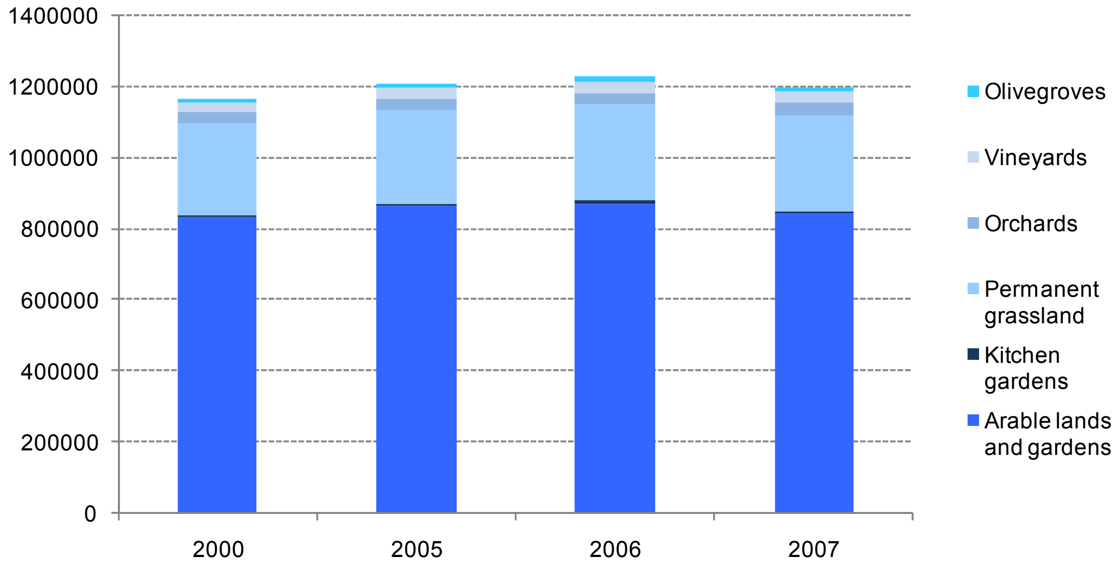
	1992.	1997.	2000.	2005.	2006.	2007.
Number of completed flats	8,115	12,854	17,487	19,995	22,121	25,609
Area, in thousand m^2	643	1,046	1,397	1,701	1,849	2,075
Average size of flats, m^2	79.2	81.4	79.9	85.1	83.6	81.0

(Source: CBS)

The old residential building has large heat losses, and flats with individual heating have not full comfort heating. Lately, there is more air-conditioning equipment, which on the coast in the new apartments has become almost standard.

2.11. Agriculture

In 2007, utilized agricultural land in Croatia was 1,201,756 ha or about 21% of the total mainland area. It includes arable land and gardens (846,730 ha), permanent grassland (meadows and pastures – 269,745 ha), orchards (32,720 ha), vineyards (32,454 ha), olivegroves (14,346 ha), kitchen gardens (5,275 ha), osier willows (276 ha) and nurseries (210 ha).[18] The usage of certain agricultural land categories is shown in Figure 2-15. In 2005, land suspected to be covered with mines in the category of agricultural land, meadows and pastures encompasses an area of 30,990 ha.[19]



Source: Statistical Yearbook

Figure 2-15: Land use in the period from 2000 - 2007

If the OECD criterion of 150 inhabitants per km^2 in local administrative units is applied for counties, it can be concluded that rural area makes 91.6% of the total area and that it is inhabitated with 47.6% of the total population. However, a large negative growth rate, regarding rural population number can be noted, which is a result of a relative and/or absolute deterioration of life conditions for young families and the increasing trend of moving to urban centres and more perspective rural/touristic regions.

[18] Statistical Yearbook, 2009. From 2005 onwards, a different methodology of data collection is apllied. Subsequently, recalculations were performed from the year 2000.
[19] Croatian Environment Agency - CEA (2007): *The State of the Environment Report of the Republic of Croatia, 2007*

According to statistical data, in 2007, family farms owned around 84% of agricultural land, mostly arable land, gardens and pastures. They also own the majority of livestock.

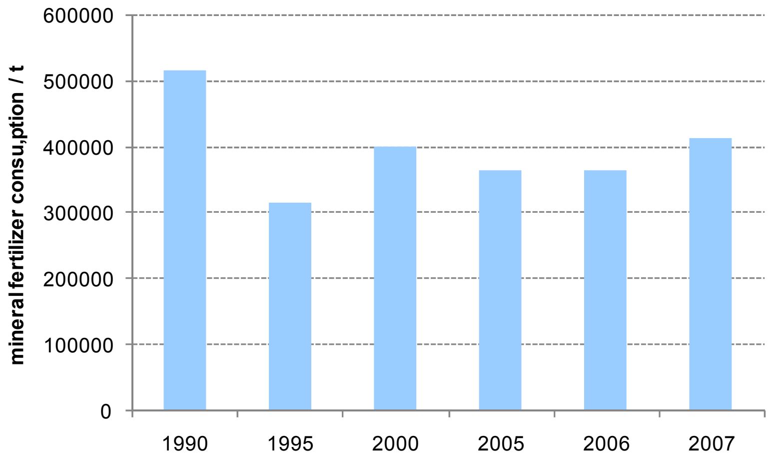
Maize and wheat production dominates on approximately 50% of total arable land. In the period from 2005 - 2007, the average maize yields amounted approximately 6.13 t/ha while the wheat yield was about 4.4 t/ha. Table 2-7 shows the production of major crops between 1990 and 2007.

Table 2-7: Production of major crops in the period from 1990-2007 (in tonnes)

production / t	1990	1995	2000	2005	2006	2007
wheat	1602435	876507	865260	601748	804601	812347
maize	1950011	1735854	1526167	2206729	1934517	1424599
rape seed	33200	24472	29436	41275	19996	39330
barley	196554	103281	151439	162530	215262	225265
soya-beans	55461	34319	65299	119602	174214	90637
sunflower	52982	37066	53956	78006	81614	54303
sugar beets	1205928	690707	482211	1337750	1559737	1582606
tobacco	12394	8548	9714	9579	10851	12639
potato	610236	692216	553712	273409	274529	296302

Source: Statistical Yearbook

In 2007, the consumption of mineral fertilizers amounted 413,900 tonnes (Figure 2-16). Considering the amount of active substance, nitrogen is the leader, followed by potassium and phosphorus.



Source: Statistical Yearbook

Figure 2-16: Consumption of mineral fertilizers for the period from 1990-2007

Ecological production of agricultural and food products has been regulated by law since 2001 (*Act on ecological production of agricultural and food products*, OG 12/01, 14/01). The latest data show that the area used for ecological agriculture is increasing. In 2007, ecological agriculture covered and area of 7,577 ha (excluding bee pastures) or 0.68% of total cultivated land in Croatia.[20]

[20] Ministry of Environmental Protection, Spatial Planning and Construction: *Sustainable Development Strategy of the Republic of Croatia* (OG 30/09)

In Croatia, about 9,000 ha of cultivated land is being irrigated. The national irrigation project has a goal to develop and improve the irrigation infrastructure system.

The total number of livestock has been decreased significantly when comparing the 2007 data with 1990 status (-38%) which affected the decrease of methane emission (Table 2-8). For example, in 2007, CH_4 emission from enteric fermentation and manure management was decreased by 34% compared to 1990. Livestock breeding has a share of approximately 44% in the value of agricultural production.[21] In 2007, family farms kept between 60 and 80% of the total number of cattle, pigs and poultry and almost all sheep (98%).[22]

Table 2-8: Livestock number in the Republic of Croatia in the period from 1990-2007 (in thousands)

NUMBER	1990	1995	2000	2005	2006	2007
Dairy Cattle	472	287	262	272	273	235
Non-Dairy Cattle	358	159	140	199	212	233
Sheep	751	453	528	796	768	646
Goats	172	107	79	134	103	109
Horses	39	21	11	9	9	14
Mules and Asses	17	4	4	4	4	4
Swine	1573	1175	1233	1205	1230	1348
Poultry	17102	12024	11256	10640	10045	10053

Source: NIR 2009

Pursuant to changes in livestock number, the amount of organic manure has also changed – in the last few years it has been of about 10 million tonnes per year.[23] The largest producers of organic manure are the cattle with more than 70% and pigs with 15% of the total volumes.[24]

The fishing sea of the Republic of Croatia consists of the external and the internal fishing sea divided into 11 fishing zones. Fishing vessels (3,716) used for sea fishing are owned by professional fishermen or companies. According to data of the Ministry of Agriculture, Fishery and Rural Development, currently there are about 3,500 authorised persons having economic fishing privileges. Total catch in 2007 amounted approximately 40,162 tonnes out of which 80% was blue fish. Mariculture includes fish farms for white fish (mostly sea bass and sea bream), blue fish (tuna) and shellfish (mussel, oyster). Total annual production amounts about 12,000 tonnes out of which about 4,000 tonnes is sea bass and sea bream, about 5,000 tonnes of tuna, 3,000 tonnes of mussel and about 2 million pieces of oysters.

The freshwater fishing in Croatia is consisted of economic and sport fishing. The economic fishing is carried out on the rivers Sava and Danube. Fish farming includes rearing of both cold-water and warm-water species. The most significant species are carp, grass carp, tench, sheat-fish, perch, pike and Californian trout. In 2007, the total production of freshwater fish amounted about 5,800 tonnes with warm-water species making 70% and the remaining share refers to the cold-water ones.

[21] Croatian Institute for Agricultural Advisory
[22] Statistical Yearbook, 2008.
[23] Croatian Environment Agency: Unofficial draft version of The State of the Environment Report of the Republic of Croatia – chapter Agriculture
[24] According to results of the Big East project.

2.12. Forestry

According to the data from the Forest Management Plan 2006-2015, in 2006, forests and forest land covered an area of 2,688,687 ha out of which 78% is owned by the state and managed by the Croatian Forests Ltd. while the remaining 22% are privately owned. Forest Advisory Service assists in management and improvement of private forests' condition. The development of the National Forest Inventory (CRONFI) is being finalized and will be available in 2010.

The Forest Management Plan 2006-2015 determines growing stock of about 398 millions of m^3 while its yearly increment amounts around 10.5 millions of m^3. Species' abundance in the total growing stock is presented in Table 2-9.[25]

Table 2-9: Specie abundance in total growing stock (in 10^6 m^3)

Species	Growing stock		
	1990	***2000***	***2005***
Common beech	110.87	129.89	139.40
Pedunculate oak	42.96	46.48	48.24
Sessile oak	29.79	35.01	37.62
Common hornbeam	24.10	30.75	34.08
Silver fir	32.97	31.49	30.75
Narrow-leafed ash	9.77	11.48	12.33
Spruce	5.58	7.39	8.30
Black alder	3.55	5.80	6.92
Black locust	2.23	5.16	6.62
Turkey oak	3.12	4.86	5.73
Other	45.40	51.81	55.02
Total	**310.34**	**360.12**	**385.01**

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

- management forest
- protective forests
- forest with special purpose

In the period from 1997 onward, an increase in the area of protected forests, compared to the management ones, can be noticed. Forest area of 21,967 ha has been classified as protected being part of National Parks Risnjak, Plitvička jezera, Mljet and Paklenica. However, forests in nature parks belong to management forests.[26]

According to statistical data, in 2007, the production in forestry has been increased by about 16% compared to 2000 (Figure 2-17).

[25] Report of the Republic of Croatia for *Global Forest Assessment 2010*
[26] Croatian Environment Agency (2007): The State of the Environment Report of the Republic of Croatia

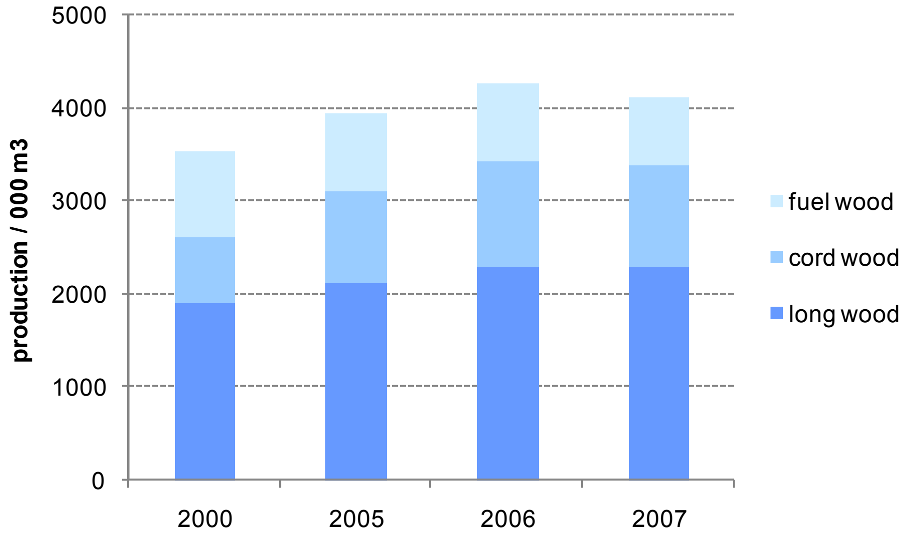


Figure 2-17: Production in forestry

The presence of landmines in forests is an important factor affecting forest management. According to the 2004 estimation, the land suspected to be contaminated with mines, and therefore excluded from the management, covers an area of 181,762 ha or 9% of the total forest and forest land area.

The Republic of Croatia lies at the crossroads of two large phytogeographical regions – the Euro-Siberian-North-American and the Mediterranean, which give the country a great variety of ecosystems, habitat types, and plant and wildlife species. The former includes 78 forest communities of the lowland, hilly, highland, mountain and pre-mountain vegetation belt and the latter 16 thermophilous, evergreen and deciduous forest communities of the Mediterranean coastal and insular Croatia.[27] National Ecological Network encompasses most of the natural forest corridors. Croatia's higher plants flora includes about 5,500 species.[28] The Red Book of Vascular Flora of Croatia provides the basic data about Croatia's flora and threats to flora, and also detailed information on 234 species that are extincted (IUCN categories of Ex and RE) or on the verge of extinction (CR, EN and VU categories).

2.13. Inland waters and Coastal Area

Spatial allocation of surface (rivers, lakes, transitional and coastal waters) and ground waters and their conjuctions are primarily determined by morphological and hydrogeological characterstics of the Croatian area. All waters are part of either Black Sea or Adriatic catchment area with the watershed running along the mountain and alpine area. Large watercourses like the Sava, the Drava and the Danube with many smaller subcatchments dominate the Black Sea catchment area. In the Adriatic catchment area, the abundance and the length of surface watercourses are significantly lower, but there are significant groundwater flows through karst systems. The majority of large watercourses of the Black Sea catchment area is of interstate significance (boundary or cross-border). Among large watercourses in Croatia following rivers flow into its cross-border watercourses as well: the Sava, the Drava and the Mura from Slovenia, the Danube from Hungary, the Una, the Vrbas, the Ukrina and the Bosna from Bosnia and Herzegovina. In the Adriatic catchment area, the boundary river with Slovenia is the Dragonja, and the largest cross-border river is the Neretva with more than 90% of its catchment

[27] Vukelić, Mikac, Baričević, Bakšić, Rosavec: *Forest habitats and forest communitiesin Croatia*, State Institute for Nature Protection, Zagreb, 2008
[28] Faculty of Science, Division of Biology

situated in Bosnia and Herzegovina. Characteristics of own waters on Croatian territory are presented in Table 2-10.

Table 2-10: Characteristics of own waters on Croatian territory

Hydrological unit	Black Sea catchment area	Adriatic catchment area	Croatia total
Average precipitation / mm	1001	1426	1162
Average evapotranspiration / mm	663	761	700
Average flow-rate / m^3/s	376	451	827
Average specific discharge / $l/s/km^2$	10.71	21.1	14.6

(Source: Water Management Strategy 2009)

The Black Sea catchment area is more abundant in water if the own and transit waters are taken into consideration; however, own waters of the Adriatic catchment area are much more water abundant per catchment unit. Waters flowing from Bosnia and Herzegovina into the Adriatic catchment area are not transit waters literally because they drain into the Adriatic Sea. Islands are presented as a special unit. According to average water balance, Croatia abounds with water but the interannual distribution of water quantities is not favourable due to the significant spatial and time unequality in water resources distribution. Pursuant to the Water Management Strategy (2009), the basic characteristics of water resources are presented in Table 2-11.

Table 2-11: Basic characteristics of water resources

INDICATOR		Black Sea catchment area	Adriatic catchment area	Croatia
Waters -total	10^9 m^3/yr.	128.38	27.94	156.32
Water resources – total*	10^9 m^3/yr.	83.72	27.94	111.66
Water resources – per capita	10^3 m^3/yr./capita	27487	20077	25163
Own waters – total	10^9 m^3/yr.	11.86	14.22	26.08
Own waters – per capita	10^3 m^3/yr./ capita	3894	10218	5877
Groundwater – total	10^9 m^3/yr.	2.66	6.47	9.13
Groundwater – per capita	10^3 m^3/yr./ capita	873	4649	2057
Independency coefficient**	10^9 m^3/yr.	0.142	0.509	0.234
Freedom coefficient***	10^9 m^3/yr.	0.00	1.00	0.25

* Including 50% of the Danube and the Sava waters downstream from the Una mouth
** Independency coefficient – the share of own waters in the renewable water resources
*** Freedom coefficient – the share of waters that do not flow into the territory of other states, that is that flow into the Adriatic Sea

The river Danube, the largest and richest in water, flows through the eastern borderland of Croatia over a length of 188 km. The rivers Sava (562 km) and Drava (505 km) have the longest courses in Croatia. The Kupa is the longest river whose entire course of 296 km flows through Croatia. The rivers of the Adriatic catchment area are short, have rapids and canyons. The largest rivers in Istria are the Mirna, the Dragonja and the Raša and in Dalmatia these are the Zrmanja, the Krka, the Cetina and the Neretva.

There are not many natural lakes in Croatia. The largest natural lakes are Vransko Lake near Pakoštane (30.7 km^2), Prokljansko Lake (11.1 km^2), Visovačko Lake (7.7 km^2) and Vransko Lake on the island of Cres (5.8 km^2).[29] The most famous Plitvice Lakes are the course of the river Korana transformed into 16 cascade lakes interconnected by travertine downstream beds.

Croatia is also characterized by significant wetland areas, especially in flooded parts of the Drava, the Danube, the Sava and the Neretva catchments. In 1993, four locations have been included in the Ramsar list: Kopački rit (17,700 ha) in the Drava and the Danube cathments, Lonjsko and Mokro polje (50,560 ha) and Crna Mlaka (625 ha) in the Sava catchment and the lower Neretva part (11,500 ha) in the Adriatic catchment.[30]

The Adriatic Sea is the northernmost part of the Mediterranean Sea. Its salinity is by average 3.83%, which is lower than the eastern Mediterranean Sea but higher than the western.[31] The total length of Croatia's coast is about 6,000 km out of which 1,800 km belongs to the mainland and 4,200 km to the island coastline. The highest measured depth is 1,233 m. Croatian coastal area is separated from the inland with high mountains. Croatian islands include almost all islands of the Adriatic eastern coast and its central part making the second Mediterranean archipelago by size. The number is 1.244 which are geographically distinguished as 79 islands, 525 islets, 640 cliffs (top above sea-level) and reefs (top below sea-level). Considering the number of islands, islets, cliffs and reefs, Croatia's Adriatic coast is one of the most indented in Europe. The islands are divided into the Istrian, the Kvarner, the northern Adriatic, the central Adriatic and the southern Adriatic group, with the largest islands being Cres (405.78 km^2), Krk (405.78 km^2), Brač (394.57 km^2) and Hvar (299.66 km^2).[32]

2.14. Specific Circumstances of Croatia under Article 4.6 of the Convention

The United Nations Framework Convention on Climate Change and the Kyoto Protocol determine the level of greenhouse gas emissions of the base year for each country (1990 as a standard), to serve as a reference value for the existing and future commitments to reduce greenhouse gas emissions.

Article 4, paragraph 6 of the Convention allows a certain degree of flexibility to Parties included in Annex I undergoing the process of transition to a market economy with respect to implementation of their commitments under the Convention and the Protocol, in order to enhance their ability to address climate change. By selecting the year with the highest emissions between 1985 and 1990 to be the base year instead of 1990, the following countries took advantage of this flexibility; Bulgaria (base year 1988), Hungary (the average of 1985-1987), Poland (1988), Romania (1989) and Slovenia (1986). The degree of the emission rise approved ranges from 10 to 20%.

The Republic of Croatia was unable to use the same flexibility model, because in the period between 1985 and 1990 the greenhouse gas emission was equal or below the 1990 level. Therefore, at the session of the Conference of Parties (COP 7) held in Marrakesh in 2001, the Republic of Croatia submitted a request for the recognition of specific circumstances under Article 4.6 of the Convention and requested the increase in emission level of the base year 1990 by 4.46 million t CO_2 eq.

The specifics of the request submitted by the Republic of Croatia lies in the fact that it did not imply the selection of another base year, but rather the increase in the emission level of

[29] Statistical Yearbook 2009
[30] The State Intitute for Nature Protection
[31] Hydrographic Institute of the Republic of Croatia
[32] Statistical Yearbook 2009

the base year 1990. It results from the fact that the greenhouse gas emission of the base year 1990, calculated according to the instructions given by the Convention Secretariat does not reflect specific circumstances with regard to Croatia's having been integrated into the common economic, infrastructure and electric power system of former Yugoslavia. The base year emission determined by the country's electricity generation in 1990 is not an appropriate basis, because this generation corresponds to Croatia's level of development in the 1970s and cannot suffice for the contemporary socio-economic life of Croatia. The non-recognition of the flexibility proposed, means for the Republic of Croatia lagging thirty years behind and experiencing a slowdown in economic growth. From 1995 to 2001 the average emission growth rate amounted to 3.2%, which is in correlation with the GDP growth. In 2003, the greenhouse gas emission exceeded the limit value laid down by the Protocol (NIR 2009).

Despite the fact that during negotiations held in Kyoto in 1997 Croatia did not have the First National Communication on Climate Change prepared and did not have integral data on greenhouse gas emissions and data about possible cost-effective measures, the estimates indicated the emission will rise in future. The obligation to reduce the emission by 5% in relation to the base year was assumed taking into account the possibility of using the flexibility under Article 4.6 of the Convention and in light of such a viewpoint, the Republic of Croatia signed the Protocol on 11 March 1999.

At the session of the Conference of Parties (COP 11) held in Montreal in 2005, the Decision 10/CP.11 was adopted considering the request of the Republic of Croatia for recognition of specific circumstances when determining the emission level of the base year. By this decision, pursuant to Article 4.6 of the Convention, Croatia was allowed a certain degree of flexibility with regard to the historical level of anthropogenic emissions of greenhouse gases chosen as a reference.

At the session of the Conference of Parties (COP 12) in Nairobi in 2006, the Decision 7/CP.12 was adopted regarding greenhouse gas emissions in Croatia in the base year. The Conference of Parties decided to: *having invoked Article 4, paragraph 6, of the Convention, Croatia shall be allowed to add 3.5 mil. t CO_2 eq to its 1990 level of greenhouse gas emissions for the purpose of establishing the level of emissions for the base year for implementation of its commitments under Article 4, paragraph 2, of the Convention*.

According to the recent inventory for the period between 1990 and 2007 (NIR 2009), the total greenhouse gas emission in the Republic of Croatia amounted to 31.37 mil. t CO_2 eq in 1990. This means that the emissions in the base year according to the Decision 7/CP.12 is 34.87 mil. t CO_2 eq.

The adoption of this Decision allowed the process of ratification of the Protocol in the Croatian Parliament in year 2007.

The Republic of Croatia submitted a request for raising the limit of the LULUCF sector (*Land Use, Land Use Change and Forestry*) by which a portion of CO_2 would be withdrawn due to absorption into the forest growing stock. By the Decision 22/CP.9 adopted at the session of the Conference of Parties (COP 9) in 2003, Croatia was allowed to use a sink of 0.265 mil. t carbon per year for the first commitment period, amounting to 0.972 mil. t CO_2.

The Republic of Croatia, as the Protocol's party, prepared and in August 2008 submitted the Initial Report of the Republic of Croatia under the Protocol. In the Report, pursuant to the Article 3, paragraphs 7 and 8 of the Protocol and Decision 13/CMP.1, calculation of the emission amount in the base year of 1990 has been submitted in a way that 3.5 Mt CO_2 eq has been added to calculation, pursuant to the Decision 7/CP.12. The Convention expert review team, after performed revision of the Initial Report, prepared the Report in which it did not agree with including the Decision 7/CP.12 and it raised the subject on compliance, proceeded to the Enforcement Branch of Compliance Commmittee (EFBCC) at consideration. Croatia submitted to the Compliance Committee a written submission, in which it explained its national particularities and legal aspects of applying the Decision 7/CP.12 in a part related to a calculation of the base year for the Protocol. The Committee held a session in Bangkok in a period from 11-13 October 2009, when the hearing on this issue has been performed. Upon the session held in Bangkok and the preliminary report (CC-2009-1-6/Croatia/EB), this issue has been considered again at the meeting held from 23-24 November 2009 in Bonn. After taking into consideration additional explanations and the hearing, the Committee concluded that adding the amount of 3.5 Mt CO_2 eq to the emission level from 1990 could not be accepted and in accordance Croatia should correct its calculation (CC-2009-1-8/Croatia/EB).

The Compliance Committee explanation indicates that the Protocol did not assumed any additions to emission from the flexibility point of view (Article 3.7 and 3.5 of the Protocol), but only selection of the second historical year or series as it was determined by the Conference of Parties decision (Decision 9/CP.2). The Compliance Committee does not question the flexibility, but claims that the Conference of Parties decisions cannot be directly transferred to the Protocol, as the Conference of Parties (COP) is one decision-making body, while the Protocol Conference of Parties (CMP) is another one.

In its defence, Croatia indicated that the flexibility was achieved by other countries in transition as well, and as such was accepted by the Decision 9/CP.2 on the base year. The same decision indicates that countries may ask for other forms of flexibility as well, so based on such decision Croatia was permitted to add emissions to the base year. The fact is that the Compliance Committee, according to the Protocol's rules, should respect relevant decisions of the Conference of Parties (COP). In case of some other countries similar decisions, regarding the flexibilities, were respected.

The Conference of Parties is the highest decision-making body, which, among other things, makes decisions on a way of emissions calculation, by accepting the emission calculation guidelines and reporting on emission. If the Kyoto Protocol applies manuals adopted by the COP, then it is not fair that decision, by which the COP decided that emission in 1990 could be increased by 3.5 Mt CO_2 eq, is not adopted as well. The COP, in permitting such correction to Croatia, understood that emission in the 1990 is not an appropriate number for Croatia and by doing so it assured an equal position with other parties to the Convention.

The Compliance Committee instructed Croatia to ask for additional approval of the Decision 7/CP.12 on the CMP, which is a discrimination in relation to other countries, as they were not obliged to do so.

Croatia warned that the Croatian Parliament has ratified the Protocol after the COP has accepted the Decision 7/CP.12.

Current emission indicates and confirms that approved flexibility has been justified. In 2007, Croatia had emission at the level of 2% below the Kyoto target, if the flexibility has been taken into consideration, and 9% above the target, if no flexibility has been taken into consideration (Figure 2-18).

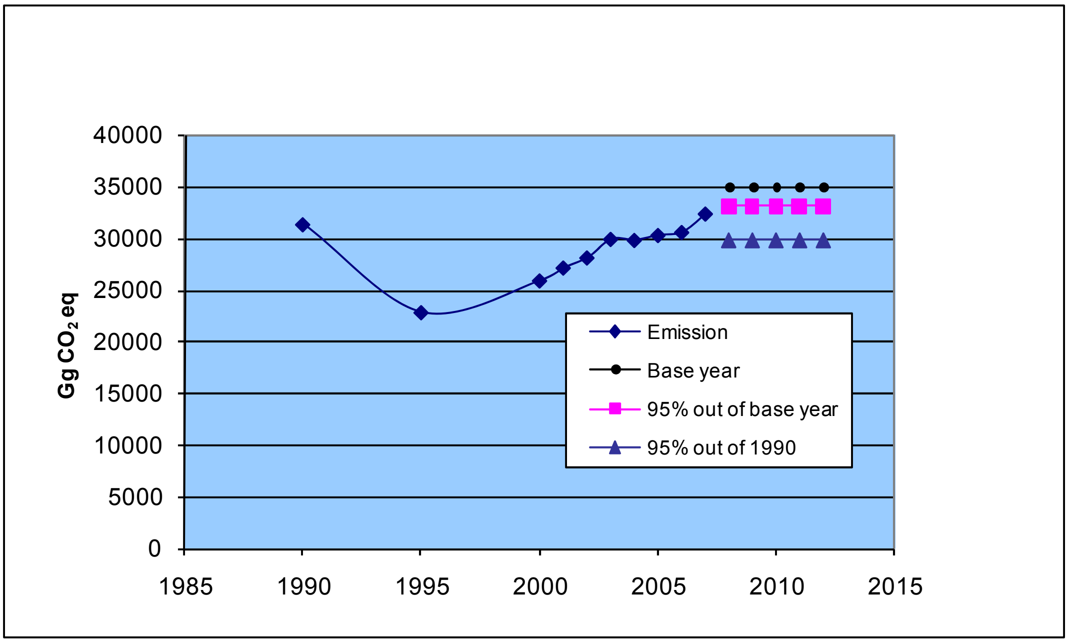


Figure 2-18: Emission trend and the Kyoto target

Croatia will appeal against the Compliance Committee decision and it will defend its position as being discriminating and that it is important to find a solution, because the practice has shown that in such case adequate solutions have been found for some countries, for example Decision 14/CP.7 on unique project.

3. GREENHOUSE GAS INVENTORY 1990 — 2007

3.1. Introduction

The first annual inventory of greenhouse gas emissions of the Republic of Croatia has been made for the First National Communication, and since 2003 it has been prepared annually in conformity with the guidelines of the Convention Secretariat and the methodology of the Intergovernmental Panel on Climate Change (IPCC).

The preparation and submission of the National Inventory Report falls within the competence of the Ministry of Environmental Protection, Physical Planning and Construction. Institutional arrangement for inventory preparation is regulated by Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia which came into force on 2 January 2007 (OG 1/07).

The quality of the inventory of greenhouse gas emissions is ensured by technical reviews arranged by the Secretariat with the assistance of nominated international experts in this field. The main objective of the development and review of the inventory is to enhance its quality in terms of accurateness, completeness, integrity, clarity and consistency.

For the preparation of the inventory of greenhouse gas emissions the methodology described in the *IPCC Guidelines for National GHG Inventories, Revised 1996* and *Good Practice Guidance and Uncertainty Management in National GHG Inventories, 2000* is used.

An important component of the inventory development is the assessment of inventory uncertainty and verification of input data and outputs aiming to enhance the quality and reliability of the inventory.

This National Communication presents the inventory of emissions and greenhouse gas removals in the Republic of Croatia in the period between 1990 and 2007.

The inventory includes emissions resulting from human activities and comprise the following direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs, PFC-s) and sulphur hexafluoride (SF_6), as well as the indirect greenhouse gases such as carbon monoxide (CO), nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). The inventory does not include greenhouse gases controlled under the Montreal Protocol on Substances that Deplete the Ozone Layer (e.g. Freon), which are, as such, a subject of separate communications.

The sources and sinks of greenhouse gas emissions are divided into six main sectors:

- Energy
- Industrial processes
- Dissolvent use
- Agriculture
- Land-use change and forestry
- Waste management.

In general, the methodology of emission calculation consists of multiplying a certain economic activity (e.g. fuel consumption, cement production, livestock number, growing stock increment, etc) by corresponding emission factors. It is recommended to apply specific national emission factors wherever justified and possible, because otherwise the methodology gives typical emission factor values for all relevant activities of individual sectors.

It was agreed to present the greenhouse gas emissions by a derived unit of weight gigagram (Gg) that corresponds to a million kilograms or a thousand tonnes.

The inventory of greenhouse gas emissions is a key component of the so-called *National System* defined under Article 5.1 of the Kyoto Protocol as a "system for the estimation of anthropogenic emissions of sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol".

The inventory of greenhouse gas emission plays an important role during the first commitment period of the Kyoto Protocol (2008-2012), or rather in monitoring the implementation of the commitment to reduce emissions by 5% as compared to the base year (1990).

3.2. Institutional and Organizational Structure of Developing the Greenhouse Gas Inventory

An important pre-condition for the efficient data management system and development of the inventory is a clearly defined organization, competences and responsibilities of institutions involved in the process of developing the inventory, which includes a number of steps to be taken in the collection and processing of data, calculation, control and verification of emission inventories and documentation and communication to competent international institutions.

Institutional arrangement for inventory preparation in Croatia is regulated in Part II of the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia (OG 01/07), entitled National system for the estimation and reporting of anthropogenic greenhouse gas emissions by sources and removals by sinks. Institutional arrangements for inventory management and preparation in Croatia could be characterized as decentralized and out-sourced with clear tasks breakdown between participating institutions including Ministry of Environmental Protection, Physical Planning and Construction, Croatian Environment Agency and competent governmental bodies responsible for providing the activity data. The preparation of inventory itself is entrusted to Authorised Institution which is elected for three year period by public tendering.

Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC) is a national focal point for the Convention, with overall responsibility for functioning of the National system in a sustainable manner, including:

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

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

- organisation of greenhouse gas inventory preparation;
- collection of activity data;

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

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

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

Activity data sources for inventory preparation are presented in Table 3-1.

Table 3-1: Data sources for GHG inventory preparation

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

3.3. Overview of Greenhouse Gas Emissions, 1990-2007

The results of the inventory of greenhouse gas emissions in the Republic of Croatia between 1990 and 2007 are shown as a total emission of all greenhouse gases converted into carbon dioxide equivalent emission by sectors and as emissions of individual greenhouse gases also by sectors.

Viewing the differing contributions of individual greenhouse gases to the greenhouse effect and with the aim to enable their summing up, the emission of each greenhouse gas was multiplied by the relevant global warming potential (GWP). The global warming potential is a measure of how much a given mass of greenhouse gas is estimated to contribute to greenhouse effect as compared to the CO_2 contribution agreed upon as a reference value. The global warming potentials of individual gases in a period of 100 years are shown in Table 3-2.

Table 3-2: Global warming potentials of the main greenhouse gases

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

The greenhouse gas emission is shown as the CO_2 equivalent emission (CO_2 eq). The greenhouse gas removals, e.g. CO_2 absorption by growing stock increment in forests, are called greenhouse gas sinks and the amount is shown bearing the negative sign.

3.3.1. Aggregate Greenhouse Gas Emissions

Total greenhouse gas emissions/removals between 1990 and 2007 and trends by sectors are shown in Table 3-3. The contribution of individual greenhouse gases is shown in Table 3-4.

Table 3-3: Greenhouse gas emissions/removals by sectors, 1990-2007 (Gg CO_2 eq)

Source	Emissions and removals of GHG (Gg CO_2 eq)						
	Base year[33]	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
Energy		22149	16391	18822	22289	22416	23803
Industrial Processes		4185	2573	3224	3682	3864	4073
Solvent and Other Product Use		80	124	115	203	231	233
Agriculture		4.328	3045	3151	3464	3418	3410
Waste		579	732	644	795	840	868
Total emission (excluding net CO_2 from LULUCF)	**34822**[34]	**31322**	**22865**	**25955**	**30433**	**30769**	**32385**
Removals (LULUCF)		-4185	-9154	-5281	-7726	-7490	-6303
Total emission (including LULUCF)		**27137**	**13711**	**20675**	**22707**	**23279**	**26082**

[33] Decision 7/CP.12 Level of emissions for the base year of Croatia

[34] According to recalculated assigned amount reported to the ERT during the course of Initial Report review

Table 3-4: Greenhouse gas emissions/removals by gases, 1990-2007 (Gg CO_2 eq)

Source	**Emissions and removals of GHG (Gg CO_2 eq)**						
	Base Year[35]	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
Carbon dioxide (CO_2)		23080	16930	19955	23424	23528	24865
Methane (CH_4)		3426	2853	2658	3124	3338	3481
Nitrous oxide (N_20)		3868	3063	3308	3519	3457	3556
HFC, PFC and SF_6		948	19	35	365	447	482
Total emission (excluding net CO_2 from LULUCF)	**34822[36]**	**31322**	**22865**	**25955**	**30433**	**30769**	**32385**
Removals (LULUCF)		-4185	-9154	-5281	-7726	-7490	-6303
Total emission (including LULUCF)		**27137**	**13711**	**20675**	**22707**	**23279**	**26082**

Contributions of individual greenhouse gases to the total 2007 emission were as follows: CO_2 (76.8%), CH_4 (10.8%), N_2O (11.0%), HFC, PFC and SF_6 (0.1%).

Figure 3-1 shows the contribution of individual sectors to the total greenhouse gas emission and sinks. The major contributor to the 2007 greenhouse gas emission was the energy sector with 73.5%, followed by industrial processes (12.6%), agriculture (10.5%), waste management (2.7%) and solvent use (0.7%). With some slight changes, this structure remained the same during the entire period 1990-2007. The "coverage" of greenhouse gas emissions by carbon dioxide removals in the forestry sectors amounted to 19.5% in 2007.

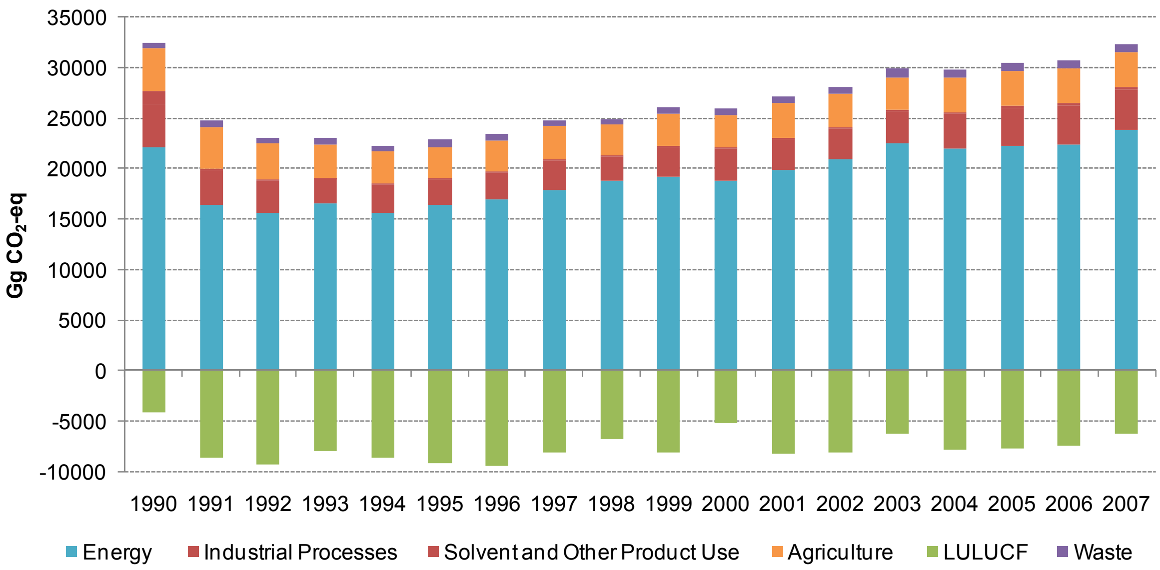


Figure 3-1: Greenhouse gas emissions and removals in Croatia by sectors, 1990-2007 (Gg CO_2-eq)

Energy sector is the largest contributor to greenhouse gas emissions. In this sector, in 2007, the total energy consumption was 6.5% higher than in 2006, whereat the total largest increase was in consumption of gaseous fuels (14.3%) from the Energy Industries sector (27.5%). Increase in total energy consumption is mostly due to unfavourable hydrological conditions which led to decrease in hydro power utilisation by 27.4%. The CO_2 emission from

[35]Decision 7/CP.12 Level of emissions for the base year of Croatia
[36]According to recalculated assigned amount reported to the ERT during the course of Initial Report review

Energy industries sector was 7,662 Gg in 2007, representing 23.6% in total greenhouse emission in the Republic of Croatia.

Emission of CH_4 and N_2O in the Agricultural sector is conditioned by different agricultural activities. For the emission of CH_4, the most important source is livestock farming (Enteric Fermentation). The number of cattle showed continuous decrease in the period from 1990 to 2000. As a consequence, this led to CH_4 emission reduction. In 2000, the number of cattle increased and this trend has been retained until 2006. However, in 2007, the number of cattle decreased by 3.5% when compared with the previous year. Direct N_2O emission from cultivation of agricultural soils, emission from animal manure (Manure Management) and indirect emission have been more or less stable for the past ten years.

In Industrial Processes sector the key emission sources are Cement Production, Lime Production, Ammonia Production, Nitric Acid Production and Consumption of HFCs in Refrigeration and Air Conditioning Equipment, which all together contributed with 99% in total sectoral emission in 2007. The iron production in blast furnaces and aluminium production ended in 1992, while ferroalloys production ended in 2003. The cement production in the period from 1997-2007 was constantly increased. The aim of the producer is maximum use of the existing capacities which amounts about 3.2 millions of tons of clinker in total per year, whereas in 2007, 3.2 millions of tons of clinker was produced. The ammonia production in 2007 was 8.6% higher in comparison to the previous year. Also, the nitric acid production in 2007 was 10.1% higher in comparison to 2006. The level of emissions from these sub-sectors strongly depends on consumer's demand for particular type of mineral fertilizer at the market.

Waste sector includes waste disposal, wastewater handling and waste incineration. Municipal waste disposal at landfills is the key source of CH_4 emissions from this sector in Croatia. Although increasing of municipal solid waste amounts as a result of the growth in the living standard, this rise has slightly declined due to effects of measures undertaken to avoid/reduce and recycle waste. Priorities given, according avoiding and reducing waste generation and reducing its hazardous properties.

3.3.2. Carbon dioxide emission (CO_2)

Carbon dioxide is the most significant anthropogenic greenhouse gas. As in the majority of countries, the most significant anthropogenic sources of CO_2 emissions in Croatia are the processes of fossil fuel combustion for electricity or/and heat generation, transport and industrial processes (cement and ammonia production). The results of the CO_2 emission calculation in Croatia are presented in Table 3-5.

Table 3-5: CO_2 emission/removal by sectors from 1990-2007 (Gg CO_2)

Sector	Emission/removal (Gg CO_2)					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
Energy	20583	**16391**	**18822**	**22289**	**22416**	**23803**
Industrial processes	2498	1909	2521	2800	2934	3040
Solvent and Other Product Use	-4185	-9154	-5281	-7726	-7490	-6303
LULUCF	**18896**	**9146**	**16062**	**17363**	**17860**	**20540**
Total CO_2 emission	**23081**	**18300**	**21343**	**25089**	**25350**	**26843**

3.3.2.1. Energy sector

This sector covers all the activities which include fossil fuel consumption and fugitive emission from fuels. Fugitive emission arises from production, transport, processing, storage and distribution of fossil fuels.

The Energy sector is the main source of the anthropogenic greenhouse gas emission with share of 73.5% in total greenhouse gas emission. CO_2 emission from fuel combustion makes the largest part of it (89% of emission in the Energy sector).
Emission by sub-sectors is presented in table 3-6.

Table 3-6: CO_2 emission by sub-sectors from 1990-2007 (Gg CO_2)

Source	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
Energy Industries	7127	5186	5890	6867	6642	7639
Manufacturing Industries & Constr.	5447	2928	3077	3650	3746	3874
Transport (Road & Off-Road)	3987	3384	4445	5549	5913	6345
Comm./Inst., Resid., Agr /For./Fish.)	3606	2826	3389	3867	3630	3301
Fugitive emissions	416	697	633	691	663	665
Total CO_2 emission	**20583**	**16391**	**18822**	**22289**	**22416**	**23803**

Emission calculation is based on fuel consumption data recorded in annual national energy balance, where the fuel consumption and supply is presented at the sufficient level of detail which enables more detailed calculation by sub-sectors within the formal IPCC methodology. Furthermore, the simplest method of the calculation was carried out, which takes into account only the total balance of fuel, without sub-sector analysis. The relative deviation of CO_2 emissions between sectoral and reference approach for Croatia is up to 7%, which is within the acceptable values (Table 3-7).

Table 3-7: CO_2 emission comparison due to fuel combustion (Gg)

	1990	**1995**	**2000**	**2005**	**2006**	**2007**
Reference approach	21068	15228	17948	21165	20923	22402
Sectoral approach	20167	14324	16800	19933	19931	21160
Relative difference (%)	**4.5**	**6.3**	**6.8**	**6.2**	**5.0**	**5.9**

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

Transport is also one of the most important CO_2 emission sources. The largest part of the emission arises from Road transportation (86 – 95% depending on the year) followed by navigation, railways and domestic civil aviation. Emission from fuel sold for the international aviation and marine transportation is reported separately and it's not included in total national emission balance. In 2007, emission from Transport sector contributed with 20.3% to total greenhouse gas emission.

Biomass combustion (fuel wood and waste wood, biodiesel, biogas) also results in greenhouse gas emissions. CO_2 emission from biomass is not included in balance according to the guidelines, due to assumption that life-cycle CO_2 emitted is formerly absorbed for the growth of biomass. Sinks or CO_2 emissions resulted in change of forest biomass are calculated in sector Land Use, Land-Use Change and Forestry.

Fugitive greenhouse gas emission from coal, liquid fuels and natural gas, resulted from exploration of minerals, production, processing, transport, distribution and activities during mineral use is also included in this sector. Although this emission is not characteristic for CO_2, yet for CH_4, there is a CO_2 emission present during the process of scrubbing of natural gas in

Central Gas Station Molve. The natural gas exploited on Croatian fields is rich in carbon dioxide (more than 15%) and before the natural gas is distributed in commercial gas pipeline it is necessary to remove the CO_2 (scrubbing) so that the maximum volume share of CO_2 in natural gas is 3%. Estimation of emission during exploitation, which amounts up to 5% ot the total CO_2 emission in Energy sector, was done using the material balance method.

3.3.2.2. Industrial processes

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

General methodology used for emission calculation from industrial processes, recommended by the Convention, includes the product of annually produced or consumed amount of a product or material with appropriate emission factor per unit of this production or consumption. Annual production or consumption data for particular industrial processes are extracted, in most cases, from monthly industrial reports published by Central Bureau of Statistics. Certain activity data were collected from survey of manufacturers. The results of the CO_2 emission in industrial processes are shown in Table 3-8.

Table 3-8: CO_2 emission from Industrial Processes for the period from 1990-2007 (Gg CO_2)

Source	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
Cement production	1085.8	628.7	1243.6	1499.9	1588.0	1612.0
Lime production	160.6	83.4	137.9	198.4	244.5	254.5
Limestone and dolomite use	43.2	17.4	13.4	21.4	18.9	16.8
Soda ash production and use	25.7	14.4	11.3	17.2	15.1	13.4
Ammonia production	871	1044.3	1022.1	894.6	870.4	945.0
Ferroalloys production	118.8	31.88	12.2	0.0	0.0	0.0
Aluminum production	111.4	0.0	0.0	0.0	0.0	0.0
Iron and steel production	0.8	0.1	0.3	0.3	0.4	0.4
Total CO_2 emission	**2417.4**	**1820.1**	**2440.9**	**2631.8**	**2737.3**	**2842.1**

The most significant CO_2 industrial processes emission sources are production of cement, ammonia and lime. In 2007, cement production contributed in total sectoral CO_2 emission with 39.6%, lime production with 6.2% and ammonia production with 23.2%. Generally, CO_2 emissions from industrial processes declined from 1990 to 1995, due to the decline in industrial activities. However, in the next period from 1996-2007 the emission was increased to the level reported in 1990.

The quantity of the CO_2 emitted during cement production is directly proportional to the lime content of the clinker. Therefore, the CO_2 emissions are calculated using an emission factor, in tones of CO_2 released per 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 activity data for clinker production were collected from survey of cement manufacturers and cross-checked with cement production data from Annual Industrial Reports published by Central Bureau of Statistics.

In ammonia production natural gas provides both feedstock and fuel. Emission of CO_2 from natural gas used as feedstock and fuel is determined based on carbon content in natural gas. Emissions of CH_4 and N_2O from natural gas used as fuel have been calculated by multiplying annual energy consumption of natural gas by default emission factors. One part of the CO_2 produced in ammonia production is further used as feedstock in urea production, i.e.

mineral fertilizer. In this way, the intermediately “bounded” carbon is being emitted as CO_2 after using mineral fertilizer in agriculture. However, according to IPCC methodology this approach is not distinguished.

3.3.2.3. CO_2 removals

Based on the Forest Management Plan of the Republic of Croatia (2006-2015), the forests and the forest land cover 47.5% of the total surface area. The problem of deforestation in Croatia does not exist. According to the current data, total forest area in Croatia has not decreased over the last 100 years. By its origin, approximately 95% of the forests in Croatia were formed by natural regeneration and 5% of the forests are grown artificially.

The total growing stock in the Croatian forests is around 398 million m^3. The most frequent species are beech (*Fagus sylvatica*), common oak (*Quercus robur*), sessile oak (*Quercus petrea*), European hornbeam (*Carpinus betulus*), common fir (*Abies alba*) and other types of deciduous and evergreen trees.

The average growing stock in the state-owned forests is 260 m^3/ha and in the privately owned forests 161 m^3/ha. The annual increment in Croatia forests is around 10.5 million m^3 of wood. The quality and quantity of increment can be improved by different methods of forest cultivation. The annual cut is a part of the forest timber stock planned for commercial harvesting for a certain period (1 year, 10 years, 20 years) expressed in timber stock (m^3, m^3/ha) or by the surface area. To satisfy the basic principles of the sustainable forest management, the annual cut must not be larger than the increment value in the same period of time.

The Republic of Croatia reports data for Forest land category only (*Forest land remaining forest land)*. Data needed for calculations of emissions/removals for other land categories are partly available but not enough adequate, consistent and complete. The methodology used to calculate CO_2 sinks corresponds to the IPCC methodology for *Land use, land use change and forestry* (LULUCF) sector and is based on data on annual increment, fellings, fuelwood gathered and forest fires. Emission/removal calculation refers only to above-ground and below-ground biomass. Other carbon pools are not included due to lack of activity data. Table 3-9 presents the trend of CO_2 removals in LULUCF sector.

Table 3-9: CO_2 emission removal in forestry sector from 1990-2007 (Gg CO_2)

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

3.3.3. Methane emission (CH_4)

The major sources of methane (CH_4) emission are fugitive emission from production, processing, transportation and activities related with fuel use in Energy sector, Agriculture and Waste Disposal on Land. In table 3-10, sectoral and total CH_4 emissions are reported.

Table 3-10: CH_4 emission in Croatia in the period from 1990-2007 (Gg CH_4)

Source	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
Energy	69.1	61.1	59.3	69.7	76.3	82.7
Industrial Processes	0.8	0.5	0.3	0.3	0.4	0.3
Agriculture	69.1	43.8	40.3	45.2	46.4	45.5
Waste	23.8	30.5	26.6	33.6	35.8	37.3
Total CH_4 emission	**163.1**	**135.9**	**126.6**	**148.8**	**159.0**	**165.8**

Fugitive methane emission is mainly the result of exploration, production, processing, transportation and distribution of natural gas (about 97%). The fugitive emission from oil accounts with about 0.6%; venting and flaring of gas/oil production accounts with approximately 2.3%. In 1999, by closing of the coal mines in Istra, large amount of fugitive emissions arising from the exploration, processing and transportation of coal, was avoided.

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

Methane emission from solid waste disposal sites (SWDSs) is a result of anaerobic decomposition of organic waste by methanogenic bacteria. The amount of methane emitted during the process of decomposition is directly proportional to the fraction of degradable organic carbon (DOC) which is defined as carbon content in different types of organic biodegradable wastes. In Croatia, more than 1.5 million tons of municipal solid waste is produced annually and the average composition of it biodegradable part is: paper and textile (21-22%), garden and park waste (18-19%), food waste (23-24%), wood waste and straw (3%). As for the wastewater handling in Croatia, aerobic biological process is used mostly in wastewater treatment. Anaerobic process is applied in some industrial wastewater treatment. During these procedures, total amount of gas is incinerated and by doing so, all methane is oxidized in carbon dioxide and water steam. Disposal of domestic and commercial wastewater, particularly in rural areas where systems, such as septic tanks, are used, are partly anaerobic without flaring, which results with CH_4 emissions.

3.3.4. Nitrous oxide emission (N_2O)

The most important sources of N_2O emissions in Croatia are agricultural activities, nitric acid production, but as well, the N_2O emissions occur in energy sector and waste management. In Table 3-11 the N_2O emission is reported according to sectors.

Table 3-11: N_2O emission in Croatia for the period from 1990-2007 (Gg N_2O)

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

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

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

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

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

3.3.5. Halogenated carbons (HFCS, PFCS) and SF_6 emissions

Synthetic greenhouse gases include halogenated carbons (HFCs and PFCs) and sulphur hexafluoride (SF_6). Although on an absolute scale their emissions are not great, due to their high global warming potential (GWP) their contribution to global warming is considerable. According to survey carried out among major agents, users and consumers of these gases, information related to import and export of HFCs was used for emission calculation which is presented in Gg of CO_2 eq and showed in Table 3-12.

Table 3-12: Halogenated carbons emission in the period from 1990-2007 (Gg CO_2-eq)

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

3.3.6. Emissions of indirect greenhouse gases

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

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

The calculations of aggregated results for the emissions of indirect gases in the period 1990-2007 are given in Table 3-13.

Table 3-13: Emission of ozone precursors and SO_2 by different sectors (Gg)

Gas	Emissions (Gg)					
	1990	**1995**	**2000**	**2005**	**2006**	**2007**
NO_x Emission	**85.91**	**60.96**	**71.73**	**75.96**	**70.82**	**73.39**
Energy Industries	13.61	10.30	11.99	12.04	11.15	13.39
Manufacturing Ind. & Construction	17.49	8.92	9.73	16.60	12.26	14.07
Transport	36.79	31.05	34.56	31.83	32.00	32.11
Other Energy (fuel combustion)	15.03	8.13	12.85	13.15	13.24	12.86
Fugitive Emission from Fuels	0.64	0.49	0.47	0.45	0.43	0.46
Industrial Processes	2.42	2.23	2.29	2.05	1.89	0.66
Agriculture	0.15	0.00	0.00	0.00	0.00	0.00
LULUCF	0.00	0.00	0.00	0.00	0.00	0.00
CO Emission	**549.87**	**378.50**	**409.91**	**343.63**	**370.50**	**357.12**
Energy Industries	1.54	0.99	1.21	0.93	1.35	1.89
Manufacturing Ind. & Construction.	40.44	41.26	37.82	32.60	36.69	44.84
Transport	252.38	186.59	193.90	159.40	159.45	159.48
Other Energy (fuel combustion)	203.98	116.74	146.47	133.02	133.47	115.58
Fugitive Emission from Fuels	0.64	0.44	0.33	0.32	0.31	0.33
Industrial Processes	46.57	32.44	30.00	17.24	39.11	34.87
Agriculture	4.34	0.00	0.00	0.00	0.00	0.00
LULUCF	0.01	0.00	0.03	0.00	0.00	0.01
NMVOC Emission	**118.47**	**86.03**	**88.42**	**102.18**	**111.99**	**113.65**
Energy Industries	0.32	0.23	0.28	0.29	0.29	0.34
Manufacturing Ind. & Construction	1.70	1.37	1.44	1.76	3.33	3.61
Transport	40.90	31.71	34.12	18.54	18.56	18.58
Other Energy (fuel combustion)	12.15	6.91	9.01	8.30	8.37	7.41
Fugitive Emission from Fuels	8.23	7.77	9.73	9.05	9.03	9.61
Industrial Processes	22.33	7.64	6.37	6.69	5.32	6.61
Solvent Use	32.84	30.40	27.46	57.56	67.09	67.51
SO_2 Emission	**172.90**	**78.15**	**67.33**	**64.77**	**62.55**	**67.62**
Energy Industries	78.51	38.98	25.39	32.76	30.44	38.94
Manufacturing Ind. & Construction	55.84	24.66	22.59	10.29	11.59	8.60
Transport	5.44	3.52	6.19	8.60	8.64	8.66
Other Energy (fuel combustion)	23.87	4.65	6.50	6.63	5.85	4.89
Fugitive Emission from Fuels	6.38	4.96	4.80	4.60	4.39	4.70
Industrial Processes	2.85	1.37	1.85	1.89	1.65	1.82

3.4. Emission inventory uncertainty

The estimation of inventory uncertainty is one of the essential elements of the national inventory of emissions. The information on uncertainty does not question the inventory accurateness, but rather helps both in identifying priority measures to enhance the inventory accurateness and in selecting methodological options. There are several reasons why actual emissions and sinks differ from inventory values. The total estimated uncertainty of emissions from individual sources is a combination of individual uncertainties of emission estimation elements: uncertainty with regard to emission factors (references or measurement) and uncertainty with regard to data on activities.

The reliability of inventories of individual emissions from specific sectors/sub-sectors is shown qualitatively in Table 3-14 and classified into several degrees: up to ±10% – a high degree of certainty, from ±10 to ±50% – medium degree of certainty and over ±50% - low degree of certainty.

Table 3-14: Qualitative uncertainty analysis

High degree of certainty:
• CO_2 emission from fuel combustion • CO_2 emission from purification of natural gas (scrubbing) • CO_2 emission from industrial processes (cement and ammonia production)
Medium degree of certainty:
• CH_4 emission from fuel combustion • CO_2 emission from industrial processes (lime production, use of limestone and • dolomites, production and use of Na2CO3, production of iron, steel, ferroalloys, • aluminium) • CH_4 emission from industrial processes (production of other chemicals) • N_2O emission from industrial processes (production of nitric acid) • N_2O emission from human sewage • N_2O emission from pasture management
Low degree of certainty:
• N_2O emission from fuel combustion • Fugitive CH_4 emissions from coal • Fugitive CH_4 emission from natural gas, oil and oil derivatives • HFC emission due to HFC consumption • CH_4 emission from enteric fermentation • CH_4 and N_2O emissions from stable manure management • N_2O emission from agricultural soils • CH_4 emission from municipal waste disposal • CH_4 emisison from wastewater handling • PFC emission from alumina production • CO_2 and N_2O emissions from production and use of solvent

3.5. Key source emission

The Parties included in Annex I to the Convention must identify their key sources of emission for the base year, for the last inventory year and for the emission trend.

Key sources of emission are those that contribute considerably to total emissions of greenhouse gases (95%), whereby all emissions are summed up starting from the major source to less important sources.

Table 3-15 shows key sources of greenhouse gas emissions in Croatia identified by analysing the total emission of the last year covered by the balance and by analysing the trend in conformity with the methodology described in the "*Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*".

Table 3-15: Key source emissions –summary table

Source category	Gas	Criterion (with LULUCF)	Criterion (without LULUCF)
ENERGY SECTOR			
CO_2 Emissions from Stationary Combustion: Coal	CO_2	Level, Trend	Level, Trend
CO_2 Emissions from Stationary Combustion: Oil	CO_2	Level, Trend	Level, Trend
CO_2 Emissions from Stationary Combustion: Gas	CO_2	Level, Trend	Level, Trend
Mobile Combustion: Road Vehicles	CO_2	Level, Trend	Level, Trend
Mobile Combustion: Agriculture/Forestry/Fishing	CO_2	Level, Trend	
Mobile Combustion: Agriculture/Forestry/Fishing	CH_4		Level, Trend
Fugitive Emissions from Oil and Gas Operations	CH_4	Level, Trend	Level, Trend
CO_2 Emissions from Natural Gas Scrubbing	CO_2	Level, Trend	Level, Trend
INDUSTRIAL SECTOR			
CO_2 Emissions from Cement Production	CO_2		Level, Trend
CO_2 Emissions from Lime Production	CO_2		Level
CO_2 Emissions from Soda Ash Production and Use	CO_2	Level, Trend	
CO_2 Emissions from Ammonia Production	CO_2	Level, Trend	Level, Trend
CO_2 Emissions from Aluminium Production	CO_2	Level, Trend	
N_2O Emissions from Nitric Acid Production	N_2O		Level, Trend
HFC Emissions from Consumption of HCFCs	HFC		Level
CO_2 Emissions from Other non-specified NEU	CO_2	Level, Trend	
SOLVENT AND OTHER PRODUCT USE			
CO_2 Emissions from solvent and other product use	CO_2	Level	
AGRICULTURE SECTOR			
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Level, Trend	Level, Trend
CH_4 Emissions from Manure Management	N_2O		Level
Direct N_2O Emissions from Agricultural Soils	N_2O	Level, Trend	Level, Trend
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Level, Trend	Level, Trend
LULUCF			
CO_2 Emissions from Forest land remaining forest land	CO_2	Level, Trend	
WASTE SECTOR			
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Level, Trend	Level, Trend

3.6. National system

Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC) is a national focal point for the UNFCCC. The head of Department for Climate and Ozone Layer Protection is the representative of national authority.

Institutional arrangement for inventory preparation in Croatia is regulated in Part II of the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia (OG 02/07), entitled National system for the estimation and reporting of anthropogenic greenhouse gas emissions by sources and removals by sinks. Institutional arrangements for inventory management and preparation in Croatia could be characterized as decentralized and out-sourced with clear tasks breakdown between participating institutions including:

- Ministry of Environmental Protection, Physical Planning and Construction
- Croatian Environment Agency
- Authorised Institution for preparation of inventory

List of competent authorities which have to provide data for inventory preparation are given in Annex II of Regulation on Greenhouse Gas Emissions Monitoring in the Republic of

Croatia (OG 02/07). Competent authorities of state management, state management organization and public institutions that collect and/or own activitx data required for the preparation of the national greenhouse gas emission inventory, have to deliver to Croatian Environment Agency data until July 30th of the current year for the antecedent year by sectors, form and scope provided in Annex III of the Regulation.

The 2008 reporting cycle represents a transition from voluntary to in principal mandatory activity data collection system stipulated by the Regulation on Greenhouse Gas Emissions Monitoring in the Republic of Croatia. Activity data sources for inventory preparation are presented in Table 3-16.

Table 3-16: Data sources for GHG inventory preparation

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

Data for inventory preparation are provided by Croatian Environment Agency to Authorised Institution. The Inventory is prepared in accordance with the Convention reporting guidelines *IPCC Guidelines for National Greenhouse Gas Inventories* and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* which are available on the Ministry’s web page.

For the purposes of transparency of the emission calculation, inventory team has continued with preparation of Inventory Data Record Sheets which were introduced in 2001 submission and which contain details of the person and/or organization responsible for an emission estimate, the primary or secondary sources of activity data and emission factors used, the methodology applied, data gaps, ways to cross-check, suggestion for future improvement in the estimates and relevant bibliographic references. The information provided in Inventory Data Record Sheets is available for each source category and for the entire time-series.

According to the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories,* key categories are those that represent 95% of the total annual emissions in the last reported year or belonging to the total trend, when ranked from contributing the largest to smallest share in annual total and in the trend. The analysis is based on the contribution of CO_2 equivalents from different sources and sinks on the sectoral level which includes/excludes LULUCF.

Recalculations were performed according to IPCC methodology and expert review team reports. It is important to emphasize that process of inventory preparation has been improved in recent submissions mainly as a result of activities carried out under the framework of two capacity building projects, i.e.:

- UNDP/GEF regional project “Capacity building for improving the quality of GHG inventories”
- EC LIFE Third Countries project “Capacity building for implementation of the UN Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia” in which following inventory related documents were prepared:

Furthermore, since the introduction of annual technical reviews of the national inventories by experts review teams , Croatia has undergone five reviews so far, in-country review in 2004 and 2008 and centralized reviews in 2005, 2006 and 2009. In the latest in-country review, the ERT formulated a review of Croatia’s 2008 Inventory Submission. According to their recommendations, certain recalculations for the whole period from 1990 to 2007 were carried out.

Croatia has prepared QA/QC plan for the 2009 reporting cycle following the recommendations from document Quality Assurance and Quality Control Plan, Samples and Manual for Development which was prepared under regional UNDP/GEF project Capacity building for improving the quality of GHG inventories (RER/01/G31).

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

During the preparation of the NIR a number of checks was carried out by sector experts related to completeness, consistency, comparability, recalculation and uncertainty of activity dataand emissions.

Finally, before submitting the NIR, an audit has been carried out by designated QA/QC manager. The audit covered all IPCC sectors with a purpose to check which quality control elements (general and specific, as defined in the *IPCC Good Practice Guidance)*, are already implemented by sector experts and which improvements and corrective actions should be carried out in the future submissions.

Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC) as a national focal point for the Convention is responsible for control of methodology for emission calculation and greenhouse gas removal in line with good practices and national circumstances, as well as for consideration and approval of the Greenhouse Gas Inventory Report prior to its formal submission to the Convention Secretariat.

3.7. National register

Croatia has established Greenhouse gas emissions registry (Registry) in order to ensure accurate accounting of the assigned amount units and to meet the requirements of monitoring, reporting and verification in accordance with Article 7 and 8 of the Protocol. Establishing and maintaining the Registry is also a requirement for participation in flexible mechanisms of the Kyoto Protocol: joint implementation, clean development mechanism and international emission trading.

Greenhouse gas emissions registry is defined by the Regulation on the Monitoring of Greenhouse Gas Emissions in the Republic of Croatia (OG 01/07) as one of the components of the system for monitoring greenhouse gas emissions monitoring on national level. It was determined by the Regulation that Environmental Protection Agency will be the institution responsible for managing the Registry (Registry Administrator) to comply with the requirements of the Protocol.

It was foreseen that Registry would serve also for the requirements of the European Emission Trading Scheme (EU ETS). As a future member of the European Union Croatia is required to establish the registry to ensure accurate accounting of emission units traded by operators of the installations under the trading system. Establishing and operation of the Registry under the trading mechanism is regulated by the Air Protection Act (OG 178/04 and 60/08) and the Regulation on Greenhouse Gas Emission Quotas and the Method of Emission Allowance Trading (OG 142/08). It has been defined by the legislation that Environmental Protection Agency will be administrator of the registry under the EU ETS. The Ministry of Environmental Protection, Physical Planning and Construction has chosen software developed by the European Commission as the technical solution that would enable proper functioning of the Registry. Software is adjusted so as to conform with the requirements of the Protocol as well as with the requirements of the EU ETS. Supply of the part of IT equipment (purchase of registry hardware), software installation services and technical support were financed by the European fund CARDS 2004 (Community Assistance for Reconstruction, Development and Stabilisation) under the project "Support for the Further Approximation of Croatian Legislation with the Environmental Acquis".

Croatia has submitted to the Convention Secretariat the "Official Communication from Registry System Administrator" with required information on Registry administrator. Croatian registry administrator has been participating in Registry System Administrator Forum (RSA Forum) since its first meeting held in April 2006.

Organizational preparations for establishment of the Registry commenced in 2006 and activities for making technical preconditions and functioning of the Registry were initiated in 2008. In December 2009, the Environmental Protection Agency finished testing procedure of the Registry regarding functionalities required under the Protocol so the registry is now fully connected to the international transaction log. Performing transactions in Croatian Registry is still not possible because assigned amount units have not been issued to Croatia yet. This will be feasible when the issue of Croatia base year emission is resolved because assigned amount is calculated on the basis of that emission.

4. POLICY AND MEASURES

4.1. Introduction

In the period between 2002 and 2005, the Parties to the Convention intensified activities of addressing climate change at the international level, which resulted in the coming into force of the Kyoto Protocol on 16 February 2005.

At the same period, and especially after acquiring the status of the EU candidate country, Croatia started the process of harmonizing the national legislation, including that of the environmental protection and energy sector, with the EU acquis communautaire.

At the same time, Croatia continued negotiating with the international community about allowing of flexibility according to Article 4.6 of the Convention with regard to the emission level of the base year. Croatia's main view is that the existing emission of greenhouse gases in 1990, selected for the base year, does not reflect specific circumstances relating to Croatia's involvement and role in the common economic and particularly energy system of the former Yugoslavia. The non-allowing of flexibility that the majority of countries with economies in transition have taken advantage of, puts Croatia more than thirty years back, for example, in the segment of security of electricity supply only, which is unacceptable from the aspect of a planned economic development.

In conformity with recommendations of the First National Communication, the Ministry of Environmental Protection, Physical Planning and Construction initiated the activities of capacity-building of the system and establishment of necessary institutional, legislative and organizational capacities.

In 2007, a study „National Strategy and Action Plan for the implementation of the Convention and Kyoto Protocol with an action plan“. The Government of the Republic of Croatia adopted in May 2008 the „Air Quality Protection and Improvement Plan in the Republic of Croatia for the period 2008-2011“ (OG 61/08) whose integral part is the Action Plan for the implementation of the Convention and Protocol with an action plan.

From the institutional aspect, the Environmental Protection and Energy Efficiency Fund was established in 2003 with the aim to secure necessary finance for projects and programmes in the field of environmental protection, energy efficiency enhancement and wider utilization of renewable energy sources.

This chapter presents the policy and measures with the direct or indirect objective to reduce greenhouse gases emission or to increase removal by sinks. In the first part, the general and development policy and the fundamental legislative framework of environmental protection in Croatia are outlined. In the second part, the policy and measures by sectors of influence, the intersectoral policy and relevant project activities are described.

4.2. General and Development Policy

The policy and measures for mitigation of climate change cannot be effectively implemented if isolated from the general and development political framework, primarily due to their marked cross-sector impact. The Croatian Government adopted the documents: *Strategic Framework of Development from 2006 to 2013* (June, 2006) and the yearly *National Programme of the Republic of Croatia for the Accession to the EU*. Among other things, the Strategic Framework, adopted in 2006, predicted an increase of the average GDP growth rate in real terms within the period 2006-2009 by 5.1%, while 7% per year in the period 2010-2013.

In 2009, relevant were the new *Pre-accession Economic Programme 2009-2011* (January, 2009) and *Guidelines for Economic and Fiscal Policy 2010-2012* (September, 2009). In these documents, GDP projections for the period untill 2012 are being revised with an anticipated beginning of the economy recovery in 2010 with a rate that could reach 3.5% in 2012.

The basic sectorial development document adopted by the Croatian Parliament in October 2009 is the *Energy Development Strategy of the Republic of Croatia* (OG 130/09) in which a development of this sector by 2020, with a view to 2030 is being observed. At this moment the Strategy Implementation Programme, defined for the period of four years, is in preparation phase. In February 2009, Croatian Parliament adopted the Sustainable Development Strategy (OG 30/09) was adopted as well, defining general principles in accordance with climate change policy and towards the less-carbon economy.

In the context of climate change and energy the process of harmonizing the legal framework with the EU acquis communautaire is the key one. The process of harmonization is practically finished and the formal termination is expected by the end of 2010. It means that at this moment Croatia has all the measures as the European Union. As the implementation of measures has just initiated, their effect is still relatively modest.

4.3. Environmental Policy in the Context of Mitigating Climate Change

In the Republic of Croatia executive and legislative bodies participate in the process of adopting and implementing the environmental policy with clearly apportioned responsibilities.

The Ministry of Environmental Protection, Physical Planning and Construction have a key role in creating the policy in accordance with the strategic priority objectives of environmental protection and in drafting bills and enforcement regulations. In the previous period a legislative framework was established laying down the principles, objectives and methods of implementing environmental protection in all of its components. It is presently undergoing the process of alignment with the EU legislation. Administrative and specialized activities relating to implementation of measures for climate protection fall within the competence of the Department for Atmosphere Protection and are operationally carried out by the Division for the Climate and Ozone Layer Protection.

The Environmental Protection Act (OG 110/07) is the basic law regulating general issues of environmental protection in the Republic of Croatia, which includes objectives, principles and implementation methods, as well as the liability for environmental pollution. This law provides for the preparation of environmental protection documents and subordinate legislation for each individual area of influence. The Environmental Protection Strategy is the key document establishing and targeting objectives of environmental protection management in accordance with the development policy in the long run.

The National Environmental Protection Strategy and the *National Environmental Action Plan* (OG 46/02) are documents intended to enable an integrated, effective and efficient implementation of environmental protection in the Republic of Croatia. The Strategy highlights two processes of vital impact on environmental protection in Croatia: the adaptation to the sustainable development concept and the EU accession process. The Strategy establishes short-term and long-term environmental protection objectives and priority issues. Climate change belong to the second priority group due to the fact that there are issues at the national level that have been neglected for many years and therefore must be addressed promptly and be given priority, such as waste and wastewater management and air quality in urban areas with excessively polluted air.

The *National Envrionmental Action Plan* elaborates objectives established by the Strategy by sectors and thematic units or rather sets out the measures for the accomplishment of objectives, responsibilities and time frames for implementation. In the segment relating to climate change the Action Plan envisages the development of the Programme for the Reduction of Greenhouse Gas Emissions and the conditions and rules for the application of flexible mechanisms of the Kyoto Protocol. A number of measures for the reduction of greenhouse gas emissions have been determined too, relating primarily to energy efficiency enhancement and increasing the share of renewable energy sources.

The Air Protection Act (OG 178/04, 60/08) determines measures and methods of organizing the implementation and control of air quality protection and improvement. The Act provides for the development of the Strategy and Air Quality Protection and Improvement Plan (OG 61/08). Air Quality Protection and Improvement Plan is related to climate change issues as well.

The Air Protection Act provides following mechanisms and instruments for the prevention and reduction of pollutions that affects the climate change, including:

- National allocation plan for the amounts of greenhouse gas emissions
- National greenhouse gas emission registry
- Emission trading system
- Joint implementation projects for the reduction of greenhouse gas emissions.

Pursuant to the *Act on Environmental Protection and Energy Efficiency* (OG 107/03) the Environmental Protection and Energy Efficiency Fund was established, with the aim to finance preparation, implementation and development of programmes and projects in the field of environmental protection, energy efficiency and use of renewable energy sources, including mitigation of climate change.

The Fund has been operating since 1 January 2004. The necessary finance is provided from revenues raised by charges on environmental polluters, which includes charges on the emission of nitrogen oxides, sulphur dioxide and carbon dioxide, charges on users of the environment, on environmental load by waste and special environmental charges on motor vehicles.

List of legislative and bylaw acts directly or indirectly associated with the climate change mitigation policy:

- The Air Protection Act (OG 178/04, 60/08)

- Regulation on the monitoring of greenhouse gas emissions in the Republic of Croatia (OG 01/07)

- Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determination of the charge for carbon dioxide emissions into the environment (OG 73/07, 48/09)

- Ordinance on the method and deadlines for calculation and payment of the charge on carbon dioxide emissions into the environment (OG 77/07)

- Ordinance on the availability of data on fuel economy and CO_2 emissions of new passenger cars (OG 120/07)

- Air Quality Protection and Improvement Plan in the Republic of Croatia for 2008-2011 (OG 61/08)

- Regulation on greenhouse gas emission quotas and the method of emission allowance trading (OG 142/08)

- Regulation on implementation of the Kyoto Protocol flexible mechanisms (OG 142/08)

- Plan on allocation of greenhouse gas emission quotas in the Republic of Croatia (National Allocation Plan) (OG 76/09)

4.4. Sectoral Policies and Measures

This chapter gives an overview of the relevant policy and measures, including project activities, in the following sectors: energy, transport, industry, agriculture, forestry and waste management. Measures have the nomenclature taken over from the *Air Quality Protection and Improvement Plan in the Republic of Croatia for 2008-2011* (OG 61/08). Measures, which are additional in relation to previously mentioned plan, are marked as MCP-XX. According to their status, measures are divided into three categories: adopted, implemented and planned. It is considered that the measure is adopted if it is formally adopted by some of a document – strategy, programme, plan or regulation. Measure is considered to be implemented if at least one of the following conditions is fulfilled: the regulation is in force within the range that enables implementation, financial resources have been provided, human or some other resources have been mobilized. Measure is in the planning status if it was subjected to professional analysis and discussion or if it is probable that it will be adopted.

4.4.1. Measures and activities in Energy sector

Energy policy falls within the competence of the Ministry of Economy, Labour and Entrepreneurship, Energy and Mining Directorate. Legal framework which regulates energy sector in the Republic of Croatia is shown in Table 4-1. Energy sector (stationary sources) makes about 50% of total Croatia’s greenhouse gases (GHG) emission.

Table 4-1: Energy legislation

	REGULATION	
A	Energy Act (OG 68/01, 177/04, 76/07, 152/08)	This Act lays down measures for secure and reliable supply of energy and its effective generation and usage. It is a legislative act determining and underlying the energy policy and energy development planning, performance of energy-related activities either on the market or in form of public services, and basic issues of conducting energy activities taking into account environmental protection measures.
B	Act on Regulating Energy-Related Activities (OG 177/04, 76/07)	This Act regulates the establishment and implementation of the system for the regulation energy activities with aim to promote the efficient and rational energy usage, entrepreneurship and investment into energy sector and environmental protection.
C	Electricity Market Act (OG 177/04, 76/07, 152/08)	This Act regulates the performance of the following activities of the energy sector: electricity generation, transmission, distribution, supply and organization of the electricity market.
D	Gas Market Act (OG 40/07, 152/08, 83/09)	This Act establishes rules and measures for performing the energy-related activities in the natural gas sector, including liquefied natural gas, rights and obligations of the gas market participants, unbundling the activities of the system operators, the third party access to the natural gas system and the natural gas market opening. The rules established by this Act and the regulations shall also apply to biogas, gas from biomass and other types of gas in so far as such gases can be technically and safely transmitted with gas through the gas system.
E	Law on Production, Distribution and Supply of Heat Energy (OG 42/05)	This Act regulates the services relating to heat generation, distribution and supply.
F	Oil and Oil Products Market Act (OG 57/06)	This Act regulates the performance of the following activities: oil derivates production, oil transport by oil pipelines, oil derivates transport by product pipelines, wholesale and retail sale of oil derivates, oil and oil derivates storage and trade, procurement and representation on oil and oil derivates market.
G	Act on Efficient End-Use of Energy (OG 152/08)	This Act regulates the field of energy end-use efficiency, adoption of programs and plans for energy efficiency improvement and their enforcement, energy efficiency measures, especially activity of energy services and surveys, public sector, energy subject and large consumer obligations and consumers rights in energy efficiency measures implementation.

International agreements, adopted by the Croatian Parliament, also represent part of the internal legal order:

- Energy Charter Treaty (OG – International treaties, 15/97)
- Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (OG – International treaties, 7/98)
- Act on Ratification/Confirmation of Modifications and Amendments of Treaty on Energy Charter Trade Provisions (OG – International treaties, 6/03)
- Treaty Establishing the Energy Community (OG – International treaties, 6/06)

The Energy Strategy of the Republic of Croatia (OG 130/09), as basic document for energy policy establishment follows tree fundamental aims/goals:

- Energy supply security
- Energy system competitiveness
- Energy development sustainability

The Strategy places following goals and measures for reduction of greenhouse gases emission:

- Energy efficiency in energy generation and consumption
  - 10% reduction of final energy consumption until 2020 in relation to average consumption in the period 2001 – 2005
- Increase of renewable energy sources share in gross final energy consumption to 20% in 2020; sectorial aims are the following:
  - 35% of RES in electricity generation including large hydropower plants (9.2% of total RES share)
  - 10% in transportation (2.2% of total RES share)
  - 20% for heating and cooling (8.6% of total RES share)
- Involvement in the European Union Emission Units Trading System (EU-ETS) and implementation of other flexible Kyoto Protocol's mechanisms;
- Preparation for applying the Carbon Capture and Storage (CCS) technology on new coal fired power plants;
- Research and implementation of CO_2 injection with Enhanced Oil Recovery (EOR) technology
- Preparation and making decision on nuclear energy usage;
- Stimulating the research and transfer of new technologies for energy generation, energy savings, renewable energy sources, hydrogen use, more efficient transport, intelligent network systems, CO_2 storage, etc.

Institutions that stimulate implementation of energy policy and whose jurisdictions are determined by the abovementioned regulations are:

- Ministry of Economy, Labour and Entrepreneurship (MELE) is responsible for national energy policy, action plans, improvement of legislation and EU legislation implementation related to energy on national level.
- Croatian Energy Regulatory Agency (HERA) is the regulator of energy activities responsible for improvement and implementation of regulations, grant of licences, setting tariffs, certification of eligible manufacturer status, etc.

- Croatian Energy Market Operator (HROTE) organizes energy market based on rules determined by HERA. Also collects fees from suppliers for renewable energy sources and cogeneration incentives and forwards them to renewable energy producers with correspondent certificates of origin.
- Transmission System Operator/ Distribution System Operator (TSO/DSO) has a role of transmission and distribution of electricity inside the network as well as the role of green energy certificate guide.
- Other institutions: Environmental Protection and Energy Efficiency Fund concerning project financing.
- Energy Institute Hrvoje Požar and non-governmental organizations
- Independent associations of business entities under auspice of the Croatian Chamber of Economy.

Measures for greenhouse gas emission reduction in energy sector are as follows:

<u>Adopted and/or implemented measures</u>

MCI-1 Promoting the application of renewable energy sources in electricity generation

Following executive acts have been adopted to encourage the generation from renewable energy sources:

- Regulation on the Minimum Share of Electricity Generated by Renewable Energy Sources and Cogeneration (OG 33/07)
- Regulation of Financial Incentives to Encourage Electricity Generation by Renewable Energy Sources and Cogeneration (OG 33/07, 133/07, 155/08)
- Tariff System for Electricity Generation from Renewable Energy Sources and Cogeneration (OG 33/07)
- Ordinance on Utilization of Renewable Energy Sources and Cogeneration (OG 67/07)
- Ordinance on Acquiring the Status of Eligible Electricity Producer (OG 67/07)

By the Regulation on the Minimum Share of Electricity Generated by Renewable Energy Sources and Cogeneration whose generation is encouraged, the aim is set for the end of 2010. Minimum share of renewable sources (without hydropower plants of installed capacity greater than 10 MW) in electricity generation should be 1,100 GWh/god, which will make 5.8% of total electricity in the year 2010. Major part of this generation will be achieved through wind turbines construction, then in biomass power plants and some in small hydropower plants, geothermal power plants and solar power plants. Utilization of renewable sources will contribute the most to greenhouse gas emission reduction in period until 2012.

The main mechanism for development of renewable energy sources are differentiated incentives (tariffs). Differentiated incentives depend upon source type, power plant size and amount of generated electricity. Table 4-2 shows incentives (feed-in tariffs) for electricity generated from renewable energy sources in 2007.

Table 4-2: Feed-in tariffs for electricity generated from renewable energy sources (kn/kWh)

Plant type	Size	
	≤ 1 MW	≥ 1 MW
Solar power plants		
Solar power plants of installed capacity up to and including 10 kW	3.40	-
Solar power plants of installed capacity greater than 10 kW up to and including 30 kW	3.00	-
Solar power plants of installed capacity greater than 30 kW	2.10	-
Hydropower plants of installed capacity up to 10 MW	0.69	
Energy up to and including 5,000 MWh generated in a calendar year		0.69
Energy greater than 5,000 MWh up to and including 15,000 MWh generated in a calendar year		0.55
Energy above 15,000 MWh generated in a calendar year		0.42
Wind turbines	0.64	0.65
Biomass power plants		
Solid biomass from forestry and agriculture (tree branches, straw, fruit stones…)	1.20	1.04
Solid biomass from wood processing industry (bark, sawdust, chaff...)	0.95	0.83
Geothermal power plants	1.26	1.26
Biogas from agricultural crops (corn silage...), and organic, agricultural and food industry waste (corn silage, manure, meat packaging waste, biofuel production waste…)	1.20	1.04
Liquid biofuel power plants	0.36	0.36
Power plants on landfill gas and gas from water treatment plants	0.36	0.36
Other renewable sources (tidal waves, etc.)	0.60	0.50

Legal framework related to renewable sources has initiate great interest of investors concerning the construction of plants for electricity generation from renewable sources. Result is a great number of investors who apply for the status of eligible electricity producer. Till now 256 applications/projects for utilization of renewable sources and cogeneration as well as for eligible producers are received: 22 applications for solar power plants, 69 for small hydro, 122 for wind, 17 for biogas, 16 applications for biomass, 1 for geothermal, 2 for landfill gas and gas from water treatment plants and 7 for high-efficiency cogeneration plants.

In 2007, in Croatia were installed 17.15 MW in wind turbines, 33 MW in small hydropower plants and 2 MW in biomass plants. Till the end of 2009, 67 MW in wind turbines were installed. Total electricity generation from renewable sources, which includes large hydropower plants and all other renewable sources, amounted 4,442 GWh in 2007, which stands for 23% of total electricity consumption. With this, GHG emission was decreased in amount of about 2,900 Gg CO_2 eq. If large hydropower plants are excused, electricity generation from renewable sources amounted 130 GWh which resulted in GHG emission decrease for 87 Gg CO_2 eq.

The Energy Strategy aim for share of 20% of renewable energy sources in 2020 was set based on the EU legislative package on climate and energy adopted in April 2009 (*Directive 2009/28/EC)*. Energy Strategy sets transitional increment aims in relation to 2005 when renewable sources share in gross final energy consumption was 12.7% (Table 4-3).

Table 4-3: Aims for RES share in gross final energy consumption

Year	Increase	Average share
2011-2012	20%	14.1%
2013-2014	30%	14.8%
2015-2016	45%	15.9%
2017-2018	65%	17.4%
2020	100%	20%

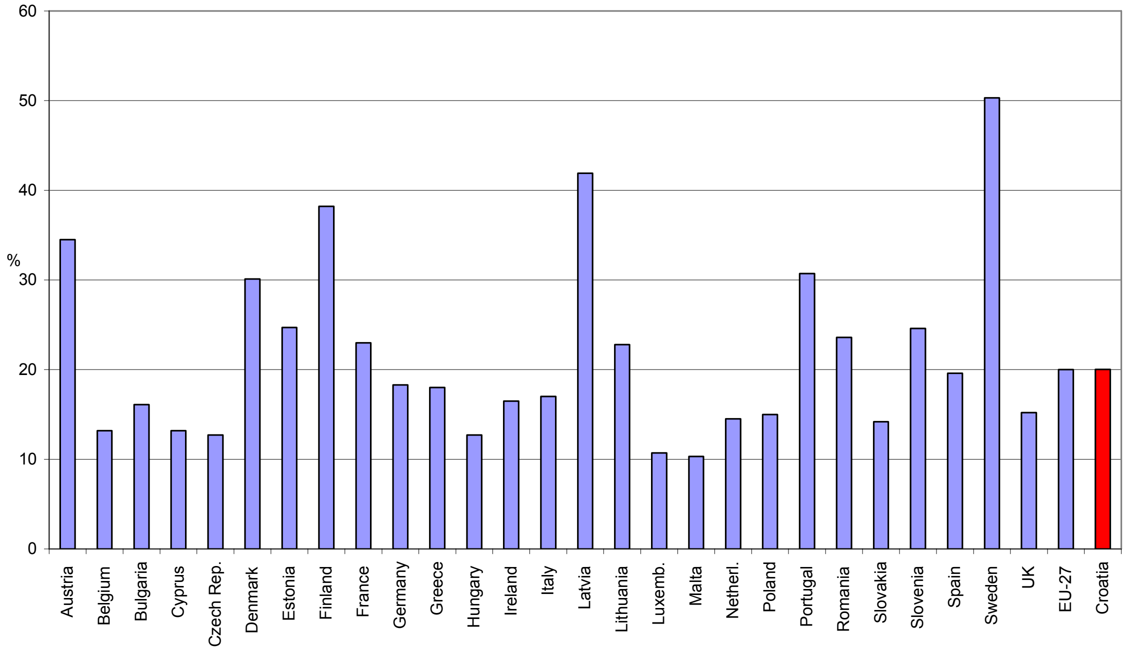


Figure 4-1: Targets for renewable energy sources share in 2020 in the EU states and Croatia (targets set based on the EU climate and energy package, Directive 2009/28/EC)

➲ ***MCI-2 Promoting the application of cogeneration***

Following executive acts have been adopted to encourage the generation from cogeneration:

- Regulation of Financial Incentives to Encourage Electricity Generation by Renewable Energy Sources and Cogeneration (OG 33/07, 133/07, 155/08)
- Regulation on the Minimum Share of Electricity Generated by Renewable Energy Sources and Cogeneration (OG 33/07)
- Tariff System for Electricity Generation from Renewable Energy Sources and Cogeneration (OG 33/07)
- Ordinance on Utilization of Renewable Energy Sources and Cogeneration (OG 67/07)
- Ordinance on Acquiring the Status of Eligible Electricity Producer (OG 67/07)

By the Regulation on the Minimum Share of Electricity Generated by Renewable Energy Sources and Cogeneration whose generation is encouraged, the aim is set for the end of 2010.

Minimum share of electricity generated from cogeneration plants whose generation is encouraged and delivered by transmission, that is, distribution network, should be 400 GWh/year, which makes about 2.0% of total electricity consumption.

Today in Croatia there is 675 MW of cogeneration capacity installed (492 MW public district heating plants and 180 MW in industrial heating plants) which amounts for about 14% of total electricity generation capacity.

For cogeneration plants tariffs rates and their amounts are set, expressed in units kn/kWh for electricity delivered in period of high (HT) and low (LT) daily tariff rate duration. Duration of HT and LT are set by tariff system for electricity generation. Electricity has to be generated in cogeneration process on the way determined by the regulation on acquiring the status of eligible producer.

➲ ***MCI-3 Reduction in fossil fuel consumption through utilization of biodegradable municipal wastes in district heating plants or landfill biogas***

The thermal utilization of wastes is understood to be in line with the Waste Management Plan of the Republic of Croatia (OG 85/07) according to which the waste management concept consists of three basic principles – avoidance, evaluation, deposition. At the same time this implies implementation of landfill remediation and closure measures and the development and establishment of regional and county waste management centres with pretreatment of wastes before final disposal or deposition that includes the mechanical-biological waste treatment procedures.

In case of thermal treatment of wastes, only the portion of biogenic origin (wood, paper, straw, shells, etc.) contributes to the reduction of greenhouse gas emissions.

Besides generating electrical and/or thermal energy, the thermal treatment of wastes reduces considerably the greenhouse gas emissions in comparison with waste deposition at dumps where no system for biogas collection and burning is available. If thermal incineration is compared with the deposition in a landfill equipped with the methane collection system, and if all of this methane is used for energy generation purposes, then the difference is relatively smaller, providing that the observation period is longer. However, one should remember that the use of landfill biogas for energy purposes is not economically justified for small landfills and that greater thermal capacities can hardly be achieved. The first landfill-gas-fired power plant in Croatia has been operating since 2004 on the Prudinec-Jakuševac landfill in Zagreb (2x1 MW). All other landfills whose gas cannot be used for energy generation should be remedied and equipped with gas collection and treatment systems. When assessing the benefits of the construction of thermal waste treatment plants all variants are to be analysed taking into consideration the overall waste management system.

In terms of GHG emission reduction, the Air Quality Protection and Improvement Plan of the Republic of Croatia for the period 2008 – 2011 (OG 61/08) has set an assumption of one waste thermal treatment plant construction based on a decision of the City of Zagreb on accession to such plant construction.

➲ *MCI-4 Reduction in fossil fuel consumption through the use of biodegradable municipal waste in cement industry*

It is assumed that by 2012 fossil fuels used in cement industry will be replaced by the so-called refuse derived fuels (RDF) to the amount of 20 per cent. The Waste Management Plan defines technological procedures of municipal waste treatment and use before final disposal to waste management centres, whereby the procedures of mechanical-biological waste treatment are considered the RDF generation procedures. The use of RDFs results in a lower consumption of primary energy sources – conventional fossil fuels. The RDF component of the biological origin is considered neutral with regard to CO_2 which contributes directly to CO_2 emission reduction. Incineration of wastes of fossil origin has no positive effect on the reduction of greenhouse gas emissions (waste oil, plastics, rubber, etc.), but it saves fossil fuels. A precondition for implementation of this measure is the provision of wastes of a stable volume, composition and structure.

➲ *MCA-5 Loan programme for the preparation of renewable energy sources projects through the Croatian Bank for Reconstruction and Development (HBOR)*

The credit supply programme for the preparation of renewable energy sources projects is a part of the GEF/IBRD grant awarded to the Republic of Croatia for implementation of the Renewable Energy Resources Project. The basic purpose of the grant is to encourage the development of an economically and ecologically sustainable market of renewable energy sources in the Republic of Croatia and to create stimulating surroundings for investments in renewable energy sources utilization projects.

Credits are granted for preparation of projects dealing with renewable energy sources, including biomass, small hydropower plants (up to 10 MW), geothermal and solar energy. Wind power plants projects are included into separate bidding for credits utilization for the preparation of renewable energy resources projects – wind power plants. The credit is used to finance preparation of public and private sector projects.

Credits are intended for the financing of design documents within the framework of renewable energy resources utilization. Credits can be used to finance:

- On-site research
- Environmental impact studies
- Documentation for obtaining a location permit
- Main design
- Investment study
- Documentation for obtaining a building permit
- Other permissions, decisions, consents and documentation in compliance with the provisions regulating the energy sector

The project implementation agency is the Croatian Bank for Reconstruction and Development and the EPEEF participates in the project as a partner – co-financer in the segment of preparing and financing the development of specific projects, as well as of evaluating the projects proposed by credit candidates from the technical and technological aspect.

➲ ***MCA-6 Promoting the use of renewable energy sources and energy efficiency through the Environmental Protection and Energy Efficiency Fund (Fund)***

This Fund was established by the Act on the Environmental Protection and Energy Efficiency Fund (OG 107/03) with the aim to secure finance for preparation, implementation and development of programmes and projects dealing with environmental protection, energy efficiency and use of renewable energy sources, including the climate change mitigation.

The necessary finance is secured from earmarked Fund revenues raised from "polluter pays" charges, which include charges for nitrogen oxide, sulphur dioxide and carbon dioxide emissions, environmental user charges, charges for environmental load by waste and special environmental charges for motor vehicles.

In co-financing the projects, the Fund merges financial resources and coordinates activities with financial instruments of the Ministry of Economy, Labour and Entrepreneurship, Ministry of the Sea, Transport and Infrastructure and Croatian Bank for Reconstruction and Development. By the Fund financial resources primarily are financed the programs, projects and similar activities defined according to the National Environmental Strategy (OG 46/02) and National Environmental Action Plan (NEAP) (OG 46/02), Air Quality Protection and Improvement Plan in the Republic of Croatia for 2008-2011 (OG 61/08), Energy Strategy of the Republic of Croatia (OG 130/09).

The Fund financial resources are intended for renewable energy resources projects including solar energy, wind energy, biomass energy, energy from small hydropower plants and geothermal energy. Projects of energy efficiency improvement, financed by the Fund resources, include cogeneration plants, centralized thermal systems, energy reviews and demonstration activities, public lightening projects, fuel substitutions and waste heat utilization and projects in the buildings and sustainable building field.

The Fund is assigning financial resources to units of local and regional government, companies, craftsmen, non-governmental organizations, nonprofit organizations and natural persons through loans, subventions of interests, financial help and donations.

Based on the Environmental Protection Act and Energy Act in the last five years the Fund has made contracts to 850 projects for renewable energy sources and energy efficiency utilization in total value of HRK 329 million. The Fund makes assessment that by investing in mentioned projects it achieves annually emission reduction of 800 Gg CO_2 eq.

➲ ***MCA-7. Promoting energy efficiency through implementation of the project "Promoting energy efficiency in Croatia"***

In July 2005 this project was started by the Ministry of Economy, Labour and Entrepreneurship and United Nations Development Programme (UNDP) with the aim to promote application of cost-effective energy efficiency technologies and procedures in the sectors of households and services in Croatia, so as to reduce energy consumption and the related greenhouse gas emissions.

The necessary finance to the amount of USD 4.4 million was secured by the Global Environmental Facility (GEF), while the domestic financial institutions are expected to co-finance the project during its implementation with USD 7.9 million.

Target groups of the project are households, service sector facilities and public facilities responsible for about 40% of total energy consumption in Croatia. The project aims to raise public awareness, assist local governments of the counties and towns in application of measures intended to public facilities and support the capacity building for systematic energy management at local levels.

Within the Project the following is carried out:

- Project “Systematic Energy Management in Cities and Counties in the Republic of Croatia” – pilot project “Systematic Energy Management in the City of Sisak”, started in 2006.
  Systematic capacity building is implementing in Sisak-Moslavina County, Karlovac County, Split-Dalmatia County, the City of Sisak, Koprivnica, Bjelovar, Karlovac and Split.

- Programme “House in Order” for improvement of energy efficiency in state (public) government buildings, started in 2008. This Programme started by the Government of Republic of Croatia, and it will comprise buildings of administrative organs, offices, hospitals, police stations, barracks, faculties, courts, penitentiaries, prisons, housing and other objects.

- Project “Energy Efficiency Master Plan” with aim of making detail scientific background for adoption of universal strategy for efficient energy utilization in the household, service and industry sector. In the Energy Efficiency Master Plan aims of energy efficiency improvement and mechanisms and measures for implementation of these aims are set. Based on the Master Plan two very important strategic documents are made:
  - Energy Efficiency Programme of the Republic of Croatia for 2008 – 2016 and
  - First Energy Efficiency National Action Plan for 2008 – 2010

Environmental Protection and Energy Efficiency Fund participates in co-financing the information campaign of this project with a total of HRK 9 million in the period from 2006 till 2009. The Fund is expected to join the project "Systematic Energy Management in Cities and Counties" with a total of HRK 20 million for 2008 and 2012 and also in the programme “House in Order” to more than HRK 47 million for the period until 2013. The total anticipated share of the Fund will exceed HRK 76 million.

In 2009 the Global Environmental Facility (GEF) has approved additional financial funds in amount of USD 1.1 million for the period 2010 – 2011.

➲ *MCA-8. HEP ESCO Energy Efficiency Programme*

HEP ESCO d.o.o. is an energy service-providing company and is part of the HEP group. HEP ESCO develops, executes and finances energy efficiency projects. Service includes modernization, reconstruction and refurbishment of existing plants and facilities with aim of more rational energy consumption in the manner that savings in energy costs and maintenance are used to achieve the investment return.

HEP ESCO ensures financing of investment which pays off in 5 or 8 years respectively.

Areas of business are public and private sectors, covering buildings (schools, kindergartens, hotels, hospitals, etc), public lighting, industry and energy supply systems (cogeneration, district heating).

HEP ESCO is an executive agency for the Energy Efficiency Project in Croatia. The Project was initiated by the World Bank (IBRD) and Global Environmental Facility (GEF) in collaboration with Hrvatska Elektroprivreda d.d. and Croatian Reconstruction and Development Bank (HBOR). The total value of the Project, with participation of domestic banks, is estimated at USD 40 million over a six-year period.

HEP ESCO currently leads more than 50 projects in the areas of public lighting, buildings, industry and energy supply systems.

➲ ***MCA-9. Measures of energy efficiency upgrading in building construction***

Commercial buildings sector is especially significant as the energy consumer because:

- Participates with 40% in total energy consumption, with constant consumption increase as reflection of life standard increasing
- It has big potential for energy and ecology savings
- Buildings due to their long lifetime have long and continuous environmental impact and energy consumption.

Energy efficiency in commercial buildings is recognized today as area with the largest potential for total energy consumption reduction.

There is a line of measures for increasing the commercial building energy efficiency:

- Improvement of existing and new buildings thermal insulation
- Heating, ventilation and air-conditioning systems efficiency improvement
- Lighting system and energy consumers efficiency improvement
- Energy control and energy management in existing and new buildings
- Legal setting of target value for total annual building energy consumption per square meter (m^2)
- Introduction of energy certificate as a system of buildings identification according to their annual energy consumption
- Constant education and promotion of measures for energy efficiency improvement.

Instruments for executing these measures are the Physical Planning and Building Act (OG 76/07, 38/09) and set of executive regulations transposing the EU Directive 2002/91/EZ on Energy Performance of Buildings:

- Technical Regulation on Heating and Air-conditioning Systems of Buildings (OG 110/08)
- Technical Regulation on Rational Energy Use and Thermal Protection in Buildings (OG 110/08, 89/09)
- Technical Regulation on Ventilation Systems, Partial Air-conditioning and Air-conditioning in Buildings (OG 03/07)
- Ordinance on Energy Certification of Buildings (OG 113/08, 91/09)
- Ordinance on the Requirements and Criteria to be met by Energy Auditors and Energy Certifiers of Buildings (OG 113/08, 89/09)
- Action Plan for Implementation in Croatian Legislation of the European Directive on the Energy Performance of Buildings
- National methodology for implementation of buildings energy audit.

Implementing the projects for building energy efficiency improvement is done with technical and financial support from the Environmental Protection and Energy Efficiency Fund, Croatian Bank for Reconstruction and Development and HEP-ESCO.

Projects comprise reconstructions of schools, kindergartens, hospitals, hotels, business buildings and other non-residential buildings with aim of energy consumption decrease from 200-300 kWh/m^2 to 60-80 kWh/m^2.

Within the Intelligent Energy Europe Programme the GreenBuildingplus Project is carrying out. GreenBuildingplus is the continuation of the successful pilot phase from the Green Building Programme. The theme of the project is modeling of informational and promotional campaign for general public on possibilities of energy efficiency improvement in non-residential buildings and awarding of best realized projects. Term for participation in the GreenBuildingplus project is 30% energy consumption reduction in reconstruction of existing buildings and for new buildings 30% less energy consumption in comparison to current national regulations. In the beginning of December 2009, national awards were given for the most efficient non-residential buildings according to the GreenBuilding Programme criteria.

Education for professional qualification and compulsory specialization for energy auditors and energy certifiers of buildings is carrying out according to the Ordinance on Energy Certification of Buildings (OG 113/08, 91/09) and Ordinance on the Requirements and Criteria to be met by Energy Auditors and Energy Certifiers of Buildings (OG 113/08, 89/09). Recently, the first group of the future Energy Certifiers of Buildings was promoted. This is a group of experts who successfully finished the education for energy auditors and energy certifiers of buildings with simple technical system.

Energy certification of buildings starts in April 2010. Based on the carried out energy audit and calculated building energy demand, energy certificate is made, by which the building energy characteristics and fulfilment of these characteristics in regard to requirements set by special regulations are demonstrated. Certificate also consists of measures proposal for economically beneficial improvement of these characteristics, and it is carried out by the authorised person.

It is expected that energy certification of buildings will initiate number of new activities in construction through integral approach of preparing the building energy such as:

- Buildings energy audits
- Energy reconstruction and existing buildings modernization
- Integral planning of modern energy concept for new buildings

➲ ***MCA-10. Energy efficiency labelling of household appliances***

The 2005 Ordinance on Energy Efficiency Labelling of Household Appliances (OG 133/05) provides that electricity-driven household appliances produced in or imported into the Republic of Croatia must be energy efficiency labelled before placing on the market. The Ordinance applies to electric refrigerators, freezers, household washing machines, tumble-driers, dishwashers, household lighting, air-conditioners and ovens. In line with the European standards energy efficiency classes are as follows: A++, A+, A, B, C, D, E, F and G.

For implementation of this measure, continuous work on increase of public awareness and education is being carried out with aim of increase of A, A+ and A++ appliances market share and decrease of appliances under class C market share.

➲ ***MCA-11. Establishing a framework for setting the ecodesign requirements***

This measure will be carried out based on the Ordinance on Setting the Ecodesign Requirements for Energy-Using Products (OG 97/09).

This Ordinance allows only placement on the market and/or usage of energy-using products that are in accordance with the conditions of the EU Directive 2005/32/EC on establishing a framework for the setting of ecodesign requirements for energy-using products.

The Ordinance enters into force on the day of accession of the Republic of Croatia to the European Union.

Planned measures

➲ ***MCP-1. Construction of nuclear power plant***

Energy Strategy and Strategy Implementation Programme prescribed that decision about establishment of nuclear development programme shall be done no later than 2012. Projections define construction of 1,000 MW nuclear power plant in 2024 with commissioning in 2025.

➲ ***MCP-2. Construction of Capturing and Storage of CO_2 system on new coal-fired power plants***

Technology for capturing the carbon dioxide from flue gases and its storage in geological formations, depleted oil and gas reservoirs, as measure of total CO_2 emission elimination, will be commercially available, in assumptions, in 10 years. So, during new coal-fired power plants design and construction it is necessary to reserve space for CCS system retrofit.

➲ ***MCP-3. Implementation of technology for enhanced oil recovery (EOR) by CO_2 injection***

National oil production will be decrease and it will participate ever less in fulfillment of energy demand of the Republic of Croatia. Thereby, energy system becomes more sensitive to primary energy sources supply. Because of the geopolitical sensitivity of energy market and high oil price on the world market, special measures to encourage a technology development of exploitation technologies of residual oil resources will be anticipated. If oil price will be high enough, enhanced oil recovery technology (EOR) in oil production is foreseen. This technology also enables production of so called by-passed oil. In Croatia, at the Central Gas Station Molve, plant for CO_2 capture from natural gas is in function and experimental CO_2 injection in oil fields is started.

Table 4-4: Policy and measures in energy sector

Measure name	Objective	Greenhouse gas	Type of instrument	Status	Implementing entities
Cogeneration	Electricity and heat cogeneration	CO_2, CH_4, N_2O	Strategy, legislation	Implemented	MELE
Energy efficiency	Decrease of final energy consumption by 10%	CO_2, CH_4, N_2O	Strategy, legislation	Implemented	MELE, MEPPPC
Renewable energy sources	Fulfillment of obligations according to the Proposal of EU Directive on the promotion of the use of energy from renewable sources	CO_2, CH_4, N_2O	Strategy, legislation	Implemented	MELE
Fuel structure change	-	CO_2, CH_4, N_2O	-	Implemented	MELE
Enhanced oil recovery	CO_2 emission reduction	CO_2	Strategy	Adopted	MELE
New 1,000 MW nuclear power plant	Assurance of regional competitiveness in electricity generation and safety of electricity supply	CO_2, CH_4, N_2O	Strategy	In consideration	MELE
CO_2 capture and geological storage on new coal-fired power plants	CO_2 emission reduction	CO_2	Strategy	Planned	MELE

Table 4-4: Policy and measures in energy sector (continuing)

Measure	Greenhouse gas	Potential for GHG emission reduction (Gg CO_2 eq)							
		1995	2000	2005	2010	2015	2020	2025	2030
Cogeneration	CO_2 eq	0	0	0	-0.3	-0.3	474.2	627.2	981.3
Energy efficiency	CO_2 eq	0	0	0	607.4	1404.9	2509.3	3277.7	3705.4
Renewable energy sources	CO_2 eq	0	0	0	284.4	2038.7	4123.9	6009.7	8551.0
Fuel structure change	CO_2 eq	0	0	0	4.9	995.3	-519.2	555.6	857.4
Enhanced oil recovery	CO_2 eq	0	0	0	1060.7	758.7	456.7	393.8	331.0
New 1000 MW nuclear power plant	CO_2 eq	0	0	0	0.0	0.0	0.0	5038.9	5038.9
CO_2 capture and geological storage on new coal-fired power plants	CO_2 eq	0	0	0	0.0	0.0	0.0	4604.2	5672.4
Total	**CO_2 eq**	**0**	**0**	**0**	**1957.1**	**5197.2**	**7044.9**	**20507.1**	**25137.3**

4.4.2. Measures and activities in Transport sector

Transport sector participates in total final energy consumption with share of about 30%. Increment rate is extremely high (more than 5% annually in the last 5 years). The largest share in energy consumption in this sector has road traffic with about 90%. This share is expected also in future, because of car/vehicle number increase, increased traveled distances per car/vehicle and decreased number of passengers per car/vehicle.Traffic sector has 20% share in total greenhouse gases emission in Croatia.

Measures for GHG emission decrease in traffic sector are as follows:

Implemented measures

➲ ***MCA-12. Raising attractiveness of rail transport***

To become attractive for the conveyance of passengers and goods, the rail transport quality needs to be improved. This implies the development of suburban passenger rail transport, terminals at city entrances, truck transport terminals, railways electrification, opening of new corridors, introduction of excursion trains for bike transport, shortening the journey times, adaptation of the timetable to passenger needs, etc. In towns the public rail transport should be encouraged by an attractive pricing policy and by merging transport zones.

In this regard some good projects and initiatives have been recorded in Croatia recently – a truck terminal in Spačva (substitution for heavy vehicles road transport), extension of passenger platforms around Zagreb, system of integral cards charge for suburban and city transport in the City of Zagreb wherewith the number of passengers of suburban train has been increased by more than 7 times, etc.

➲ ***MCA-13. Introduction of biofuel***

Implementation instruments of this measure are:

- Act on Biofuels for Transport (OG 65/09) which regulates production, trade and storage of biofuels, biofuels utilization in transport, adoption of plans and programs for stimulating the production and utilization of biofuels in transport, authorities and responsibilities for setting and implementing the incentive policy and measues of biofuel production and utilization in transport.
- Ordinance of Biofuel Quality (OG 141/05) which sets up national indicative goal/aim for achieving the share of 5.75% of biofuels in total liquid fuel consumption in 2010.
- Decision on the percentage of biofuels in total share of fuel (OG 52/08); which sets up a percentage of 1.21% of biofuels in total fuel energy consumption in 2008 that is equivalent to 1.13 PJ of biodiesel.

In Croatia, the production of biodiesel is carrying out in two industry plants, factory in Ozalj has capacity of 20000 t/year and in Virovitica plant capacity is up to 9,000 t/year of biodiesel and it uses the waste edible oil as raw material. During 2007, in Croatia 4,334 tonnes of biodiesel was produced whereof 3,583 tonnes was placed on home market. About 1,300 tonnes of biodiesel is produced from oilseed rape and 320 tonnes from collected waste edible oil. Residual raw material is from import.

Construction of plant for biodiesel production with larger capacity is being planed.

The Energy Strategy of the Republic of Croatia (OG 130/09) puts as a goal an increase of yield and increase of cultivated areas sown with raw material for biodiesel end bioethanol production (oilseed rape, sunflower, soy, corn, wheat and barley) to accomplish a share of 10% of renewable energy sources in transport in 2020 (8.91 PJ) without raw material import i.e. biofuels production based on raw materials from domestic agricultural and other production.

➲ ***MCA-14. Promoting the use of low CO_2 vehicles***

Passenger cars manufactured in 1995 emitted about 180 g CO_2/km and those in 2003 about 164 g CO_2/km. The goal of the European Climate Change Programme is to develop low consumption vehicles emitting 140 g CO_2/km (equivalent to a consumption of 4.5 l/100 km for diesel fuel and 5 l/100 km for petrol) by 2008-2009 and 120 g CO_2/km by 2010-2012. Hybrid vehicles produce also emissions of this size. In order for this measure to be effective, a better consumer information is needed. In this regard, in 1999 the EU launched the fuel economy and CO_2 labelling scheme for new passenger cars. In November 2007 the Ordinance 95 Relating to Availability of Data on Fuel Efficiency and CO_2 Emissions from New Passenger Cars (Official Gazette No. 120/07) was adopted, whereby each supplier of new passenger cars intended for sale must provide information on fuel and CO_2 efficiency at each point of sale, including promotional fairs. Moreover, a guide is prepared on a yearly basis containing a list of all new passenger car models available on the market in the Republic of Croatia in the current year and a list of ten new passenger car models showing the highest fuel efficiency by values of a specific official CO_2 emission arranged in ascending order. The guide gives also a recommendation to drivers relating to the proper use and regular maintenance of their cars and driving habits that reduce fuel consumption and, consequently, the CO_2 emissions too.

Significant reduction, up to 25%, of fuel consumption can be accomplished by economy driving without additional technical measures. The Croatian Automobile Club in cooperation with the Environmental Protection and Energy Efficiency Fund is carrying out the campaign “Make Cars Green”. The World Cars Federation, Fédération Internationale de l'Automobile (FIA) adopted in 2007 a Declaration on Air Quality, Climate Change and Automotive Fuel Economy as foundation for global world campaign implementation. Declaration offers framework for FIA policy which on global level involves taking care on air quality, climate change, efficiency and ecological fuel acceptability. Campaign is the stimulation to all national automobile clubs, FIA members around the world, to promote a fight for waste gases emission reduction on, for environment/nature acceptable and sustainable level. Declaration offers to clubs, FIA members, number of principles, policies, proposals and actions that initiate and promote campaign to increase the level of public awareness. Declaration is amended by the Guidebook for green driving in 10 items which automobile clubs will promote to their members and other motorized citizens.

Ministry of the Sea, Transport and Infrastructure and the Fund started the Programme of decreasing the negative traffic impact on the environment. The Programme covers number of measures with aim to reduce the harmful gases emission from traffic sector. First measure in row is a reduction of harmful gases emission from road vehicles (categories N2, N3 and M3). The Fund grants irreclaimable funds to carriers for replacement of non-ecological road vehicles for transport of passenger and goods with new ones EURO 4 and EURO 5 standard. Till now, the Fund approved funds for replacement of 639 vehicles in amount of HRK 44.5 million.

➲ ***MCA-15. Promoting the use of gas in vehicles***

The consumption of liquefied petroleum gas (LPG) for motor vehicle transport is increasing, in 2005 the consumption was at the level of 22,000 tonnes and in 2008 it increased to an amount of 69,000 tonnes. By doing so, it reached about 3% of the total gasoline and diesel fuel consumption. With regard to gasoline, consumption of liquefied petroleum gas does not result in large CO_2 emission reduction (about 15%) because the emission reduction is compensated by increased gas consumption in relation to liquid fuels. Apart from liquefied gas, the usage of compressed natural gas (CNG) has begun in Croatia.

Table 4-5: Policy and measures in energy sector

Measure name	Objective	Greenhouse gas	Type of instrument	Status	Implementing entities
Energy efficiency	Decrease of final energy consumption by 10%	CO_2, CH_4, N_2O	Strategy, legislation	Implemented	MELE
Renewable energy sources	Fulfillment of obligations according to the Proposal of EU Directive on the promotion of the use of energy from renewable sources, till 2020 10% share of renewable energy sources	CO_2, CH_4, N_2O	Strategy, legislation	Implemented	MELE
Fuel structure change	-	CO_2, CH_4, N_2O	Strategy, market	Implemented	MELE

Table 4-5: Policy and measures in energy sector (continuing)

Measure	Greenhouse gas	Potential for GHG emission reduction (Gg CO_2 eq)							
		1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Energy efficiency	CO_2 eq	0	0	0	97.2	141.0	319.7	360.5	400.5
Renewable energy sources	CO_2 eq	0	0	0	139.9	367.4	460.1	515.7	576.4
Fuel structure change	CO_2 eq	0	0	0	6.5	30.5	67.3	93.4	119.4
Total	**CO_2 eq**	**0**	**0**	**0**	**243.6**	**538.8**	**847.1**	**969.5**	**1096.3**

4.4.3. Measures and activities in the Industrial Processes sector (non-energy emission)

Industrial processes sector contributed to the total GHGs emission in 2007 by 13%, whereof 99% came from the key sources: production of cement, lime, nitric acid, ammonia and the consumption of hydrofluorocarbons in refrigerating and air-conditioning equipment. Solvent use sector, which is considered in the framework of industrial processes sector, contributed to the total GHGs emission in 2007 by 1%.

In the period until, GHGs emission reduction in industrial processes could be achieved by implementation of measures in production of cement, lime, glass and nitric acid. GHGs emission reduction measures are not defined for ammonia production and consumption of hydrofluorocarbons in refrigerating and air-conditioning equipment. In the period until 2030 GHG emission reduction in solvent use could be achieved by preparing the solvent management plan. Reduction of volatile organic compounds emission has the influence on CO_2 emission reduction.

Status of process measures in industrial processes depends on presence/appliance of regulations concerning the GHGs emission reduction as well as economic advisability of measure application. Energy measures (energy efficiency improvement of production process and introduction of fuel with lower carbon content) have the effect in energy sector.

Regulation on unit charges[37], which came into force in July 2007, prescribed obligation to pay taxation for all stationary sources of CO_2 emission, i.e. technological processes, industrial facilities and devices which release CO_2 into air in the quantity higher than 30 tonnes per year. The purpose of taxation is environment performance and economic efficiency.

Certain measures in industrial processes are conditioned by market requests and new standards of products. Their application could not be enforced by regulations.

Implementation of measures in solvent use depends on appliance of regulations. Confirmation of the Protocol Concerning the Control of Volatile Organic Compounds Emissions[38] define requirement for control of volatile organic compounds emission and emission reduction measures enforcement.

INDUSTRIAL PROCESSES

<u>Adopted measure</u>

➲ ***MCA-16. N_2O emission reduction in nitric acid production***

Non-selective Catalytic Reduction (NSCR) is a measure for N_2O emission reduction in nitric acid production. N_2O is reduced to N_2 by means of ammonia with conversion efficiency of 80 - 90%. NSCR (secondary process for N_2O emission reduction - installation of catalyst, with conversion efficiency of 85%) is the only N_2O reduction measure from nitric acid production which is included in the business strategy of Croatian nitric acid producer. Because of high emission reduction potential and low marginal cost NSCR is very attractive and cost-effective measure.

[37] Regulation on Unit Charges, Corrective Coefficients and Detailed Criteria and Benchmarks for Determination of the Charge for Carbon Dioxide Emissions into Environment (OG 73/07, 48/09)
[38] Protocol Concerning the Control of Volatile Organic Compounds Emissions or their Transboundary Fluxes (OG-IT 110/07)

Implemented measures

- ***MCP-1. Reduction of clinker factor in cement***
- ***MCP-2. Increase of recycled glass (cullet)***

Reduction of clinker factor in cement and increase of recycled glass (cullet) are implemented measures but not conditioned by regulations. Reduction of clinker factor has the influence on CO_2 emission reduction in Portland cement production. This measure is conditioned by market requests and new standards of products. Increase of recycled glass (cullet), respectively replace the container glass which loss applied values in the production process as cullet, has the influence on raw material saving and energy consumption decreasing. Cost-effectiveness of measure is emphasized as well as lower disposal of glass at landfills which influence on environment protection.

SOLVENT USE

Adopted measures

- ***MCP-3. Measures for reduction of volatile organic compounds emission in the solvent use sector***

Reduction of volatile organic compounds emission has the influence on CO_2 emission reduction. CO_2 emission is calculated using conversion factor which contains ratio C/NMVOC = 0.8 and recalculation ratio of C to CO_2 equal to 44/12. The overall conversion factor has value of 2.93[39].

The highest emission reduction potentials could be achieved by implementation the solvent management plan, measures for modification of the application techniques and biofiltration[40].

[39] National inventory report 2009, Croatian greenhouse gas inventory for the period 1990 - 2007
[40] Programme for gradual emission reduction of determined pollutants in the Republic of Croatia for the period till the end of 2010, with the emission projections for the period from 2010 to 2020 (OG 152/09)

Table 4-6: Policy and measures in industrial processes and solvent use

	Measure name	Objective	Greenhouse gas	Type of instrument	Status	Implementing entities
MCA-16	N_2O emission reduction in nitric acid production	Non-selective Catalytic Reduction (secondary process) influences the N_2O reduction to N_2 by means of ammonia, with conversion efficiency of 85%	N_2O	Economic	Adopted	Nitric acid producer
MCP-1	Reduction of clinker factor in cement	CO_2 emission reduction in Portland cement production - depend on market requests for the cement types with lower content of clinker	CO_2	Economic (CO_2 emission taxation), market requests	Implemented	Portland cement producers
MCP-2	Increase of recycled glass (cullet)	CO_2 emission reduction in production of container glass is achieved by replacing of the cullet in the production process - the consequence is raw material saving, energy consumption decreasing and waste reduction	CO_2	Economic (CO_2 emission taxation), environment protection	Implemented	Container glass producer
MCP-3	Measures for reduction of volatile organic compounds emission in the solvent use sector	CO_2 emission reduction could be achieved by reduction of volatile organic compounds emission - implementation of solvent management plan, measures for modification of the application techniques and biofiltration	CO_2	Regulatory	Adopted	Government

Table 4-6: Policy and measures in industrial processes and solvent use (cont.)

	Name of measure	GHG affected	GHG emission reduction potential (Gg CO_2 eq)							
			1995	2000	2005	2010	2015	2020	2025	2030
MCA-16	N_2O emission reduction in nitric acid production	N_2O	0	0	0	608.6	608.6	608.6	608.6	608.6
MCP-1	Reduction of clinker factor in cement	CO_2	0	0	0	181.6	201.1	220.7	240.3	259.9
MCP-2	Increase of recycled glass (cullet)	CO_2	0	0	0	13.7	14.1	15.6	16.5	17.4
MCP-3	Measures for reduction of volatile organic compounds emission in the solvent use sector	CO_2	0	0	0	40.1	140.4	157.0	180.5	197.7
	Total	**CO_2 eq**	**0**	**0**	**0**	**844.0**	**964.2**	**1001.9**	**1045.9**	**1083.6**

4.4.4. Measures and activities in the Waste Management sector

Waste management sector contributed to the total GHGs emission in 2007 by 3%, whereof 70% came from the municipal solid waste disposal at landfills, which is the key source of this sector. In the period until 2030 GHGs emission reduction in waste management could be achieved by implementation of measures which are defined by the hierarchical concept of the municipal waste management.

The waste management policy falls within the competence of the Ministry of Environmental Protection, Physical Planning and Construction. The basic law of this sector is the *Waste Act*[41] regulating the way of managing waste. According to the Strategy[42] and Plan[43] the condition for implementing the integral waste management system is acquired. Strategy defines the main objectives of waste management in the period from 2005 to 2025. The basic task of the Plan is to organize the implementation of the main goals of the Strategy in the period from 2007 to 2015. According to objectives defined by the Strategy dynamic of measures for utilization of material and energy potentials of municipal solid waste and landfill gas has been defined. These objectives include the assumed time-lags with respect to relevant EU legislation[44].

Environmental Protection and Energy Efficiency Fund (EPEEF) finances landfills rehabilitation, avoiding and reducing of municipal waste generation, treatment of waste and reuse/recovery of waste.

Implemented measures

- ***MCP-1 Avoiding and reducing of municipal waste generation***
- ***MCP-2 Enhancement of separate collected and recycled municipal waste***
- ***MCP-3 Increasing of population involved in municipal waste collection system***
- ***MCI-17 Landfill gas flaring or utilization of landfill gas for electricity generation***

Basic measures defined by the Strategy (MCP-1, MCP-2, MCP-3) are included in 'without measures' scenario which assumes that quantity of municipal solid waste would constantly rise as a result of the growth in the living standard, but this rise would gradually decline due to effects of measures undertaken to avoid/reduce and recycle waste as well as increase of population involved in municipal waste collection system.

Landfill gas collection and treatment at landfills with biodegradable waste (which is included in MCI-17) is prescribed by the Plan. Collected gas which could not be used for energy generation must be burnt at the flare. Rehabilitation of landfills, providing ecological and economic advisability, ensure that landfills are equipped with the systems for collection and treatment of the landfill gas.

Adopted measures

- ***MCP-4 Decreasing of disposed biodegradable municipal waste***
- ***MCP-5 Utilization of biogas in bioreactors for electricity generation***
- ***MCP-6 Production and utilization of refuse derived fuel (RDF) in cement industry***

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[41] Waste Act (OG 178/04, 111/06, 60/08, 87/09)
[42] Waste Management Strategy of the Republic of Croatia (OG 130/05)
[43] Waste Management Plan of the Republic of Croatia for 2007 - 2015 (OG 85/07)
[44] Landfill Directive 99/31/EC

Implementation of these measures depends on achievement of objectives defined by the Strategy and Plan, with establishment of the waste management system in regional and counties' waste management centres, as central places for treatment and disposal of municipal waste. Mechanical-biological treatment of municipal waste with bioreactor landfills will be performed in the centres.

Planned measures

➲ ***MCP-7 Thermal treatment of municipal waste***

About 300,000 tonnes/year of municipal waste and 70,000 tonnes/year of dry sludge from Central installation for wastewater treatment are planned to be treated in power plant in Zagreb until 2020.

Table 4-7: Policy and measures in waste management

	Measure name	Objective	Greenhouse gas	Type of instrument	Status	Implementing entities
MCP-1	Avoiding and reducing of municipal waste generation	Reducing of quantity and adversity of waste which enter in the waste management system	CH_4	Regulatory (Strategy), incentive (EPEEF)	Implemented	Government, counties, local self-governments
MCP-2	Enhancement of separate collected and recycled municipal waste	Reducing of quantity and adversity of waste which undergo the waste management system	CH_4	Regulatory (Strategy), incentive (EPEEF)	Implemented	Government, counties, local self-governments
MCP-3	Increasing of population involved in municipal waste collection system	Increasing of waste quantity which is in the sustainable waste management system	CH_4	Regulatory (Strategy)	Implemented	Government, counties, local self-governments
MCI-17	Landfill gas flaring or utilization of landfill gas for electricity generation	Landfill gas must be collected and treated (combusted) with or without energy utilization	CH_4, CO_2	Regulatory (Strategy, Plan), incentive (EPEEF)	Implemented	Counties, local self-governments
MCP-4	Decreasing of disposed biodegradable municipal waste	Increasing of municipal waste quantity which treated by mechanical-biological treatment	CH_4	Regulatory (Strategy, Plan), incentive (EPEEF)	Adopted	Government, counties, local self-governments
MCP-5	Utilization of biogas in bioreactors for electricity generation	Decreasing of fossil fuel consumption - biogas is considered as CO_2 neutral fuel	CO_2	Regulatory (Strategy, Plan), incentive (EPEEF)	Adopted	Counties, local self-governments
MCP-6	Production and utilization of refuse derived fuel (RDF) in cement industry	Decreasing of fossil fuel consumption - refuse derived fuel with biological origin is considered as CO_2 neutral fuel	CO_2	Regulatory (Strategy, Plan), incentive (EPEEF)	Adopted	Counties, local self-governments, Portland cement producers
MCP-7	Thermal treatment of municipal waste	Decreasing of fossil fuel consumption - municipal waste with biological origin is considered as CO_2 neutral fuel	CO_2	Regulatory, economic	Planned	City of Zagreb

Table 4-7: Policy and measures in waste management (cont.)

	Name of measure	GHG affected	GHG emission reduction potential (Gg CO_2 eq)							
			1995	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
MCI-17	Landfill gas flaring	CH_4	0	0	52.1	83.0	136.6	169.5	190.2	210.8
	Utilization of landfill gas for electricity generation	CO_2	0	0	0	7.7	12.7	15.7	17.7	19.6
MCP-4	Decreasing of disposed biodegradable municipal waste	CH_4	0	0	0	15.8	249.8	591.9	637.3	682.7
MCP-5	Utilization of biogas in bioreactors for electricity generation	CO_2	0	0	0	1.6	9.1	10.8	11.6	12.4
MCP-6	Production and utilization of refuse derived fuel (RDF) in cement industry	CO_2	0	0	0	41.5	92.0	144.9	144.9	144.9
MCP-7	Thermal treatment of municipal waste	CO_2	0	0	0	0	187.3*	187.3*	146.4*	105.4*
			0	0	0	0	106.9**	106.9**	83.6**	60.2**
	Total* **	**CO_2 eq**	**0**	**0**	**52.1**	**98.8**	**386.4**	**761.4**	**827.5**	**893.5**

* CO_2 emission reduction potential is achieved by substitution of coal with municipal waste.
** CO_2 emission reduction potential is achieved by substitution of natural gas with municipal waste.
*** only CH_4 emission reduction potential is included - CO_2 emission reduction potential is included in energy sector.

4.4.5. Measures and activities in the Agriculture sector

The agricultural policy falls within the competence of the Ministry of Agriculture, Fisheries and Rural Development. The basic starting point of all agricultural activities is the legislation. Regarding policy and measures, certain legislative provisions which have or will have a significant impact on greenhouse gas emissions are presented in Table 4-8. This sector covers about 12% of total greenhouse gas emissions.

Table 4-8: Legislation in agriculture sector

	LEGISLATION	
A	***Livestock Breeding Act (OG 70/97, 36/98, 151/03, 132/06)***	Among other things, the Act governs environmental protection in livestock breeding and utilization.
B	***Act on Agricultural Land (OG 152/08)***	Among other things, the Act governs the protection, utilization and changes in agricultural land usage.
C	***Ordinance on Agricultural Land Protection of Contamination on Harmful Substances (OG 15/92)***	Determines which substances are considered adverse for agricultural land, what are the permitted amounts of these substances in soil, measures for prevention and control of soil pollution aiming to protect agricultural land from chemical and biological degradation and to maintain the land in a condition which makes it favourable habitat for healthy food production.
D	***Act on Fertilizers and Soil Improvers (OG 163/03, OG 40/07)***	Governs quality, quality control, marking, trading and supervision in fertilizer trading (of both mineral and organic fertilizers) and also soil improvers. Moreover, it governs the production and supervision of organic fertilizers and soil improvers.
E	***Ordinance on Good Agricultural Practice in Using Fertilizer (OG 56/08)***[45]	Prescribes general principles of good agricultural practice in fertilizer usage, periods in the year when applying the fertilizer on agricultural soil is not permitted, the manner in which these should be applied on certain terrains and soils, conditions for applying the fertilizers near the watercourses, procedures for applying the mineral and organic fertilizers, size and characteristics of organic (animal) manure containers.
F	***Act on State Support to Agriculture and Rural Development (OG 83/09)***	Prescribes the types of state support to agriculture and rural development, conditions and users of the support. In regard to rural development, the part related to supporting the environment and landscape preservation and improvement, the support is approved, among other, to those family farms which voluntarily accept commitments from agricultural environmetal programmes.
G	***Agriculture Act (OG 66/01, 83/02)***	Among other things, governs the goals and measures of agricultural policy. Measures of the structural policy are a group of measures which encourage economic efficiency of agricultural production in order to ensure stable incomes and appropriate life standard of farmers in rural areas and moreover a balanced development of agricultural regions and rural areas which includes the development of agriculture in a way that it takes care of the natural environment and the preservation of biodiversity.

[45] The Ordinance will enter into force when Croatia joins the EU. All other provisions form table 4-8 are already in force.

In order to adapt the Croatian system to the European standards, regarding the environmental protection (soil, water, air) and animal welfare, the *Principles of Good Agricultural Practice* have been developed and the fulfillment of these requirements will be the initial basis for acquiring the rights for support in agriculture when entered in the EU. In 2008, the Government adopted the *Rural Development Strategy of the Republic of Croatia for the period from 2008-2013* in which preservation, protection and sustainable usage of environment, landscape, natural and cultural inheritage is one of the strategic goals, and the sustainable use of agricultural (and forest) land is one of the priorities.

Measures for greenhouse gas emission reduction in the agriculture sector are as follows:

Adopted measures

- ***MCA-18 Action plan for the agriculture sector from the aspect of climate change adjustment and greenhouse gas emission reduction***

The Plan should analyze the potentials of agricultural measures and socio-economic aspects of their application.

- ***MCP-1 Rational usage of mineral fertilizers based on soil analyses and nutrient balance while implementing good agricultural practice***

Legislation under B, C, D and E make the legal framework for this measure. Currently, its potential in the next period and eventual costs can not be quantitatively expressed (therefore it was not included in emission projections).

Implemented measures

- **MCP-2** ***Efficient management of organic manure***

Project “Pollution control in agriculture” with the national goal to implement and encourage acceptable agricultural practices according to the standards set with the Nitrate Directive, and besides that, adopting the best procedures in production to protect the soil, water, air and animals which, at the same time, increase quality and profit, is one of the most important activities in Croatian agriculture within the process of preparation for the EU membership. To the interested farmers, the project offers the possibility of cofinancing the construction of platforms and the equipment for storage and distribution of fertilizers and also promotes agri-environmental measures.

Usage and/or storage of organic (animal) manure has already had a certain legal frame (A, B, C, D) but the development of the *Ordinance on Good Agricultural Practice in Using Fertilizer* (OG 56/08) (and the *Principles of Good Agricultural Practice*) precisely defined the conditions for using and manipulating with organic manure. It is estimated that the potential of this measure by 2020 is approximately 70 Gg CO_2 eq compared to the 'without measures' scenario, and its implementation costs about 75 EUR/t CO_2 eq.

State support to agriculture (direct payments) represents an instrument in implementation of measures since the users can become only those farmers who fulfill the cross compliance conditions in agricultural production: a) conditions related to environmental protection, the health of humans, animals and herbs and animal welfare which are defined within special regulations and b) conditions related to good agricultural and environmental practice.

In order to carry out the direct payments within the EU Common Agricultural Policy, it is necessary to establish the Integrated Administration and Control System – IACS and its most important component for agriculture support monitoring – Land Parcel Identification System –

LPIS. The Government of the Republic of Croatia, by adopting the National Programme for LPIS establishment in 2007, has set a framework for its implementation. By establishing it, Croatia will have an information system which contains real data on agricultural land use in the entire country and they will be used for administrative purposes of processing support applications by area, also to analyze and develop backgrounds for making decisions in the process of creation and implementation of agricultural and rural development policy.

In 2010, a development of the Agriculture Sector Plan from the aspect of climate change adaptation and greenhouse gas emission reduction (measure MCA-18 in the *Air Quality Protection and Improvement Plan for the Republic of Croatia for the period 2008-2011, OG 61/08) is anticipated.* The Plan is to analyze potentials of agricultural measures and socio-economic aspects of their application.

In a previous period, war, privatization, transition and unfavourable weather conditions have affected the agriculture greenhouse gas emissions. The sector revitalization is a long-standing; therefore, certain measures, although a legal framework was set, could not be fully implemented – thus it is difficult to state former quantitative effect of each policy and measure. The assumption is that above mentioned measures will be fully implemented in the following period, as principles of good agricultural practice, especially after joining the EU when the *Ordinance on Good Agricultural Practice in Using Fertilizer* (OG 56/08) enters into force. The implementation of this policy and measures should reduce greenhouse gas emissions originating from agriculture, especially from *Manure Management* and *Agricultural Soil*. Moreover, a positive effect, in the sense of emission reduction, is expected regarding non-CO_2 gases, first of all ammonia. Certain agricultural measures can also have an indirect effect in other sectors, for example, energy sector, transport and manure management (production of biogas from liquid manure in order to produce electricity, biofuel production, etc.).

Table 4-9: Policy and measures in agriculture

Measure name	Objective	Greenhouse gas	Type of instrument**	Status	Implementing entities
Action plan for the agriculture sector from the aspect of climate change adjustment and greenhouse gas emission reduction	The analysis of agricultural measures'potentials from the aspect of climate change adaptation and greenhouse gas emission reduction and also the analysis of socio-economic impacts of their application.	CH_4, N_2O	*Air Quality Protection and Improvement Plan for the Republic of Croatia for the period 2008-2011*	Adopted	
Rational usage of mineral fertilzers	Applying mineral fertilizers based on soil analyses and nutrient balance along with the implementation of good agricultural practice all aimed to protect environmental compounds (soil, water, air).	N_2O	B, C, D, E, F *Principles of Good Agricultural Practice*	Adopted	State, farms
Efficient management of organic manure*	Proper and in due time appliance of organic manure and also its proper storage aimed to protect environmental compounds (soil, water, air) and animal welfare.	CH_4, N_2O	A, B, C, D, E, F *Principles of Good Agricultural Practice*	Implemented	State, farms

*The measure is included in the 'with measures' scenario.
** See Table 4-8.

Table 4-9: Policy and measures in agriculture (cont.)

Measure name	GHG affected	Estimated mitigation impact (Gg CO_2 eq)							
		1995	2000	2005	2010	2015	2020	2025	2030
Efficient management of organic manure	CH_4	0	0	0	20.8	25.3	28.0	28.0	28.0
	N_2O	0	0	0	29.2	34.5	38.6	38.6	38.6
Total	**CO_2 eq**	**0**	**0**	**0**	**50.0**	**59.8**	**66.6**	**66.6**	**66.6**

4.4.6. Measures and activities in the Land Use, Land Use Change and Forestry (LULUCF) Sector

The forestry policy falls within the competence of the Ministry of Regional Development, Forestry and Water Management. *The Forestry Act* (OG 140/05, 82/06, 129/08) regulates the growing, protection, usage and management of forests and forest land as a natural resource aimed to maintain biodiversity and ensure management based on principles of economic sustainability, social responsibility and ecological acceptability. One of the most important provisions of this law, in the context of climate protection, is that forests should be managed in conformity with the sustainable management criteria, implying the maintenance and enhancement of forest ecosystems and their contribution to the global carbon cycle.

In the context of measures for greenhouse gas emission reduction, the usage of forest biomass (fuelwood, harvest residue and bark) has a great potential. Therefore, as in agriculture, the effect of these measures is also manifested in other sectors (for example, energy sector).

Measures to increase the CO_2 sink in LULUCF sector (*Land Use, Land Use Change and Forestry*) are as follows:

__Adopted measures__

- **MCA-19 Decision on taking advantage of Article 3.4 of the Kyoto protocol**

The role of the forest management in implementing the UN Framework Convention on Climate Change and the Kyoto protocol objectives is very important considering the fact that forest represents carbon sink. In regard to LULUCF sector and Kyoto protocol, the most important are Articles 3.3 and 3.4. Reporting on Article 3.3 activities is mandatory and, as stated in the Initial Report, the Republic of Croatia decided to report on Forest Management pursuant to Article 3.4 during the first commitment period. Current limitation in using the sink from Forest Management in Croatia, according to the Decision 22/CP.9, is 0.265 Mt C per year (about 0.972 Mt CO_2 per year). Subsequently, the potential of this measure amounts about 4860 Gg CO_2 for the whole period from 2008-2012. For the next period (second commitment period from 2013-2020), the potential of this measure will depend on the option selected for implementation.

__Implemented measures__

- **MCP-1 Improving private forest management**

Possible measures for which status can not be yet determined:

- **MCP-2 Planting new forests on forest land without tree cover**
- **MCP-3 Managing certain parts of previous agricultural areas that went through natural succession and became (degraded) forest vegetation**
- **MCP-4 Improving carbon sequestration in forest soils**
- **MCP-5 Improving cropland management**

Currently, the potential of possible measures can not be quantitatively expressed.

Considering the sensitivity and the complexity of LULUCF sector, the abovementioned measures present possibilities for sink increase. However, their realization will depend on a number of factors. Possible measure for implementation, effects of which are yet to be analyzed, is to, by applying the Article 3.4 of the Kyoto Protocol, take into calculation the carbon stored in forest soil not only in forest biomass.

Table 4-10: Policy and measures in the LULUCF sector

Measure name	Objective	Greenhouse gas	Type of instrument	Status	Implementing entities
Decision on taking advantage of Article 3.4 of the Kyoto protocol	Increasing carbon sink in forest biomass	CO_2	*Air Quality Protection and Improvement Plan for the Republic of Croatia for the period 2008-2011*	Adopted	MRDFWM (Ministry), Croatian Forests Ltd
Improving private forest management	Protection of forests from devastation and degradation, stopping the decreasing trend of private forest value, the development of rural areas.		*Forestry Act*	Implemented	Private owners

4.4.7. Cross sectoral measures and activities

- ***MCA-20 Establishment of emission units trading system***

Government of the Republic of Croatia adopted the Regulation on Greenhouse Gas Emission Quotas and the Method of Emission Allowance Trading (OG 142/08) at the end of 2008. The Regulation was adopted as a part of the process of harmonization of Croatian legislation with the European Union legislation, specifically with Directive 2003/87/EC. This Directive establishes greenhouse gas emission trading system in EU member states as a market-based instrument and the leading mechanism for reducing greenhouse gases from sources on the territory of EU. The Regulation establishes domestic greenhouse gas emission trading system that will be valid until Croatia's accession to the European Union when domestic system will be integrated into the existing EU system. This is the first time that greenhouse gas emission cap is introduced for electricity producers and industrial installations in Croatia. Government of the Republic of Croatia also adopted the Greenhouse Gas Allocation Plan for the Republic of Croatia (OG 76/09) based on the Air Protection Act. This Plan establishes carbon dioxide emission caps for the period 2010 – 2012 for all obligatory participants of emission trading system.

The establishment of the trading scheme itself is expected to be carried out in Croatia in two phases: entities liable to obtain emission permits shall do so in 2009 and in the period 2010-2012 they shall monitor emissions from installations and submit verified reports. Upon accession of the Republic of Croatia to EU, quota will be distributed to the installations to their accounts in the Registry and the Croatian ETS system will be connected to the EU ETS.

- ***MCA-21 CO_2 emission charges***

By adopting the Regulation on Unit Charges, Corrective Coefficients and Detailed Criteria and Benchmarks for Determination of the Charge for Carbon Dioxide Emissions into Environment (OG 73/07) Government of the Republic of Croatia introduced carbon dioxide emission charges for all stationary sources emitting more than 30 tonnes of CO_2 per year. Emission sources are stimulated to invest in increasing energy efficiency and renewable energy sources to reduce CO_2 emissions as well as to invest in other CO_2 emission reduction measures by means of lowering their CO_2 emission charges.

At the moment the charges are equal to 2 – 2.5 EUR/t CO_2 eq and they do not make any immediate impact on CO_2 emission reduction. Participants of EU emission trading scheme could be exempted from the charges after the inclusion in the trading system. Some sources of financing other than carbon charges are suggested in Air Protection and Air Quality Improvement Plan in the Republic of Croatia for the Period 2008 – 2011 (OG 61/08) but the most important source will definitely be auctioning of emission allowances in the future. Proceeds from the auctioning of the allowances would be used for implementation of climate change policy.

- ***MCA-22 Reporting under the Convention and the Kyoto Protocol***

This measure has no direct effect on emission reduction and therefore it is described in other chapters.

➲ ***MCA-23 Capacity building program for implementation of the Convention and the Kyoto Protocol***

Three-year project "Capacity Building for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia" co financed by LIFE Third Countries program of European Commission was completed in October 2007. The capacity building of national system accomplished by the project covered several areas: national greenhouse gas emission inventory, greenhouse gas emission projections, climate change policy and measures with the assessment of the effects of policies and measures, education and raising public awareness, establishment of the greenhouse gas emission registry, reporting obligations and Kyoto Protocol flexible mechanisms.

➲ ***MCA-24 Active participation in international negotiations on second commitment period after 2012 ("post – Kyoto")***

This measure has no direct effect on emission reduction and therefore it is described in other chapters.

➲ ***MCA-25 Preparation of plans, programs and studies for more efficient implementation and creation of climate change policy***

This measure has no direct effect on emission reduction and therefore it is described in other chapters.

➲ ***MCA-26 Establishment of the research and development programs for climate change issues***

This measure has no direct effect on emission reduction and therefore it is described in other chapters.

➲ ***MCA-27 National energy programs***

Energy programs are established by the Energy Law (OG 68/01, 177/04, 152/08) for the purpose of promoting research, planning and implementation of energy efficiency measures and renewable energy utilization in various areas. In recent years activities of those programs are reduced to minimum and are performed mainly through activities of the Energy Institute Hrvoje Požar. Programs were significant in years 2002 – 2005 during the inception phase of development of national climate change policy.

➲ ***MCA-28 Education and public awareness programs***

This measure is described in other chapters.

➲ ***MCA-29 Support to programs and projects of the technology and know-how transfer***

This measure has no direct effect on emission reduction and therefore it is described in other chapters.

4.4.8. Application of the Kyoto protocol flexible mechanisms

Kyoto Protocol defined three flexible mechanisms: Joint Implementation (JI), Clean Development Mechanism (CDM) and International Emission Trading (IET).

Analyses have shown that Croatia could meet the requirements in the first commitment period of the Kyoto Protocol by domestically applied emission reduction measures, which means that use of flexible mechanisms is not planned. In case domestic measures would fail to realize their full potential and meeting the requirements of the Kyoto Protocol would become uncertain, application of flexible mechanisms and possible purchase of emission units in international market would be considered.

After 2012 Croatia is going to intensively use mechanisms of international climate change agreements, in particular emission trading through the EU trading scheme.

➲ ***MCA-30 Establishment of the infrastructure for application of the Kyoto Protocol flexible mechanisms***

The Regulation on Implementation of the Kyoto Protocol Flexible Mechanisms (OG 142/08) defines modalities of implementation of mechanisms after Croatia fulfils all necessary requirements for participation in flexible mechanisms. Regulation encompasses modalities of clean development mechanism implementation and joint implementation abroad, joint implementation in Croatia and international greenhouse gas emission trading.

➲ ***MCA-31 Implementation of JI projects in Croatia***

Croatia decided not to enter JI projects as a host until the end of 2012.

➲ ***MCA-32 Enabling investments in CDM and JI projects abroad***

Please see MCA-30.

➲ ***MCA-33 Inclusion of Croatia into the European emission trading scheme***

Please see MCA-20.

4.4.9. Actions on local level

Actions with a view to reduce greenhouse gas emissions on local level are reflected in decision of some Croatian cities to participate in the initiative of the European cities to combat climate change as well as in establishment and activities of several energy agencies.

Six Croatian cities: Zagreb, Rijeka, Ivanić Grad, Duga Resa, Klanjec and Ozalj are signatories to the "Covenant of Mayors". By signing the Covenant cities commit themselves to go beyond the objectives of EU energy policy in terms of reduction in CO_2 emissions through enhanced energy efficiency and cleaner energy production and use. This commitment comes out of the general cognition that significant greenhouse gas emission reduction can and should be achieved on local level in which local authorities play the key role. Since over half of greenhouse gas emissions are created in and by cities and since 80 % of the population lives and works in cities where 80 % of energy is consumed, local authorities are well positioned to translate emission reduction objectives into local development objectives.

Emission reduction measures in transport sector implemented in cities of Koprivnica and Zagreb can serve as an example of good practice in domain of local measures to reduce greenhouse gas emissions in cities. Those cities as well as other cities in Croatia are systematically promoting alternative ways of transport in urban areas. City of Koprivnica won the award for the year 2007 among 2,016 European cities in contest for achievements in promotion of sustainable mobility in cities under the "European mobility week". Among other things Koprivnica has earned this award for promoting walking, reallocating roads in the city centre to non-motorized traffic, promoting use of bicycles and use of biofuel in public transport. City of Zagreb was selected as a finalist of the same contest for the year 2008.

City of Zagreb has implemented following emission reduction measures in transport sector:

- building 250 km of cycling roads;
- blending diesel with biodiesel for powering buses of public transport;
- supply of 56 new buses (approximately one sixth of the fleet) for public transport powered by natural gas;
- integrated billing for tram and suburban railroad traffic which led to increase of passengers from 7,000 to 70,000;
- participating in international project "Civitas Elan" with the objective of implementation of better and cleaner traffic in cities.

By signing "The Mayor's and County Prefect's Energy Charter" (Figure 4-2) mayors of 127 cities and county prefects of 20 counties in Croatia expressed their concern for climate change and increased energy consumption. The Charter represents a declarative act of representatives of local and regional self-government which indicates awareness and political will for managing the energy on local level, concern for environment and rational managing of natural resources.

Figure 4-2: The Mayor's and County Prefect's Energy Charter

Within the framework of "Intelligent Energy for Europe Program" supported by the European Commission five energy agencies have been founded or their foundation was initiated, four of which being regional agency and one being local energy agency:

- North – West Croatia Regional Energy Agency;
- Regional Energy Agency Kvarner;
- Istria Regional Energy Agency;

- Regional Energy Agency of Slavonia and Baranja;
- Medjimurje Energy Agency (local agency).

Since within their scope of work agencies support energy management practice, advocate the concept of sustainability, raise awareness on energy efficiency and renewable energy sources, they could be considered as implementers of greenhouse gas emission reduction policy and measures. Until now more than 50 projects supported by regional energy agencies have been executed or are in process of execution.

Range of services and main tasks of energy agencies are:
- initiation, monitoring and execution of renewable energy and energy efficiency projects;
- technical support to counties;
- education of public and target groups;
- preparation of documentation for application to EU funds and tenders;
- application of projects to the Environmental Protection and Energy Efficiency Fund and other source of financing.

Project "Organization of regional incentives for climate change mitigation in Croatia" is performed within the framework of the bilateral Croatian-German cooperation. The German society for technical cooperation (GTZ) by order of the Federal Ministry of Environment, Nature Protection and Nuclear Safety (BMU) from Germany in cooperation with the Ministry of Environmental Protection, Physical Planning and Construction and Cities' Association performs activities within this project in the period from February 2009 till March 2011, including 15 local self-government units with corresponding counties. The objective of the project is related to adopted cost-effective packages of measures for climate change mitigation in selected Croatian cities and municipalities, as well as to their implementation.

4.4.10. Monitoring of policy and measure implementation

Monitoring of implementation and results of policy and measures for greenhouse gas reduction and sink enhancement related to meeting the requirements of UNFCCC and associated international agreements is regulated by the Regulation on the Monitoring of Greenhouse Gas Emission in the Republic of Croatia (OG 1/07). It is defined by the Regulation that report on policy and measure implementation containing quantified statements shall be prepared every two years starting from 2009. A report on greenhouse gas emission projections for those years shall also be prepared.

The Ministry of Economy, Labour and Entrepreneurship publishes yearly report "Energy in Croatia" with the objective of detailed monitoring of all relevant energy data and energy efficiency indices.

4.4.11. Measures and policy no longer in use

There are no measures contributing to greenhouse gas emission reduction that are no longer in use.

5. PROJECTIONS OF EMISSIONS AND THE TOTAL EFFECTS OF POLICIES AND MEASURES

5.1. Projections of emissions by sectors

5.1.1. Energy

Projections are presented for three scenarios: the 'without measures' scenario (business-as-usual), 'with measures' scenario and 'with additional measures' scenario. Assumptions are defined in each sector for each scenario, it should be noted that the definition of the 'without measures' scenario is always in the realm of theoretical analysis, because the trends, depending on the starting assumptions, can be very different. For example, if in energy sector trend of historical series is selected, the question is how many years should be taken for extrapolation of energy demands. Also, assumptions may be different in the way of covering energy demand (fuel structure). Thus, the 'without measures' scenario below should be accepted as a rough prediction.

Projections in the energy sector are based on assumptions, objectives, measures and guidance provided by the Energy Development Strategy of Croatia, adopted in October 2009 (OG 130/09). The strategy observes a development of energy sector by 2020, with a view to the 2030. Based on the Strategy, implementation program for the period of 3 years will be developed.

The Strategy is based on the following assumptions:

- The Republic of Croatia is a candidate for full membership in the European Union (EU). Croatia expects to become a full member in 2012;
- The Republic of Croatia has accepted the Energy Community agreement;
- Republic of Croatia signed and ratified the Kyoto protocol in addition to the UN Framework Convention on Climate Change. Croatia has obligations of the post-Kyoto commitment period from 2013 onward;
- The Republic of Croatia faced with great instability in energy prices on the world market.

The goal of the Strategy is to build a sustainable energy system that makes a balanced contribution to security of energy supply, competitiveness and environmental protection and provides for security and availability of energy supply to the Croatian citizens and business sector.

As a future EU member, Croatia will use all mechanisms established by the European Union in accomplishing obligations that will occur in post-Kyoto period.

EU objective to reduce emissions by 20%, in relation to 1990, that is by 30% in the case of a comprehensive global agreement is setted. The EU methodology of effort sharing distribution appreciates economic differences among EU member countries. The method differs for two sectors: sector in which emission trading is allowed (ETS sector1[46]) and the non-ETS sector which includes other emission sources.

[46] ETS Sector consists of facilities which business is: electricity production, oil processing, cement, lime, iron, steel, aluminium, non ferrous metals, glass, ceramic production and etc.

In the EU's non-ETS sector, emission should be reduced by 10% in 2020, in relation to 2005, but the commitments of individual countries will range between +20 to -20% depending on the economic development.

In the period after 2012, the EU-ETS sector will have a joint emission quota at the EU level, that is, member countries will not have to prepare National Allocation Plans. The total emission quota will have a linear decrease till 2020 when a 21% reduction, in relation to 2005, should be achieved (18% if air traffic is included in the EU-ETS sector). Emission allowances will be bought at the auctions. Access to auctions will be opened to all market participants regardless of the home country. Participants of electricity generation sector will have to buy all their emission allowances at the auction, and for certain industry branches, a partial auction will exist. Very sensitive industry branches will get free emission allowances. The rules are defined by the national selling quotas. Means gathered at the auction belong to a country at the level of allowed quota and 50% of these means should be spent on climate change policy.

The emission projections for Croatian ETS and non-ETS sector indicate the following:

Emissions in Croatian non-ETS sector will grow and stabilized in the coming period. In this sector, which represents 60-65% of the total national emissions, energy is represented by traffic and small furnaces in other sectors and industry, and the remaining emissions are from agriculture, industrial processes (part) and waste management sectors. Croatia may meet the 2020. target that could be set for non-ETS sector according to the EU methodology of internal commitment distribution, if some minor additional measures, are implanted..

Croatian ETS-sector will increase its emissions, mainly in the electricity and heat generation sectors and in refineries due to increase of their productions. In new coal fired power plants emissions in the ETS sector will decrease after 2020, due to assumption that CO_2 carbon capturing and storage technology (CCS) will be applied. Due to increase in emissions till 2020, some of the emission units will have to be purchased within the EU scheme, or internationally.

The Strategy emphasizes that all future participants of the ETS's during planning its business should take into account the costs of emission allowances according to expected international prices. The Republic of Croatia will ensure conditions for accessing to international market and usage of Kyoto Protocol mechanisms (CDM - Clean Development Mechanism, JI - Joint Implementation projects).

5.1.1.1. Final energy consumption

BUSINESS AS USUAL PROJECTION OF FINAL ENERGY CONSUMPTION

The Energy Strategy provides business-as-usual projection of final energy consumption till 2020 (with a view to 2030). This business-as-usual scenario (Table 5-1 and Figure 5-1) corresponds to ‘without measures’ scenario. This projection represents consumption pathern in line with market trends and consumers’ habits, without government interventions, provided new, sophisticated products that reach the market are used.

Table 5-1: Business-as-usual projection of final energy consumption

PJ	2006	2015	2020	Increase rate from 2006 to 2020, %	2030
Industry	58.8	75.8	84.4	2.6	103.0
Transport	85.6	124.5	135.2	3.3	152.5
Other sectors	123.4	162.4	189.9	3.1	245.1
Total	**267.8**	**362.7**	**409.6**	**3.1**	**500.8**

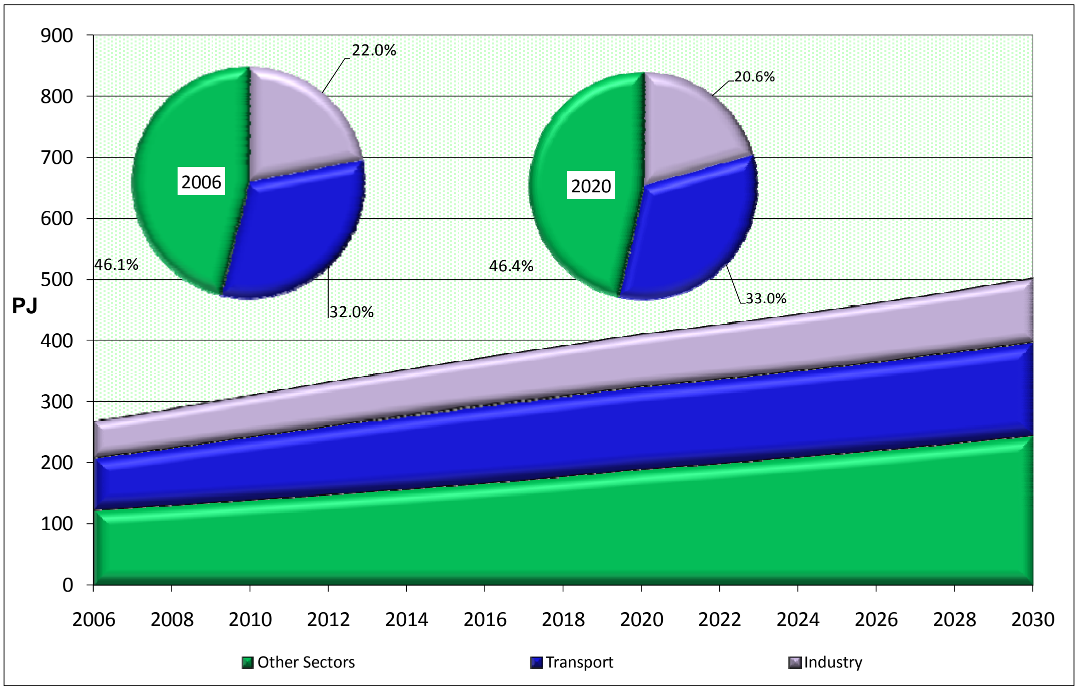


Figure 5-1: Business-as-usual projection of final energy consumption

Increase in energy consumption is based on assumption of stable economic growth by 5% yearly, which enable Croatia to reach EU average about 2020. This is a continuation of positive trends from the period 2003 to 2007, in which the real GDP growth rate was 3,8-5,5%, while growth of final energy consumption was 3.0% per year. In projections, increase in final energy consumption correlates with the growth of GDP. The theory of analogy with the EU countries of similar development trends, especially those surrounding the Mediterranean, is taken into consideration.

SUSTAINABLE SCENARIO OF FINAL ENERGY CONSUMPTION

The Croatian Energy Strategy defines Sustainable scenario. It is a derivative of the Business-as-usual projections of final energy consumption after implementation of measures described in section 4.4.1 policies and measures. Sustainable scenario is the "with measures" scenario, it includes those measures that are already being applied and measures that are adopted. Table 5-2 and Figure 5-2 show the energy consumption for sustainable scenarios by industrial sectors for 2015, 2020 and 2030.

Table 5-2: Sustainable scenario of final energy consumption

PJ	2006	2015	2020	Increase rate from 2006 to 2020, %	2030
Industry	58.8	72.8	80.3	2.2	97.1
Transport	85.3	119.2	128.5	2.9	144.0
Other sectors	123.4	153.9	180.3	2.7	232.9
Total f.e.d.	267.8	346.0	389.1	2.7	474.0
Brutto[47] f.e.d.	278.4	358.9	404.3	2.7	492.5

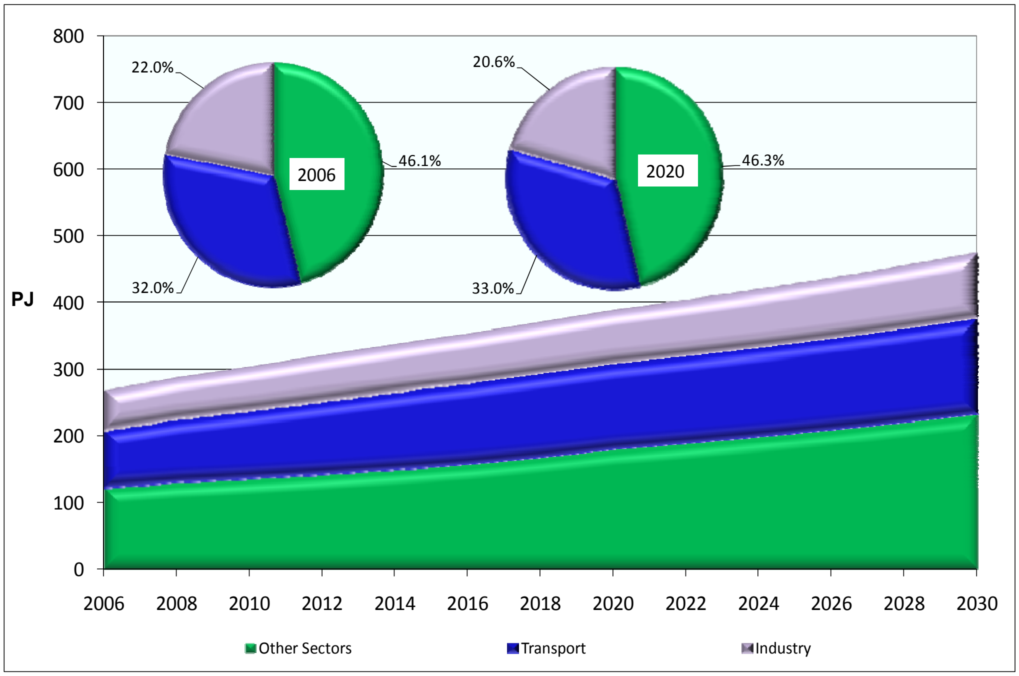


Figure 5-2: Sustainable scenario of final energy consumption

Sustainable scenario has growth of final energy consumption with a rate of 2.7% per year, which is 0.4% less than the Business-as-usual scenario.

5.1.1.2. Energy sector

FUTURE NEEDS FOR ELECTRICITY

The Energy Strategy estimates average annual increase in total electricity consumption by 3.5% in 2020. Total electricity consumption without power plant's own use will be approximately 28 TWh in 2020 (Table 5-3). This is slightly higher increase than in the period from 2002 to 2007 when it was 3.3% per year. With technological development, a demand for electricity becomes larger despite of energy efficiency measures implementation. It is estimated that peak load in Croatian energy system in 2020 will amount approximately 4,600 MW.

[47] Final energy demand increased by own electricity and heat use in energy sector and for electricity and heat losses

Table 5-3: Final and total electricity consumption in sustainable scenario

Year	2006	2015	2020	Growth rate 2006-2020, in%	2030
Final energy consumption according to business-as-usual scenario, TWh	15.0	22.0	27.0	4.3	36.9
Final energy consumption according to sustainable scenario, TWh	15.0	21.0	25.0	3.7	33.0
Total electricity consumption in sustainable scenario, TWh	17.3	23.7	28.0	3.5	36.8

STRATEGY FOR NEW ELECTRICITY-GENERATING CAPACITIES

The Strategy is based on the principle that the independent, regulated, competitive electricity market is the most effective and costly the most affordable way to achieve that objective.

Electricity consumption has increasing trend (3-4%) while import of electricity amounts about 20-30%. Power Plants in the Croatian energy system are at the end of their lifetime. Some of them will be shut down before planned or economically justified because of adaptations to the EU regulations. According to the Strategy in the next 15 years 1,100 MW will go out of operation, which is about 27% of today's installed capacity in the system. By the 2020, 2,400 MW should be provided by new capacities (Figure 5-3). This includes capacities that Croatia needs to build up as a substitution of supply from the joint energy system of the former State, which is approximately 650 MW.

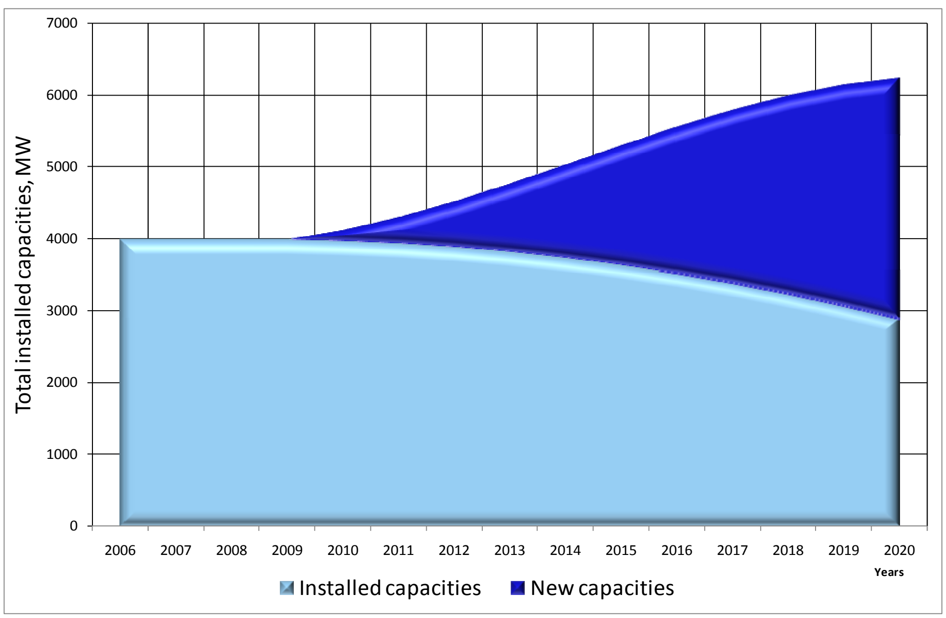


Figure 5-3: Installed existing capacities and needed new capacities

In the background study for the development of strategy that were in the public debate (Green Paper), three electricity supply scenarios were observed. Final electricity consumption and the share of renewable energy sources in all three scenarios are equal, the differences between the scenarios are the following (Table 5-4):

Table 5-4: Scenarios for power plants sector development according to Green Paper[48]

Starting year	Blue scenario MW	Green scenario MW	White scenario MW
2013	Gas 400	Gas 400	Gas 400
2015	Coal 600	Gas 400	Coal 600
2019	Coal 600		
2020	Gas 400	Nuclear 1000	Nuclear 1000

All three scenarios assume decreasing trend for electricity import which today amounts about 20-30%. In 2020 Croatia should be able to cover its own demand for energy from its own sources.

The above mentioned scenarios are evaluated through the following criteria: the possibility of exporting electricity, generated reserves in system, the diversity of energy sources, the cost of energy imports, the impact of the increase in GDP, CO_2 emissions, electricity price, and electricity price sensitivity to changing rates of CO_2 emission allowances. With such evaluation, white scenario appears to be the optimal. White scenario predicts mixed sources, construction of one gas fired power plant, one coal fired power plant and one nuclear power plant.

Discussion has shown that the public is not ready for decision about nuclear option, and it is very uncertain whether nuclear power plant could be build by 2020.

Obstacle in establishing the Green Scenario, which only assumes a construction of natural gas fired power plants, is not just the electricity generation costs, but uncertainty in gas supply as well. Today, Croatia has gas shortages in winter, existing gas storages are not enough for including new gas consumers. During winter, the largest gas consumer, fertilizer plant Petrokemija Kutina, is being disconnected. In 2009 Croatia was exposed to energy crisis as, due to the absence of gas import from Russia, industry did not have any gas for few weeks. At this moment 60-70% of gas demand is covered by own production, but this share will fall as domestic resources are mostly declined, so in 2020 60% will be compensated by the imported gas. It is necessary to ensure new sources and supply routes. The Republic of Croatia will be included into international projects due to its transit position. For now, following projects are possible: Nabucco project of gas supply for Europe from the Caspian area, South Flow project of gas supply from Russia and construction of LNG terminal on the Adriatic coast. Realization of these international projects could be expected within the next 5 to 10 years. At this moment, gas pipeline system in the eastern Slavonia and towards Dalmatia is in progress.

Taking into consideration the above mentioned, final version of the Strategy suggested an additional scenario, as combination of blue and white one from the Green Paper (hereafter: Blue-White Scenario). It is based on the usage of all forms of energy, gas, coal and nuclear energy; however, nuclear energy is delayed for the period after 2020. Decision on nuclear power plant should be made within next few years, and it could go into operation in 2024. In projections, the nuclear power plant is observed as an additional measure.

The Strategy assumes the following source structure (hereafter: Blue-White Scenario):

- **Construction of large hydropower plants** - new installed capacities in hydropower plants in 2020 will amount to 300 MW, and they will start-up in 2015. In addition to the

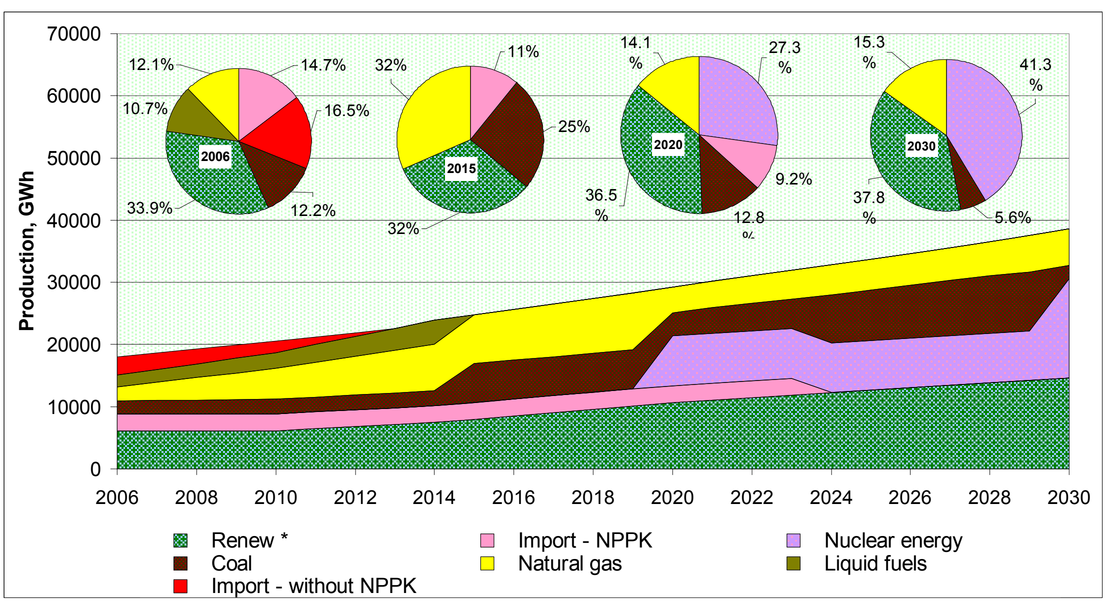
[48] Update/Upgrade of the Energy Strategy and of the Implementation Programme of the Republic of Croatia, Green Paper draft, Ministry of Economy, Labour,and Entrepreneurship, October 2009

construction of new hydropower plants, increased capacities will be enabled with the rehabilitation of existing plants

- **Exploitation of renewable energy sources** – defined goal is to maintain the level of 35% of a share of electricity generation from renewable energy sources and large hydropower plants, in total electricity consumption until 2020
- **Thermal power plants** – In a period of 2013-2020 thermal power plants of total capacity of 1,100 MW will be shut down in Croatia due to their deterioration, so thermal power plants of total capacity of at least 2,400 MW should be built in a period until 2020 (Figure 5-8)
- **Electricity and heat cogeneration** - cogeneration units of total capacity of at least 300 MW shall be built by 2020. The majority of this capacity is related to the industrial cogeneration units, while the minority to cogeneration units in district heating systems.
- **Natural gas-fired power plants** - Natural gas-fired power plants of total capacity of at least 1,200 MW should be built by 2020. At least 800 MW in natural gas-fired power plants should be built by 2013. This capacity includes cogeneration units and capacity of thermal power plants already in construction
- **Coal-fired power plants** - Coal-fired power plants of total capacity of at least 1,200 MW are expected to be built by 2020
- Croatia initiates the Croatian nuclear energy program.

As it was already mentioned in introduction, the Strategy will not strictly prescribe which power plants should be built, regarding a selection between coal-fired or gas-fired power plants. It assumes that investors will, depending on the electricity market conditions, price of the CO_2 allowance units, electricity demand in Croatia and region, decide on selecting the fuel and technology. Comparative analyses of scenarios assume that all power plants, the existing ones and the new ones, should buy the emission allowances at the auction with presumed price of 20 EUR/t CO_2 eq.

Structure of generated electricity of energy system is indicated in Figure 5-4.



*Renewables; NPPK-Nuclear power plant Krško

Figure 5-4: The structure of electricity generation (Blue-White scenario)

In 2020 the share of electricity generation from renewable energy sources is assumed to be 35-36%. The largest generation will be in hydropower plants of 6.6 TWh, in wind power plants of 4 TWh, while the rest will be based on the biomass, biodegradable waste and geothermal power plants. The usage of liquid fuels terminates in 2015 and their production is substituted by modern coal-fired power plants of high efficacy (45-46% of energy conversion efficiency) having less specific CO_2 emission than the existing liquid fuel-fired power plants.

5.1.1.3. Emission Projections of the Energy Sector (Energy Stationary Sources)

Projections are indicated for three scenarios:

The "without measures" scenario – it is the bussines-as-usual scenario of final energy consumption from Energy Strategy. Within the electricity generation sector it is assumed that all new energy demands are covered from coal-fired power plants. It means that specific CO_2 emission is presumed to about 720 g CO_2/kWh, which is for over ten percent higher than the presence average specific thermal power plant emission within the system.

The "with measures" scenario – it is the Sustanable scenario of final energy consumption from Energy Strategy. This scenario represents a group effect of measures indicated in Chapter Policy and Measures, marked as the measures in status of "implemented" or "adopted". The scenario assumes a construction of source structure in the electricity generation sector according to the Blue-White scenario.

The "with additional measures" scenario – the effect of two additional measures is indicated. The first one is a construction of nuclear power plant of 1,000 MW after 2024 and the second one is the additional construction of the CO_2 capturing and storage plant in coal-fired power plants after 2020, in power plants that will be built between 2010 and 2020.

In the "without measures" scenario the emission intensively grows, mostly in power sector (Figure 5-5). Reason of growth is an increased energy demand, decrease of dependence on the electricity import and greater exploitation of existing capacities in refineries, as well as the assumption that all new electricity demands in that scenario are covered by thermal power plants (emission factor as the existing TPP). It should be taken into consideration that in the "without measures" scenario there is even a significant share of renewable energy sources, in large hydropower plants that maintain the existing level of production, and usage of firewood in heating needs.

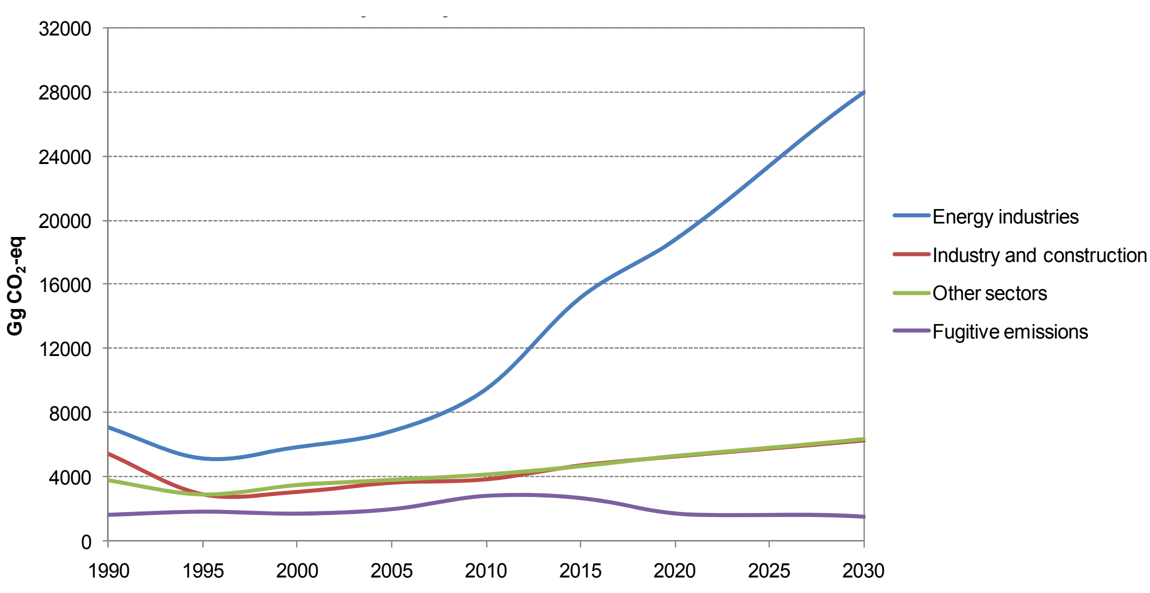


Figure 5-5: Emission projections for energy stationary sources for 'without measures' scenario

Table 5-5 show effects of application 'measures' in relation to 'without measure' scenario. For now, it is possible to monitor effects of the measures only on aggregated level. Figure 5-5 shows emissions by sectors: energy industries, industry and construction and other sectors.

Table 5-5: *Emission reduction potential in 'with measures' scenario in relation to 'without measure' scenario*

MEASURES AND THEIRS POTENTIALS (Gg CO_2 eq)	**2010**	**2015**	**2020**	**2025**	**2030**
Energy industries	395.5	2929.2	4021.9	7376.2	10144.7
Electricity generation	385.4	2860.3	3872.3	6972.6	9727.2
Renewable energy sources, 1.1 TWh u 2010	176.4	1245.8	2507.4	3516.7	5030.7
Cogeneration 0.4 TWh	-0.3	-0.3	474.2	627.2	981.3
Energy efficiency	227.3	735.4	1574.2	2391.1	2897.6
Change of fuel structure	-18.0	879.4	-683.6	437.6	817.6
Production of steam and hot water	10.1	68.9	149.6	403.6	417.5
Renewable energy sources	0.0	40.1	118.1	361.0	376.4
Energy efficiency	10.1	28.9	31.5	42.5	41.1
Industry and construction	354.1	525.6	1059.5	1190.3	1663.7
Energy efficiency	248.0	336.0	754.7	842.6	823.3
Renewable energy sources	108.1	191.8	290.8	332.4	858.4
Other measures	-1.9	-2.2	14.1	15.3	-18.0
Other sectors	323.2	983.8	1506.8	1903.7	2286.7
Renewable energy sources	176.3	561.1	1207.6	1799.6	2285.5
Energy efficiency	122.1	304.6	148.9	1.4	-56.6
Other measures	24.8	118.1	150.4	102.7	57.8
TOTAL (Gg CO_2 eq)	**1072.8**	**4438.5**	**6588.2**	**10470.2**	**14095.1**
Energy efficiency	607.4	1404.9	2509.3	3277.7	3705.4
Renewable energy sources	460.8	2038.7	4123.9	6009.7	8551.0
Other measures	4.5	994.9	-45.0	1182.8	1838.7

The overview of the "additional measures" potential is given in Table 5-6. It is a great potential, by which the emission is reduced to the emission level below the level in 2007. However, as it was already commented, the realization of these measures is uncertain. A decision on building the nuclear power plant is yet not made. It is expected that technology of CO_2 capturing and storage will be commercially developed within the next ten years. It is uncertain whether it will be actually available in ten years and at which price. Implementation of the Kyoto Protocol's flexible mechanisms is considered to be the additional measure that surely can be applied prior to 2020. In 2012 Croatia should enter the ETS scheme of the European Union and required decreases could be ensured by trading.

Table 5-6: Emission reduction potential in 'with additional measures' scenario

ADDITIONAL MEASURES AND THEIRS POTENTIALS (Gg CO_2 eq)	**2010**	**2015**	**2020**	**2025**	**2030**
Energy industries	0.0	0.0	0.0	9643.1	10711.2
Electricity generation	0.0	0.0	0.0	9643.1	10711.2
New nuclear power plant 1,000 MW	0.0	0.0	0.0	5038.9	5038.9
CO_2 capturing and storage in new coal TPP	0.0	0.0	0.0	4604.2	5672.4
Fugitive emissions	1060.7	758.7	456.7	393.8	331.0
Enhanced oil recovery	1060.7	758.7	456.7	393,8	331,0
TOTAL (Gg CO_2 eq)	**1060.7**	**758.7**	**456.7**	**10036.9**	**11042.2**

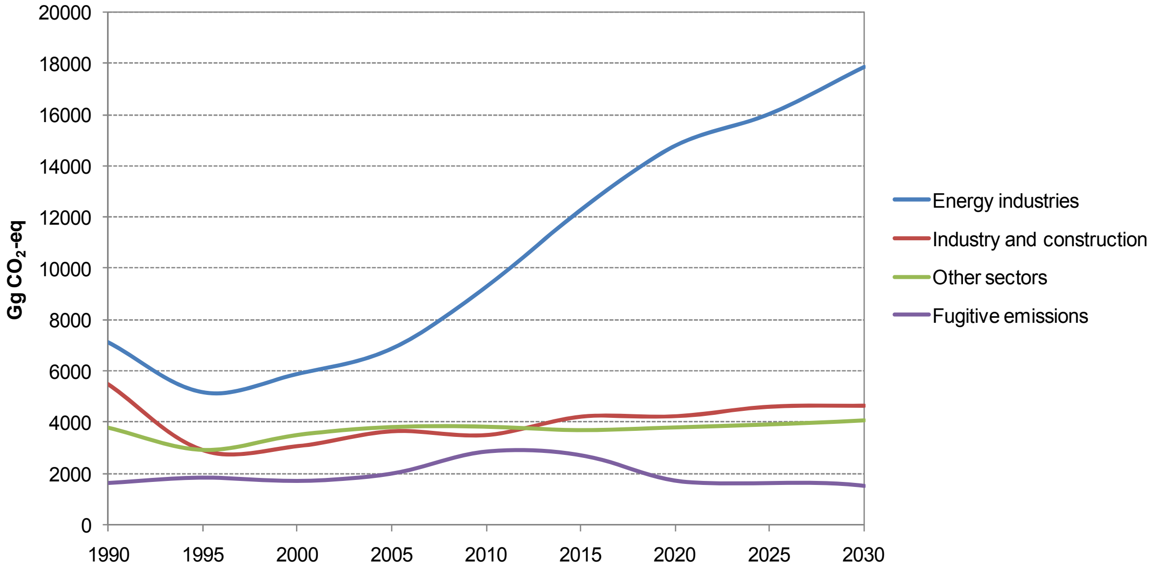


Figure 5-6: Emission projections for energy stationary sources for 'with measures' scenario

Table 5-7 shows emission projections for 'With measures' scenario while table 5-8 shows emission projections for 'With additional measures' scenario for the period till 2030.

Table 5-7: 'With measures' scenario

'With measures' scenario	1990	2005	2010	2015	2020	2025	2030
Energy industries	7144.0	6891.1	9293.9	12282.0	14781.5	16021.5	17847.4
Industry and construction	5475.3	3666.5	3520.1	4224.9	4243.0	4611.9	4648.7
Other sectors	3793.9	3844.1	3855.1	3718.2	3832.5	3942.5	4108.7
Fugitive emissions	1665.9	2021.4	2864.6	2727.4	1754.3	1652.7	1550.5
TOTAL (Gg CO_2 eq)	**18079.0**	**16423.1**	**19533.8**	**22952.5**	**24611.2**	**26228.6**	**28155.2**

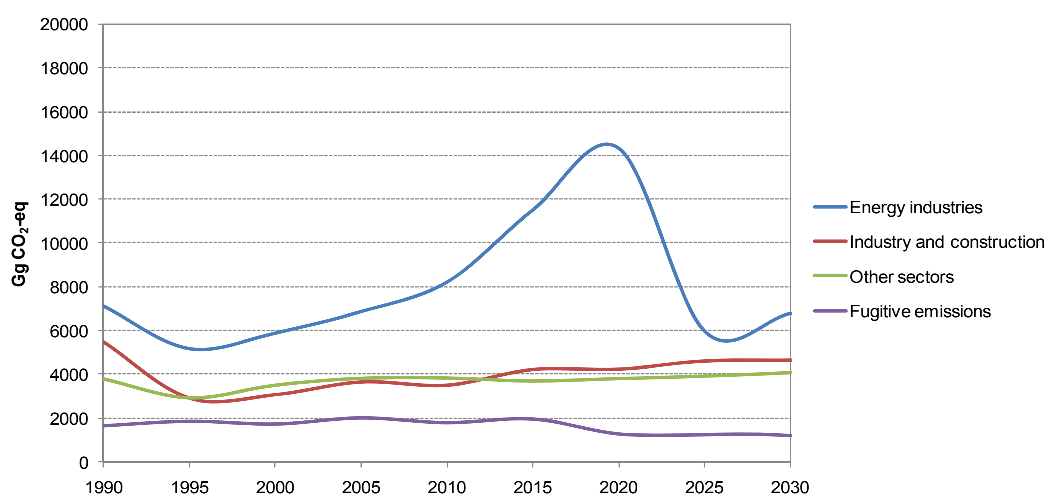


Figure 5-7: Emission projections for energy stationary sources for 'with additional measures' scenario

Table 5-8: Emission projections for 'with additional measures' scenario

'With additional measures' scenario	1990	2005	2010	2015	2020	2025	2030
Energy industries	7144.0	6891.1	8233.3	11523.3	14324.8	5984.6	6805.2
Industry and construction	5475.3	3666.5	3520.1	4224.9	4243.0	4611.9	4648.7
Other sectors	3793.9	3844.2	3855.1	3718.2	3832.5	3942.5	4108.7
Fugitive emissions	1665.9	2021.4	1804.0	1968.8	1297.7	1258.9	1219.5
TOTAL (Gg CO_2 eq)	**18079.0**	**16423.1**	**17412.4**	**21435.1**	**23697.9**	**15797.9**	**16782.0**

Figure 5-7 shows that the largest increase is in the Energy industries, mostly due to the entry into operation of new power plants. It should be noted that in 2020 35% of electricity is generated from renewable energy sources. Emission increase is due to a growth in electricity demand, due to reduction of electricity from import and because of coal which increased his emission factor by 10% in relation to today's fuel structure. If enough natural gas will be available and price of natural gas could compete with coal price, emission will be about 3 Mt CO_2 eq lower in 2020, which would rest on the level of emissions from 2010. In the other sectors and industrial sector the growth is very mild. Figure 5-8 shows emission projections for energy sector for all three scenarios.

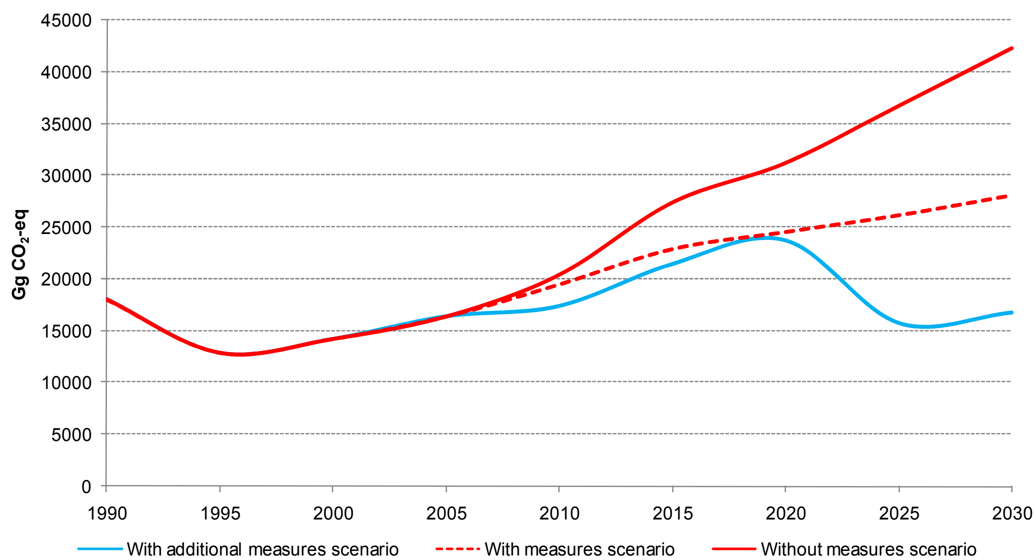


Figure 5-8: Energy sector emission projections (with Blue-white scenario in energy industries sector in 'with measures' and 'with additional measures' scenario)

5.1.1.4. Emission projections from Transport sector

'WITH MEASURES' SCENARIO

Table 5-9 shows effects of application 'measures' in relation to 'without measure' scenario which came out of existing regulations and the transfer of the acquis.

Table 5-9: Emission reduction potential in 'with measures' scenario in relation to 'without measure' scenario

MEASURES AND THEIR POTENTIALS (Gg CO_2 eq)	2010	2015	2020	2025	2030
Transport	243.7	538.8	847.1	969.5	1096.3
Energy efficiency	97.2	141.0	319.7	360,5	400,5
Renewable energy sources	139.9	367.4	460.1	515,7	576,4
Other measures	6.6	30.5	67.3	93,4	119,4
TOTAL (Gg CO_2 eq)	243.7	538.8	847.1	969.5	1096.3

Figure 5-9 shows emission projections for: 'without measures' and 'with measures' scenarios of Transport sector.

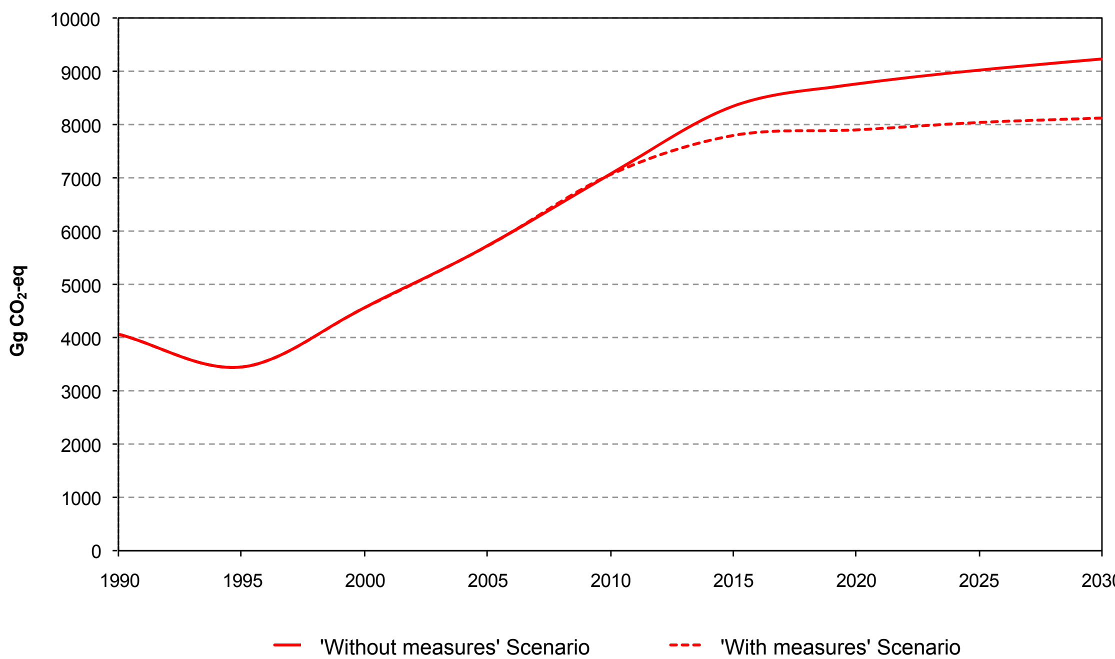


Figure 5-9: Transport sector emission projections

The transport sector local initiatives may result with a stronger effect than it was planned, also new EU regulation, that is being prepared, will contribute in additional reduction of emissions. These additional measures should ensure that after 2015 emissions from Transport sector remain at a constant level.

5.1.2. Industrial processes

'Without measures' scenario includes GHGs emission projections from industrial processes and solvent and other product use. It is assumed that production in industrial processes will reach planned, maximum values until 2030 and that neither GHGs emission reduction measures will be implemented.

'With measures' scenario includes appliance of cost-effectiveness GHGs emission reduction measures in production of cement, glass and nitric acid as well as solvent use. Mitigation scenario for industrial processes involves following measures: N_2O emission reduction in nitric acid production, reduction of clinker factor in cement and increase of recycled glass (cullet). Scenario comprises process emission while emission from fuel combustion is included in energy sector. Mitigation scenario for solvent use involves measures for reduction of volatile organic compounds emission (solvent management, measures for modification of the application techniques and biofiltration).

Emission projections of ‘without measures’ and ‘with measures’ scenarios in industrial processes and solvent use are shown in Figure 5-10.

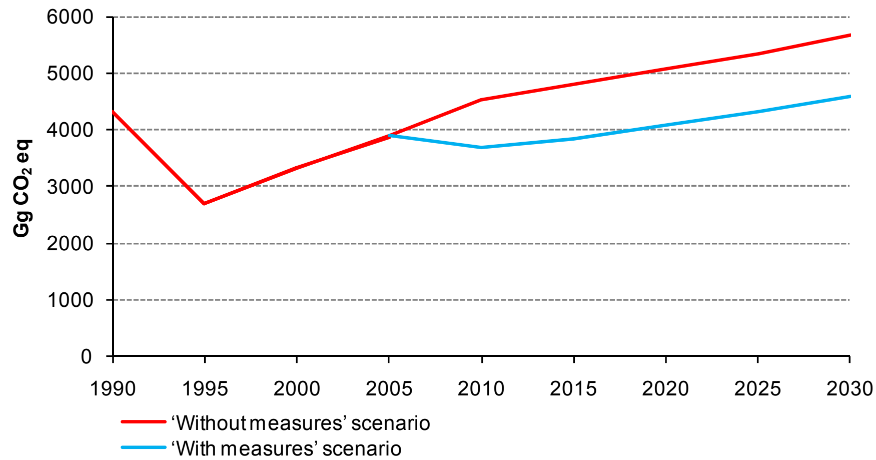


Figure 5-10: GHGs emission projections in industrial processes and solvent use

The GHGs emission reduction potentials (expressed in Gg CO_2 eq) which could be achieved until 2030 by applying the measures involved in ‘with measures’ scenario are presented in Table 5-10.

Table 5-10: GHGs emission reduction potentials in industrial processes and solvent use (Gg CO_2 eq)

Measure/GHG emission reduction potential	Gg CO_2 eq				
	2010	**2015**	**2020**	**2025**	**2030**
N_2O emission reduction in nitric acid production	608.6	608.6	608.6	608.6	608.6
Reduction of clinker factor in cement	181.6	201.1	220.7	240.3	259.9
Increase of recycled glass (cullet)	13.7	14.1	15.6	16.5	17.4
Measures for reduction of volatile organic compounds emission in the solvent use sector	40.1	140.4	157.0	180.5	197.7
GHG emission reduction potential (Gg CO_2 eq)	**844.0**	**964.2**	**1001.9**	**1045.9**	**1083.6**

The CO_2 emission reduction potentials (expressed in Gg CO_2 eq), which could be achieved until 2030 by applying the energy measures (energy efficiency improvement of production process and introduction of fuel with lower carbon content), whose effect is included in energy sector, are presented in Table 5-11.

Table 5-11: CO_2 emission reduction potentials in industrial processes - effect in the energy sector (Gg CO_2 eq)

Measure/CO_2 emission reduction potential	**Gg CO_2 eq**				
	2010	**2015**	**2020**	**2025**	**2030**
Energy measures in cement production	10.1	31.5	52.8	58.1	63.9
Energy measures in lime production	11.7	56.0	58.6	64.5	70.9
Energy measures in glass production	5.9	14.4	15.9	17.4	19.2
CO_2 emission reduction potential (Gg CO_2 eq)	**27.7**	**101.9**	**127.3**	**140.0**	**154.0**

Cost analysis of measures included in 'with measures' scenario defines difference regarding 'without measures' scenario. Costs are estimated for 2010, with discount rate of 8%. Estimated costs are classified as low costs (0-20 EUR/t CO_2). Consequently, application of measures fulfils cost-effectiveness criterion.

5.1.3. Agriculture

Projections of greenhouse gas emissions from agriculture (CH_4, N_2O) for the period from 2010-2030, i.e. scenarios described below, were created based on several assumptions. The uncertainty of the estimation is in the lack of appropriate and reliable statistic and economic indicators and also in the uncertainty related to economic crisis.

While creating the projections, 2 "without measures" scenarios (with and without additional areas) and consequently 2 "with measures" scenarios (with and without additional areas) were developed. The basic difference is, therefore, in the increase of agricultural land (all marked with +).

The "without measures" and "with measures" scenarios with no increase in agricultural land assume that also there will be no increase in the mineral fertilizer consumption and in plant production. For the abovementioned and other parameters required for emission calculation, the year 2005 represents the reference year. The Ministry of Agriculture, Fishery and Rural Development provided the data on the number of animals until 2020.[49] For the next period until 2030, it is assumed that the number of animals will remain at the level as in 2020. The difference between the "without measures" and "with measures" scenarios is that the latter implies the implementation of the MCP-1 measure for which it is assumed that it can reduce greenhouse gas emissions from agriculture by 15% in relation to "without measures" scenario until 2020.

The "without measures" and "with measures" scenarios with an increase in agricultural land (all marked with +) assume that the agricultural land will increase by about 100,000 ha till 2015 in order to ensure raw material for biofuel production. At the same time, mineral fertilizer consumption and plant production (mostly rape seed) will be increased proportionally. For all other parameters, 2005 represents the reference year. The projections of animal number are the same as in the scenarios which do not assume increase in utilized agricultural land. The "with measures" (+) scenario includes the implementation of MCP-1 measure for which it is assumed that it can reduce greenhouse gas emissions from agriculture by 15% in relation to "without measures" (+) until 2020.

In all scenarios, emissions in 2025 and 2030 remain the same as in 2020.

[49] *Programme for gradual reduction of emissions of certian pollutants in the Republic of Croatia for the period till the end of 2010 with emission projections for the period from 2010 to 2020 (OG 152/09).*

Figure 5-11 shows former methane and nitrous oxide emissions and projected ones for the period from 2010–2020. The projections indicate an increase in methane (CH_4) emissions due to the animal number increase which is a crucial factor. In regard to N_2O emissions, increase of agricultural areas is a very important parameter that entails a number of other assumptions that all together result in emission increase. The potentials of greenhouse gas emission reduction in agriculture are presented in Table 5-12.

Table 5-12: Potentials of GHG emission reduction in agriculture (Gg CO_2 eq)

Measure/Potential to reduce GHG emissions	Gg CO_2 eq				
	2010	2015	2020	2025	2030
Efficient management of organic manure	50.0	60.0	66.6	66.6	66.6

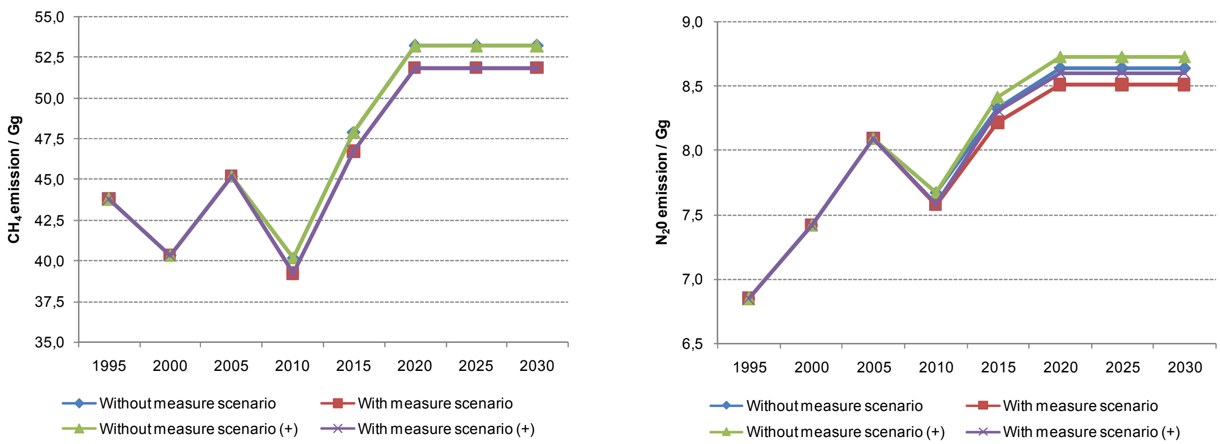


Figure 5-10: Methane and nitrous oxide emissions

In previous National Communication, projections were based on previous agricultural production and trends before and after the war. The maintenance of population increase, the lower rate of gross domestic product and increase in agricultural product consumption were assumed. Consequently, it entailed increase in agricultural land and livestock fund. However, the area increase was related to arable land and gardens, orchards and vineyards.

5.1.4. Forestry

The complexity of the LULUCF sector is based on three unique characteristics that can affect carbon stocks and consequently CO_2 emissions/removals: carbon storage limitation (saturation), the reversibility of carbon sequestration in the biosphere (non-permanence) and natural disturbances and human control. These issues require further attention.

The modalities of management and the habitat and structural conditions of the forests also affect carbon stock. If the current management continues (removing about 60% of annual increment), natural disturbances will become the most important factor affecting the emissions/removals. If linear extrapolation is used to project future sinks, the selection of time period required for this method is crucial.

Present forest management removes about 60% of annual increment. Additional carbon stock increase in existing forests can be achieved by improving the management of private forests. Afforestation of productive forest land without tree cover, which currently covers an area of 208,467 ha, and increasing the growing stock to 513,144 ha of other forest land, could result in significant carbon sink increase.

In regard to provisions of the Article 3.3. of the Kyoto protocol, after 1990 newly planted areas in Croatia were relatively small and sinks due to the latter were not utilizable for the first commitment period from 2008-2012. According to the Article 3.4, the Republic of Croatia has decided to report the activities under *Forest Management*. The amount of sink (*cap*) in this period was defined by the Decision 22/CP.9 and it amounted 0.265 Mt C per year (0.972 Mt CO_2) which represented approximately 15% of total sink in 2007 (6,302 Gg CO_2). After the first commitment period, there are several different approaches while considering the activities of Article 3.4 within the LULUCF sector. If forest management improves, that is, if carbon sequestration in forest biomass is increased, the *cap* will become more and more limitating factor. Since CO_2 sinks in Croatia, due to forest management, vary mostly due to the difference in areas caught by fire each year and also due to the war (1991-1995) during which the scope of forest management activities was not as usual, the determination of a base year (base period) represents a crucial step if the net-net approach will be applied.[50]

5.1.5. Waste management

'Without measures' scenario includes GHGs emission projections from municipal solid waste disposal at landfills, wastewater handling and waste incineration. Projections regarding municipal solid waste disposal involve following measures: avoiding and reducing of municipal waste generation, enhancement of separate collected and recycled municipal waste and increasing of population involved in municipal waste collection system.

'With measures' and 'with additional measures' scenarios include GHGs emission projections from municipal solid waste disposal at landfills. 'With measures' scenario consists of measures which will be implemented under mechanical-biochemical treatment of municipal solid waste in waste management centres and landfill gas flaring or utilization of landfill gas for electricity generation. Within a framework of the mechanical-biochemical treatment of municipal solid waste following measures are contained: decreasing of disposed biodegradable municipal waste, utilization of biogas in bioreactors for electricity generation and production and utilization of refuse derived fuel (RDF) in cement industry. 'With additional measures' scenario involves thermal treatment of municipal solid waste.

The CH_4 emission reduction could be achieved by decreasing of disposed biodegradable municipal waste and landfill gas flaring. Application of other measures included in 'with measures' and 'with additional measures' scenarios contributes to the CO_2 emission reduction which is included in the energy sector.

Emission projections of 'without measures' and 'with measures' scenarios in waste management are shown in Figure 5-12.

[50] Net-net - emissions and removals during the commitment period are compared with emissions/removals of the activities during the previous period (base year or base period).

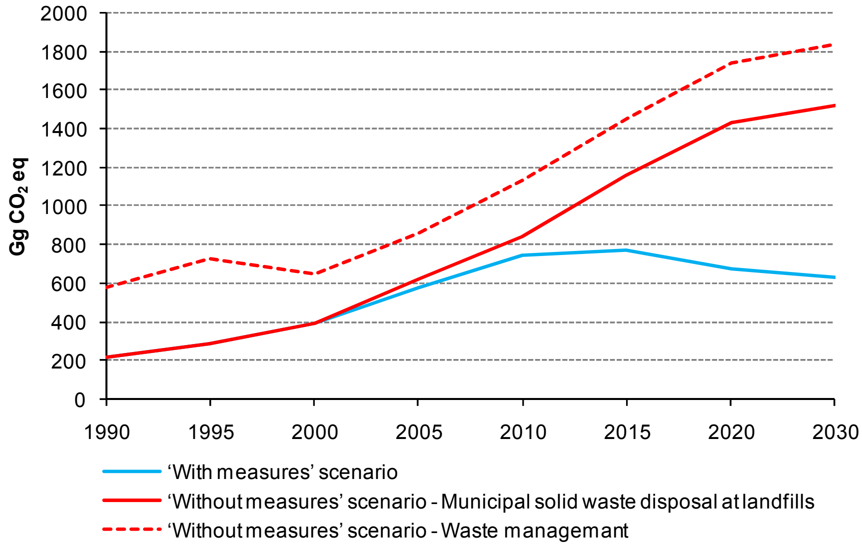


Figure 5-12: GHGs emission projections in waste management

The CH_4 emission reduction potentials (expressed in Gg CO_2 eq) which could be achieved until 2030 by applying the measures involved in 'with measures' scenario are presented in Table 5-13.

Table 5-13: CH_4 emission reduction potentials in waste management (Gg CO_2 eq)

Measure/CH_4 emission reduction potential	**Gg CO_2 eq**					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Decreasing of disposed biodegradable municipal waste	0	15.8	249.8	591.9	637.3	682.7
Landfill gas flaring	52.1	83.0	136.6	169.5	190.2	210.8
CH_4 emission reduction potential (Gg CO_2 eq)	**52.1**	**98.8**	**386.4**	**761.4**	**827.5**	**893.5**

The CO_2 emission reduction potentials (expressed in Gg CO_2 eq), which could be achieved until 2030 by applying the measures involved in 'with measures' and 'with additional measures' scenarios are presented in Table 5-14. Decreasing of CO_2 emission is a result of fossil fuel substitution. The CO_2 emission reduction potentials are included in energy sector.

Table 5-14: CO_2 emission reduction potentials in waste management - effect in the energy sector (Gg CO_2 eq)

Measure/CO_2 emission reduction potential	Gg CO_2 eq				
	2010	**2015**	**2020**	**2025**	**2030**
Utilization of landfill gas for electricity generation	7.7	12.7	15.7	17.7	19.6
Utilization of biogas in bioreactors for electricity generation	1.6	9.1	10.8	11.6	12.4
Production and utilization of refuse derived fuel (RDF) in cement industry	41.5	92.0	144.9	144.9	144.9
Thermal treatment of municipal waste	0	187.3*	187.3*	146.4*	105.4*
	0	106.9**	106.9**	83.6**	60.2**
CO_2 emission reduction potential (Gg CO_2 eq)	**50.8***	**301.1***	**358.7***	**320.6***	**282.3***
	50.8**	**220.7****	**278.3****	**257.8****	**237.1****

* CO_2 emission reduction potential is achieved by substitution of coal with municipal waste

** CO_2 emission reduction potential is achieved by substitution of natural gas with municipal waste

Cost analysis of measures included in ‘with measures’ and ‘with additional measures’ scenarios defines difference regarding ‘without measures’ scenario. Costs are estimated for 2010 i.e. 2015 (depending on measure appliance), with discount rate of 8%. Measures included in ‘with measures’ scenario are economic measures (if those are considered separately) because estimated costs are classified as low costs (0-20 EUR/tCO_2) or negative cost, that is, revenue, caused by fossil fuel saving, is realized. Thermal treatment of municipal waste is not economic measure because it belongs to category with high costs (>50 EUR/tCO_2). Introducing of gate fee could provide decreasing of marginal costs. At the same time measure appliance could be increased.

5.2. Total greenhouse gas emission projections

'With measures' scenario reduces the emissions of greenhouse gases in 2020 by 11% in relation to the BAU scenario, while 'with additional measures' scenario reduces emissions to 19%[51]. Projections of emissions for all three scenarios are shown in Figure 5-13.

Emission is being increased until 2020, after 2020 it is rapidly reduced, due to the assumptions of: CO_2 capturing and storage technology application, entering the nuclear power plant in 2024 and due to strong growth in use of renewable sources. Further reduction of emissions in 2020 could be achieved using expensive domestic measures and using flexible mechanisms of Kyoto Protocol (CDM, JI, ETS). Projections show that installations which are in ETS sector will have to buy emission allowances on the EU-ETS market.

[51] without carbon sink by sequestration in forest biomass from - 972 Gg CO_2-eq

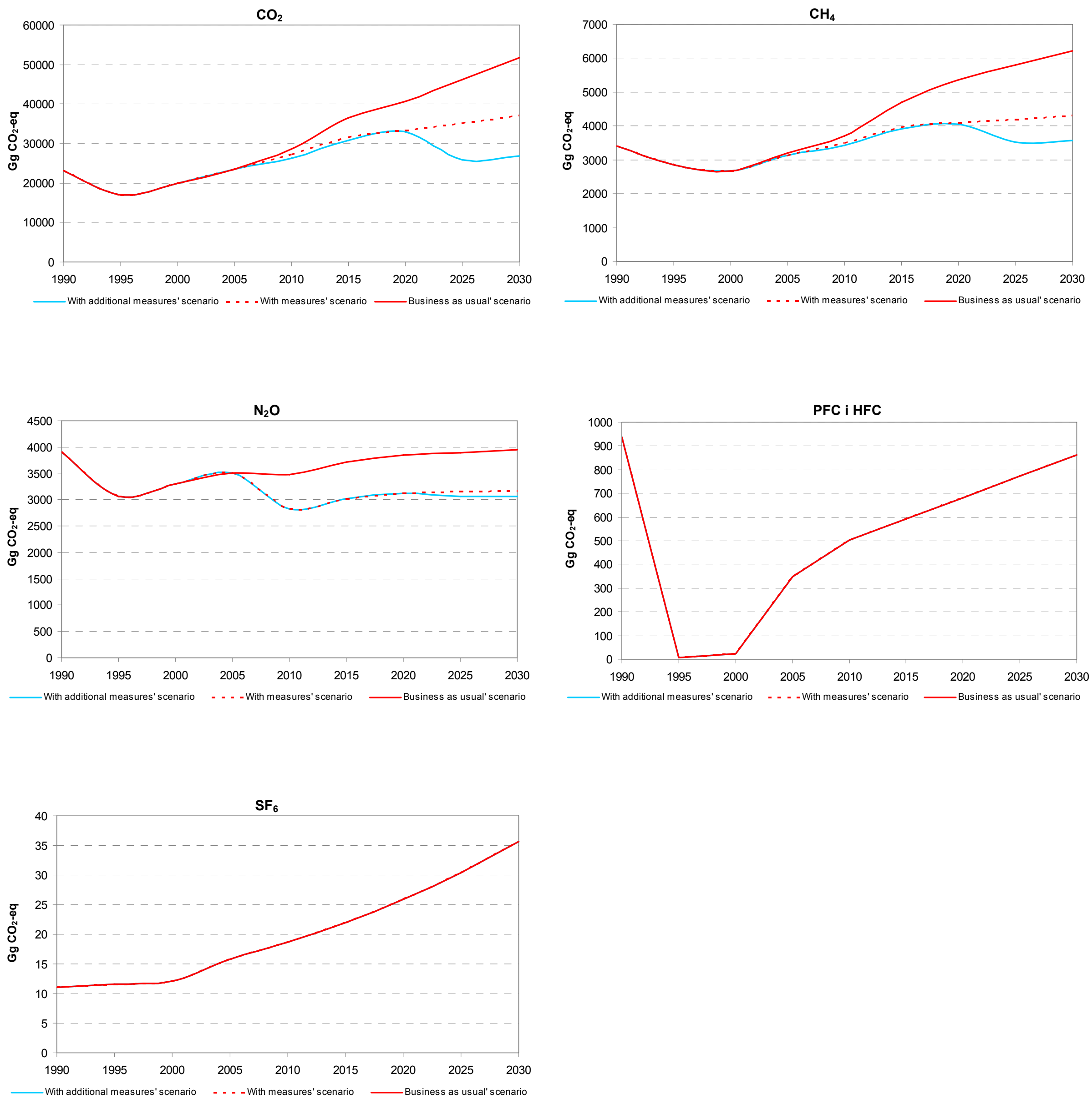


Figure 5-13: Total emissions of greenhouse gases-by gases, projections till 2030 (without LULUCF)

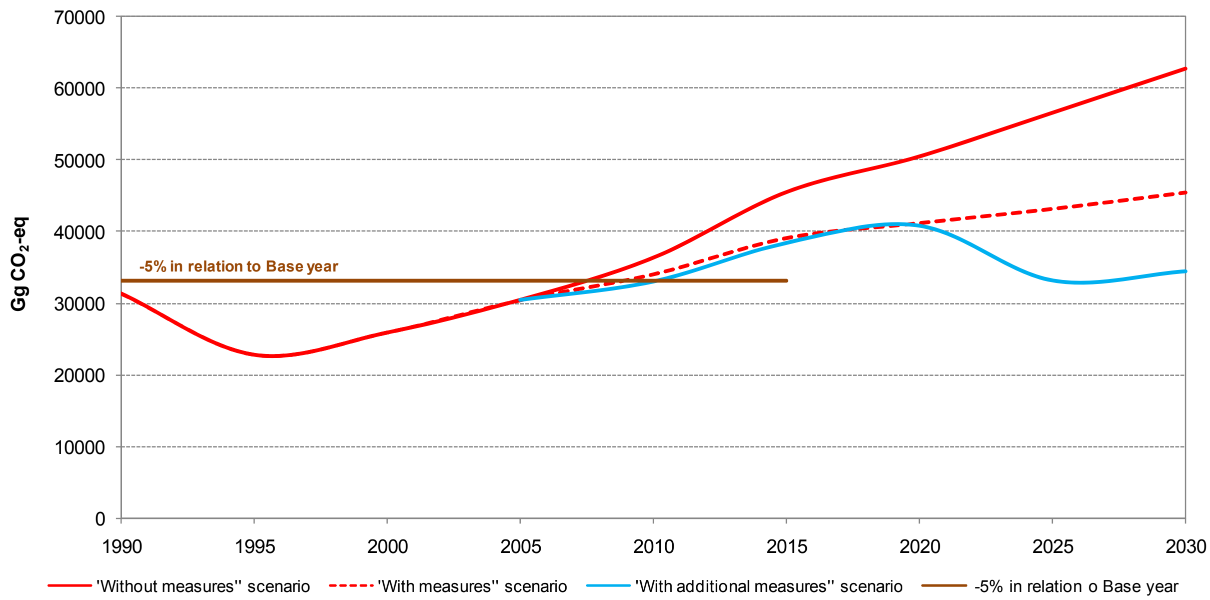


Figure 5-14: Total emissions of greenhouse gases[52], projections till 2030 (without LULUCF)

Tables 5-15 to 5-18 indicate emission projections for 'without measures', 'with measures' and 'with additional measures' scenarios by sectors till 2030 while Table 5-19 shows 'with measures' scenario in regard to Kyoto target.

Table 5-15: Emission projections for 'without measures' scenario till 2030

'WITHOUT MEASURES' SCENARIO	2010	2015	2020	2025	2030
Energy industries	9513	15211	18803	23398	27992
Industry and construction	3874	4750	5302	5802	6312
Transport	7073	8348	8762	9024	9235
Other sectors	4178	4702	5339	5846	6395
Fugitive emissions	2865	2727	1754	1653	1551
Industrial processes and Solvent use	4523	4797	5058	5343	5659
Agriculture	3235	3532	3732	3732	3732
Waste	1133	1455	1740	1790	1840
TOTAL (Gg CO_2 eq)	**36394**	**45523**	**50492**	**56588**	**62716**

[52] With assumptions that referent scenario in agriculture sector is 'BAU scenario-Ref'

Table 5-16: Emission projections for 'with measures' scenario till 2030

'WITH MEASURES' SCENARIO	2010	2015	2020	2025	2030
Energy industries	9118	12282	14781	16022	17847
Industry and construction	3520	4225	4243	4612	4649
Transport	6829	7809	7915	8055	8139
Other sectors	3855	3718	3832	3943	4109
Fugitive emissions	2865	2727	1754	1653	1551
Industrial processes and Solvent use	3679	3832	4056	4297	4575
Agriculture	3185	3472	3666	3666	3666
Waste	1034	1068	979	963	946
TOTAL (Gg CO_2 eq)	**34085**	**39135**	**41227**	**43209**	**45481**

Table 5-17: Emission projections for 'with additional measures' scenario till 2030

'WITH ADDITIONAL MEASURES' SCENARIO	2010	2015	2020	2025	2030
Energy industries	8057	11523	14325	5985	6805
Industry and construction	3520	4225	4243	4612	4649
Transport	6829	7809	7915	8055	8139
Other sectors	3855	3718	3832	3943	4109
Fugitive emissions	2865	2727	1754	1653	1551
Industrial processes and Solvent use	3679	3832	4056	4297	4575
Agriculture	3185	3472	3666	3666	3666
Waste	1034	1068	979	963	946
TOTAL (Gg CO_2 eq)	**33024**	**38376**	**40771**	**33172**	**34439**

Total emission projections by scenarios for the period from 2010 to 2030 are shown in Table 5-18. The difference between Kyoto target and each scenario are shown in Tables 5-19 and 5-20.

Table 5-18: Emission projections by scenarios till 2030 GgCO_2-eq

	1990	1995	2000	2005	2010	2015	2020	2025	2030
'WITHOUT MEASURES'	31322	22892	25986	30388	36394	45523	50492	56588	62716
'WITH MEASURES'	31322	22892	25986	30335	34085	39135	41227	43209	45481
'WITH ADDITIONAL MEASURES'	31322	22892	25986	30335	33024	38376	40771	33172	34439
'WITH MEASURES' +LULUCF	31322	22892	25986	29363	33113	38163	40255	42237	44509

Table 5-19: 'with measures ' scenario in regard to Kyoto target, Gg CO_2 eq

		1990	2008	2009	2010	2011	2012	2008-2012
1	EMISSION	31322						
2	BASE YEAR, According to 7/CP12 Decision	34822						
3	KYOTO TARGET, 95% OF THE BASE YEAR	33081	33081	33081	33081	33081	33081	165405
4	'WITH MEASURES' SCENARIO		32585	33335	34085	35095	36105	171205
5	'WITH MEASURES' SCENARIO + LULUCF		31613	32363	33113	34123	35133	166345
6	IN REGARD TO KYOTO TARGET (5-3)		-1468	-718	32	1042	2052	940

Table 5-20: The difference between Kyoto target and each scenario for the period from 2008-2012, Gg CO_2 eq

	2008	2009	2010	2011	2012	2008-2012
'WITHOUT MEASURES'	911	2112	3313	5139	6965	18439
'WITH MEASURES'	-496	254	1004	2014	3024	5800
'WITH ADDITIONAL MEASURES'	-1132	-594	-57	1014	2084	1314
'WITH MEASURES' +LULUCF	-1468	-718	32	1042	2052	940

Conclusion:

In 'with measures' +LULUCF scenario emissions are slightly above Kyoto target for the period from 2008 to 2012 (target is defined according to the Base year from 7/CP.12 Decision).

Effects of economic crises which are immanent in 2008 are not taken into account. Foreseeable effects of crises will affect the greenhouse gas emission in a way that probability of accomplishment of Kyoto target will be enhanced.

In the period from 2012-2025, Croatian emissions will be increased despite implementation of measures. The growth will be immanent till new technologies such as CO_2 capturing and storage will become commercially available.

6. EDUCATION, TRAINING AND PUBLIC AWARENESS

6.1. Education and training

Education is of vital importance for implementation of sustainable development that implies economic and social growth and development, preservation of environmental quality and rational exploitation of natural resources. Environmental education and sustainable development represent the essential components of life-long learning.

The education system of the Republic of Croatia consists of the pre-school, primary, secondary and university education. It is the view of the Ministry of Science, Education and Sports responsible for institutional education that all school subjects and activities must contribute to the development of ecological awareness and environmental education of students.

Regarding the above mentioned, the Sustainable Development Program has been implemented within the pre-school education, where children are educated on coexistence with nature, with every human being in order to develop environmental awareness of children.

In the Republic of Croatia the primary school syllabus determines programmes of compulsory and optional courses for schoolchildren and guidelines for other forms of educational activities of primary schools. Environmental and sustainable development education is an activity integrated into teaching and other forms of work. The knowledge of climate changes is acquired through regular primary school lessons in nature and society, nature, biology, chemistry and geography, including numerous out-of-school activities.

Projects and programs regarding the environmental protection and sustainable development, such as GLOBE and SEMEP international programs, Eco-schools projects, *Young Environmental Keepers* national program, etc. provide thematic and content-related framework to environmental education activities, enable networking of schools of similar interests and provide mutual support and experience exchange.

Since 1995, 130 schools of Croatia have been included in the scientific and educational programme GLOBE (Global Learning and Observation to Benefit the Environment), with schoolchildren performing regular and continuous measurements and observations in the environment. Measurements and observations are performed in a field of atmosphere, water, soil and vegetation cover, while the research results are mutually completed and connected and thus the global environmental monitoring program is being realized. The application of information technology tools ensures connectivity and information exchange among over 23000 schools in 111 countries worldwide.

International Eco-schools represent the program of Foundation for Environmental Education (FEE), recognized as one of the most successful environmental education models in the world. Non-governmental association Nature Friends Movement "Our Beautiful Homeland" acts as a national coordinator of this program. Over 300 primary and secondary schools, student homes and nursery schools from Croatia participate in this program, while 226 schools acquired the status of international Eco-school till now. In implementing programs at the level of entire schools in cooperation with parents and the local community special attention is given to waste reduction and disposal, reasonable use of energy and water and arrangement of schoolyards.

The eco-quiz show "Our Beautiful Homeland" is a competition in knowledge, a meeting of schoolchildren of Croatia's primary and secondary schools organized by the association "Our Beautiful Homeland", Ministry of Science, Education and Sports and the Education and Teacher Training Agency of the Republic of Croatia. The objective of the quiz show is to develop the awareness of environmental protection and sustainable development at the level of primary and secondary schools. The competition levels are: school, county and national.

The AWERES project (Awereness and Education in Renewable Energy Sources) of the Society for Sustainable Development Design, for two professional schools provides the equipment required for teaching on renewable energy sources – solar heating systems with all necessary measuring equipment, photovoltaic systems, wind generators and meteo-stations for measuring the meteorological indicators. Within the project, the Ministry of Science, Education and Sports created and accepted new optional course “Renewable energy sources” implemented into professional technical schools. The “Renewable energy sources within my community” brochure was created as the final project production and it will serve to associations, schools, managements and other interested organizations as a guide for promoting the renewable energy sources exploitation, in education, environmental protection and sustainable development of the community.

At the level of the universities, polytechnics, scientific and research institutes and other institutions the area of environmental protection, sustainable development and climate change is addressed through natural, technical, biomedicine, biotechnical, social and humanistic sciences within the framework of numerous compulsory or elective courses of undergraduate and postgraduate studies.

“Eco-engineering” course is organized as a postgraduate interdisciplinary specialist study at the University of Zagreb. The postgraduate scientific studies in environmental protection are organized at the University of Zagreb: “Ecology” Department of the Division of Biology (Faculty of Science); “Environmental Protection” (Faculty of Mining, Geology and Petroleum Engineering) and “Protection of Nature and Environment” at the Josip Juraj Strossmayer University of Osijek. “Environmental Management” represents an international master and doctoral studies at the University of Zagreb.

The Ministry of Environmental Protection, Physical Planning and Construction issues periodically printed materials (manuals, educational booklets, picture-books) and supplies multimedia information on climate change issues and ozone layer protection to be used for teaching in primary and secondary schools.

6.2. Raising Public Awareness

MEPPPC conducts a serie of activities related to implementation of commitments according to Article 6 of the Convention. Moreover, it is an authorized body for the implementation of the first two parts of the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention). Croatia conducts activities covered within this Convention. MEPPPC employees regulary participate in round tables discussions, public discussions, radio and TV programmes and also do lectures for the public. A brochure *Climate changes – school guide* aiming to encourage the young to protect the climate and spread the knowledge on climate changes was published and distributed to elementary schools and high schools in entire Croatia. Atmosphere, Sea and Soil Sector, in the period from June 2007 to October 2008, did regular monthly publications of informative articles in a magazine “National Geographic Croatia” on the following issues: climate changes, ozone layer protection, air quality, air emissions, produciona nd use of fosile fuels and biofuels and the protection of Croatian sea environment.

National Geographic Croatia, along with support of the Ministry of Environmental Protection, Physical Planning and Construction and the City of Zagreb, is the initiator of the action called “Ice Cube” by which the attention should be directed to global warming issues. In March 2008, an ice cube of 3.375 t was placed on a main square in Zagreb, and by melting it quite rapidly it warned the citizens that Croatia, although a small country with insignificant share in global warming, is also a responsible member of the world community.

Croatian Environment Agency, as independent public institution established by a decision of the government of the Republic of Croatia to collect, integrate and process environmental data. By applying the system of clear environmental data it facilitates the availability to requested information for all interested and thus ensures a fulfilment of rights to timely, true and accurate information on the environment. By using the publications, reports, internet portals etc., the Agency participates in raising and strengthening the public awareness.

In Croatia the Planet Earth Day has been traditionally celebrated since 1990 by environmental protection associations, non-governmental organizations, educational institutions and a number of other organizations. It is supported by the Ministry of Environmental Protection, Physical Planning and Construction as well by inviting all Croatian citizens to accept environmental-friendly way of behaving. As one of the greatest challenges is climate change and greenhouse gases emission increase, in 2008 the motto of the Planet Earth Day was “A Call for Climate”. The motto of a two-year campaign 2009-2010 is “Green Generation Campaign”, which basic principles are the carbon dioxide free future based on renewable energy and an individual contribution to responsible and sustainable consumption.

The Croatian centre "Environmental Knowledge" has, within the LIFE project "Capacity Building for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia", published a book called “A Drop over the Edge of Glass: Climate change - the World and Croatia” in order to educate and rise public awareness. The book was distributed to a number of schools and libraries in Croatia. Furthermore, within the education campaign, the Centre held 13 educational seminars for teachers and professors of Geography, Biology and Chemistry, as well as for representatives of non-governmental associations. Also, the Centre prepared a promotional DVD “Climate Change and Global Warming – the Croatian Story” with 20-minute documentary on climate change and global warming from the Croatia point of view.

United Nation Development Program (UNDP), Environmental Protection and Energy Efficiency Fund, Ministry of Environmental Protection, Physical Planning and Construction and

Ministry of Economy, Labour and Entrepreneurship have prepared “The One Ton CO_2 Challenge" brochure. The purpose of the brochure is to inform, educate and instruct Croatian citizens about specific actions aimed at reducing greenhouse gases emission through personal contribution of each individual. The goal is to curtail and slow down the negative climate change. On the World Environment Day, in 2007, 540.000 brochures were inserted into daily newspapers, while additional 60.000 were distributed on the same day at Information Points in the cities and the counties participating in the project.

Within the “Energy Efficiency in Croatia” project two brochures were published – “200 EE Advices” – how to use the energy more efficiently, to live a life of higher quality and to pay less, and “Standard measures for increasing the energy efficiency of your home”, where advices requiring larger investments were additionally worked out and described. The purpose of brochures is to inform, educate and instruct Croatian citizens about specific actions aimed at reducing the energy consumption, bills savings and at reducing the greenhouse gases emission into the atmosphere.

Regional Environmental Centre for the Middle and Eastern Europe, Croatian Office – REC, operates within nine program areas: building the institutional capacities in a field of environmental issues, providing information, supporting the associations, economy and environment, local initiatives, public participations, developing environmental protection strategies, climate change and environmental rights. Financial support program at the local level consists of providing the financial support to non-governmental organizations operating in a field of environmental protection. From 1996 to 2001, the REC’s office in Croatia has financially supported more than 120 non-governmental associations’ projects.

The REC promotes the energy efficiency concept by providing the support through educational projects, in which local governments, public and private companies and experts participate, as well as through promotion of energy efficiency principle in a wider area. The most important initiatives of the REC office in Croatia are:

- Project Energy efficiency in small and medium companies in Croatia in which the companies’ representatives of the energy most intense sectors estimated the potential to implement energy efficiency measures.
- Programme “The development of business plans for projects of cleaner production, energy efficiency and usage of renewable energy sources” which, in 4 years of implementation, resulted in 31 projects of cleaner production and energy efficiency with total investment of 45 mil. EUR.
- International project INTENSE with 3 mil. EUR in which local partners (REC office in Croatia, the Cities of Samobor and Koprivnica) introduced a complete approach to planning of energy optimal buildings. The project aims to provide assistance to the participants in establishing and implementing the EU legislation and in integration of energy efficiency as a key element in municipality and city spatial planning included in the project. The project includes the development of strategies for raising public

awareness and the preparation of tools that will enable the latter, and also the improvement of knowledge and skills of different co-partners through training programmes and material drafting.

In Croatia daily and weekly press cover various areas of environmental protection such as climate and climate changes, harmful effects of natural disasters (drought, heat, floods, storms), the use of renewable energy sources and biofuel and international commitments and activities of the Republic of Croatia in implementing the Framework Convention (UNFCCC) and the Kyoto Protocol.

In their news, scientific and educational broadcasts, radio and television stations occasionally provide information on climate changes.

Some important internet sites aimed at informing, educating and exchanging the information on climate change and associated topics (sustainable development, energy, energy efficiency, renewable energy sources, etc.):

- Within the internet site of the Ministry of Environmental Protection, Physical Planning and Construction www.mzopu.hr web-pages "A Call for Climate" klima.mzopu.hr were launched, dealing with climate change and all activities and projects implemented towards their mitigation.
- Site of the Environmental Protection and Energy Efficiency Fund www.fzoeu.hr provides data on fees paid by polluters and environment users, specific fees paid by owners and authorized persons of having the rights to motor vehicles, data on collecting and using the funds managed by the Fund, financing the projects, programs and other activities in a field of environmental protection and energy efficiency.
- Portal of the Croatian Environment Agency www.azo.hr contains, above other things, the National Greenhouse Gases Emission Register
- Meteorological and Hydrological Service regularly informs public, users and expert community about climate evaluation on the internet site www.meteo.hr and by mass media releases on a monthly, seasonal and yearly basis.
- Site of the Hrvoje Požar Energy Institute www.eihp.hr provides information on the energy; on national energy programs, renewable energy sources projects, energy efficiency projects that contribute in reducing the greenhouse gases emission, etc.
- Site www.MojaEnergija.hr created by the Society for Sustainable Development Design promotes sustainable development in all segments of the society, especially in energy sector. Purpose of the site is to educate, inform and raise public awareness in a field of energy and its impact on the environment.
- Site of the UNDP project "Energy Efficiency in Croatia" www.energetska-efikasnost.undp.hr
- Internet site of the "Green Action" association contains web pages with information on activities of the association relating to climate changes and promotion of renewable energy sources.

6.3. Activities of Non-governmental Associations

According to the data provided by the Ministry of Environmental Protection, Physical Planning and Construction there are presently 630 non-governmental organizations registered for environmental protection and conservation activities in Croatia.

Society for Sustainable Development Design (DOOR) performs a number of activities with a purpose to raise the public awareness, inform and educate in a field of renewable energy sources, energy efficiency, cleaner production and sustainable development. Some important projects:

- The AWERES project - "Awereness and Education in Renewable Energy Sources" is aimed at improving the environmental protection and sustainable development by stimulating the renewable energy sources exploitation in Croatia
- Site MojaEnergija
- "Energy Efficiency Video Manual" – series of short educational films that in a simple and acceptable way advice how to increase the energy efficiency in everyday life.
- RES Boat project – aimed at raising the public awareness on renewable energy sources.
- SolCamp – project for promoting and stimulating the usage of solar heating equipment in camps.

- "**Dialogue for Sustainable Energy"**- stimulating the cooperation between environmental protection associations being active or wanting to be active in a field of energy and environmental protection, and a dialogue with the expert community.

- **"Renewable Energy Sources" picture book** created for primary-school children.

"Green Action" association, a branch office of the "Friends of the Earth" international organization, expresses systematic activity in climate change related issues. Energy program of the "Green Action" deals with the promotion of sustainable energy sources, energy efficiency stimulation and climate change. In the last few years in the "Green Action" organization there were ten public discussions, street actions and conferences, as well as Autumn eco-seminars.

7. CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

7.1. Global Climate Change

Since the beginning of the global air temperature measurements in 1850, 2005 and 1998 were the two warmest years. Global mean temperature increased especially after 1950. Total temperature rise from 1850-1899 to 2001-2005 is 0.76°C ± 0.19°C. The linear warming trend over the last 50 years was nearly twice that for the last 100 years.

In case the future greenhouse gas emissions remain at current levels or being increased, further warming up would appear and it will start many changes within the global climate system, probably even larger ones than it was observed in the 20th century. By modeling the scenarios of future emissions it has been determined that climate change will reduce the efficiency of the Earth system (ground and ocean) in absorbing the carbon dioxide occurred by human activities. Consequently, large share of anthropogenic carbon dioxide will remain in the atmosphere, which may directly cause the ocean acidification.

Concerning the mean annual temperature in Europe, an increase larger than the global mean value is expected. In northern Europe it is probable that warming will be the largest during winter and annual precipitation will be increased as well. It is also quite possible that extreme daily precipitation will be increased as well. For the area of Mediterranean warming up will be probably the largest during summer, as well as reduction of annual precipitation. The risk of summer droughts will probably increase, except in the Mediterranean area and in central Europe. Duration of snow season will be probably reduced in a whole Europe.

According to IPCC, with continuation of existing trend of GHG emission in atmosphere, global mean temperature will increase 1,4 – 5,6 º C in the year 2100. In order to keep temperature increase bellow 2º C comparing to preindustrial period, global emission of GHG should be reduced in 2050 for 50-85%, in relation to emission in 2000. Temperature increase in Europe will be 0,1-0,4º C per decade, and the greatest worming is predicted in south and north Europe. As consequence of worming, global sea level will rice. Scenarios predict increase of sea level between 9 and 88 cm (average 48 cm) till year 2100.

7.2. Observed Climate Change in Croatia

Detection of climate variations and changes in air temperature and precipitation over the area of Croatia since the beginning of the 20th century has been performed according to the long-term meteorological measurements that started during the 19th century at meteorological stations in different climate regions: Osijek (continental climate), Zagreb-Grič (continental climate under a mild maritime influence), Gospić (continental climate of highland Croatia under a strong maritime influence), Crikvenica (maritime climate of eastern coast of the northern Adriatic) and Hvar (maritime climate of the Dalmatian area).

Decadal trends during the 20th century as well as those till 2008 were compared in order to determine the differences that appeared due to the changes in temperature and precipitation regimes at the beginning of the 21st century.

7.2.1. Air temperature

Increase of mean annual air temperature, which in the 20th century was between +0.02°C per 10 years in Gospić up to +0.07°C per 10 years in Zagreb, continued and amplified by the beginning of the 21st century (Table 7-1 and 7-2). In such way, decadal trends were proceeding until 2004 within the range from 0.04°C up to 0.08°C, and by 2008 between 0.05°C and 0.10°C. Prevailing positive trend has become particularly expressed within the last 50 years, even more within the last 25 years (Figure 7-1, Table 7-1). Trends of mean annual air temperature within the 108-year period are statistically significant at all stations except for Osijek, while within the last 50, i.e. 25 years at all observed stations. The positive temperature trends in the continental part of Croatia is mostly due to winter trends (+0.06 °C/10 years in Osijek, +0.13 °C/10 years in Zagreb and Gospić), while on the Adriatic to summer trends (+0.13 °C/10 years in Crikvenica and +0.07 °C/10 years in Hvar). The greatest trends were recorded in Zagreb; however, it should take into account that such increase is partially a result of the urban heat island.

Consequence of the faster atmosphere warming up during the last period of time is a result that out of ten warmest years since the beginning of the 20th century 7 of them were recorded in Zagreb, 6 in Gospić and Crikvenica, 5 in Hvar and 4 in Osijek (Table 7-3).

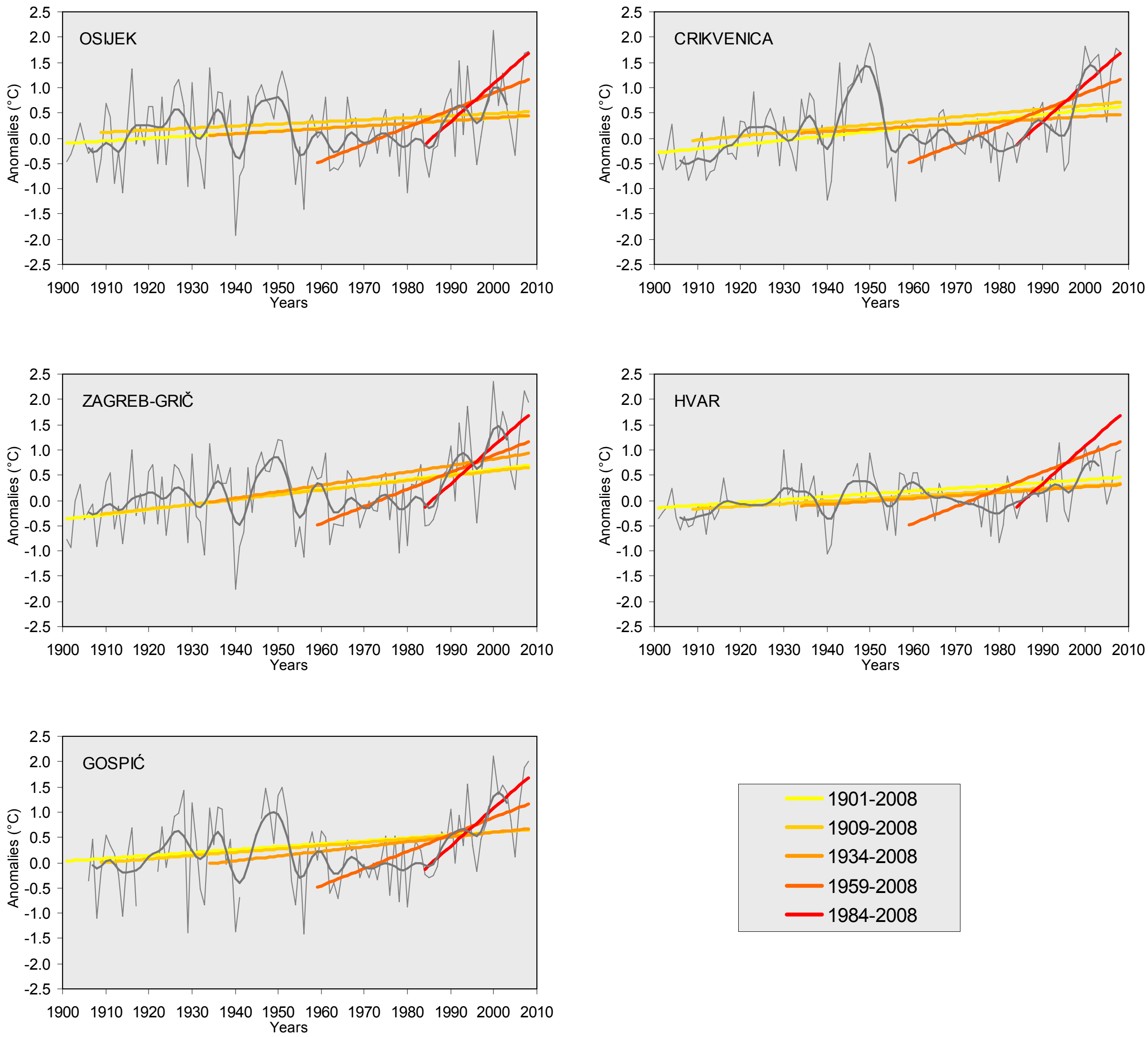


Figure 7-1: Time series for the mean annual air temperature related 11-year binomial moving averages, and trends for 108-, 100-, 75-, 50- and 25-year period. Unit is anomalies (°C) with respect to 1961-1990 average.

Table 7-1: Trends in mean annual air temperature (°C/10 years) for 108-, 100-, 75-, 50- and 25-year period. Trends significant at the 5% level are bolded.

	Osijek	Zagreb-Grič	Gospić	Crikvenica	Hvar
1901-2008 (108years)	+0.05	**+0.10**	**+0.06**	**+0.09**	**+0.06**
1909-2008 (100 years)	+0.04	**+0.09**	**+0.07**	**+0.08**	**+0.05**
1934-2008 (75 years)	+0.05	**+0.13**	+0.09	+0.05	+0.06
1959-2008 (50 years)	**+0.23**	**+0.34**	**+0.32**	**+0.28**	**+0.12**
1984-2008 (25 years)	**+0.52**	**+0.75**	**+0.69**	**+0.75**	**+0.35**

Table 7-2: Trends in mean annual and seasonal air temperature .(°C/10 years) Trends significant at the 5% level are bolded.

	Osijek	Zagreb-Grič	Gospić	Crikvenica	Hvar
Mean air temperature trend 1901-2000 (°C / 10 years)					
WINTER	+0.04	+0.09	+0.10	+0.06	+0.04
SPRING	+0.02	+0.07	+0.00	-0.01	+0.02
SUMMER	+0.03	+0.05	-0.03	**+0.07**	+0.03
AUTUMN	+0.03	+0.05	+0.00	+0.07	+0.05
YEAR	+0.03	**+0.07**	+0.02	**+0.05**	**+0.04**
Mean air temperature trend 1901-2004 (°C / 10 years)					
WINTER	+0.04	+0.10	+0.11	+0.07	+0.04
SPRING	+0.04	**+0.09**	+0.03	+0.02	+0.04
SUMMER	+0.05	**+0.08**	+0.02	**+0.11**	+0.06
AUTUMN	+0.03	+0.06	+0.02	**+0.08**	+0.06
YEAR	+0.04	**+0.08**	+0.04	**+0.07**	**+0.05**
Mean air temperature trend 1901-2008 (°C / 10 years)					
WINTER	+0.06	+0.13	+0.13	+0.08	+0.04
SPRING	+0.05	**+0.11**	+0.05	+0.04	**+0.05**
SUMMER	+0.06	**+0.09**	+0.04	**+0.13**	**+0.07**
AUTUMN	+0.03	+0.07	+0.03	**+0.09**	+0.05
YEAR	+0.05	**+0.10**	**+0.06**	**+0.09**	**+0.06**

Table 7-3: The ten warmest years. Years from the period 1991-2008 are bolded.

Osijek		Zagreb-Grič		Gospić		Crikvenica		Hvar	
year	°C	year	°C	year	°C	year	°C	year	°C
2000	***12.9***	**2000**	***13.8***	**2000**	***10.5***	1950	*16.0*	1945	*19.2*
2008	***12.5***	**2007**	***13.6***	**2008**	***10.4***	**2000**	***15.9***	**1994**	***17.5***
2007	***12.4***	**2008**	***13.4***	**2007**	***10.3***	**2007**	***15.9***	**2003**	***17.4***
1992	***12.3***	**1994**	***13.3***	**1994**	***9.9***	**2008**	***15.8***	**2000**	***17.4***
1994	***12.2***	**2002**	***13.2***	**2002**	***9.9***	**2003**	***15.8***	1930	*17.3*
1934	*12.2*	**1992**	***13.0***	1951	*9.9*	1951	*15.7*	**2008**	***17.3***
1916	*12.1*	**2003**	***12.9***	1947	*9.9*	1949	*15.7*	**2007**	***17.3***
1951	*12.1*	**2006**	***12.7***	1928	*9.8*	**2002**	***15.7***	1950	*17.3*
2002	***12.1***	**2001**	***12.7***	**2003**	***9.8***	1943	*15.6*	**2002**	***17.3***
1927	*11.9*	1950	*12.7*	**2001**	***9.7***	**2001**	***15.6***	1947	*17.1*

Assuming that the warming observed in mean air temperatures is a result of changes in frequencies of temperature extremes. Analysis of changes in number of days, in which the air temperature exceeds some specific values, does not provide any comparison of observed characteristics in different climate conditions. Namely, frequency of cold (t_{min}<0°C) or warm days (t_{maks}≥25°C) significantly differs between continental climate (Osijek) and maritime climate of Adriatic islands (Hvar). Therefore, The Expert Team on Climate Change Detection Monitoring and Indices of the World Meteorological Organization - Commission for Climatology (WMO-CCI) and Research Programme on Climate Variability and Predictability (CLIVAR) suggested a number of indices of meteorological parameters. Suggested indices are related to days in which the air temperature exceeds the threshold specified by the probability of appearance, i.e. in specific return period. Six indices have been used for the analysis of temperature extremes, four of them with thresholds specified by percentiles and two of them by fixed thresholds. Three warm temperature indices are warm days and warm nights with maximum and minimum air temperature above the 90th percentile of the daily temperature distribution in the 1961-1990 baseline period, as well as summer days with maximum air temperature higher than 25°C. Three cold temperature indices are cold days and cold nights with maximum and minimum air temperatures below the 10th percentile, as well as frost days with minimum air temperature lower than 0°C.

Within the whole analyzed period, a majority of warm temperature indices has a positive trend, while a majority of cold temperature indices has a negative trend (exceptions are warm nights Tn10% in Hvar, and summer days in Gospić and frost days in Osijek) (Table 7-4). Comparison with trends from earlier periods 1901-2000 and 1901-2004 indicates that almost all trends by 2008 has been amplified, some of them have become statistically significant, while changes in trends of warm temperature indices are greater than changes in trends of cold indices. Trends are much more expressed at the Adriatic, than in the inland, except in Zagreb, where they are probably a result of urban heat island impact.

Table 7-4: Trends in indices of temperature extremes (FD, Tn10%, Tx10%, SU, Tn90% and Tx90%) (number of days) according to the reference period 1961-1990, and mean values of number of frost (FD) and summer (SU) days. Trends significant at the 5% level are bolded.

	Osijek	**Zagreb Grič**	**Gospić**	**Crikvenica**	**Hvar**
Trend 1901-2000 (days / 10 years)					
FD	+1.1	-0.9	+0.1	**-0.7**	0.0
Tn10%	-0.3	**-0.3**	-0.3	**-0.3**	**+0.9**
Tx10%	**-1.1**	**-1.4**	-0.5	**-1.9**	**-5.4**
SU	-0.2	0.0	-1.2	+1.0	**+2.6**
Tn90%	-0.5	**+2.7**	+0.6	+0.7	**-0.8**
Tx90%	-0.3	+0.5	-0.1	**+1.4**	**+3.3**
Trend 1901-2004 (days / 10 years)					
FD	+1.0	-0.9	+0.1	**-0.8**	-0.1
Tn10%	-0.4	**-2.7**	-0.6	**-2.9**	+0.5
Tx10%	**-1.2**	**-1.7**	-0.4	**-2.0**	**-5.2**
SU	0.0	+0.1	-0.6	**+0.1**	**+2.6**
Tn90%	+0.1	**+3.2**	**+1.3**	+1.7	+0.4
Tx90%	0.0	+1.2	+1.1	**+1.6**	**+3.8**
Trend 1901-2008 (days / 10 years)					
FD	+0.9	**-0.1**	-0.1	**-0.8**	-0.1
Tn10%	-0.6	**-2.7**	**-0.8**	**-2.9**	+0.2
Tx10%	**-1.2**	**-1.7**	-0.8	**-1.9**	**-5.1**
SU	0.0	+0.3	-0.4	**+1.1**	**+2.6**
Tn90%	+0.6	**+3.5**	**+1.9**	**+2.2**	+1.0
Tx90%	+0.4	+1.8	+1.5	**+1.8**	**+4.1**
Mean number of days in period 1961-1990.					
FD	88	60	120	18	5
SU	90	61	47	84	110

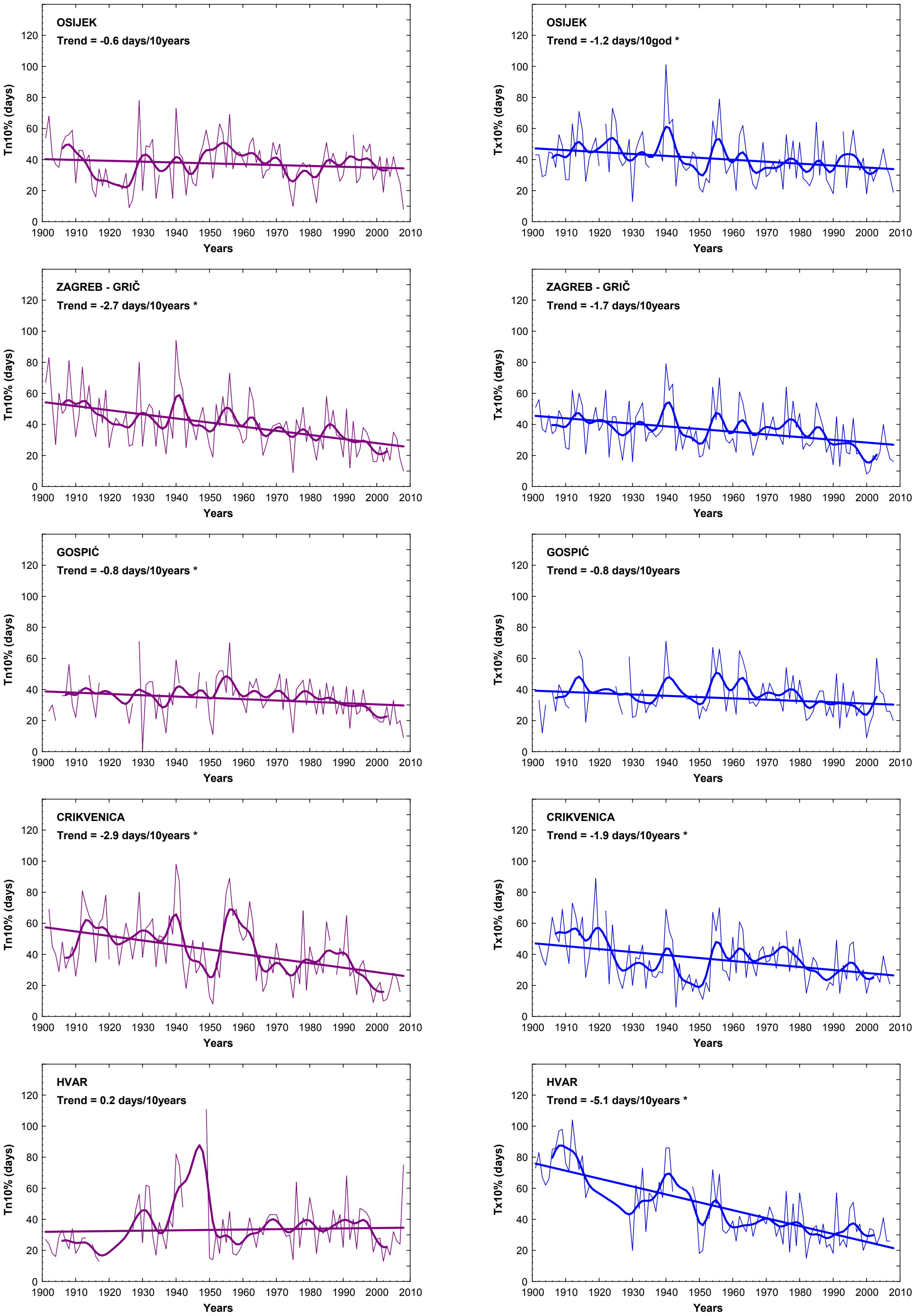


Figure 7-2: Time series for the number of days with minimum (Tn10% - left) and maximum (Tx10% - right) air temperatures below the 10th percentile, related binomial moving averages and trends (- trends significant at the 5% level). Period: 1901-2008.*

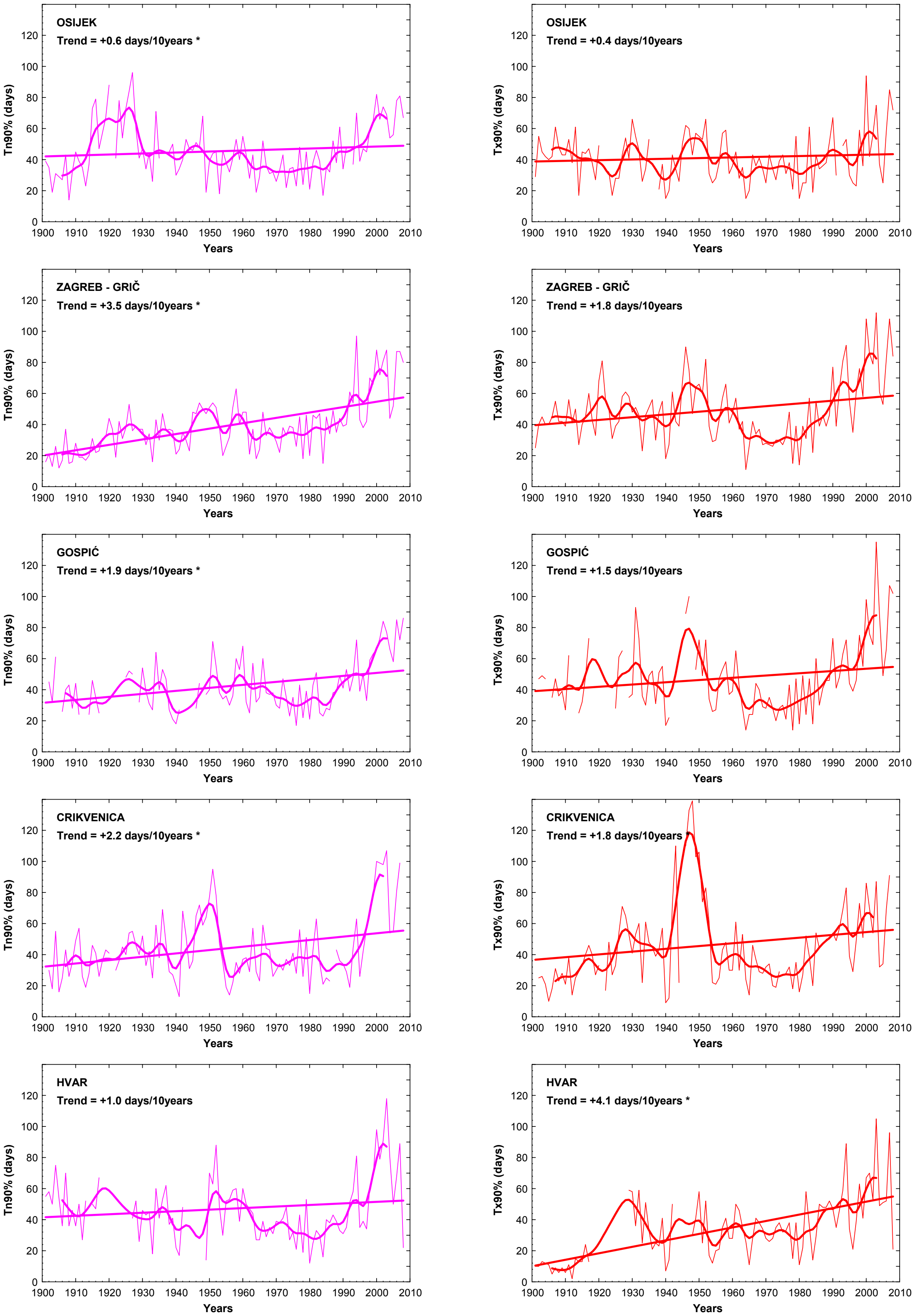


Figure 7-3: Time series for the number of days with minimum (Tn90% - left) and maximum (Tx90% - right) air temperatures above the 90th percentile, and related binomial moving averages and trends (- trends significant at the 5% level). Period: 1901-2008.*

7.2.2. Precipitation

During the 20th century annual amounts of precipitation showed a downward trend in all parts of Croatia, thus joining the trend of drying across the Mediterranean (Figure 7-4 and Table 7-5). It is more expressed over the Adriatic (Crikvenica: -1.8% in 10 years, statistically significant and Hvar: -1.2% in 10 years), than in the inland (mountainous hinterlan– Gospić: -0.8% in 10 years, eastern Slavonija, Osijek: -1.3% in 10 years, north-western Croatia, Zagreb-Grič: -0.3% in 10 years). These are the results of the seasonal precipitation trends which differ among regions. In the area of northern Adriatic (Crikvenica) decrease in all seasonal precipitation amounts has been observed, mostly expressed during summer (-2.7% in 10 years), then in spring (-2.2% in 10 years) and winter (-1.8% in 10 years). On Dalmatian islands (Hvar) decrease in annual precipitation amounts is a result of decline in winter (-2.9% in 10 years) and spring (-2.0% in 10 years) precipitation amounts. In the mountainous hinterland (Gospić on the Lika plateau) a decrease in winter (-2.7% in 10 years) and spring (-2.0% in 10 years) precipitation amounts is mostly expressed. The decline in annual amounts of precipitation over the area north of the Sava River results from decrease in spring (Osijek: -4.1% in 10 years and Zagreb-Grič: -1.1% in 10 years) and autumn (Osijek: -3.0% in 10 years and Zagreb-Grič: -1.4% in 10 years) precipitation amounts.

Decadal trends in annual and seasonal precipitation amounts have not been significantly changed according to data series prolonged by 2008 (Table 7-5). Less changes are present with Osijek, where attenuation of negative spring precipitation trend was observed, but still remaining statistically significant, as well as weakening of negative autumn precipitation trend and strengthening of positive summer trend. Negative spring precipitation trend weakened in the area of Hvar.

Precipitation amounts have large interannual variability, both on annual and seasonal scales. Therefore, in order to find out position of 10 driest years in the observed 108-year period, it can be seen that they do not occur grouped in some period. During the last 18 years, i.e. since the beginning of 1990's, there was only one out of three driest years. 2003 is one of 10 driest years at all locations. Beside this year, there was 2000 in Osijek, 2007 and 1994 in Gospić and 1992 in Hvar. (Table 7-6).

Variability of annual precipitation amounts in the period 1901-2008, expressed by time series of coefficients of variability, calculated for 30-year periods with one year shift, indicates a decrease in Zagreb, Gospić and Crikvenica (Figure 7-4 right). Such a decrease was present in Osijek by the end of the 20th century as well, but the changes since the beginning of the 21st century contribute to an increase of variability. In Hvar there was an increase of variability in a period from the middle of the 20th century,.

Change in precipitation regime patterns, which can result in precipitation decrease in Croatia, can be also indicated by tendency in frequency and intensity of precipitation extremes defined by number of days in which the precipitation amount R_d exceeds defined thresholds (dry days, wet days and very wet days), i.e. part of annual precipitation amount occurring during very rainy days, annual maximum 5-day and 1-day precipitation amounts. Dry days are defined as days in which R_d<1.0 mm, wet days have $R_d \geq 75^{th}$ percentile and very wet days $R_d \geq 95^{th}$ percentile of daily amounts, determined by the sample of all precipitation days (R_d≥1.0 mm) within standard reference period 1961-1990.

In the period 1901-2008 there was statistically significant increase of annual number of dry days (R_d<1.0 mm) in the whole area of Croatia, mostly negative trend of wet days (Rd≥R75%), significant in Osijek and Crikvenica, while in the number of very wet days (Rd≥R95%) there was no change (Table 7-7). Fraction of annual total precipitation due to very wet days (R95%T) is almost unaltered. Absolute annual 1-day and 5-day maxima indicate large interannual variability, with weak positive trend only on Dalmatian islands, while in the inland and Littoral there is a decrease of precipitation amounts during heavy precipitation events, statistically significant for 5-day maxima in Osijek (-1.0 mm/10 years) and 1-day maxima in Gospić (-1.4 mm/10 years).

As seen from above, in the area of drying such as Croatia there is no signal of major secular changes in extremes related to the high amounts of precipitation and frequency of wet and very wet days over the larger part of Croatia. The reduction

n in the annual amounts of precipitation can be attributed to changes in the frequency of low-intensity rain days and significant increase in incidence of dry days all over Croatia.

Table 7-5: Trends in annual and seasonal precipitation amounts. Trends significant at the 5% level are bolded..

	Osijek	Zagreb-Grič	Gospić #	Crikvenica	Hvar
Precipitation amount trend 1901-2000 (% / 10 years)					
WINTER	+0.6	-0.3	-2.7	-1.8	-2.9
SPRING	**-4.1**	-1.1	-2.0	-2.2	-2.0
SUMMER	+0.7	+1.2	+0.9	-2.7	+2.8
AUTUMN	-3.0	-1.4	+0.1	-0.9	-0.4
YEAR	-1.3	-0.3	-0.8	**-1.8**	-1.2
Precipitation amount trend 1901-2004 (% / 10 years)					
WINTER	+0.2	-0.4	-2.6	-1.9	**-2.4**
SPRING	**-3.6**	-0.9	-2.0	-2.1	-2.0
SUMMER	+0.8	+0.9	-0.1	**-3.4**	+2.9
AUTUMN	-1.8	-1.0	+0.6	-0.7	-1.0
YEAR	-1.0	-0.3	-0.8	**-1.8**	-1.3
Precipitation amount trend 1901-2008 (% / 10 years)					
WINTER	-0.0	-0.4	-2.9	-1.6	**-2.9**
SPRING	**-3.2**	-0.9	-1.8	-1.9	-1.3
SUMMER	+1.3	+1.1	+0.1	**-2.9**	+2.9
AUTUMN	-2.0	-1.3	-0.2	-1.1	-0.5
YEAR	-0.8	-0.3	-1.0	**-1.7**	-1.0

since 1924.

Table 7-6: Ten driest years. Years from the period 1991-2008 are bolded.

Osijek		Zagreb-Grič		Gospić #		Crikvenica		Hvar	
Year	*mm*	year	*mm*	year	*mm*	year	*mm*	year	*mm*
2000	***316***	1949	*581*	1983	*910*	1949	*704*	1983	*384*
1921	*422*	1973	*607*	1953	*973*	1945	*726*	**2003**	***431***
1983	*467*	1971	*616*	1949	*1085*	**2003**	***752***	1989	*444*
1947	*494*	1927	*624*	1971	*1091*	1953	*786*	1913	*461*
1953	*500*	**2003**	***624***	**2003**	***1099***	1971	*835*	1903	*479*
1949	*505*	1921	*651*	**2007**	***1109***	1973	*842*	1977	*496*
2003	***517***	1946	*665*	1989	*1119*	1956	*850*	1938	*505*
1971	*519*	1942	*671*	**1994**	***1121***	1921	*861*	1946	*542*
1928	*522*	1938	*688*	1975	*1135*	1983	*877*	1950	*557*
1924	*523*	1911	*691*	1946	*1136*	1920	*882*	**1992**	***563***

since 1924.

Table 7-7: Trends in indices of precipitation extremes (DD – dry days, R75% - wet days, R95% - very wet days, R95%T – annual precipitation fraction due to very wet days, Rx1d – annual 1-day precipitation maxima, Rx5d – annual 5-day precipitation maxima). Trends significant at the 5% level are bolded .

	Osijek	Zagreb-Grič	Gospić #	Crikvenica	Hvar
Trend 1901-2000 (in 10 years)					
DD (days)	+0.9	**+1.5**	+1.6	**+2.1**	**+1.1**
R75% (days)	-0.3	+0.0	-0.2	-0.5	-0.3
R95% (days)	-0.1	+0.1	+0.1	-0.1	-0.0
R95%T (%)	-0.3	+0.4	+0.5	+0.1	+0.3
Rx1d (mm)	-0.4	+0.0	-1.3	+1.4	+0.5
Rx5d (mm)	**-2.2**	-0.4	-0.3	-2.7	-0.7
Trend 1901-2008 (in 10 years)					
DD (days)	**+1.0**	**+1.4**	+1.4	**+2.3**	**+1.1**
R75% (days)	**-0.2**	+0.1	-0.2	**-0.5**	-0.2
R95% (days)	-0.1	+0.1	+0.0	-0.1	-0.0
R95%T (%)	-0.2	+0.3	+0.1	-0.0	+0.3
Rx1d (mm)	+0.2	-0.2	**-1.4**	+0.8	+0.9
Rx5d (mm)	**-1.0**	-0.6	+0.3	-2.4	+0.6

since 1924.

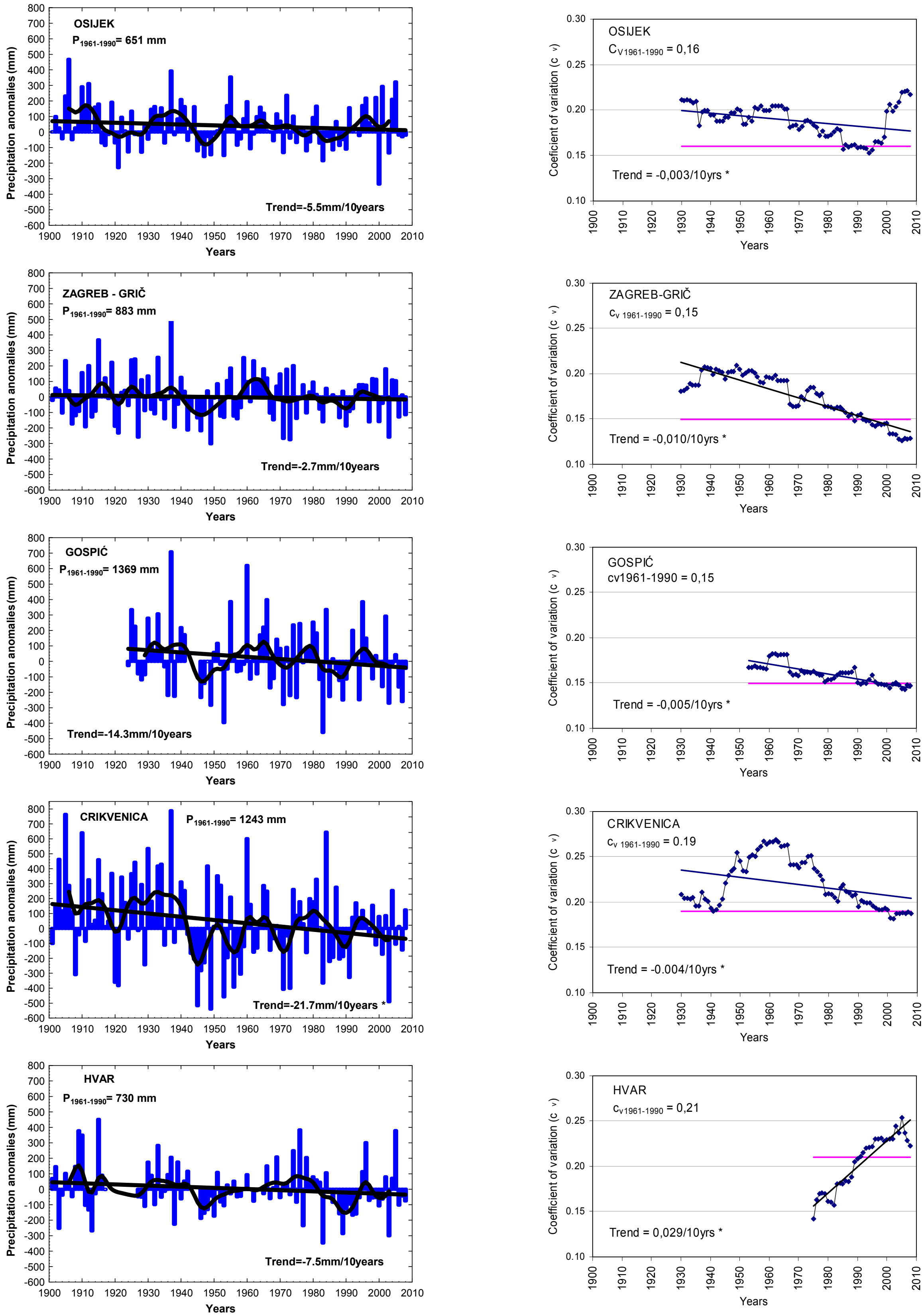


Figure 7-4: Time series for the annual precipitation amounts, related 11-year binomial moving averages and trends (left), unit is anomalies (mm) with respect to 1961-1990 average). Time series for the coefficients of variation for 30-year periods with one year shift and trends (right). (- trends significant at the 5% level). Period: 1901-2008*

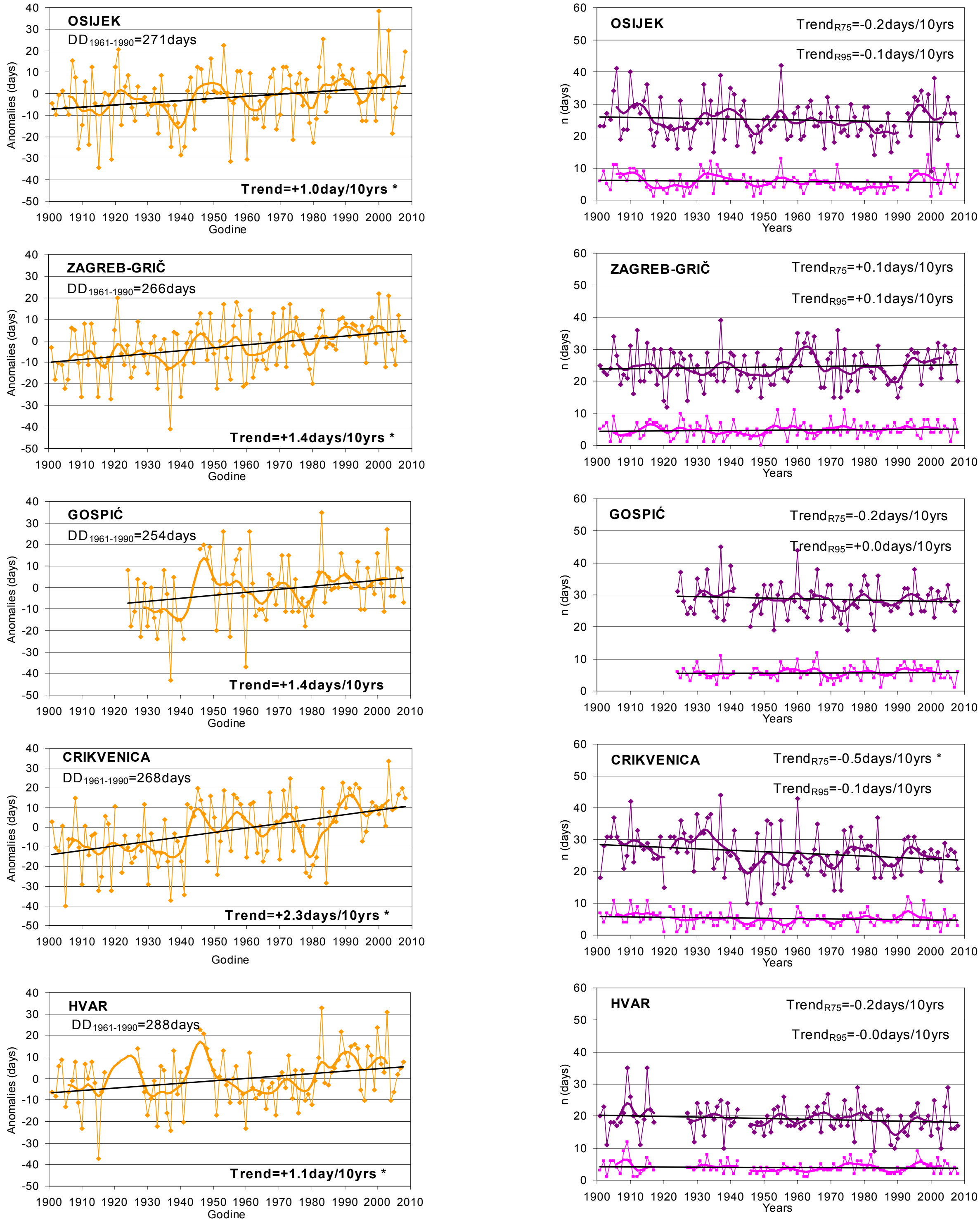


Figure 7-5: Time series for the number of dry days (left), unit is anomalies (days) with respect to 1961-1990 average. On the right time series for the number of moderate wet days (Rd>R75% - above) and very wet days (Rd>R95% - below), related 11-year binomial moving averages and trends (- trends significant at the 5% level). Period: 1901-2008. (Gospić: 1924-2008).*

7.2.3. Dry spells

Detected significant positive trend in number of dry days in the area of Croatia raises the question on frequency of consecutive dry days. Variations of dry sequences are analysed imploying daily precipitaiton data from the period 1961-2000 at 25 meteorological stations, which uniformly comprise main climate zones in Croatia (continental, mountain and maritime). Dry spell is defined as a sequence of days with daily precipitation amount (Rd) less than defined threshold. Seasonal and annual mean and maximum durations of dry spells have been analyzed for precipitation threshold of 1 mm and 10 mm. Trend is expressed as depature per decade in relation to the respective long-term mean value.

Results of trend analysis indicate prevailing increase of mean annual duration of dry spells with Rd < *1 mm* . It is statistically significant in Istria (5 to 6%/10 years) and on southern islands (Hvar and Lastovo 5%/10 years) (Figure 7-6). Increase of dry spells on annual basis is a result of prevailing increase in all seasons, except in autumn, when negative trend has been observed. The most significant changes have been detected in spring, especially in northern Adriatic (8 to 11%/10 years). Analysis of annual maximum dry spells with Rd < 1 mm does not reveal any significant positive or negative trend in Croatia (Figure 1-6). Positive trend prevails in spring and it is statistically significant in northern Adriatic (9 to 11%/10 years), while negative trend prevails in autumn, which is significant only in Rijeka, Šibenik and Osijek (9 to 12%/10 years).

Analysis of annual mean durations of dry spells for daily precipitation threshold of *10 mm* indicates prevailing positive trend in Croatia, significant in Istria and Dubrovnik (6 to 8%/10 years) (Figure 7-6). Negative, but statistically insignificant trend has been observed only in lowlands of Croatia. Statistical significance of trend at annual scale is mostly forced by winter and summer significant increase of mean dry spells. Still, positive trend, statistically the most significant one, has been observed in spring; while in autumn, durations of mean dry spells with Rd < 10 mm decline, especially in the area of Slavonija (10 to 11%/10 years). Maximum dry spells have being increased along the coast (10 to 11 %/10 years), while reduced in the inland (8 %/10 years) (Figure 7-7). Such annual trend of maximum dry spells is mostly contributed by summer variations. Prevailing increase of dry spells at the Adriatic, as well as poorly expressed trend in the continental area contribute to the fact that Croatia remains within the transitional area between the northern Europe with general tendency of precipitation increase, and the drying Mediterranean.

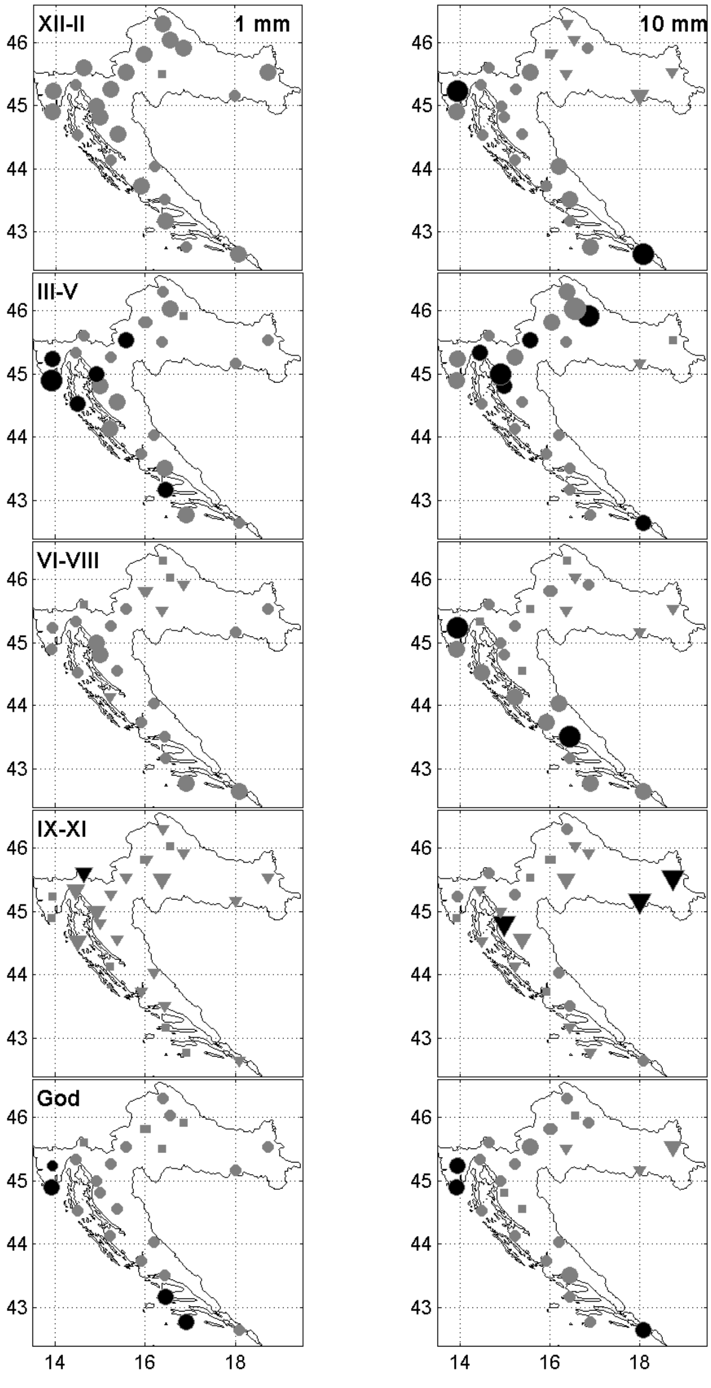


Figure 7-6: Trend results of mean dry spells for the precipitation threshold of 1 mm (left column) and 10 mm (right column), for seasons (upper four rows) and a year (lower row). Circles indicate positive trend, triangles negative trend, while symbols in bold type indicate statistically significant trend. Size of symbols is proportional to the absolute value of change per decade relative to the respective average: 1-5%/10 years, 5-10%/10 years and larger than 10%. Squares indicate trend between +/- 1%/10 years.

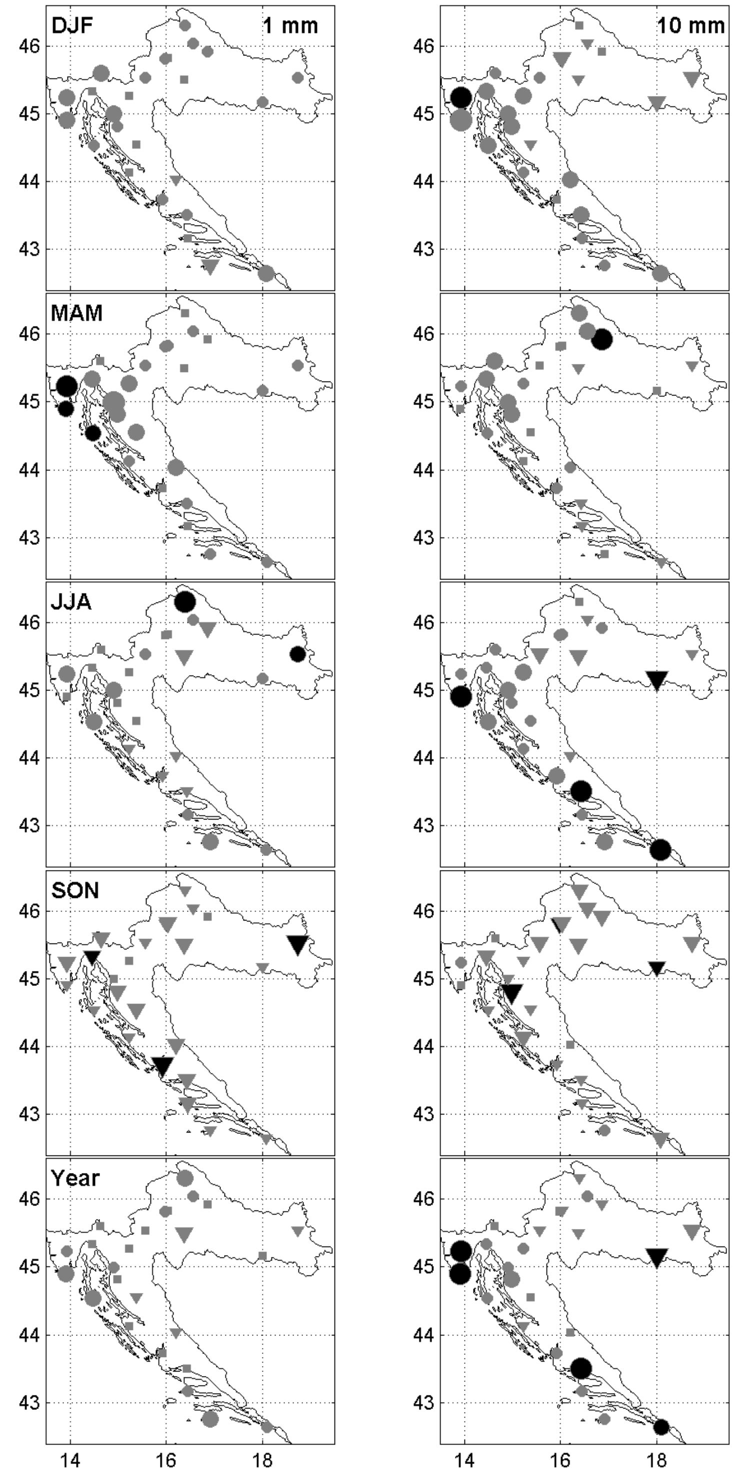


Figure 7-7: Trend results for maximum durations of dry spells for precipitation threshold of 1 mm (left column) and 10 mm (right column), for seasons (upper four rows) and a year (lower row). Circles indicate positive trend, triangles negative trend, while symbols in bold type indicate statistically significant trend. Size of symbols is proportional to the absolute value of change per decade relative to the respective average: 1-5%/10 years, 5-10%/10 years and larger than 10%. Squares indicate trend between +/- 1%/10 years.

7.3. Climate Change Scenario

7.3.1. Introduction

7.3.1.1. General remarks

Information on global climate change of the mean value of some climatological parameter, temperature for example, is not sufficient to estimate climate change at regional or local level. The intensity of local climate change can differ from the change of global mean value because of specific latitude, topographic features, distribution of land and sea, etc. However, local climate change should be viewed within the context of global change modulated by local impacts. In this report the results of dynamical downscaling by a regional climate model for the two 30-year periods are described and discussed – for the climate of the 20th century and the future climate from the 21st century, according to the A2 scenario of Intergovernmental Panel on Climate Change (IPCC).

Dynamical downscaling is the method that adjusts the output of a global climate model to a smaller area by the help of a regional climate model. Thus, the results of climate change at a relatively coarse resolution (200-300 km) are being adjusted to much finer space resolution (20-50 km). In this process a regional model defines its “own” hydro- and thermo-dynamical processes at smaller scales, adjusting to the boundary forcing from a global model. In such a way, dynamical consistency in the modelled atmosphere is being achieved. Space variations of climate parameters are better represented at smaller scales by dynamical downscaling, especially extreme events, whose intensity in global models is usually weakened as the smallest grid box of few hundred kilometres can cover the whole region of interest. The alternatives to dynamical downscaling are statistical downscaling methods, but they do not take into account the dynamical connection between global and regional scales.

Although defined for smaller areas and finer resolution, regional climate models cannot improve possible poor results of global models. Of course, vice versa is valid as well – dynamical downscaling by a poor regional climate model cannot improve the global model simulation regardless of the resolution improvement. In other words, the quality of dynamical downscaling results depends on the quality of regional model used for dynamical downscaling as well as on the quality of global model results.

It should be pointed out that the results of a regional climate model cannot accurately describe observational data at regional (local) scale. Of course, it is important that the difference between model results and observations would be as small as possible, but, as model offers only approximation of the actual situation, it inevitably contains errors. Accordingly, a good model is the one with relatively small (systematic) errors. After comparing the model results with observations, by which the modelled climate “state” of the atmosphere for the 20th century is determined, differences between the future model climate and 20th century climate have been analysed. Such differences primarily point out to qualitative assessment of climate change. Due to a number of uncertainties, quantitative climate change assessments should be taken with caution. However, they are necessary in order to execute concrete adaptation and mitigation measures to climate change effects. For example, one of key uncertainties in climate change is the definition of future scenarios given by IPCC (see chapter 7.3.1.4). This uncertainty is not a result of our lack of understanding of climate system, but a fact that human activities and their possible impact on a future climate should be observed through complex and unpredictable interactions.

7.3.1.2. Global model, regional model and dynamic downscaling

Dynamical downscaling has been applied to the results of the EH5OM global model, included in the IPCC Fourth Assessment Report (AR4). EH5OM is a coupled atmospheric and oceanic model developed at Max Planck Institute for Meteorology, Hamburg, Germany. Details of EH5OM are given in Roeckner et al. (2003). The EH5OM simulation of the 20th century climate was performed for three different realisations, which differ in a definition of initial conditions. In such a way, sensitivity of climate model to initial conditions is accounted for. For the A2 scenario there are also three model realisations available, each of them being the continuation of the current climate.

The IPCC scenarios for some future period (see Nakićenović et al. 2000) define general assumptions, which climate models should take into consideration after they have been adapted to a model. The A2 scenario assumes the growth of global population to 15 billion by 2100, a moderate economic growth, very high energy consumption and variable hydrocarbons (gas, oil, coal) consumption, as well as moderate to significant arable land usage. These projections are then adapted to a model as the concentrations of greenhouse gases and ozone. The A2 scenario is also called the strong forcing scenario because it predicts the most unfavourable conditions that could occur to the environment – it represents the upper limit of anthropogenic impact to the atmosphere and climate in this century.

For this report, the results of dynamical downscaling by so-called Regional Climate Model of the third generation (RegCM3), have been used. RegCM was developed by Dickinson et al. (1989) and Giorgi (1990). The detailed description of the model version used here is given in Pal et al. (2007). In our experiments the Grell convection scheme (Grell 1993) has been applied along with the Fritsch-Chappel closure (Fritsch and Chappel, 1980). The model horizontal resolution is 35 km in the area with 126 X 88 points centred at 46ºN, 7.5ºE and cover central and eastern Europe and a large part of the Mediterranean. In the vertical, there are 23 levels with the highest level at 100 hPa. Boundary conditions, taken from the EH5OM model, were updated every 6 hours. Dynamical downscaling is performed for all three realisations of the EH5OM global model for 20th century climate and for future climate according to the IPCC A2 scenario.

7.3.1.3. Selection of periods and seasons

Seasonal mean values for all climatological seasons have been used in the analysis of climate change, while for upper-air fields only the results for winter and summer have been shown. For winter, seasonal mean values were calculated for December-January-February (DJF) period, for spring for March-April-May (MAM) period, etc. Mean values of the 30-year period of future climate (2041-2070) have been compared with mean values of the 30-year period of the 20th century climate (1961-1990). For each parameter and season, statistical significance of the change in the mean value between future and 20th century climate has been calculated. It is based on the testing of the null-hypothesis where the mean values of future and current climate “populations” do not differ. The null-hypothesis is accepted or rejected at the 95% confidence level. In addition to mean values, interannual variability within each 30-year period has been calculated as well. The change in variability is expressed as a difference in standard deviation between future and 20th century climate, calculated from all three model realisations. From the change in mean value and variability, the change of extreme values for the given parameter can be indirectly assessed.

7.3.1.4. Uncertainties in climate modelling

An estimate of uncertainty in the assessment of future climate change, in particular at regional scale, is an important aspect of the climate change analysis. Uncertainty can be attributed to the following factors: firstly, uncertainty due to inherent (internal) variability of climate system; secondly, uncertainty in defining the future climate scenarios; and thirdly, modelling uncertainty because of approximations in representing processes in the atmosphere and oceans. Relative significance of each of the above factors varies on how far we reach into the future, as well as on spatial and time averaging scales (Hawkins and Sutton 2009). For example, at the regional level, for multi-decade time scales, dominant source of uncertainty is uncertainty in modelling and uncertainty of the given scenario. For smaller time scales, model and inherent variability of climate system represent the main cause of uncertainty. This report does not include explicit assessment of uncertainties of climate integrations by regional model.

However, some results of regional model were compared with the results of global model, thus enabling to evaluate, at least partly, to what extent the uncertainty of climate change could be attributed to different modelling approaches.

7.3.2. Upper level fields

Climate change of the large-scale circulation, analyzed from the EH5OM global climate model, is discussed in, for example, Branković et al. (2010). We briefly summarize some of general features of global change, as climate change for a wider region of Croatia should not be analysed separately from global change. Here, the comparison with the results of EH5OM climate model is appropriate, as these results are used to define initial and boundary conditions in dynamical downscaling by RegCM.

Global warming in EH5OM model is relatively uniform in the upper troposphere and it is associated with the strengthening of the upper-air westerlies within the jet stream core. The largest increase of surface temperature in Europe is in winter in the north-eastern part (over 3 °C), while in summer is larger than 3.5 °C in the southern Europe and the Mediterranean. The amplitude of warming is larger than model systematic error, whereas the spread within the three model realisations is smaller than the amplitude of climate change. For precipitation, however, such a conclusion is not valid, indicating a large uncertainty in the assessment of future hydrological balance.

Similar to global warming, an increase in temperature in future climate by the middle of the 21st century, i.e. the warming throughout the entire troposphere is evident in RegCM (Figure 7-8). In south Europe and the Mediterranean warming is larger in summer than in winter, while the largest inter-seasonal difference is in the south-western Europe. In summer, at the 850-hPa level (T850, at approx. 1.5 km altitude) the Mediterranean and south Europe (particularly the Iberian Peninsula) are clearly identified with warming larger than in the other areas of the integration domain (Figure 7-8d). In winter, a uniform warming is seen through the entire troposphere, while in summer the warming is slightly larger at the lower than at higher layers. The differences between the future and the 20th-century climate in Figure 7-8 are statistically significant even at the 99% confidence level within entire integration domain.

In accordance with temperature increase, an increase in geopotential is found throughout the troposphere. The meridional gradients in temperature differences at 200 hPa (Figure 7-8 a,b) indicate that high-altitude wind above Europe will be intensified in future climate in both seasons. This strengthening of the high-altitude wind in winter will occur practically over the entire Europe, but it will be strongest in the western part along with the Atlantic. These changes are statistically significant in the entire integration domain. Similar situation, but with a reduced increase in the wind amplitude, can be found in the lower troposphere. Pinto et al. (2007) associated such an intensified wind in the Atlantic storm path during winter with an increased cyclonic activity in future climate. In summer, the intensification of the upper-level winds is more pronounced in the northern part of the domain, whereas above our areas the northern wind component will be strengthened, although the westerly wind will still prevail.

7.3.3. Surface fields

7.3.3.1. Temperature at 2 m (T2m)

In all seasons temperature at 2 m will be increased in future climate (Figure 7-9); this is statistically significant even at the 99% confidence level. However, warming of the European continent is not the same across the seasons. For example, in winter and spring, the warming is larger in the north-eastern part of Europe than in the Mediterranean (Figure 7-9 a,b). Such a differential field in T2m is reflected on the Croatian region as well, where a temperature increase in winter is slightly higher in the northern part (for approximately 1.8 °C), and less pronounced in the southern parts of the country (about 1.5 °C; Figure 7-9a). The warming in future climate, indicated in Figure 2-2a, is smaller, on average, for about 0.5-1.0 degree than the warming obtained by EH5OM global model (Branković et al. 2010). In spring, an increase in temperature is relatively uniform throughout Croatia (Figure 7-9b), and, with the amplitude of warming of about 1.5 °C, it is quite similar to winter warming.

In summer and autumn, warming is more pronounced in south Europe and along the coastal part of the Mediterranean (Figure 7-9 c,d), and significantly exceeds the warming from colder part of the year. For example, above the Iberian Peninsula, amplitude exceeds 4 °C in summer, while in Croatia the warming is between 2 °C in the northern and almost 3 °C in the southern part of the country. In autumn, the T2m increase will be between 1.5 °C in a larger portion of the continental Croatia and slightly above 2 °C in the coastal zone, as well as in Istria and the Dalmatian hinterland. In summer, the warming is similar to that from the winter period (Figure 7-9c), and for approximately 1 °C smaller than in EH5OM global model. The differences in the future T2m warming between global and regional model can be the consequence of various factors or of their combination. Probably the main source of largest differences between the models is differently defined parameterization of unresolved physical processes. However, the differences could be also attributed to a more detailed (better) orography resolution in the regional model.

The above warming is calculated as the mean value of the three-member ensemble. Unlike the ensemble mean, change in temperature interannual variability, expressed by standard deviation, indicates only a slight increase of temperature variability in future climate (not shown). The T2m standard deviation has a maximum a little higher than 0.3 °C in summer in the eastern and southern Croatia – that is much lower than mean values from Figure 7-9. In autumn and winter, the change in variability is even smaller, with no change at all in spring. Such a result indicates that in future climate interannual variation of extreme temperature (usually quantified as the sum of mean value and interannual variation) will mostly depend on change/increase of mean temperature, while it will depend significantly less on the year-to-year temperature variation. Räisänen (2002) came to a similar conclusion analyzing results for the globe from 19 global models.

Increased greenhouse gases concentration according to the A2 scenario will cause relatively larger warming of near-surface atmosphere in summer, which may have a negative impact on human activities and health (see e.g. Srnec i Zaninović 2008). However, global warming should not have damaging consequences if adequate adaptation measures are taken. A higher average temperature in spring can cause an earlier beginning of the vegetation period, while higher temperature in autumn could bring, for example, a prolonged tourist season at the Adriatic coast. However, positive consequences in one season can be “counterbalanced” by negative consequences in another season (for example, a possible reduction of energy consumption for heating in winter is being compensated by increased energy consumption for cooling in summer).

7.3.3.2. Surface pressure and wind

The increase of geopotential above south Europe in winter is reflects as an increase in mean surface pressure in future climate (not shown). This increase in surface pressure is statistically significant for southern Croatia, but not for other areas. A tendency towards increased pressure can result in an increased frequency of anticyclonic weather types. In summer our regions will be affected by relatively insignificant change of mean pressure – the pressure will be slightly higher in northern areas and slightly lower in south Croatia. However, regardless of the small change in amplitude, the pressure decrease in south Croatia is statistically significant. Therefore, the middle and southern Adriatic will be exposed to an increased cyclonic activity in summer, which will cause more frequent unstable weather types.

In chapter 7.3.2., it has been ascertained that in future climate, associated with an intensification of the Atlantic storm path, westerly upper-level winds will become stronger, in particular in winter within free atmosphere above the north-western Europe. Similar is true for wind at 10 m (surface wind), which will be intensified in winter to the north of the Alps and weakened at its southern slopes (Figure 7-10a). Above our areas differential wind (the difference between mean wind in future climate and mean wind in the 20th century climate) will retain similar intensity as in the 20th century, but it will slightly turn to the north-east direction, i.e. it will get a somewhat stronger south-western component. Such a differential surface wind will bring to our areas a slightly increased humidity from the western Mediterranean and the Adriatic (not shown), causing a slight increase in winter precipitation in the littoral and mountain areas (see Figure 7-11a).

In spring and autumn surface wind will remain unchanged in future climate, while in summer north-eastern component will be intensified (Figure 7-10b). Related to this intensified wind from the inland of the Balkan Peninsula (where in summer humidity in the near-surface layer is smaller than humidity above the Adriatic Sea) is the associated precipitation decrease, at the coastal part of Croatia (compare with Figure 7-11c).

7.3.3.3. Precipitation

At regional and local scale the precipitation may have large spatial variability even in climatological mean. It primarily depends on physical features of the surface – altitude and relief indentation. These features are better represented in regional than in global models, so it can be expected that precipitation will be better represented as well. In addition to the representation of precipitation, a better resolved orography has a more appropriate impact on physical processes - for example, in triggering summer convection.

(i) Total precipitation

Change in total precipitation in future climate relative to the 20th century climate, is shown in Figure 7-11 for all four seasons. The structure of change – an increase of future total precipitation in north Europe and a decrease in the south – is similar in all seasons and it is associated with the path of storm disturbances from the Atlantic into the European continent. The region of the precipitation increase is moved to the north in summer as storm paths are located further north. Giorgi and Coppola (2007) noticed such a “transition” of climate change in precipitation through year analysing the results from 22 global climate models. Clearly, our results for regional adaptation bear semblance to global models.

From Figure 7-11, it can be seen that total precipitation is decreased in three seasons (spring, summer and autumn), primarily in the coastal, southern and mountainous Croatia. The decrease is less than 0.5 mm day^{-1} (or 45 mm in a season), except in autumn in southern areas, when it is slightly higher than 0.5 mm day^{-1}. Only in winter (Figure 7-11a) there will be a slight precipitation increase, mainly in the littoral and mountainous part of Croatia, as well as in the northern and eastern parts.

Total precipitation change, especially in winter and spring (Figure 7-11 a,b), is concentrated in relatively narrow zone along the Adriatic, whereas for a major part of the Adriatic Sea there is small or no change in total precipitation. Considering quite a complex orography of our Adriatic coast (steep rise of high mountains), such a structure of climate change in precipitation (narrow and elongated) indicates the need of dynamical downscaling with even finer horizontal resolution than the current 35 km.

In summer, a *relative* decrease of total precipitation along the eastern Adriatic coast and its inland is larger than in spring and autumn, as total precipitation is smallest in summer. For a major part of our Adriatic coast and its inland a relative decrease of total precipitation in summer is over 20%, while in autumn and spring deficit is lower than 15%. This is indirectly confirmed in Figure 7-12, where shaded areas of t-test indicate statistical significance in total precipitation change at the 95% confidence level. In summer, a decrease of total precipitation along the eastern Adriatic coast and inland is statistically significant (Figure 7-12c), while in spring (Figure 7-12b) and autumn (Figure 7-12d) precipitation decrease in future climate is significant only in the southern part of the eastern Adriatic coast. It is interesting to notice that precipitation increase in winter is not significant. It could be concluded therefore that in future climate in most of the year there will be a deficit in precipitation in western and southern Croatia, while the increase in winter is not reliable. In northern parts of the country there will be no significant change in total precipitation in future climate. Change in interannual variation of precipitation described by the variation coefficient, indicates an increase in variability in future climate. It is pronounced mainly in the Mediterranean (mostly in summer, least in winter) and it is very weak north of 45 °N (not shown).

The comparison of climate change in total precipitation in Figure 7-11 with the results of global model indicates the following: the structure of anomaly fields in Figure 7-11 generally coincides with those from global model (compare with Giorgi and Coppola, 2007, and Branković et al. 2010); however, in Figure 7-11 there are clearly details at a finer scale, which cannot be seen in global model. In winter, the amplitude of positive anomaly (increase of total precipitation) in the littoral Croatia is slightly higher in RegCM (Figure 7-11a), than in global model, where the result is mostly neutral. In summer, a decrease of total precipitation is slightly more evident in the littoral Croatia and its hinterland in RegCM model, while in global model it is more pronounced in the northern Croatia. Therefore, model results should be interpreted cautiously, as they could indicate the opposite effects, particularly in the analysis at smaller scales (see comment in 7.3.1.4).

(ii) Snow

It is expected that the change in the coverage (spatial distribution) and height of snow cover in Europe will occur in association with global warming in winter (Figure 7-9a). A large decrease of snow cover in future climate, more than 30 mm (but less than 50 mm) of equivalent water, can be found in the Alps (Figure 7-13a). In other mountainous areas of middle and southern Europe (the Carpathians, the Balkan mountains, the Pyrenees) there will be a reduction of snow cover as well, and also in the lowlands of Germany, Poland and Russia. In our areas, the reduction is 1 mm in northern Croatia, up to slightly more than 2 mm in mountainous areas. Although such a reduction of snow cover in Croatia may seem irrelevant, compared, for example, with the Alps, in relative terms it is quite significant. Except in the north-western Croatia and Istria, the reduction of snow cover by the middle of this century is statistically significant (Figure 7-13b). The reduction of snow cover will generally bring a decrease in interannual variability (not shown); only in the areas with relatively small snow reduction, for example in the Pannonian lowland, variability will be slightly increased.

From the RegCM model results, the number of days with snow cover for the 20th century has been calculated and compared with the data from the Croatian meteorological and climatological stations (Figure 7-13c). Model results underestimate observational data, because the model is not capable to distinguish horizontal and vertical scales of climatological stations. For example, the isoline indicating 15 days with snow borders with Gorski Kotar in the north, while data from Sisak and Slavonski Brod indicate 21 and 20 days with snow. In the south, the same isoline is moved too far inland due to an inadequate resolution of a quite sharp gradient in number of days with snow between the littoral and mountainous Croatia, e.g. the Zavižan station in the northern Velebit sticks out with 39 snowy days. However, more relevant is the relative change of number of days with snow in future climate relative to the 20th century climate (Figure 7-13d). The number of days with snow in future climate is significantly reduced, in many parts, and even halved relative to the 20th century. Regardless to the errors in the representation of present climate, such a decrease is a significant indicator of what to be expected by the middle of this century.

7.3.3.4. Some significant or extreme occurrences

As for days with snow (Figure 7-13 c,d), similar statistics is considered for some climatological parameters describing significant or extreme values of surface atmosphere (temperature and precipitation). For climatological stations many extreme events are processed and shown in Zaninović et al. (2008). Figure 7-14a shows a comparison of stations data and regional model for hot summer days, i.e. when maximum temperature is higher or equal to 30 °C. Although model generally underestimates a number of hot days, still the model results are acceptable for many areas. The number of hot days in model is increased from mountainous areas of the western Balkan, northwards to the Pannonian lowland and towards the Adriatic coast. The largest discrepancy is found at the Knin station, where the number of observed hot days (37) is the largest in Croatia and significantly exceeds the model value (4). Model orography, which is much higher at the location of the Knin station than in reality, effects a general decrease of temperature, as well as frequency of hot days. Also, vegetation cover has an impact on temperature. Namely, in the model in each grid box only one vegetation type is represented (usually the prevailing one), while in reality in the area of 35 x 35 km various types of vegetation could be found. Generally, deficiencies and approximations in model contribute to differences between measured (observed) values and simulated climate.

Difference between future climate and the 20th century climate indicates to an increase of hot days; in many areas the number of hot days will be doubled by the middle of this century. For example, the increase will be from 6 days in mountainous areas up to almost severe 20 days at the Adriatic (Figure 7-14b). Such an increase of the number of hot days could greatly influence social-economical circumstances in south Europe and the Mediterranean.

Average number of winter days with precipitation larger than 10 mm is shown in Figure 7-14c. For a major part of Croatia, particularly in the north, model relatively successfully simulates this type of statistics, even some details such as precipitation decrease in Zadar and Split relative to adjacent areas. In mountainous Croatia (Parg, Ogulin) precipitation is underestimated in the model, while in inland Dalmatia (Knin) and southern Croatia (Dubrovnik) it is overestimated. This is probably the result of the southern Croatia orography being higher in model than in reality. It can be concluded that in extremely orographically complex areas of the littoral Croatia it is very hard to reproduce detailed spatial variation of observed number of days by a model.

In future climate, in a major part of the coastal Croatia and its hinterland average number of days with precipitation larger than 10 mm will be increased from 0.5 up to 1 day (Figure 7-14d). Such a change is consistent with results in Figure 7-11a, indicating an increase of total precipitation in winter in the coastal Croatia. According to Figure 7-14d only on the southern Dalmatian islands the number of days with precipitation larger than 10 mm will remain unchanged or slightly decreased relative to the 20th century climate.

In summer model generally underestimates a number of days with precipitation larger than 10 mm (not shown), probably due to showery nature of summer precipitation, which is relatively difficult to reproduce. However, consistent with Figure 7-11c, in future climate the number of days with such significant precipitation in coastal area and hinterland is decreased (for more than 1.2 days), while in continental Croatia it will be slightly increased.

7.3.4. Conclusions

The results of the RegCM regional climate model integrations have been analysed for all seasons from the two 30-year periods: 1961-1990, representing the present climate, and 2041-2070, representing the projection of future climate according to the IPCC A2 scenario. By comparing climatological mean values from both periods, it is possible to conclude on possible climate change in the integration domain. Changes of climatological means have been tested by objective statistical method. Interannual variations of some meteorological parameters within selected periods have been compared from which it can be concluded on the change of variability in future climate in relation to the present one.

In all seasons, RegCM predicts temperature increase within the entire integration domain, as well as throughout the depth of the model atmosphere. In the cold part of the year, the warming will be slightly increased in the northern (continental) Croatia, while in warm periods the warming will be increased in the littoral Croatia. Warming in RegCM integrations is in agreement with warming in EH5OM global model, whose data were used to force RegCM via initial and boundary conditions; however, the amplitude of the warming is generally a little lower in RegCM, than in EH5OM model.

The decrease of total precipitation in future climate is expected in a large part of the year, primarily in the littoral Croatia and its hinterland. Such a decrease is, in relative terms, highest in summer because of pronounced climatological minimum in the annual cycle for total precipitation in this part of Croatia. In winter there will be a slight increase of precipitation, again in a narrow littoral zone, but such an increase is not statistically significant. In the northern Croatia no significant precipitation change in future climate is expected.

Analysis of the modelled number of days for some significant and extreme events (number of days with snow, hot days and days with precipitation larger than 10 mm) for the 20th century climate broadly matches observational data, although not in all details. The largest differences between the model and the observations could be attributed to inadequate orography representation regardless of the fact that regional model has relatively fine horizontal resolution. Future changes indicate a decrease in the average number of days with snow, an increase in the number of hot days, as well as slight increase in the number of days with significant precipitation in winter. This statistics agrees well with climate change of the mean values for near-surface temperature and total precipitation.

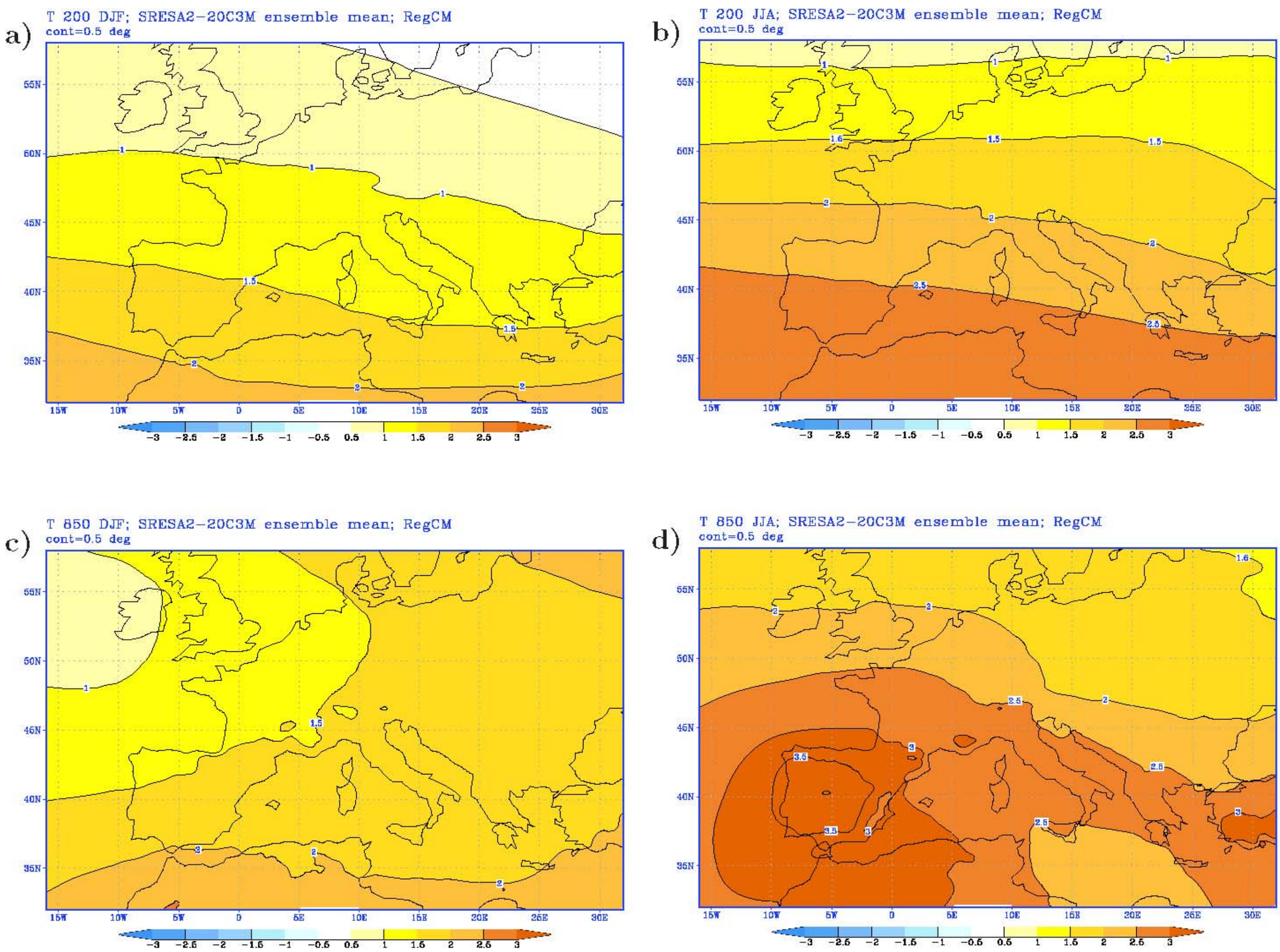


Figure 7-8: Altitudinal temperature, future climate minus the climate of the 20th century: a) winter 200 hPa, b) summer 200 hPa, c) winter 850 hPa, d) summer 850 hPa. Isolines 0.5 degrees.

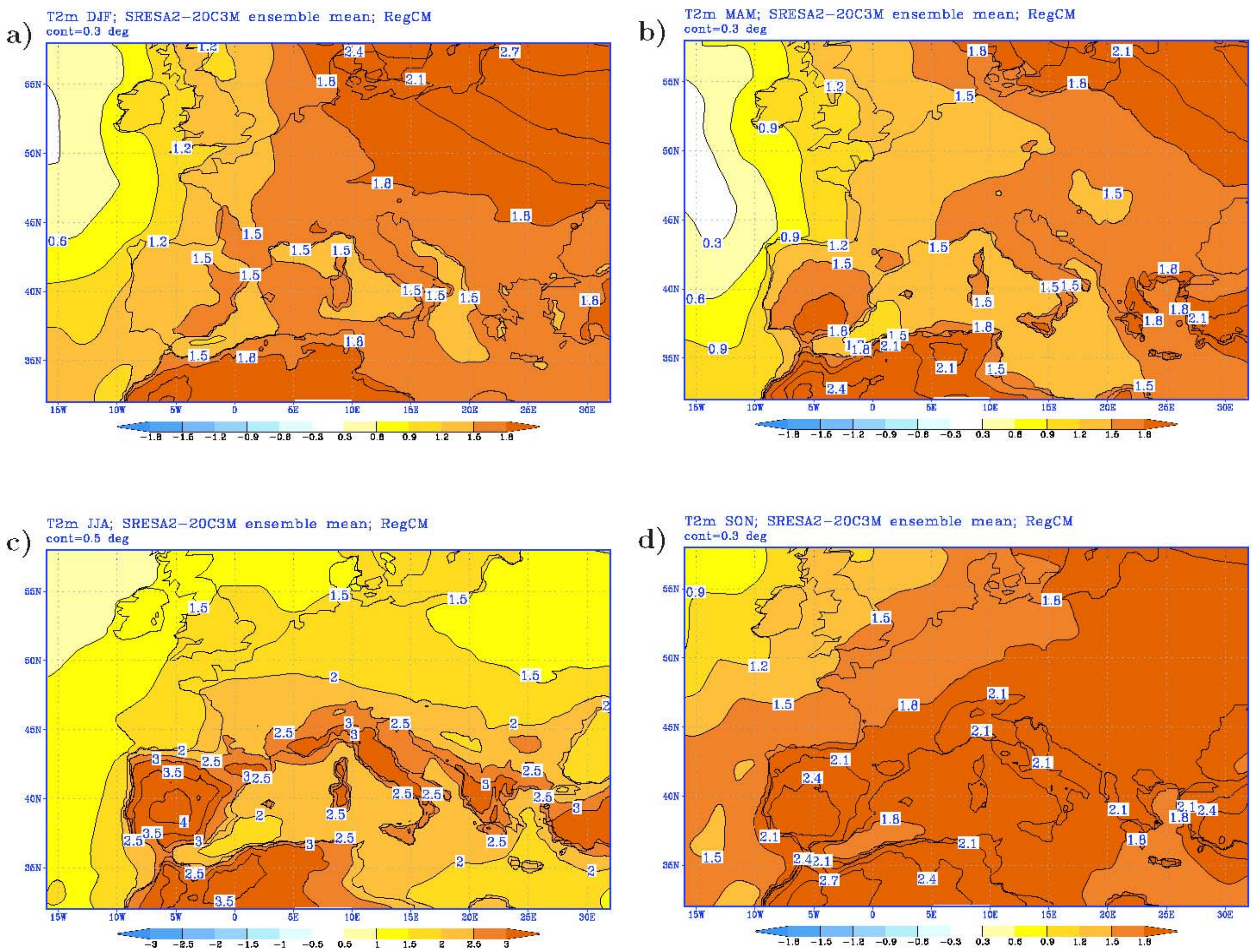
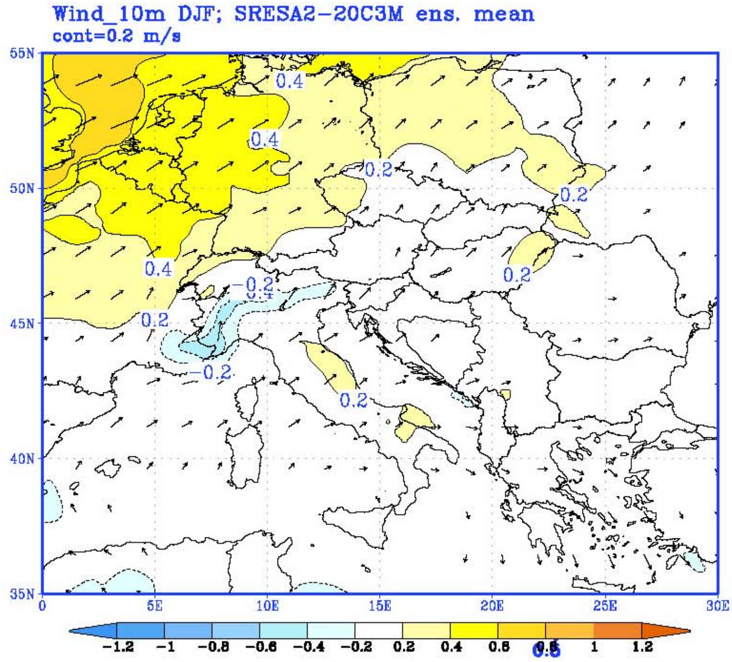


Figure 7-9: Temperature at 2 m, future climate minus the climate of the 20th century: a) winter, b) spring, c) summer, d) autumn. Isolines every 0.3 degrees in a), b) and d), and every 0.5 degrees in c).

a)



b)

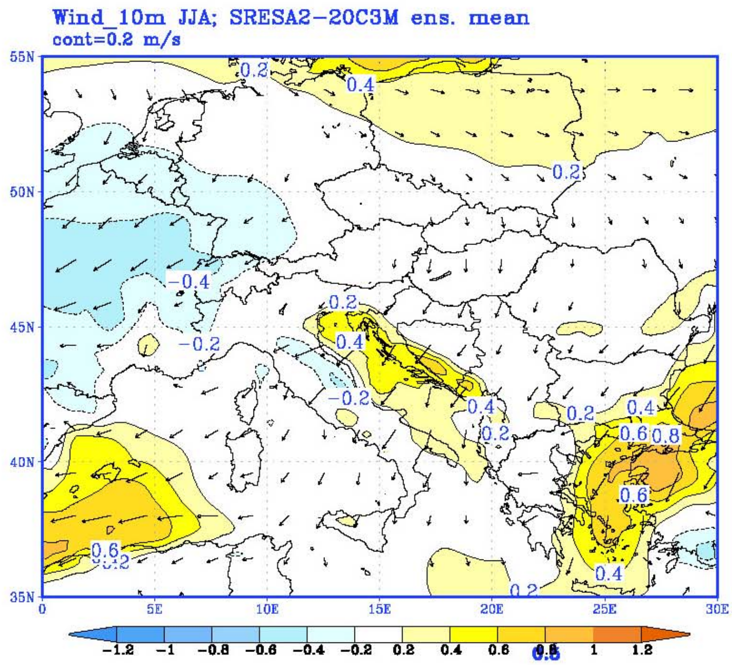


Figure 7-10: Wind at 10 m, future climate minus the climate of the 20th century: a) winter, b) summer. Isolines every 0.2 m/s.

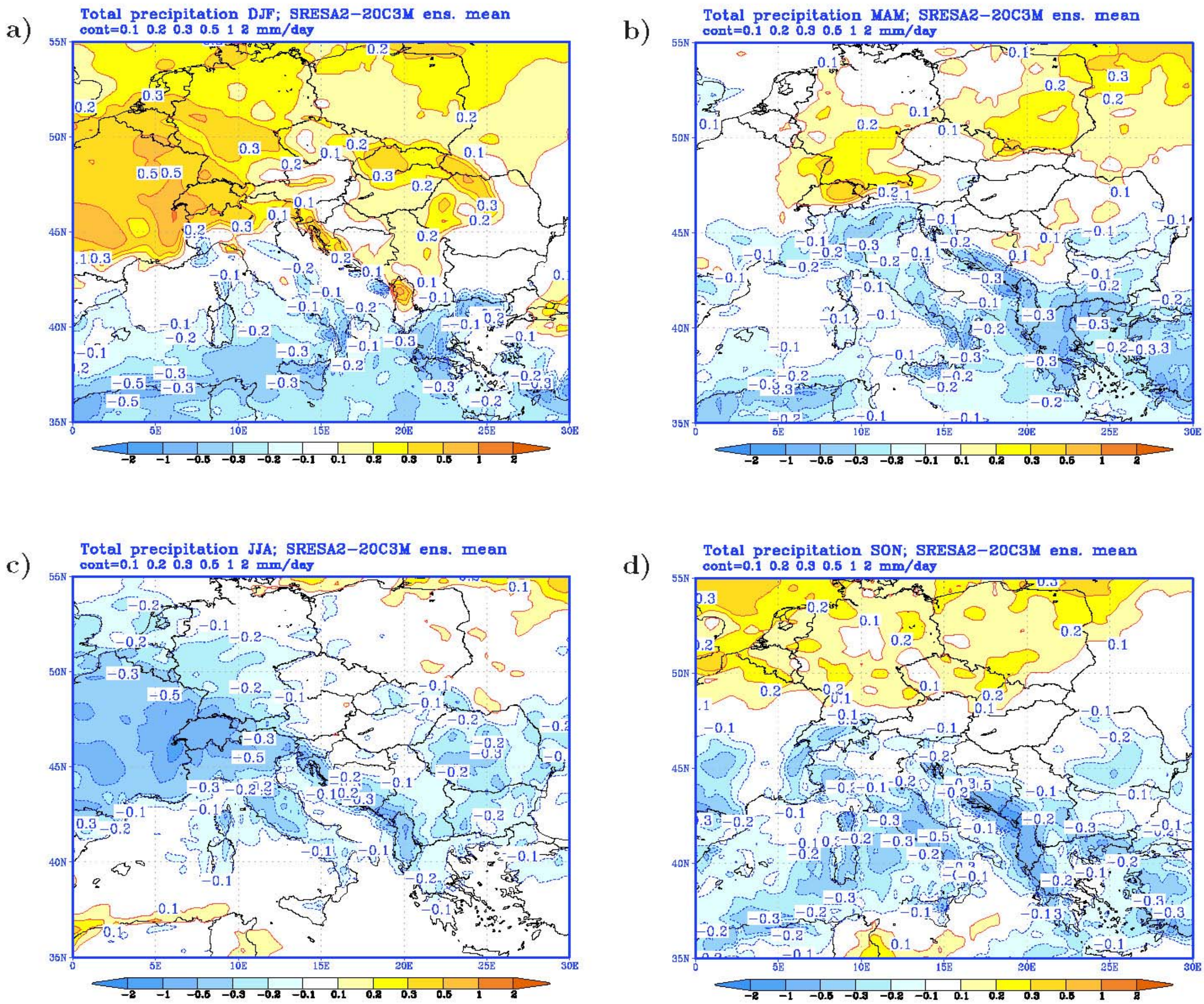


Figure 7-11: Total precipitation, future climate minus climate of the 20th century: a) winter, b) spring, c) summer, d) autumn. Isolines 0.1, 0.2, 0.3, 0.5, 1, 2 mm/day; bold lines positive values, dashed lines negative values.

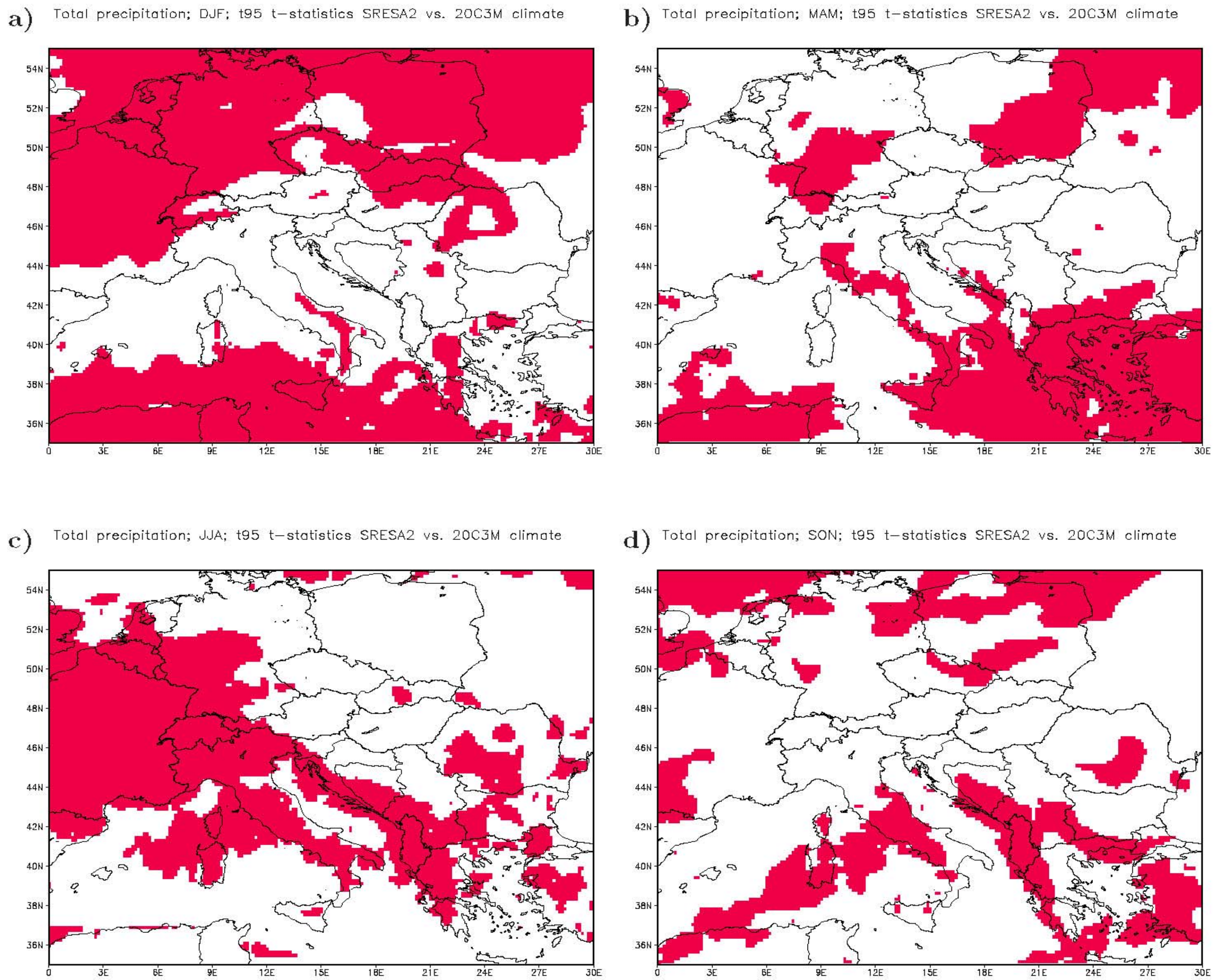


Figure 7-12: t-test significancy of the differences in total precipitation, future climate minus the climate of 20th century with a 95% level of confidence: a) winter, b) spring, c) summer, d) autumn.

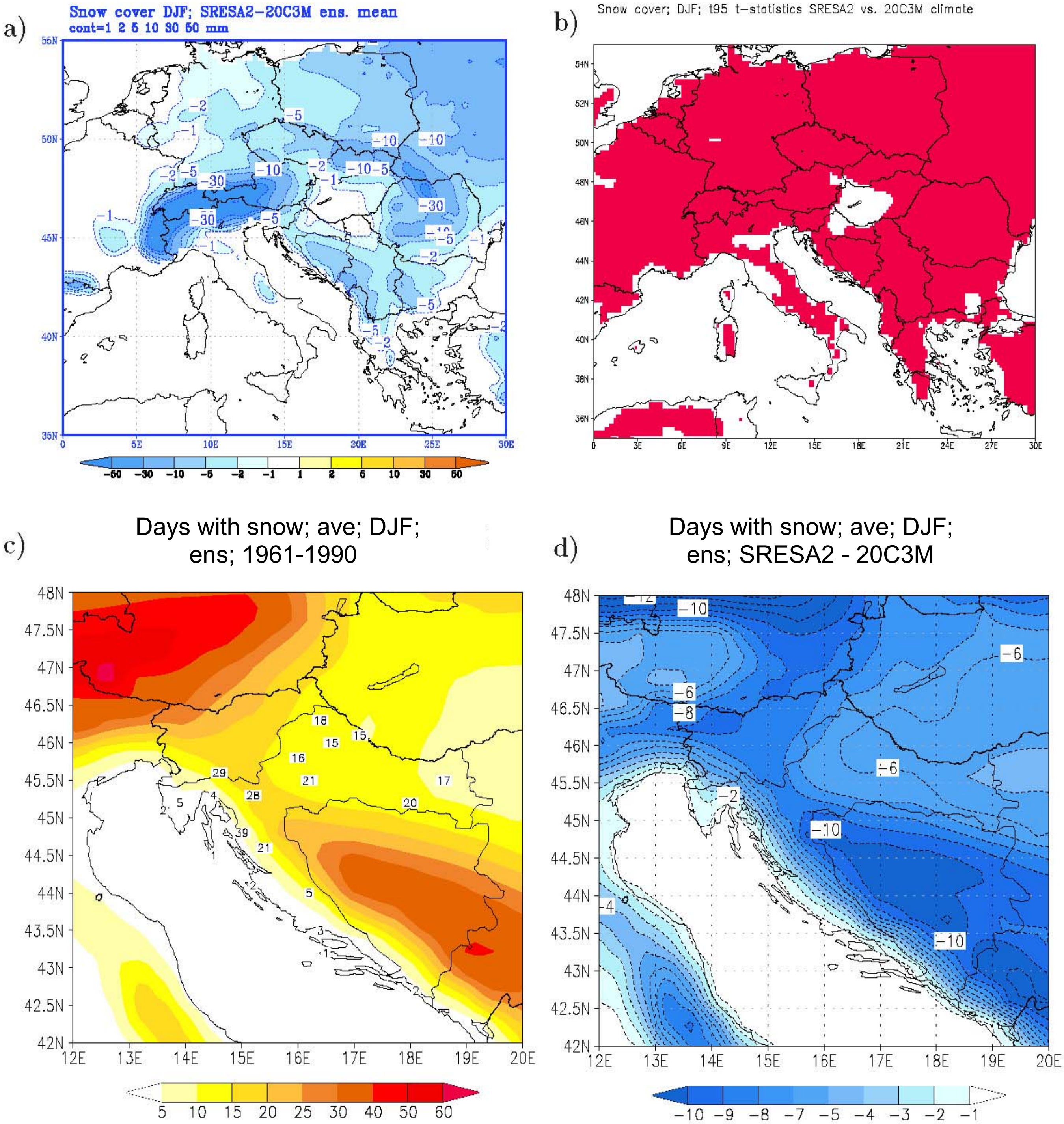


Figure 7-13: Snow in winter, future climate minus the climate of the 20th century: a) difference in mean values, b) t-test significancy of the difference of mean values with a 95% level of confidence. Mean number of days with snow in winter c) model and climate stations for the period 1961-1990, d) change of the number of days future climate minus the climate of the 20th century. Isolines in a) 1, 2, 5, 10, 30, 50 mm of equivalent water. Isolines in c) 5, 10, 15, 20, 25, 30, 40, 50 days, in d) 1 day.

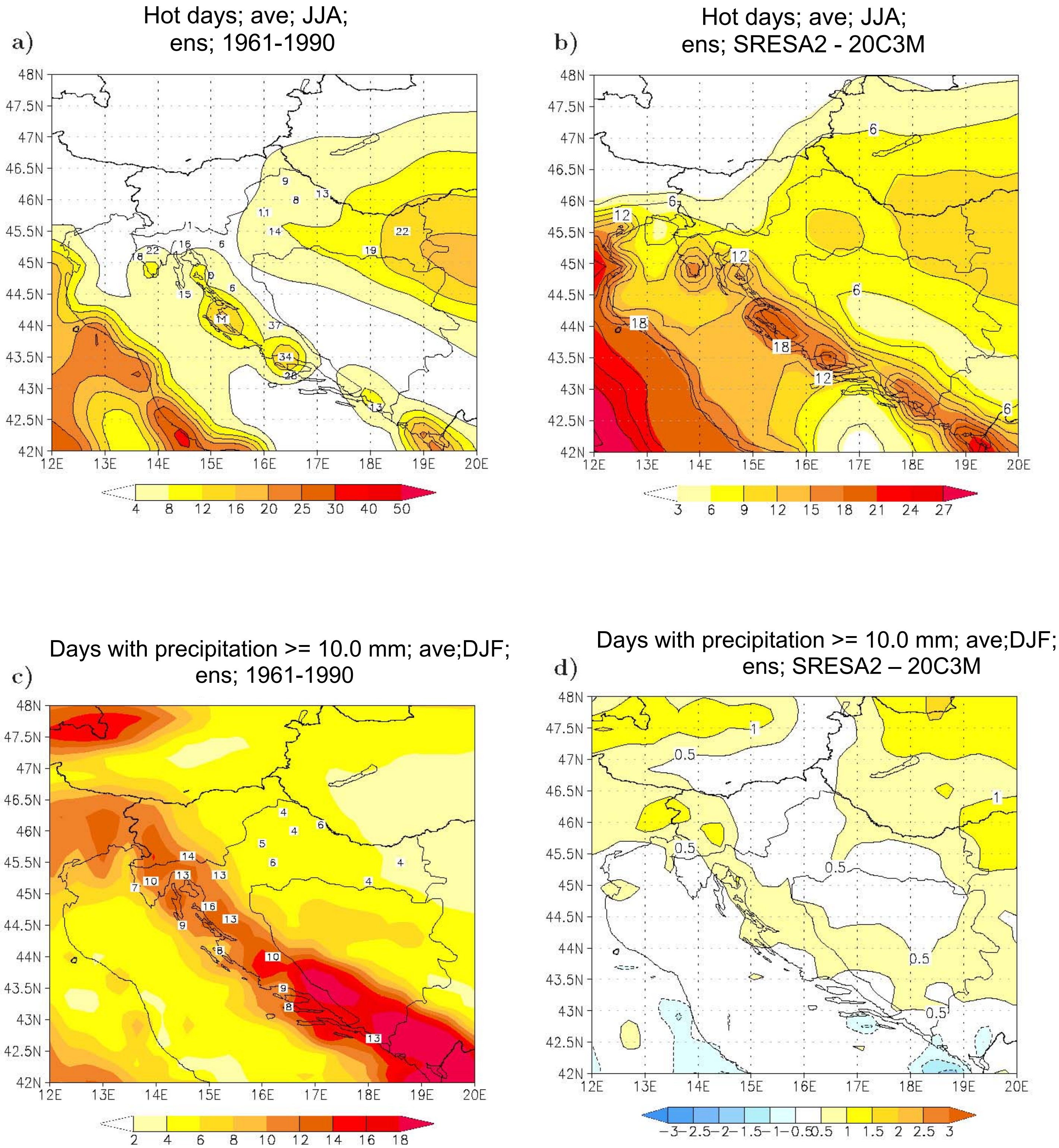


Figure 7-14: Median number of hot days a) model and climate stations for the period 1961-1990, b) change of the number of days minus the climate of the 20th century. Mean number of days with precipitation larger than 10 mm c) model and climate stations.

7.4. Impact and Adaptation to Climate Change by Areas

7.4.1. Hydrology and Water Resources

Waters are among major natural resources of the Republic of Croatia. Although it belongs to a group of countries for which water issues are not a limiting factor of development, climate changes will cause problems in water supply and meeting the ever-growing drinking water requirements.

Climate changes or variations combined with anthropogenic activities have significantly affected the changes in hydrological regime of open watercourses. Catchment areas of different sizes, geological and pedological base with different vegetation cover will respond differently to climate changes.

Research show that water resources in Croatia are already under challenge of climate change, as certain impacts and changes occur in regard to water flow, evapotranspiration, groundwater inflow, water level in rivers and lakes, water temperature, etc.

Change in precipitation form will influence not only the discharge, but the intensity, time period and frequency of floods and droughts as well. Some sources estimate that discharges in the largest watercourses of the Republic of Croatia will be decreased by 10% to 20%, although in eastern part of the country such change could be less than 10%. This issue requires research, since results of global and regional models of climate change indicate changes in precipitation in Croatia. Moreover, evapotranspiration increase due to temperature rise could also make an impact. Climate changes will, to some extent, impact electricity production in hydro power plants.[53]

7.4.2. Forestry

The assumed climate changes may lead to changes in spatial distribution of forest vegetation reflected in the altered share of current forest types, possible disappearance of the existing or appearance of new types, change in the density of population of certain tree species, productivity of forest ecosystems, ecological stability, forest health condition and the change in the overall productive and welfare forest value.

Croatian Adriatic coast, particularly islands, is a typical example of area where the common interconnection between water (precipitation) and fire is fully expressed. Generally, it can be said that, in summer, a number of fires and burned areas increase from the north to the south, as well as from the inland to the coast and islands, while in winter and early spring it is vice versa. Even the precipitation amount is decreased from north to south and from inland to islands. Due to its specificity, the most endangered areas considering forest fires are the islands, among them particularly middle Dalmatian islands. Results of global and regional models indicate that the largest changes could be expected in the coastal southern part of Adriatic.

In Croatia, there are 300 fires per year which burn on average about 10,000 ha. In the last 10 years the largest number of forest fires, total of 706, was recorded in 2000 when 68,171 ha burned out.[54] In extremely hot and dry years, such as 1998, 2003 and 2007, above average number of forest fires was recorded in the Adriatic area.

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[53] UNDP (2008): Human Development Report

[54] Croatian Forests Ltd.

For already 30 years, the Meteorological and Hydrological Service has been applying the Canadian method *Fire Weather Index* (*FWI*) to assess a danger of forest fires at the Adriatic. By means of *FWI* daily severity rating *(DSR)* is determined, i.e. assessment of potential danger according to relation:

$$DSR = 0.0272\ FWI^{1.77}$$

Mean *Monthly Severity Rating (MSR)* or mean *Seasonal Severity Rating (SSR)* are calculated from *DSR*. Generally, SSR values above 7 indicate extreme potential danger, values between 3 and 7 are large to very large, values between 1 and 3 are moderate, while values less than 1 are equal to small potential danger.

As severity assessment contains meteorological conditions, as well as moisture dead fuel , *MSR* and *SSR* serve for climate-fire review of average state in certain area per months and fire season. *DSR* daily values could be indicator of change of state from hour to hour for fast acting and distribution of fire brigades in endangered area.

For the analysis of MSR secular variations, long-term time series of meteorological stations Crikvenica (1891–2005) and Hvar (1867–2005) as representatives for climate conditions of northern and middle Adriatic (Figure 7-16). Due to a higher mean monthly air temperature and lower precipitation amount in Hvar than in Crikvenica, *MSR* is 2-3 times larger than in middle Adriatic in relation to the northern (Table 7-8).

Table 7-8: Mean (MEAN), maximum (MAX) and minimum (MIN) monthly severity rating MSR along with related standard deviation (STD) and amplitude (AMPL = MAX - MIN) for Crikvenica (1891–2005) and Hvar (1867–2005), as well as a comparison with a normal 1961–1990.

MONTHS	May	June	July	August	September
CRIKVENICA (1891-2005)					
MEAN	0.9	1.3	3.2	3.8	1.7
STD	0.8	1.1	2.3	3.6	2.1
MAX	3.3	4.4	7.8	16.9	10.5
MIN	0.0	0.0	0.6	0.3	0.1
AMPL	3.3	4.4	7.2	16.6	10.5
CRIKVENICA (1961-1990)					
MEAN	0.8	1.3	2.6	3.2	1.8
STD	1.3	1.3	2.2	3.2	2.0
MAX	5.6	6.4	10.9	23.7	19.8
MIN	0.0	0.0	0.1	0.0	0.0
AMPL	5.6	6.4	10.8	23.7	19.8
HVAR (1867-2005)					
MEAN	2.5	4.1	6.9	7.1	4.4
STD	1.9	2.8	3.3	3.2	3.4
MAX	10.1	12.5	22.2	17.8	18.0
MIN	0.1	0.5	1.2	1.8	0.0
AMPL	10.1	12.0	21.0	16.0	18.0
HVAR (1961-1990)					
MEAN	3.0	4.5	8.0	8.2	4.9
STD	1.7	2.4	2.9	3.6	3.6
MAX	7.0	10.6	13.2	16.8	14.7
MIN	0.5	0.7	2.5	2.8	0.6
AMPL	6.4	9.9	10.6	14.0	14.1

Comparison of mean *MSR* secular values with an average from the period 1961–1990 indicates similar values in Crikvenica and less in Hvar for long-time period in relation to a normal.

In order to determine possible danger increase of forest fires at Adriatic, linear trends for MSR and non-parametric Mann-Kendall rank test have been analyzed for Crikvenica and Hvar within the season from May to September (Table 7-9 and Figure7-15). Significant increase of potential danger is notified in Crikvenica in all months of fire season, while in Hvar in June and July. Progressive test indicates a beginning of *MSR* increase in early 1980's, while trends became significant by the beginning of the 21st century.

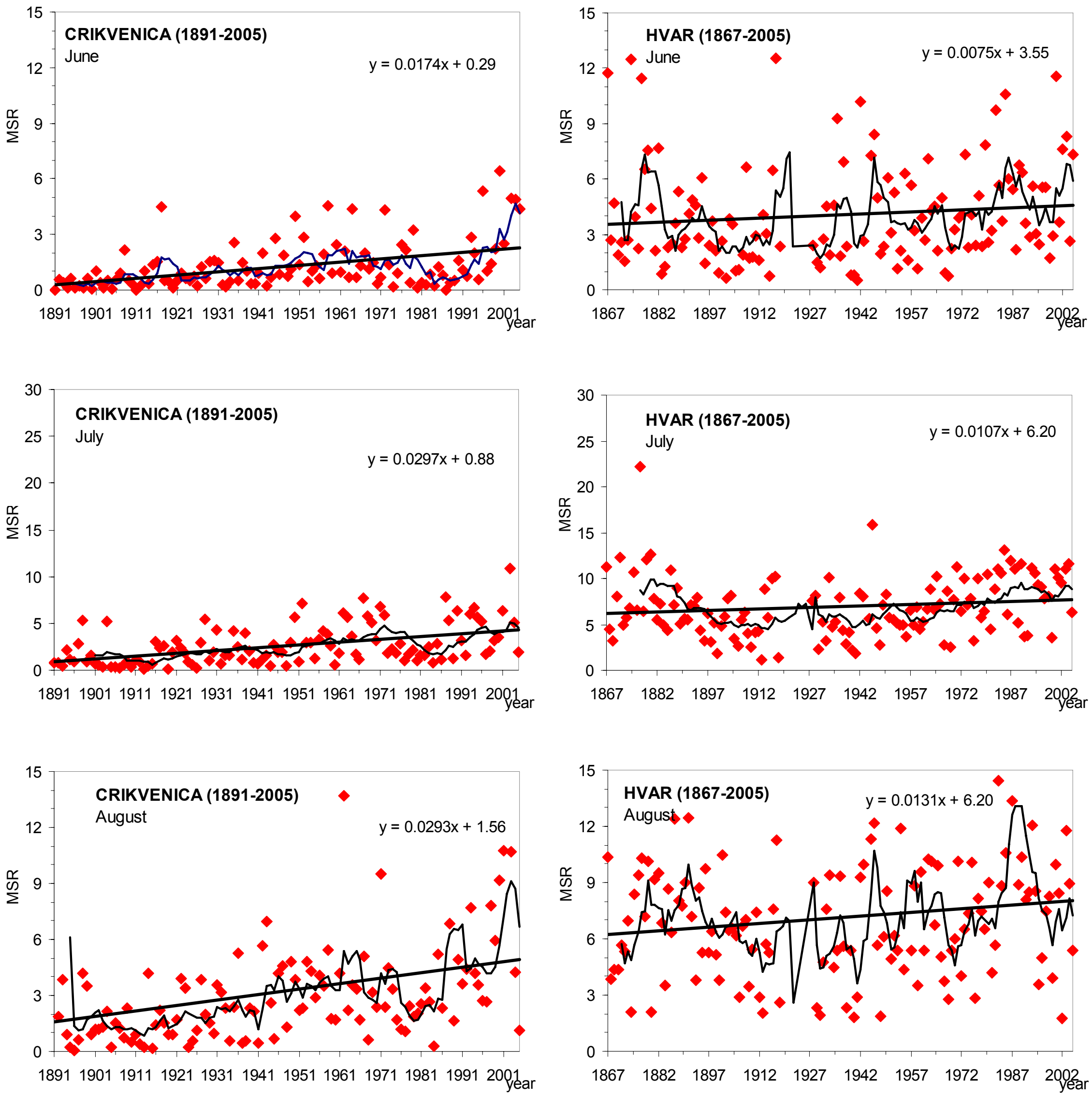

Figure 7-15: The time series of the monthly severity rating (MSR), the curves of the 5-year series of the moving average and linear trends for the meteorological stations Crikvenica (1891–2006) and Hvar (1867–2005). x is the number of years (1, 2, 3 …n)..

Table 7-9: Trends of monthly severity rate MSR (/10 years) for Crikvenica (1891–2005) and Hvar (1867–2005). Significant linear trends at the level ≤ 0.05 are in bold.

MONTHS	May	June	July	August	September
CRIKVENICA (1891–2005)					
TREND (/10 years)	**0.12**	**0.17**	**0.29**	**0.29**	**0.06**
HVAR (1867–2005)					
TREND (/10 years)	-0.03	**0.07**	**0.11**	0.13	0.02

Increased risk of forest fire, recorded in June, is particularly important as it indicates an earlier beginning of fire season at Adriatic. However, the analysis also shows the expansion of the area with increased forest fire risk from the middle to northern Adriatic, especially in July and August. The reason of increased forest fire risk at northern Adriatic is due to a significant increase of mean air temperature and significant decrease of precipitation in summer.

7.4.3. Agriculture

Effects of climate variability and disasters associated with weather conditions are more and more frequent in the whole world and in Croatia as well. Variability has already significantly influenced on agriculture and welfare of rural population.

By the insight into possible climate change scenarios, as they are predicted by the experts of meteorological profession, it is evident that expected climate changes are of such intensity and direction that they will gradually bring to significant changes in plant production systems. According to such forecast and analysis, the main feature of the environmental condition change is in the increase of CO_2 concentration in the atmosphere, gradual increase of organic matter (humus) in soil, increase of average annual temperature and probability of droughts in summer followed by water shortage of 30-60% in relation to the present situation. Also, annual number of days of active vegetation (with temperature above 5 ^oC) within the 100-year period would be increased in the lowland parts of Croatia for 35-84 days, while a period with temperature above 20 ^oC for 45-73 days. If such predictions come true, present technology of agriculture plant production will suffer great changes. However, by means of modern technology and in conditions of increased temperatures and providing enough amounts of water, total predicted climate change could bring to a positive effect on the increase in yields and quality of agricultural crops.

Of course, predicted climate change can have negative effects as well, of which only some are predictable, if plant production is observed outside the global ecosystem.

The total amount, distribution, form and intensity of precipitation are highly important for plant production. For modern agriculture it is important to maintain the soil water balance in favourable condition, while in future such condition will be even more emphasized.

Beside combination effects of various climate factors on a result in production of some crops (winter wheat, maize), other edaphic, economic and social factors influenced as well. Such combinations will be crucial for agriculture development in the future as well, along with probable development of new techniques, including precision farming, robots, etc. Modern technology in wheat and maize cultivation enabled that today, along with the utilization of equal or smaller agricultural land, the yields are significantly increased. If the yields analysis is performed, it is easy to determine a crucial impact of weather conditions during some years when yields were quite lower than the average. The most common case of yields decrease is conditioned by water shortage but all other meteorological factors, which in various combinations influenced the yields realization in Croatia, are of great importance as well.

Climate conditions limit wheat production to spring or winter cultivars to suitable areals. Winter wheat cultivars are dominant in Croatia, while spring cultivars are usually also grown in regions with long, harsh winters. Unfavorable weather conditions during vegetative season played a critical detrimental role in winter wheat crop yields, averaging to lower yields every fifth year during the last 50 years. Majority of of the adverse impact is caused by water shortages during critical phenophases, followed by other factors such as surface water stagnation, frost, inability to adhere to optimal agrotechnical terms, etc.

Maize crop yield in Croatia is mostly limited due to water shortages during flowering and fertilization phases and kernel starch filling. Late frosts in spring also cause adverse impacts, as does a long list of many other unfavorable weather conditions during crop growth, all of which cannot be practically listed here. In the last 20 years where were 4 years with extremely low maize yields, usually due to droughts.

All natural disasters and climate variability resulted in economical damage. In a period from 2000 to 2007, Croatian counties reported damage on crops caused by extreme weather conditions in amount of EUR 1.4 billions. Therefore, a damage caused by existing climate conditions and climate variability has already an important impact on agriculture in Croatia. The cause may or may not be in climate change, but certainly indicates on current vulnerability. In a period from 1980 – 2002, natural disasters caused approximately EUR 5 billions of damage in Croatia. About 73% of these damages has been caused by weather conditions. Damage caused by drought, frost and hail – extreme weather conditions causing damage mostly in agriculture – is estimated to EUR 3.5 billions for the period from 1980 – 2002, which corresponds with amount of EUR 152 millions per year. Drought caused the largest damage (65%), followed by hail, frost, rain, floods and wind/storms.

However, there is not enough data to estimate consequence of agricultural practices and climate variables. Crop models and economic models that would help in understanding existing and future sectoral sensitivity to climate change are scarce. Furthermore, not even the basic economic sectoral or crop gross margin data are available. Although climate change present a a certain risk for the future, there are multiple steps that can be taken today in order to resolve current climate vulnerability problem.

Precise, economically and ecologically acceptable adaptation measures to climate change in various agroecological conditions are yet to be worked out in details. Surely, it would be measures according to which adaptation capacities will be created (in terms of performing the research, developing and applying the model for impact simulation, as well as climate change adaptation, etc.), technical measures presuming, for example, increase of carbon content in the soil, wider crop rotation, implementation of fast growing crops, etc.), investing into irrigation and other. Within the MFCAL concept (*Multifunctional character of agriculture and land*) other possibilities of implementing new technologies, which could be useful for agriculture adaptation to climate change, should be searched for as well. Obstacles are numerous, but they can be overcome by proper activities. These activities mean more investments into researches, as well as education of all included into agriculture sector.

7.4.4. Biodiversity

In the area of Croatia, three various interconnected impacts of climate change on species are expected: phenological, distributional and genetic.

Phenological changes, recorded in Europe, such as the shift in a period of the freshwater fish spawning and earlier arrival of migratory birds from the wintering grounds, occur in Croatia as well.

Research of climate change impact on plants is based on the idea that plants are the first that react to weather and climate change, for which purpose the phenological data are suitable for monitoring development phases of certain plant species. Results of linear trends of longterm phenological phases of common lilac, apple and olive trees from phenological stations Daruvar, Zagreb, Gospić, Rab and Hvar (Figure 7-16), mostly from the period 1961-2008, are indicated below. The stations were chosen in order to cover basic climate types in Croatia: continental, mountainous and Mediterranean, as well as the city part of Zagreb.

Weather conditions of the last years less and less follow known annual and seasonal cycles and there are more and more extreme weather events not following average conditions. Thus, for example, during 2007, due to extremely warm winter and spring, phenophases occurred much earlier. Analyses of linear trends of olive tree phenophases along the Adriatic coast and islands, as well as forest trees and fruit trees phenophases in mountainous Croatia within the last 50 years, indicated significant earlier beginning of their flowering (2–4 days/10 years) as a result of significant increase of spring air temperature values in this area.

Figure 7-16: Position of selected meteorological and phenological stations in Croatia

In the Croatian inland, vegetation period for the majority of plants begins in March or April. The beginning of common lilac leaf unfolding in Zagreb is on 26 March in average, while in Daruvar on 1 April (Table 7-10). Naturally, the periods are changed from year to year, so the range between the latest and the earliest date can be even month and a half.

The flowering usually starts three weeks after the leaf unfolding, while its fully flowering the common lilac achieves a week after the flowering start. High values of standard deviation (8-12 days) also indicate to a great annual variability of common lilac leaf unfolding and flowering from year to year.

In mountainous Croatia the beginning of vegetation is moved to April and May, so in Gospić the common lilac is usually leaf unfolding on 15 April and flowering on 6 May. It is exactly a month later than in Hvar. Naturally, a limit of vegetation beginning is earlier as it moves to the south of Croatia. Comparison between northern and middle Adriatic shows 4-5 days earlier start of common lilac leaf unfolding and flowering in Hvar than in Rab.

In average, apple tree is leaf unfolding and flowering two weeks earlier in Daruvar (9 and 17 April) than in Gospić (25 April 25th and 2 May). Apple maturation also starts two weeks earlier in Daruvar (6 September) than in Gospić (22 September). Such vegetation period of apple tree in the Croatian inland lasts for seven months, while in mountainous Croatia for six months due to an earlier beginning of colouring and leaves falling.

Appearance of the first flowers, full flowering and end of olive tree flowering is a week earlier in Hvar than in Rab. However, first ripe fruits are usually by the middle of October, while the picking is in the first 10-day period in November at both locations.

Table 7-10: Mean (MEAN), maximum (MAX) and minimum (MIN) phenophase dates for common lilac, apple and olive trees along with related standard deviation (STD) and amplitude (AMPL = MAX - MIN) at selected stations in Croatia mostly within the period 1961–2008.

PHENOPHASES			UL	BF	FF	EF	RF	RP	CL	FL
COMMON LILAC	MEAN	DARUVAR	1.4.	21.4.	28.4.					
	STD		12	10	9					
	MAX		23.4.	7.5.	13.5.					
	MIN		8.3.	30.3.	9.4.					
	AMPL		46	38	34					
	MEAN	ZAGREB	26.3.	20.4.	26.4.					
	STD		12	8	8					
	MAX		15.4.	2.5.	10.5.					
	MIN		8.3.	1.4.	9.4.					
	AMPL		38	31	31					
	MEAN	GOSPIĆ	15.4.	6.5.	12.5.					
	STD		11	9	9					
	MAX		2.5.	20.5.	26.5.					
	MIN		24.3.	10.4.	17.4.					
	AMPL		39	40	39					
	MEAN	RAB	22.3.	11.4.	18.4.					
	STD		8	9	8					
	MAX		3.4.	28.4.	6.5.					
	MIN		27.2.	22.3.	30.3.					
	AMPL		36	37	37					
	MEAN	HVAR	17.3.	6.4.	14.4.					
	STD		9	8	9					
	MAX		31.3.	22.4.	1.5.					
	MIN		21.2.	19.3.	24.3.					
	AMPL		39	34	38					
APPLE TREE	MEAN	DARUVAR (1969-2008)	9.4.	17.4.	23.4.	2.5.	6.9.	22.9.	22.10.	8.11.
	STD		9	9	8	7	7	6	11	11
	MAX		25.4.	3.5.	9.5.	16.5.	18.9.	9.10.	11.11.	25.11.
	MIN		19.3.	23.3.	31.3.	19.4.	24.8.	9.9.	29.9.	7.10.
	AMPL		37	41	39	27	25	30	43	49

LEGEND:

UL – beginning of leaf unfolding
BF – beginning of flowering
FF – full (general) flowering
EF – end of flowering
RF – first ripe fruits
RP – fruit ripe for picking
CL – colouring of leaves
FL – leaf fall

Table 7-10: Mean (MEAN), maximum (MAX) and minimum (MIN) phenophase dates for common lilac, apple and olive trees along with related standard deviation (STD) and amplitude (AMPL = MAX - MIN) at selected stations in Croatia mostly within the period 1961–2008 (cont.)

PHENOPHASES			UL	BF	FF	EF	RF	RP	CL	FL
APPLE TREE	SRED	GOSPIC (1968.-2008.)	25.4.	2.5.	8.5.	14.5.	22.9.	5.10.	19.10.	29.10.
	STD		9	8	8	9	6	7	9	9
	MAKS		8.5.	19.5.	23.5.	29.5.	7.10.	18.10.	4.11.	11.11.
	MIN		3.4.	17.4.	20.4.	27.4.	7.9.	24.9.	1.10.	6.10.
	AMPL		35	32	33	32	30	24	34	36
OLIVE TREE	SRED	RAB		27.5.	3.6.	14.6.	14.10.	7.11.		
	STD			8	8	7	10	10		
	MAKS			14.6.	18.6.	30.6.	3.11.	25.11.		
	MIN			6.5.	13.5.	31.5.	9.9.	30.9.		
	AMPL			39	36	30	55	56		
	SRED	HVAR		21.5.	28.5.	6.6.	16.10.	9.11.		
	STD			10	10	11	11	8		
	MAKS			5.6.	15.6.	26.6.	5.11.	25.11.		
	MIN			4.4.	8.4.	14.4.	9.9.	20.10.		
	AMPL			62	68	73	57	36		

In order to estimate a tendency of delay/earliness of phenophases in Croatia, linear trends of their appearance have been calculated for observed long-time period (Table 7-11 and Figure 7-17). Linear trends values in Table 7-11 are reduced to 10-year period. One of the methods providing the evaluation of statistical significance of limit change, around which the members of time series are distributed, i.e. evaluation of linear trend existence is non-parametric Mann-Kendall rank test (Michell et al., 1966).

Statistically significant trend at the level of 0.05 is noticed in earlier flowering of observed plants (2-4 days/10 years) in all climate zones, except in city of Zagreb. Air temperature rise in Zagreb cannot be just a result of global warming, but in rapid expansion of Zagreb in the last hundred years.

Earlier apple tree flowering (3-4 days/10 years) is more expressed in the mountainous Croatia than in the inland (2 days/10 years). Significant trend of apple tree ripe fruits and picking is noticed only in the inland of Croatia, as well as a tendency of vegetation extension (leaves falling is later 2 days/10 years). On the contrary, in the mountainous Croatia a negative trend of apple tree colouring and leaves falling (3 days/10 years) has been observed, which indicates to shortening the vegetation period in autumn.

Olive tree flowering is earlier 2 days/10 years in northern Adriatic, while in Dalmatia 3 days/10 years. Earlier olive ripe 2 days/10 years is observed in Dalmatia, while earlier picking is not just a result of weather conditions, but it depends on available olive oil processing plants, amount of yield that can be processed at defined moment, as well as on market demand for certain oil quality.

Analysis of climate change impacts on plants indicated in all climate zones an earlier beginning of flowering of observed plants in spring, which is a result of warmer winter and spring. In autumn there is no such unambiguous delay in colouring and leaves falling in all climate zones, i.e. vegetation period extension is observed in the inland, but not in the mountainous Croatia. These results are in accordance with observed more expressed mean air temperature rise in spring than in autumn.

Table 7-11: Linear trends of phenophases (day/10 years) for common lilac, apple and olive trees at selected stations in Croatia mostly in the period 1961-2008. Significant linear trends at the level ≤ 0.05 are in bold.

TREND (day/10 years)	PHENOPHASES	UL	BF	FF	EF	RF	RP	CL	FL
COMMON LILAC	DARUVAR	0.7	**-2.1**	**-2.8**					
	ZAGREB	-3.4	0.2	0.3					
	GOSPIĆ	**-3.5**	**-2.2**	**-2.4**					
	RAB	-0.6	**-2.7**	**-2.3**					
	HVAR	-1.6	**-1.9**	**-2.3**					
APPLE TREE	DARUVAR (1969-2008)	-0.8	**-2.2**	**-2.2**	**-1.7**	**-1.8**	**-2.1**	-0.2	1.7
	GOSPIĆ (1968-2008)	**-2.4**	**-3.0**	**-3.8**	**-4.5**	-0.6	-0.7	**-2.7**	**-2.9**
OLIVE TREE	RAB		**-1.8**	**-2.2**	0.0	0.0	-1.7		
	HVAR		**-2.9**	**-2.9**	**-2.9**	-2.6	-2.0		

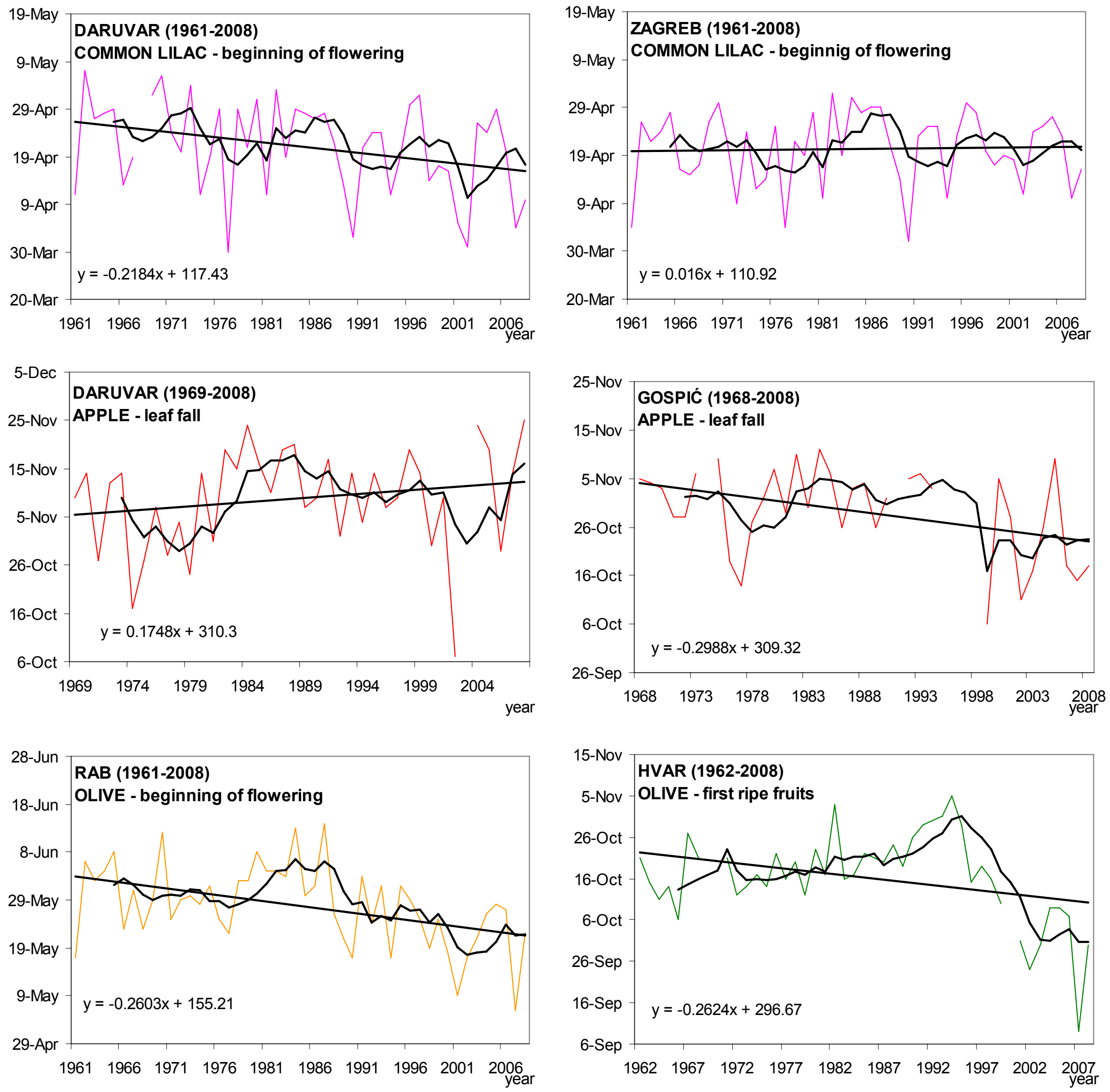

Figure 7-17: Time series of the pheno-phases of common lilac, apple and olive trees, the 5-year moving average series and linear trends for Daruvar, Zagreb, Gospić, Rab and Hvar mainly for the period 1961–2008 x is a number of years (1,2…n)

Considering the climate change impact on species distribution, applying the Hopkins' Bioclimate Law saying that a temperature rise of 3°C corresponds to the shift of vegetation by altitude of 500 m, it is predicted that the vegetation of the pre-mountain region of the Dinarides will be replaced by the vegetation of a temperate climate zone. The most endangered will be plant species of a circumpolar (40 species), pre-Alpine (266 species) and of the Alpine (607 species) distribution. Particularly endangered will be rich and endemic flora of small southern and middle Adriatic islands of small migration possibilities.

Populations of numerous species, especially those on the edges of the areals, are expected to be exposed to fragmentation to smaller subpopulations. The populations possessing large and numerous subpopulations and migrating slowly will lose the least genetic diversity and vice versa.

If the sea level increases, wetlands and ponds, as worth habitats of great biodiversity, could be facing a great challenge. In such way, for example, a sea water flood could harm a vulnerable balance of Vransko jezero Nature park – the only large wetland near the Adriatic coast representing a special ornithological reservation of great biodiversity.

Main indirect measures for the protection of terrestrial ecosystems and biodiversity are:

- *ex-situ* and *in-situ* protection[55] of threatened species, especially endemics, in order to protect the gene fund;
- preservation of migratory corridors for species able to survive by changing the area and scope of appearance;
- adjustment of spatial plans and protected areas management plans;
- planning/predicting changes in boundaries of protected areas;
- adjustment of protection programmes at the species level;
- development of infrastructure for scientific evaluation of the status, forecast and monitoring of changes in terrestrial ecosystems and biodiversity.

Based on the Nature Protection Act (OG 70/05), in 2007, the Regulation on the proclamation of the Ecological Network was adopted (OG 109/07). The Regulation covers areas important for protection of endagared wild taxa and habitat types at national and the European level (including potential areas of the NATURA 2000 ecological network) which make 47% of the mainland and 39% of the sea territory of the Republic of Croatia and two corridors: corridor for sea turtles and Palagruža-Lastovo-Pelješac corridor (area important for bird migrations).

Based on present evaluation of analyzed plant, fungal and animal groups (vertebrates, daily butteflies, dragonflies, underground fauna, corals, bround beetles, stoneflies, vascular flora an fungi) endangerment, there are 2235 endagered species in the red list out of which freshwater fish are the most endagered, followed by reptiles, amphibians and birds. All these species are protected by the Ordinance on proclamation of Wild Taxa as Protected and Strictly Protected (OG 7/06). It should be mentioned that, for some groups, climate changes are only one cause of their endangerment.

7.4.5. Coast and Coastal Zone

The whole Croatian coast lies on carbonate rocks and karstic habitats which are quite vulnerable to physical changes, so the sea-level increase could be potentially one of the most serious and expensive climate change consequences. However, there is still a certain uncertainty considering the sea level increase. There are two basic reasons of sea-level increase (total sea water volume increase):

- surface warming which causes thermal expansion of sea water[56]
- the Earth atmosphere warming which causes rapid melting of the Earth ice cover and Alps glaciers

Both factors bring to a global sea-level increase, affecting the Adriatic sea as well. Although measurements during the last decade indicate constatnt sea-level increase, considering the shortness of monitored period, it cannot be determined with certainty whether the level increase is a result of general sea-level increase trend or just a 10-year sea level variation.

Several areas, which will probably be vulnerable to a sea level increase at the Croatian coast, were identified by one of relatively new studies[57] as it follows:

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[55] „Ex situ“ protection means preserving biodiversity components outside their natural habitats while „in situ“ refers to the preservation of biodiversity components within their natural habitats.

[56] According to IPCC report from 2007., at this moment, thermal expansion of wate ris the main cause of the sea level increase.

[57] Baric, Grbec i Bogner, 2008.

- cities:
  - Nin
  - Zadar
  - area of Šibenik
  - Split
  - Stari Grad on the island of Hvar
  - Dubrovnik

- rivers:
  - the Raša
  - the Cetina
  - the Krka
  - the Zrmanja
  - the Neretva

- lakes:
  - Vransko jezero on the island of Cres
  - Vransko jezero near Biograd
- western Istrian coast
- the island of Krapanj

Significant sea level-increase could endanger numerous commercial and fishing ports, contaminate coastal freshwater sources in karstic zone, disrupt touristic and recreative activities depending on coastal areas, etc.

During the creation of the Human Development Report (UNDP), area and land type, that could be covered by sea water or could be endangered by a flood, have been analyzed according to two different scenarios of sea level increase – at 50 and 88 cm. The 50 cm increase represents high rise considering a potential sea level increase mentioned in the IPCC report, while the 88 cm increase represents the maximum projected increase in case if there is no any melting of the Grenland and the Antarctic ice cover. It should be emphasized that methodology of lower mentioned assessments has several limitations and assessments are slightly conservative, which should be taken into consideration during the results analysis.

Preliminary results of the analysis for the first scenario (level increase at 50 cm) indicate that more than 100 km^2 of the land will be flooded, while in case of an 88 cm increase (the second scenario) additional 12.4 km^2 will be under water (Table 7-12). Probably the most endangered coastal resources are freshwater areas and wetlands.

Table 7-12: Impact of sea level increase at 50 and 88 cm

LAND	Total surface covered by sea level increase at 50 cm (m^2)	Total surface covered by sea level increase at 88 cm (m^2)
Vegetated/semi-vegetated	14175625	15897500
Bare rocks	420625	4383750
Forests	10861875	11615000
Beaches/sand dunes	176250	1871875
Salines	4384375	4406250
Freshwater and wetlands	42124375	43815000
Agricultural land	12393750	12410000
Sport/leisure facilities	2386875	2499375
Roads/railways	60625	559375
Urban/semiurban	9803125	10010625
Ports/marine installations	965000	2682500
Industrial activity	2303125	2308125
TOTAL	**100055625**	**112459375**

(taken from the Human Development Report, UNDP, 2008.)

Regarding climate change adaptation, time period, within which the sea-level increase is predicted to occur, is a very important factor. Taking into consideration the assessments of gradual sea-level increase, there is still enough time to prepare and take measures and activities in order to alleviate negative effects. Thus, institutional capacities should be improved for an overall and consistent planning and managing of the coastal resources, to take into consideration future sea-level changes while designing and managing coastal area, to develop capacities for designing the measures and adaptation projects to possible sea-level increase, etc. Adaptation to climate change impacts, related to the coast and coastal area, can include numerous technical measures as well, such as the silting of beaches with gravel and sand, developing alternative sources of water supply, increasing the capacities for water purification due to salinity intrusion, etc.

7.4.6. Marine Ecosystems and Fish Resources

Climate change have both positive and negative effects to the Croatian fishery sector, from marine ecosystem change, change in behaviour and migration patterns of pelagic fish, change in biodiversity, etc.

Research of the Adriatic Sea have shown the impact of the water inflow from the Mediterranean Sea: changes in phytoplankton and zooplankton species composition, productivity increase of the Adriatic, that otherwise has relatively low nutrient levels.

Climate change caused a biodiversity change in Adriatic as well, that can be observed through the expansion of areals of thermophilic fish species, i.e. through species movement from south to north. Although there is a number of factors that could cause changes in migration patterns of pelagic fish, temperature is considered to be the key factor.

Impacts of new species appearing in the Adriatic could be twofold, depending on whether they are observed in economic or ecological sense. For example, migration of dusky groupers from southern to middle and northern Adriatic has a positive economic impact to fishery, as dusky groupers are rare and quite wanted fish. However, due to a competition, negative impact reflected on some local species.

Positive impact of climate change is possible within the area of aquaculture. Species, which are better adapted to higher sea temperatures, for example, sea bream, due to the increase in winter, could have more favourable conditions to grow and develop during this season. Global warming will probably have a positive impact on tuna breeding as well, as the most important economic product in fishery sector.

Likely impact of climate change on important commercial fish in the Republic of Croatia is indicated in Table 7-13.

Table 7-13: Likely impact of climate change on important commercial fish in the Republic of Croatia

Type of fish	Mariculture or Fishing	Likely Impact of Climate Change
tuna	Mariculture	positive due to increased temperatures
oyster	Mariculture	negative – especially if temperature is over 26.5 C
sea bass	Mariculture	negative due to increased temperatures
sea bream	Mariculture/ Fishing	positive- faster growth, prolonged spawning season
sardine	Fishing	moving of spawning centres, expanding of spawning period, negative according to effects of predators
anchovy	Fishing	
hake	Fishing	moving of spawning centres, prolonged spawning season
prawn	Fishing	effects on boreal species, changes in bathymetric distribution

(taken from the Human Development Report, 2008)

Climate change-related warming may have the following implications for the Croatian fishing sector:

- Temperature increases will enhance the risk of oxygen level decrease and result in fish depletion in shallow areas of the Adriatic. This situation will create conditions that allow the increase of species that tolerate warm water and lower oxygen levels.
- Due to faster biological processes at all levels of marine ecosystems, the growth rate of fish should be higher and reproduction seasons should be longer for most species. As a result, the recruitment of species that thrive in warm water should be significantly better.
- The opposite is likely to occur with species that thrive in cold water, such as prawn. These species will migrate to colder areas, either horizontally (moving north, south, east or west) or vertically (moving to deeper levels).
- The introduction of new organisms that transmit disease or exotic or undesired species is likely to occur due to increased sea temperatures.

In order to react to climate change impacts on time and as appropriate, establishment of adaptable sector managing should be promoted. In order to identify, understand and predict all interactions between climate and marine ecosystem, research, condition monitoring and analysis of climate change impacts in neighboring and/or similar countries are required.

Some of technical adaptation measures would assume, for example, certain changes in breeding (e.g. breeding transfer to deeper waters).

7.4.7. Human Health

According to climate scenarios, a higher incidence of hot and dry summers with maximum daily and high night temperatures (over 25°C) is expected. A more frequent occurrence of heat waves will pose a serious threat to human health in future, especially as regards older people and chronic patients. In winter, vascular patients suffer most from situations of low air pressure, the air streaming southwards and unstable weather with rain, clouds and wind.

The predicted decline in frequency of winter cold weather will cause the reduction in the number of coronary failures, cerebrovascular insults and asthmatic attacks in winter. Low air temperatures affect adversely the respiratory diseases. Asthmatic attacks are more frequent in winter during cold high-pressure periods and in other seasons, especially in summer they are associated with the movements of a cold front.

Warmer and drier conditions as projected by climate scenarios may favour the spread of diseases borne by food or water, such as diarrhoea and dysentery. A consequence of warmer summers and an extended vegetation season will be the rise in the number of patients becoming sensitized to and affected by respiratory allergies: seasonal allergic rhinitis and allergic asthma caused by pollen from the trees, grasses and weeds. It is estimated that every tenth inhabitant of Croatia suffers from pollen allergy caused by Ambrosia (*Ambrosia artemisifolia* L.).

Climate changes stimulate the spread of diseases outside their natural seats. Due to global warming malaria is increasingly occurring in traditionally cool mountainous areas of Africa, Asia and South America inhabited by some 10% of the world's population. The coastal area of Croatia might also be threatened by malaria. The tiger mosquito (*Aedes albopictus*) is spreading from South-Eastern Asia and Oceania to other continents by trade and transport of used tyres. It was recorded for the first time in Croatia in October 2004. It spreads quite rapidly and adapts to new spaces, significant as molester as regards to health and as potential carrier of various arboviruses (among which the most important is the virus of the - VHG) and parasites.

In Croatia the tick-borne virus meningoencephalitis, caused by a forest ticks (*Ixodes ricinus*), occurs seasonally from spring to autumn, which correlates to tick activities. A warmer and longer autumn time contributes to extension of tick activities and mild winters favour the tick survival. The rise of the annual mean temperature shifts altitudinal limit for tick occurrence.

8. RESEARCH, SYSTEMATIC OBSERVATION AND MONITORING

8.1. Global Climate Observation System (GCOS)

Global Climate Observation System (GCOS) was established in 1992 and the Republic of Croatia, represented by the Meteorological and Hydrological Service, has been its member since. This system includes observation in all parts of the climate system – in the atmosphere, ocean, sea and land. It is intended to define and cover all the observations required for monitoring the climate system including satellite observations at the global, regional and national levels, and to create conditions for observation enhancement.

Global Earth Observation System of Systems (GEOSS) is a new initiative taken with the objective to co-ordinate and enhance all current observing systems at the global level in support of the requirements of user areas: natural disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity. The Republic of Croatia joined the GEOSS in 2004.

Within the framework of the UNDP/GEF project CRO/03/G31/A/1G/99 "Climate Change Enabling Activity; Additional Financing for Capacity Building in Priority Areas", the Meteorological and Hydrological Service printed the publication *Croatian Climate Observing System*. In this publication, all observations carried out, their methodology and the implementing institutions were specified in conformity with the GCOS methodology.

The observing systems existing in Croatia suffer from numerous deficiencies and barriers that are to be overcome. While some of the systems have reached an enviable organizational, qualitative and operational level, others are yet to be established or included in those existing.

The basic guidelines for future planning of observing systems in Croatia are:

- to participate actively and continuously in the GCOS and its partnership systems, with the principal aim to promote and cooperate in systematic observations and development of data archives related to all segments of the climate system (atmosphere, sea, land);
- to ensure cooperation between various observing systems at the national level;
- to plan actions for ensuring collection, exchange and use of data, to extend the area of their application in support of the local, regional and international requirements for data;
- to enhance the quality of observing, maintaining equipment and verifying and keeping data archives in the existing networks related to the climate system;
- to modernize the current observing networks and renew or establish observations not yet functional;
- to upgrade current climate databases and to develop a system that will improve access to data and facilitate their use and exchange;
- to continuously make efforts to save historical sets of data, to restore old records and to enter them into the machine processing medium, process and store;
- to develop strategies for the introduction of cosmic (satellite) observation programmes in all segments of the climate system (atmosphere, sea, land).

8.2. Data Collection and Systematic Observations in Croatia

The Republic of Croatia has a long tradition of monitoring elements in all segments of the climate system. The Meteorological and Hydrological Service is the fundamental institution for meteorology and hydrology and has been carrying out meteorological observations for operational needs, verifying, storing and publishing data since 1851.

Croatian institutions that maintain observing systems in the climate segments of atmosphere, sea and land are:

- Meteorological and Hydrological Service;
- Ministry of the Sea, Transport and Infrastructure (airports and road transport);
- Ministry of Environmental Protection, Physical Planning and Construction;
- Ministry of Health and Social Welfare, Institute for Medical Research, Public Health Institute
- Institute of Oceanography and Fisheries;
- Hydrographic Institute;
- "Ruđer Bošković" Institute – Marine Research Centre;
- "Andrija Mohorovičić" Geophysical Institute, College of Science.

Apart from the institutions listed, numerous institutions and branches of economy run their own observing systems or individual stations. Table 8-1 shows all stations in Croatia involved in measuring atmospheric parameters.

Table 8-1: Types and number of stations observing atmospheric parameters (state of 31 December 2004)

Type of stations	**Number of stations**
Ground-level meteorological stations	651
Ground-level main meteorological stations	38
Aeronautical meteorological stations	5
Climatological stations	109
Rain measuring stations with totalizers	326
Automatic meteorological stations with transfer of data to information system of the Meteorological and Hydrological Service	58
Automatic meteorological stations not included in the information system of the Meteorological and Hydrological Service	> 115
High-altitude weather stations	11
Radio-sonde stations	2
Pilot balloon stations	1
Radar stations	8
Atmospheric composition (pollution) measuring stations	50 + > 250
Ozone measuring stations	3
Sulphur dioxide etc. • by analysing daily precipitation samples • by automatic station	25 19 6
Nitrogen dioxide etc. • by analysing daily air flow through solution • by automatic station	16 12 4
Fume and aerosol properties	3
Greenhouse gases	4
Measuring air pollution parameters at local level	> 250

8.3. Research into the Climate Change Impacts by Areas

8.3.1. Hydrology and Water Resources

The assessment of climate change impacts on waters, in a small, but from the aspect of geology and climate highly heterogeneous country as Croatia, depends on the assessment of changes in precipitation, on evapotranspiration and determination of future water requirements.

Present knowledge does not allow any precise assessment of climate change impacts in this sector. The preservation and development of water resources and agrotechnical systems, including the application of the water management strategy, are necessary preconditions for adaptation and factors that the economic progress of the state depends upon.

Extreme hydrological phenomena such as floodings, for example, are unavoidable, but the consequences may be mitigated. A single large flood may cause damage equivalent to 30-years investment in flood defence. A new strategic approach requires further investments in flood defence and an integrated approach to water resources management. Droughts are not a sporadic phenomenon. In Croatia the shortage of water is expected in the long run during the vegetation period and the tourist season, when water requirements reach their peak. It is therefore recommended to carry out research and to cooperate with other countries whose positive experiences in combating drought may be applied.

Within the framework of the hydrology and water resources sector the following activities of studying the impacts and adaptation to climate changes are recommended:

- monitoring and recording of hydrological and meteorological data ;
- assessment of climate change impacts on evapotranspiration and discharge;
- assessment of climate change impacts on water balance;
- assessment of climate change impacts on water management activities;
- preparation of regional studies of expected climate change impacts on water resources.

8.3.2. Forestry

The response of forest ecosystems to expected climate changes will be investigated by monitoring systematically:

- phenological manifestations of leaf unfolding, flowering, fruit-bearing, leaf-losing of certain characteristic tree species and the overall duration of the vegetation period;
- emergence, activities and number of certain forest pests;
- leaves falling of crowns of major tree species;
- incidence of forest fires;
- changes in the floristic composition of urban forests;
- groundwater level oscillations;
- frequency and scope of occurrence of certain plant diseases;
- frequency of stormy weather and range of forest damages caused by wind;
- selected biological, physical and chemical variables of forests ecosystems, especially in zones of physical contact between the Mediterranean and continental climate;
- adaptation of individual provenances of forest tree species in provenance tests.

An efficient monitoring is only possible within the framework of a system for funding scientific and research projects of national importance and in cooperation with scientific institutions of neighbouring countries so as to ensure the coverage of an as wide as possible area of possible climate change effects.

The following research projects are recommended for implementation:

- Research of carbon absorption from the atmosphere into the biomass
- Carbon uptake by forest soils
- Modelling changes in forest ecosystems of Croatia under the influence of climate change;
- Natural regeneration of forests under the conditions of exposure to harmful impacts;
- Monitoring climate changes in testing the provenance of domestic and foreign forest tree species;
- Forest pests as an indicator of changed climate conditions.

Within the INTERREG III-B Programme related to European Union's efforts to fulfill Kyoto Protocol commitments and also to reinforce linkage and cooperation among neighbouring countries and regions, financing of the project "Carbon Balance Drafting and New Resource Management Tools According to Kyoto Protocol (Carbon-pro) was approved. The project duration was from April 1st 2006 to 31st December 2007 aimed to apply and mutually share integrated methods, systems and tools of sustainable management of forest and agricultural resources in the CADSES area (area of the Central and Eastern Europe, Adriatic and Danube region). From Croatian side, project partner was Croatian Forest Institute which has, among other things, established stations for field measuring. Within the project concerned, in 2007, a round-table discussion "Kyoto Protocol and Forestry" was held in Croatian Forest Society. Such project and the similar ones should be maintained.

In parks, public gardens and lines of trees found in settlements whose climate conditions favour plant communities of a colder climate it is recommended to investigate the composition of dendroflora and register the emergence of species naturally inhabiting the areas of warmer climates.

The following species are suitable indicators of climate change impacts on dendroflora of urban forests of the continental area of Croatia: *Albizzia julibrissin* Durazz., *Caesalpinia gilliesii* (Wall. ex Hook.) Benth., *Camelia japonica* L., *Cedrus deodara* (Roxb.) G. Don, *Colutea arborescens* L., *Cupressus bakeri* Jeps., *Cupressus cashmeriana* Royle ex Carrière, *Cupressus lusitanica* Mill., *Cupressus sempervirens* L., *Cycas revoluta* Thunb., *Eriobotrya japonica* (Thunb.) Lindl., *Ficus carica* L., *Fraxinus ornus* L., *Juniperus oxycedrus* L., *Magnolia grandiflora* L., *Pinus halepensis* Mill., *Pinus pinaster* Aiton, *Poncirus trifoliata* (L.) Raf., *Punica granatum* L. etc.

Changes in forest ecosystems that occurred under the influence of climate changes may be monitored and quantified by a direct long-term monitoring of selected biological, physical and chemical variables *in situ*. Since a permanent long-term monitoring cannot cover all forest ecosystem types in Croatia it is recommended to monitor:

- forest types in zones of physical contact of the Mediterranean and continental climate;
- forest types on the tree-line in physical contact with mountain grasslands;
- forest types in which vulnerable species dominate (e.g. *Abies alba*);
- lowland forest types dependent upon additional wetting by floods and groundwater.

8.3.3. Agriculture

The guidelines for research in agriculture are:

- to identify areas in the world having already the climate profile similar to that predicted for Croatia and analyse the agricultural production technology and the product range in such areas;
- to initiate (finance) improvement projects focused on the development of populations and varieties adapted to soil types and climate conditions in Croatia's agricultural regions that will meet new requirements in the future;
- to initiate permanent research into existing agricultural crops (maize, wheat, potato, apple, wine grape) in the areas of Croatia or abroad (through international cooperation) containing already elements of the model predicted (e.g. testing maize or soya bean for drought under the conditions of the Dalmatian hinterland and islands);
- to investigate new systems of tillage, sowing (planting), sowing density, cultivation forms and fertilization that will maximally economize on humidity in the soil.

8.3.4. Biodiversity and Natural Terrestrial Ecosystems

The assessment of climate change impacts on terrestrial ecosystems is based on two groups of data: climatic prognostic models of global changes relating to the given area and data on terrestrial ecosystems in the widest context.

For the purpose of overcoming the shortage of adequate amounts and quality of data on thematic areas of biodiversity and natural terrestrial ecosystems it is necessary:

- to develop climate change models under one or more selected scenarios specifically for the area of Croatia, respecting national climatic and orographic peculiarities and applying sufficient resolution of basic data for the entire national territory (approx. 100 m pixel);
- to map current distribution of target indicator flora and fauna groups using the adequate methodology as a basis for monitoring changes and developing prognostic models;
- to increase resolution of Croatia's map of habitats from a scale of 1:100 000 to a scale of 1:25 000 as a basis for monitoring changes and for predictive models;
- to monitor the development, to acquire and apply in time the latest methodological achievements in the field of ecological modelling with the aim to develop as reliable prognostic scenarios as possible;
- to map the distribution and determination of areals in Croatia for target indicator groups of flora and fauna;
- to evaluate appropriateness of migratory ways for the most threatened flora and fauna taxa;
- to evaluate the migration of invasive flora and fauna taxa on the national territory;
- to establish a seed-bank for keeping the collected plant seed material and to collect samples of animal taxa, all this for the purpose of conserving the gene fund of endemic and vulnerable plant and wildlife taxa

8.3.5. Coast and Coastal Zone

The existing system for the collection of data relating to the sea level changes, sea current directions and forecasts of wind waves along the eastern Adriatic coast is to be improved.

A mareographic station founded in Bakar in 1929 and completely renewed in 2005 operates within the Geophysics Institute of the College of Science in Zagreb. The data registered by this station are regularly processed, published and used in preparation of scientific and specialized papers. In addition to permanent measuring along the coast, periodic measurements are also carried out in coastal waters and the open sea. The Geophysics Institute carries out research in the field of physical oceanography within the framework of domestic projects such as, for example, "Interactions of the Atmosphere and the Sea" and "System of Atmospheres – the Adriatic", and a number of international projects. The research work was focused on physical processes in the Adriatic and their dependence on atmospheric effects, and evolved from the empirical and theoretical analysis into the first attempts to forecast processes in the Croatian coastal zone.

The Croatian Hydrographic Institute in Split is implementing the project entitled "Web Presentation of Tides and Sea Levels along the Croatian Coast of the Adriatic Sea and Construction of the Corresponding Database" and providing the users with information on real (measured) sea level at the tide gauge station in Split and with scientific analyses of data measured.

In view of climate change impacts and the sea level rise, the coastal area management requires preparation of detailed scientific and expert studies to estimate the maximum area of the coast that will be overflown or periodically flooded, the population exposed to flooding effects and the penetration of salt water into freshwater reservoirs.

These outputs will be used to formulate a national strategy and action plan for the prevention and mitigation of negative socio-economic effects, which should be adopted by competent government bodies. The strategy and action plan is to cover two main areas: protection of existing natural assets and man-made structures and facilities and instructions for the construction of new structures and facilities in the coastal zone.

8.3.6. Marine Ecosystem and Fish Resources

The research into marine ecosystems and fish resources is supplemented by oceanographic and hydrographic researches into the Adriatic Sea.

The following activities are recommended:

- implementation of multidisciplinary oceanographic and hydrographic research into the Adriatic Sea and identification of the process of interaction between the climate and marine ecosystems;
- investigation of changes in the composition and number of Adriatic fish populations;
- monitoring the commercial catch fluctuations for the purpose of preparing the action plan for adaptation of Croatia's sea fishery to climate changes;
- establishment of permanent monitoring of fish species that are biological indicators of changes in hydrographic properties of the sea with the final aim to get to know their biology and ecology.

8.3.7. Human Health

The investigation into the connection between individual meteorological parameters and the incidence of hospitalization of patients with cerebrovascular insult and myocardial infarction in Zagreb hospitals and the monitoring of blood coagulation parameters showed the adverse effect of cold winter periods and summer situations with warm and sulky weather.

In February 1999 the Zagreb polyclinic "Srčana" started investigating the effects of a meteorological stress on patients suffering from cardiac difficulties. The investigations performed in the Urgent Medicine Institute of Zagreb showed a considerable rise in the incidence of neurovegetative disorders accompanied by the drop in blood pressure, dizziness and collapse in situations of high temperatures of air, especially if persisting several days.

Meteorological and aerobiological parameters affect mostly the incidence of symptoms with pulmonary and cardiovascular patients. It is therefore of utmost importance to provide timely information on the atmospheric state and effects of such a state on the organism.

Biometeorological researches have been performed in Croatia for some 50 years now. Since 2004 the Meteorological and Hydrological Service has started to perform biometeorological forecast for the whole Croatian area. Biometeorological forecast is monitoring the atmosphere parameters impacts on human health and daily public informing on expected meteorological conditions with a purpose to give certain advice on health protection and symptoms prevention. Bioforecasts regularly appear in daily press and radio and television news broadcasts.

Pollen calendars provide information on the presence of (especially increased) concentrations of pollen of alergogenic plants in the air of a specific climate area based on data obtained by measuring continuously pollen concentrations in the air at measuring stations. Meteorological parameters mostly affecting a dynamics of pollen presence in the air are temperature and precipitation. Rapid warming will stimulate pollen creation and discharge into the atmosphere, while during the precipitation period it will not almost be present in the air at all. This enables the patients to adapt their activities and thus minimize the contact with allergens.

The first expert conference on climate changes and their effects on health was organized by the Croatian Society for Environmental Health and took place in Zagreb on 24 May 2001.

ANNEX: GREENHOUSE GASES EMISSIONS FROM 1990-2007 TABLES

Croatia	CO_2	CH_4		N_2O		HFC, PFC & SF_6	Total	Share
Year 1990	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**20582.79**	**69.13**	**1451.68**	**0.37**	**114.52**	**NO**	**22148.99**	**70.71**
A. Fuel Comb (Sectoral Appr.)	20166.84	9.61	201.74	0.55	114.52	NO	20483.11	65.40
1. Energy Industries	7126.54	0.17	3.61	0.07	13.80	NO	7143.95	22.81
2. Man. Ind. and Constr.	5447.30	0.48	10.08	0.09	17.96	NO	5475.33	17.48
3. Transport	3987.25	1.55	32.56	0.24	50.17	NO	4069.97	12.99
4. Comm./Inst, Resid., Agric.	3605.76	7.40	155.50	0.16	32.59	NO	3793.85	12.11
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	415.95	59.52	1249.94	NO	NO	NO	1665.89	5.32
1. Solid Fuels	NO	NO	48.76	NO	NO	NO	48.76	NO
2. Oil and Natural Gas	415.95	57.20	1201.18	NO	NO	NO	1617.13	5.16
2. Industrial Processes	**2417.36**	**0.78**	**16.45**	**2.59**	**804.08**	**947.58**	**4185.46**	**13.36**
A. Mineral Products	1315.38	NE,NO	NE,NO	NE,NO	NE,NO	NO	1315.38	4.20
B. Chemical Industry	870.99	0.78	16.45	2.59	804.08	NO	1691.52	5.40
C. Metal Production	230.99	NE,NO	NE,NO	NO	NO	936.56	1167.56	3.73
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	11.01	11.01	0.04
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**80.21**	**NO**	**NO**	**NE**	**NE**	**NO**	**80.21**	**0.26**
4. Agriculture	**NO**	**69.42**	**1457.81**	**9.26**	**2870.60**	**NO**	**4328.40**	**13.82**
A. Enteric Fermentation	NO	58.54	1229.36	0.00	0.00	NO	1229.36	3.92
B. Manure Management	NO	10.88	228.44	1.22	378.74	NO	607.18	1.94
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	8.04	2491.86	NO	2491.86	7.96
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NE
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-4184.93**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-4184.92**	**-13.36**
A. Forest Land	-4184.93	0.00	0.01	0.00	0.00	NO	-4184.92	-13.36
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.09**	**23.81**	**499.94**	**0.25**	**78.69**	**NO**	**578.72**	**1.85**
A. Solid Waste Disp. on Land	NE,NO	10.53	221.21	0.00	0.00	NO	221.21	0.71
B. Waste-water Handling	0.00	13.27	278.73	0.25	78.69	NO	357.42	1.14
C. Waste Incineration	0.09	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.09	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**18895.52**	**163.14**	**3425.89**	**12.48**	**3867.89**	**947.58**	**27136.87**	**86.64**
Total Emissions without LUCF	**23080.45**	**163.14**	**3425.89**	**12.48**	**3867.89**	**947.58**	**31321.79**	**100.0**
Share of Gasses in Total Em./Rem.	**69.63**		**12.62**		**14.25**		**100.00**	
Share of Gasses in Total Em.	**73.69**		**10.94**		**12.35**		**100.00**	
Memo Items:								
International Bunkers	451.83	0.01	0.20	0.01	3.28	NO	455.31	
Aviation	343.29	0.00	0.05	0.01	3.01	NO	346.35	
Marine	108.54	0.01	0.15	0.00	0.27	NO	108.96	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	2.436.76	NO	NO	NO	NO	NO	2436.76	

NO (*not occurring*); **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC, PFC & SF_6	Total	Share
Year 1991	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**15079.24**	**62.04**	**1302.75**	**0.26**	**80.97**	**NO**	**16462.96**	**66.50**
A. Fuel Comb (Sectoral Appr.)	14623.41	6.31	132.56	0.39	80.97	NO	14836.94	59.93
1. Energy Industries	4768.18	0.11	2.27	0.04	9.03	NO	4779.47	19.31
2. Man. Ind. and Constr.	3882.52	0.37	7.70	0.06	13.10	NO	3903.32	15.77
3. Transport	2936.85	1.18	24.78	0.18	37.07	NO	2998.70	12.11
4. Comm./Inst, Resid., Agric.	3035.86	4.66	97.82	0.10	21.77	NO	3155.45	12.75
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	455.83	55.72	1170.19	NO	NO	NO	1626.02	6.57
1. Solid Fuels	NO	NO	43.45	NO	NO	NO	43.45	NO
2. Oil and Natural Gas	455.83	53.65	1126.74	NO	NO	NO	1582.57	6.39
2. Industrial Processes	**2015.38**	**0.58**	**12.26**	**2.28**	**706.28**	**653.29**	**3387.20**	**13.68**
A. Mineral Products	870.62	NE,NO	NE,NO	NE,NO	NE,NO	NO	870.62	3.52
B. Chemical Industry	928.55	12.26	12.26	2.28	706.28	NO	1647.08	6.65
C. Metal Production	216.20	NE,NO	NE,NO	NO	NO	642.44	858.65	3.47
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	10.85	10.85	0.04
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**93.82**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**128.54**	**0.52**
4. Agriculture	**NO**	**64.45**	**1353.47**	**9.17**	**2842.28**	**NO**	**4195.75**	**16.95**
A. Enteric Fermentation	NO	53.70	1127.78	0.00	0.00	NO	1127.78	4.56
B. Manure Management	NO	10.75	225.68	1.17	361.98	NO	587.67	2.37
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	8.00	2480.30	NO	2480.30	10.02
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8699.64**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8699.63**	**-35.14**
A. Forest Land	-8699.64	0.00	0.01	0.00	0.00	NO	-8699.63	-35.14
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**24.06**	**505.21**	**0.24**	**75.73**	**NO**	**580.98**	**2.35**
A. Solid Waste Disp. on Land	NE,NO	11.12	233.57	0.00	0.00	NO	233.57	0.94
B. Waste-water Handling	0.00	12.93	271.63	0.24	75.73	NO	347.37	1.40
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**8488.83**	**151.13**	**3173.69**	**11.95**	**3705.26**	**653.29**	**16055.79**	**64.86**
Total Emissions without LUCF	**17188.48**	**151.13**	**3173.69**	**11.95**	**3705.26**	**653.29**	**24755.42**	**100.0**
Share of Gasses in Total Em./Rem.	**52.87**		**19.77**		**23.08**		**100.00**	
Share of Gasses in Total Em.	**69.43**		**12.82**		**14.97**		**100.00**	
Memo Items:								
International Bunkers	139.53	0.01	0.11	0.00	0.77	NO	140.41	
Aviation	68.19	0.00	0.01	0.00	0.60	NO	68.80	
Marine	71.34	0.00	0.10	0.00	0.18	NO	71.61	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1680.37	NO	NO	NO	NO	NO	1680.37	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC & SF_6	Total	Share
Year 1992	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**14280.99**	**60.81**	**1276.92**	**0.24**	**75.46**	**NO**	**15633.37**	**67.79**
A. Fuel Comb (Sectoral Appr.)	13803.66	5.14	107.98	0.36	75.46	NO	13987.10	60.65
1. Energy Industries	5338.81	0.11	2.35	0.05	9.79	NO	5350.96	23.20
2. Man. Ind. and Constr.	3087.45	0.30	6.26	0.05	9.97	NO	3103.68	13.46
3. Transport	2828.24	1.04	21.93	0.18	37.27	NO	2887.45	12.52
4. Comm./Inst. Resid.. Agric.	2549.15	3.69	77.44	0.09	18.43	NO	2645.02	11.47
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	477.33	55.66	1168.94	NO	NO	NO	1646.27	7.14
1. Solid Fuels	NO	NO	33.77	NO	NO	NO	33.77	NO
2. Oil and Natural Gas	477.33	54.06	1135.18	NO	NO	NO	1612.51	6.99
2. Industrial Processes	**2198.05**	**0.51**	**10.71**	**2.98**	**923.47**	**10.85**	**3143.08**	**13.63**
A. Mineral Products	930.19	NE,NO	NE,NO	NE,NO	NE,NO	NO	930.19	4.03
B. Chemical Industry	1182.05	10.71	10.71	2.98	923.47	NO	2116.23	9.18
C. Metal Production	85.81	NE,NO	NE,NO	NO	NO	NO	85.81	0.37
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	10.85	10.85	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**76.73**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**111.45**	**0.48**
4. Agriculture	**NO**	**50.52**	**1060.91**	**8.14**	**2524.09**	**NO**	**3585.00**	**15.55**
A. Enteric Fermentation	NO	42.44	891.26	0.00	0.00	NO	891.26	3.86
B. Manure Management	NO	8.08	169.65	0.91	282.80	NO	452.45	1.96
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.23	2241.29	NO	2241.29	9.72
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-9294.33**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-9294.32**	**-40.30**
A. Forest Land	-9294.33	0.00	0.00	0.00	0.00	NO	-9294.32	-40.30
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**24.30**	**510.38**	**0.25**	**77.21**	**NO**	**587.63**	**2.55**
A. Solid Waste Disp. on Land	NE,NO	11.71	245.84	0.00	0.00	NO	245.84	1.07
B. Waste-water Handling	0.00	12.60	264.54	0.25	77.21	NO	341.74	1.48
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**7261.48**	**136.14**	**2858.92**	**11.61**	**3600.23**	**10.85**	**13766.20**	**59.70**
Total Emissions without LUCF	**16555.81**	**136.14**	**2858.92**	**11.61**	**3600.23**	**10.85**	**23060.53**	**100.0**
Share of Gasses in Total Em./Rem.	**52.75**		**20.77**		**26.15**		**100.00**	
Share of Gasses in Total Em.	**71.79**		**12.40**		**15.61**		**100.00**	
Memo Items:								
International Bunkers	137.25	0.01	0.12	0.00	0.70	NO	138.1	
Aviation	56.62	0.00	0.01	0.00	0.50	NO	57.1	
Marine	80.62	0.01	0.11	0.00	0.20	NO	80.9	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1459.04	NO	NO	NO	NO	NO	1459.0	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 1993	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**15035.03**	**67.00**	**1407.07**	**0.26**	**81.90**	**NO**	**16524.00**	**71.84**
A. Fuel Comb (Sectoral Appr.)	14358.91	4.88	102.41	0.39	81.90	NO	14543.22	63.23
1. Energy Industries	5821.81	0.14	2.85	0.05	9.84	NO	5834.50	25.37
2. Man. Ind. and Constr.	3005.87	0.29	6.09	0.05	9.54	NO	3021.50	13.14
3. Transport	3000.03	1.02	21.43	0.21	45.12	NO	3066.59	13.33
4. Comm./Inst. Resid.. Agric.	2531.20	3.43	72.04	0.08	17.40	NO	2620.63	11.39
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	676.12	62.13	1304.66	NO	NO	NO	1980.78	8.61
1. Solid Fuels	NO	NO	32.31	NO	NO	NO	32.31	NO
2. Oil and Natural Gas	676.12	60.59	1272.35	NO	NO	NO	1948.47	8.47
2. Industrial Processes	**1772.76**	**0.54**	**11.30**	**2.25**	**696.15**	**10.92**	**2491.13**	**10.83**
A. Mineral Products	797.98	NE,NO	NE,NO	NE,NO	NE,NO	NO	797.98	3.47
B. Chemical Industry	945.15	11.30	11.30	2.25	696.15	NO	1652.61	7.19
C. Metal Production	29.62	NE,NO	NE,NO	NO	NO	NO	29.62	0.13
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	10.92	10.92	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**81.68**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**116.40**	**0.51**
4. Agriculture	**NO**	**49.96**	**1049.18**	**7.17**	**2223.89**	**NO**	**3273.08**	**14.23**
A. Enteric Fermentation	NO	41.60	873.65	0.00	0.00	NO	873.65	3.80
B. Manure Management	NO	8.36	175.54	0.91	281.23	NO	456.77	1.99
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.27	1942.66	NO	1942.66	8.45
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8036.66**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-8036.63**	**-34.94**
A. Forest Land	-8036.66	0.00	0.02	0.00	0.01	NO	-8036.63	-34.94
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**24.58**	**516.16**	**0.26**	**79.07**	**NO**	**595.28**	**2.59**
A. Solid Waste Disp. on Land	NE,NO	12.32	258.72	0.00	0.00	NO	258.72	1.12
B. Waste-water Handling	0.00	12.26	257.44	0.26	79.07	NO	336.52	1.46
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**8852.86**	**142.08**	**2983.74**	**9.94**	**3081.03**	**10.92**	**14963.27**	**65.06**
Total Emissions without LUCF	**16889.51**	**142.08**	**2983.74**	**9.94**	**3081.03**	**10.92**	**22999.89**	**100.0**
Share of Gasses in Total Em./Rem.	**59.16**		**19.94**		**20.59**		**100.00**	
Share of Gasses in Total Em.	**73.43**		**12.97**		**13.40**		**100.00**	
Memo Items:								
International Bunkers	253.72	0.01	0.18	0.00	1.50	NO	255.40	
Aviation	139.18	0.00	0.02	0.00	1.22	NO	140.42	
Marine	114.54	0.01	0.16	0.00	0.28	NO	114.98	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1388.13	NO	NO	NO	NO	NO	1388.13	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 1994	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**14295.41**	**60.63**	**1273.13**	**0.26**	**80.49**	**NO**	**15649.04**	**70.48**
A. Fuel Comb (Sectoral Appr.)	13690.54	5.13	107.63	0.38	80.49	NO	13878.67	62.51
1. Energy Industries	4712.78	0.12	2.49	0.04	7.45	NO	4722.73	21.27
2. Man. Ind. and Constr.	3175.64	0.28	5.90	0.04	8.96	NO	3190.50	14.37
3. Transport	3186.32	1.10	23.14	0.22	45.50	NO	3254.96	14.66
4. Comm./Inst. Resid.. Agric.	2615.80	3.62	76.10	0.09	18.58	NO	2710.48	12.21
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	604.87	55.50	1165.50	NO	NO	NO	1770.37	7.97
1. Solid Fuels	NO	NO	28.97	NO	NO	NO	28.97	NO
2. Oil and Natural Gas	604.87	54.12	1136.53	NO	NO	NO	1741.40	7.84
2. Industrial Processes	**1957.82**	**0.52**	**10.90**	**2.43**	**752.82**	**11.20**	**2732.74**	**12.31**
A. Mineral Products	963.54	NE,NO	NE,NO	NE,NO	NE,NO	NO	963.54	4.34
B. Chemical Industry	964.02	10.90	10.90	2.43	752.82	NO	1727.74	7.78
C. Metal Production	30.26	NE,NO	NE,NO	NO	NO	NO	30.26	0.14
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	11.20	11.20	0.05
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**89.23**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**123.95**	**0.56**
4. Agriculture	**NO**	**45.80**	**961.84**	**7.17**	**2222.60**	**NO**	**3184.44**	**14.34**
A. Enteric Fermentation	NO	37.45	786.35	0.00	0.00	NO	786.35	3.54
B. Manure Management	NO	8.36	175.50	0.84	259.10	NO	434.60	1.96
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.33	1963.50	NO	1963.50	8.84
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8658.34**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8658.32**	**-39.00**
A. Forest Land	-8658.34	0.00	0.01	0.00	0.00	NO	-8658.32	-39.00
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**20.43**	**429.02**	**0.27**	**83.20**	**NO**	**512.26**	**2.31**
A. Solid Waste Disp. on Land	NE,NO	12.98	272.60	0.00	0.00	NO	272.60	1.23
B. Waste-water Handling	0.00	7.45	156.42	0.27	83.20	NO	239.62	1.08
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**7684.16**	**127.38**	**2674.91**	**10.13**	**3139.12**	**11.20**	**13544.10**	**61.00**
Total Emissions without LUCF	**16342.50**	**127.38**	**2674.91**	**10.13**	**3139.12**	**11.20**	**22202.43**	**100.0**
Share of Gasses in Total Em./Rem.	**56.73**		**19.75**		**23.18**		**100.00**	
Share of Gasses in Total Em.	**73.61**		**12.05**		**14.14**		**100.00**	
Memo Items:								
International Bunkers	326.50	0.01	0.22	0.01	1.99	NO	328.71	
Aviation	188.18	0.00	0.03	0.01	1.65	NO	189.85	
Marine	138.33	0.01	0.19	0.00	0.34	NO	138.86	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1403.18	NO	NO	NO	NO	NO	1403.18	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 1995	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**15020.51**	**61.10**	**1283.08**	**0.28**	**87.55**	**NO**	**16391.15**	**71.69**
A. Fuel Comb (Sectoral Appr.)	14323.59	5.29	111.16	0.42	87.55	NO	14522.30	63.51
1. Energy Industries	5185.76	0.14	2.86	0.04	9.38	NO	5198.01	22.73
2. Man. Ind. and Constr.	2928.27	0.26	5.56	0.04	8.79	NO	2942.63	12.87
3. Transport	3384.01	1.18	24.75	0.24	50.30	NO	3459.06	15.13
4. Comm./Inst. Resid.. Agric.	2825.55	3.71	77.98	0.09	19.09	NO	2922.62	12.78
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	696.92	55.81	1171.92	NO	NO	NO	1868.84	8.17
1. Solid Fuels	NO	NO	23.07	NO	NO	NO	23.07	NO
2. Oil and Natural Gas	696.92	54.71	1148.84	NO	NO	NO	1845.77	8.07
2. Industrial Processes	**1820.10**	**0.45**	**9.40**	**2.34**	**723.99**	**19.41**	**2572.90**	**11.25**
A. Mineral Products	743.86	NE,NO	NE,NO	NE,NO	NE,NO	NO	743.86	3.25
B. Chemical Industry	1044.28	9.40	9.40	2.34	723.99	NO	1777.67	7.77
C. Metal Production	31.96	NE,NO	NE,NO	NO	NO	NO	31.96	0.14
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	19.41	19.41	0.08
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**89.07**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**123.79**	**0.54**
4. Agriculture	**NO**	**43.77**	**919.12**	**6.86**	**2125.61**	**NO**	**3044.74**	**13.32**
A. Enteric Fermentation	NO	36.22	760.72	0.00	0.00	NO	760.72	3.33
B. Manure Management	NO	7.54	158.40	0.79	245.37	NO	403.77	1.77
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.07	1880.25	NO	1880.25	8.22
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-9154.24**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-9154.24**	**-40.04**
A. Forest Land	-9154.24	0.00	0.00	0.00	0.00	NO	-9154.24	-40.04
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**30.54**	**641.28**	**0.29**	**90.98**	**NO**	**732.31**	**3.20**
A. Solid Waste Disp. on Land	NE,NO	13.74	288.59	0.00	0.00	NO	288.59	1.26
B. Waste-water Handling	0.00	16.80	352.70	0.29	90.98	NO	443.68	1.94
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**7775.48**	**135.85**	**2852.89**	**9.77**	**3028.14**	**19.41**	**13710.64**	**59.96**
Total Emissions without LUCF	**16929.73**	**135.85**	**2852.89**	**9.77**	**3028.14**	**19.41**	**22864.88**	**100.0**
Share of Gasses in Total Em./Rem.	**56.71**		**20.81**		**22.09**		**100.00**	
Share of Gasses in Total Em.	**74.04**		**12.48**		**13.24**		**100.00**	
Memo Items:								
International Bunkers	288.76	0.01	0.17	0.01	1.89	NO	290.82	
Aviation	186.75	0.00	0.03	0.01	1.64	NO	188.42	
Marine	102.01	0.01	0.14	0.00	0.25	NO	102.40	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1452.60	NO	NO	NO	NO	NO	1452.60	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 1996	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**15612.61**	**61.78**	**1297.34**	**0.31**	**97.16**	**NO**	**17007.1**	**72.44**
A. Fuel Comb (Sectoral Appr.)	14968.57	6.24	131.04	0.46	97.16	NO	15196.8	64.73
1. Energy Industries	5113.34	0.13	2.81	0.04	8.84	NO	5125.0	21.83
2. Man. Ind. and Constr.	2972.45	0.27	5.58	0.04	8.76	NO	2986.8	12.72
3. Transport	3653.74	1.30	27.25	0.27	56.52	NO	3737.5	15.92
4. Comm./Inst. Resid.. Agric.	3229.04	4.54	95.40	0.11	23.03	NO	3347.5	14.26
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	644.04	55.54	1166.30	NO	NO	NO	1810.3	7.71
1. Solid Fuels	NO	NO	18.61	NO	NO	NO	18.6	NO
2. Oil and Natural Gas	644.04	54.65	1147.69	NO	NO	NO	1791.7	7.63
2. Industrial Processes	**1841.18**	**0.42**	**8.81**	**2.17**	**674.11**	**72.11**	**2596.2**	**11.06**
A. Mineral Products	827.84	NE,NO	NE,NO	NE,NO	NE,NO	NO	827.8	3.53
B. Chemical Industry	1000.20	8.81	8.81	2.17	674.11	NO	1683.1	7.17
C. Metal Production	13.14	NE,NO	NE,NO	NO	NO	NO	13.1	0.06
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	72.11	72.1	0.31
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**97.80**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**132.5**	**0.56**
4. Agriculture	**NO**	**42.00**	**882.02**	**6.93**	**2149.00**	**NO**	**3031.0**	**12.91**
A. Enteric Fermentation	NO	34.56	725.74	0.00	0.00	NO	725.7	3.09
B. Manure Management	NO	7.44	156.28	0.75	230.97	NO	387.2	1.65
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.19	1918.03	NO	1918.0	8.17
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-9489.96**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-9490.0**	**-40.42**
A. Forest Land	-9489.96	0.00	0.01	0.00	0.00	NO	-9490.0	-40.42
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**29.72**	**624.08**	**0.28**	**86.80**	**NO**	**710.9**	**3.03**
A. Solid Waste Disp. on Land	NE,NO	14.57	305.92	0.00	0.00	NO	305.9	1.30
B. Waste-water Handling	0.00	15.15	318.16	0.28	86.80	NO	405.0	1.72
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.0	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**8061.66**	**133.92**	**2812.25**	**9.70**	**3007.07**	**72.11**	**13987.8**	**59.58**
Total Emissions without LUCF	**17551.63**	**133.92**	**2812.25**	**9.70**	**3007.07**	**72.11**	**23477.8**	**100.0**
Share of Gasses in Total Em./Rem.	**57.63**		**20.11**		**21.50**		**100.0**	
Share of Gasses in Total Em.	**74.76**		**11.98**		**12.81**		**100.0**	
Memo Items:								
International Bunkers	290.93	0.01	0.19	0.01	1.83	NO	292.9	
Aviation	176.02	0.00	0.03	0.00	1.54	NO	177.6	
Marine	114.91	0.01	0.16	0.00	0.28	NO	115.4	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1734.09	NO	NO	NO	NO	NO	1734.1	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 1997	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**16455.41**	**64.87**	**1362.32**	**0.36**	**110.66**	**NO**	**17928.38**	**72.17**
A. Fuel Comb (Sectoral Appr.)	15855.63	6.32	132.64	0.53	110.66	NO	16098.92	64.80
1. Energy Industries	5578.19	0.12	2.61	0.05	10.62	NO	5591.41	22.51
2. Man. Ind. and Constr.	3000.47	0.29	6.13	0.04	9.41	NO	3016.02	12.14
3. Transport	3996.73	1.39	29.24	0.32	67.67	NO	4093.65	16.48
4. Comm./Inst. Resid.. Agric.	3280.24	4.51	94.65	0.11	22.95	NO	3397.85	13.68
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	599.78	58.56	1229.68	NO	NO	NO	1829.46	7.36
1. Solid Fuels	NO	NO	13.61	NO	NO	NO	13.61	NO
2. Oil and Natural Gas	599.78	57.91	1216.07	NO	NO	NO	1815.84	7.31
2. Industrial Processes	**2068.96**	**0.39**	**8.10**	**2.29**	**708.49**	**102.91**	**2888.47**	**11.63**
A. Mineral Products	934.42	NE,NO	NE,NO	NE,NO	NE,NO	NO	934.42	3.76
B. Chemical Industry	1094.24	8.10	8.10	2.29	708.49	NO	1810.84	7.29
C. Metal Production	40.29	NE,NO	NE,NO	NO	NO	NO	40.29	0.16
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	102.91	102.91	0.41
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**85.89**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**120.61**	**0.49**
4. Agriculture	**NO**	**41.47**	**870.96**	**7.72**	**2393.45**	**NO**	**3264.41**	**13.14**
A. Enteric Fermentation	NO	34.18	717.86	0.00	0.00	NO	717.86	2.89
B. Manure Management	NO	7.29	153.11	0.73	226.59	NO	379.70	1.53
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.99	2166.86	NO	2166.86	8.72
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8202.94**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8202.93**	**-33.02**
A. Forest Land	-8202.94	0.00	0.01	0.00	0.00	NO	-8202.93	-33.02
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**26.41**	**554.59**	**0.28**	**86.88**	**NO**	**641.51**	**2.58**
A. Solid Waste Disp. on Land	NE,NO	15.48	325.17	0.00	0.00	NO	325.17	1.31
B. Waste-water Handling	0.00	10.92	229.42	0.28	86.88	NO	316.30	1.27
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**10407.35**	**133.14**	**2795.99**	**10.64**	**3299.48**	**102.91**	**16640.45**	**66.98**
Total Emissions without LUCF	**18610.30**	**133.14**	**2795.99**	**10.64**	**3299.48**	**102.91**	**24843.38**	**100.0**
Share of Gasses in Total Em./Rem.	**62.54**		**16.80**		**19.83**		**100.00**	
Share of Gasses in Total Em.	**74.91**		**11.25**		**13.28**		**100.00**	
Memo Items:								
International Bunkers	263.80	0.01	0.13	0.01	1.85	NO	265.78	
Aviation	190.17	0.00	0.03	0.01	1.67	NO	191.87	
Marine	73.63	0.00	0.10	0.00	0.18	NO	73.92	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1793.72	NO	NO	NO	NO	NO	1793.72	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 1998	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**17483.91**	**57.22**	**1201.54**	**0.39**	**120.88**	**NO**	**18806.33**	**75.32**
A. Fuel Comb (Sectoral Appr.)	16894.74	6.13	128.71	0.58	120.88	NO	17144.33	68.66
1. Energy Industries	6264.48	0.14	2.87	0.06	11.65	NO	6279.00	25.15
2. Man. Ind. and Constr.	3286.89	0.30	6.20	0.05	9.59	NO	3302.68	13.23
3. Transport	4202.17	1.46	30.62	0.37	78.19	NO	4310.97	17.27
4. Comm./Inst. Resid.. Agric.	3141.20	4.24	89.02	0.10	21.45	NO	3251.67	13.02
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	589.17	51.09	1072.83	NO	NO	NO	1661.99	6.66
1. Solid Fuels	NO	NO	14.26	NO	NO	NO	14.26	NO
2. Oil and Natural Gas	589.17	50.41	1058.57	NO	NO	NO	1647.73	6.60
2. Industrial Processes	**1879.34**	**0.35**	**7.42**	**1.72**	**533.42**	**29.90**	**2450.09**	**9.81**
A. Mineral Products	1003.08	NE,NO	NE,NO	NE,NO	NE,NO	NO	1003.08	4.02
B. Chemical Industry	858.38	7.42	7.42	1.72	533.42	NO	1399.23	5.60
C. Metal Production	17.88	NE,NO	NE,NO	NO	NO	NO	17.88	0.07
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	29.90	29.90	0.12
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**91.48**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**126.20**	**0.51**
4. Agriculture	**NO**	**40.70**	**854.78**	**6.87**	**2129.52**	**NO**	**2984.29**	**11.95**
A. Enteric Fermentation	NO	33.52	703.96	0.00	0.00	NO	703.96	2.82
B. Manure Management	NO	7.18	150.82	0.72	221.96	NO	372.78	1.49
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.15	1907.56	NO	1907.56	7.64
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6841.15**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-6841.12**	**-27.40**
A. Forest Land	-6841.15	0.00	0.02	0.00	0.01	NO	-6841.12	-27.40
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**24.64**	**517.49**	**0.27**	**84.13**	**NO**	**601.65**	**2.41**
A. Solid Waste Disp. on Land	NE,NO	16.45	345.37	0.00	0.00	NO	345.37	1.38
B. Waste-water Handling	0.00	8.20	172.11	0.27	84.13	NO	256.24	1.03
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**12613.61**	**122.92**	**2581.25**	**9.25**	**2867.95**	**29.90**	**18127.43**	**72.60**
Total Emissions without LUCF	**19454.76**	**122.92**	**2581.25**	**9.25**	**2867.95**	**29.90**	**24968.55**	**100.0**
Share of Gasses in Total Em./Rem.	**69.58**		**14.24**		**15.82**		**100.00**	
Share of Gasses in Total Em.	**77.92**		**10.34**		**11.49**		**100.00**	
Memo Items:								
International Bunkers	287.83	0.01	0.14	0.01	2.01	NO	289.98	
Aviation	206.83	0.00	0.03	0.01	1.81	NO	208.67	
Marine	81.00	0.01	0.11	0.00	0.20	NO	81.31	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1678.97	NO	NO	NO	NO	NO	1678.97	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 1999	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**17902.71**	**56.01**	**1176.17**	**0.42**	**129.38**	**NO**	**19208.25**	**73.60**
A. Fuel Comb (Sectoral Appr.)	17377.46	5.90	123.98	0.62	129.38	NO	17630.82	67.55
1. Energy Industries	6437.02	0.14	2.92	0.06	11.73	NO	6451.67	24.72
2. Man. Ind. and Constr.	2956.89	0.25	5.24	0.04	8.07	NO	2970.20	11.38
3. Transport	4434.37	1.51	31.66	0.42	88.58	NO	4554.62	17.45
4. Comm./Inst. Resid.. Agric.	3549.17	4.01	84.17	0.10	20.99	NO	3654.34	14.00
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	525.25	50.10	1052.18	NO	NO	NO	1577.43	6.04
1. Solid Fuels	NO	NO	4.29	NO	NO	NO	4.29	NO
2. Oil and Natural Gas	525.25	49.90	1047.89	NO	NO	NO	1573.14	6.03
2. Industrial Processes	**2300.41**	**0.31**	**6.61**	**2.03**	**629.42**	**21.45**	**2957.89**	**11.33**
A. Mineral Products	1251.83	NE,NO	NE,NO	NE,NO	NE,NO	NO	1251.83	4.80
B. Chemical Industry	1027.84	6.61	6.61	2.03	629.42	NO	1663.87	6.38
C. Metal Production	20.74	NE,NO	NE,NO	NO	NO	NO	20.74	0.08
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	21.45	21.45	0.08
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**82.10**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**116.82**	**0.45**
4. Agriculture	**NO**	**41.41**	**869.61**	**7.47**	**2314.70**	**NO**	**3184.31**	**12.20**
A. Enteric Fermentation	NO	33.46	702.63	0.00	0.00	NO	702.63	2.69
B. Manure Management	NO	7.95	166.97	0.73	226.32	NO	393.29	1.51
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.74	2088.39	NO	2088.39	8.00
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8153.08**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-8153.08**	**-31.24**
A. Forest Land	-8153.08	0.00	0.00	0.00	0.00	NO	-8153.08	-31.24
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**25.91**	**544.02**	**0.28**	**88.24**	**NO**	**632.30**	**2.42**
A. Solid Waste Disp. on Land	NE,NO	17.53	368.16	0.00	0.00	NO	368.16	1.41
B. Waste-water Handling	0.00	8.37	175.86	0.28	88.24	NO	264.10	1.01
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**12132.17**	**123.64**	**2596.41**	**10.20**	**3161.74**	**21.45**	**17946.50**	**68.76**
Total Emissions without LUCF	**20285.26**	**123.64**	**2596.41**	**10.20**	**3161.74**	**21.45**	**26099.58**	**100.0**
Share of Gasses in Total Em./Rem.	**67.60**		**14.47**		**17.62**		**100.00**	
Share of Gasses in Total Em.	**77.72**		**9.95**		**12.11**		**100.00**	
Memo Items:								
International Bunkers	263.26	0.01	0.12	0.01	1.89	NO	265.28	
Aviation	197.59	0.00	0.03	0.01	1.73	NO	199.35	
Marine	65.68	0.00	0.09	0.00	0.16	NO	65.94	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1495.79	NO	NO	NO	NO	NO	1495.79	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2000	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**17433.51**	**59.29**	**1245.17**	**0.46**	**143.36**	**NO**	**18822.03**	**72.52**
A. Fuel Comb (Sectoral Appr.)	16800.49	6.38	134.05	0.68	143.36	NO	17077.90	65.80
1. Energy Industries	5889.65	0.14	3.01	0.07	14.61	NO	5907.27	22.76
2. Man. Ind. and Constr.	3076.76	0.26	5.40	0.04	8.43	NO	3090.59	11.91
3. Transport	4444.93	1.49	31.28	0.46	97.20	NO	4573.41	17.62
4. Comm./Inst. Resid.. Agric.	3389.15	4.49	94.37	0.11	23.11	NO	3506.63	13.51
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	633.02	52.91	1111.11	NO	NO	NO	1744.13	6.72
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	633.02	52.91	1111.11	NO	NO	NO	1744.13	6.72
2. Industrial Processes	**2440.87**	**0.33**	**6.91**	**2.39**	**740.65**	**35.31**	**3223.74**	**12.42**
A. Mineral Products	1406.19	NE,NO	NE,NO	NE,NO	NE,NO	NO	1406.19	5.42
B. Chemical Industry	1022.14	6.91	6.91	2.39	740.65	NO	1769.70	6.82
C. Metal Production	12.53	NE,NO	NE,NO	NO	NO	NO	12.53	0.05
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	35.31	35.31	0.14
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**80.47**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**115.19**	**0.44**
4. Agriculture	**NO**	**40.33**	**846.90**	**7.43**	**2303.85**	**NO**	**3150.75**	**12.14**
A. Enteric Fermentation	NO	32.95	691.90	0.00	0.00	NO	691.90	2.67
B. Manure Management	NO	7.38	155.00	0.71	219.27	NO	374.27	1.44
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.72	2084.58	NO	2084.58	8.03
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-5280.74**	**0.00**	**0.04**	**0.00**	**0.01**	**NO**	**-5280.69**	**-20.35**
A. Forest Land	-5280.74	0.00	0.04	0.00	0.01	NO	-5280.69	-20.35
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**26.64**	**559.48**	**0.27**	**84.24**	**NO**	**643.76**	**2.48**
A. Solid Waste Disp. on Land	NE,NO	18.62	391.10	0.00	0.00	NO	391.10	1.51
B. Waste-water Handling	0.00	8.02	168.39	0.27	84.24	NO	252.63	0.97
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**14674.14**	**126.60**	**2658.50**	**10.56**	**3272.11**	**35.31**	**20674.78**	**79.65**
Total Emissions without LUCF	**19954.88**	**126.59**	**2658.50**	**10.56**	**3272.11**	**35.31**	**25955.47**	**100.0**
Share of Gasses in Total Em./Rem.	**70.98**		**12.86**		**15.83**		**100.00**	
Share of Gasses in Total Em.	**76.88**		**10.24**		**12.61**		**100.00**	
Memo Items:								
International Bunkers	226.42	0.00	0.10	0.01	1.62	NO	228.15	
Aviation	169.40	0.00	0.03	0.00	1.48	NO	170.91	
Marine	57.02	0.00	0.08	0.00	0.14	NO	57.24	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1680.11	NO	NO	NO	NO	NO	1680.11	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2001	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**18325.34**	**64.44**	**1353.27**	**0.49**	**151.90**	**NO**	**19830.50**	**73.03**
A. Fuel Comb (Sectoral Appr.)	17637.70	5.32	111.67	0.72	151.90	NO	17901.27	65.92
1. Energy Industries	6308.87	0.16	3.39	0.07	15.17	NO	6327.42	23.30
2. Man. Ind. and Constr.	3217.12	0.26	5.36	0.04	8.45	NO	3230.93	11.90
3. Transport	4506.03	1.39	29.18	0.52	108.98	NO	4644.19	17.10
4. Comm./Inst. Resid.. Agric.	3605.68	3.51	73.75	0.09	19.30	NO	3698.73	13.62
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	687.64	59.12	1241.59	NO	NO	NO	1929.23	7.10
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	687.64	59.12	1241.59	NO	NO	NO	1929.23	7.10
2. Industrial Processes	**2459.57**	**0.34**	**7.13**	**2.01**	**622.93**	**61.74**	**3151.36**	**11.61**
A. Mineral Products	1613.96	NE,NO	NE,NO	NE,NO	NE,NO	NO	1613.96	5.94
B. Chemical Industry	841.32	7.13	7.13	2.01	622.93	NO	1471.38	5.42
C. Metal Production	4.29	NE,NO	NE,NO	NO	NO	NO	4.29	0.02
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	61.74	61.74	0.23
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**86.94**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**121.66**	**0.45**
4. Agriculture	**NO**	**41.17**	**864.65**	**8.03**	**2488.33**	**NO**	**3352.98**	**12.35**
A. Enteric Fermentation	NO	33.75	708.75	0.00	0.00	NO	708.75	2.61
B. Manure Management	NO	7.42	155.90	0.71	221.57	NO	377.47	1.39
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.31	2266.76	NO	2266.76	8.35
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8213.80**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8213.78**	**-30.25**
A. Forest Land	-8213.80	0.00	0.01	0.00	0.00	NO	-8213.78	-30.25
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**28.96**	**608.24**	**0.29**	**90.26**	**NO**	**698.55**	**2.57**
A. Solid Waste Disp. on Land	NE,NO	19.88	417.47	0.00	0.00	NO	417.47	1.54
B. Waste-water Handling	0.00	9.08	190.77	0.29	90.26	NO	281.04	1.03
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**12658.09**	**134.92**	**2833.31**	**10.82**	**3353.42**	**61.74**	**18941.27**	**69.75**
Total Emissions without LUCF	**20871.89**	**134.92**	**2833.31**	**10.82**	**3353.42**	**61.74**	**27155.06**	**100.0**
Share of Gasses in Total Em./Rem.	**66.83**		**14.96**		**17.70**		**100.00**	
Share of Gasses in Total Em.	**76.86**		**10.43**		**12.35**		**100.00**	
Memo Items:								
International Bunkers	258.85	0.01	0.15	0.01	1.71	NO	260.70	
Aviation	169.48	0.00	0.03	0.00	1.48	NO	170.99	
Marine	89.37	0.01	0.13	0.00	0.22	NO	89.71	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1315.01	NO	NO	NO	NO	NO	1315.01	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2002	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**19375.40**	**66.93**	**1405.55**	**0.54**	**166.78**	**NO**	**20947.73**	**74.46**
A. Fuel Comb (Sectoral Appr.)	18710.08	5.38	112.93	0.79	166.78	NO	18989.79	67.50
1. Energy Industries	7211.59	0.19	3.92	0.09	17.89	NO	7233.40	25.71
2. Man. Ind. and Constr.	2998.89	0.25	5.17	0.04	8.10	NO	3012.16	10.71
3. Transport	4807.67	1.36	28.54	0.58	121.04	NO	4957.25	17.62
4. Comm./Inst. Resid.. Agric.	3691.92	3.59	75.31	0.09	19.75	NO	3786.99	13.46
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	665.32	61.55	1292.62	NO	NO	NO	1957.94	6.96
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	665.32	61.55	1292.62	NO	NO	NO	1957.94	6.96
2. Industrial Processes	**2364.90**	**0.29**	**6.05**	**1.95**	**604.67**	**62.94**	**3038.56**	**10.80**
A. Mineral Products	1601.16	NE,NO	NE,NO	NE,NO	NE,NO	NO	1601.16	5.69
B. Chemical Industry	763.57	6.05	6.05	1.95	604.67	NO	1374.29	4.89
C. Metal Production	0.17	NE,NO	NE,NO	NO	NO	NO	0.17	0.00
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	62.94	62.94	0.22
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**110.21**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**144.93**	**0.52**
4. Agriculture	**NO**	**40.74**	**855.46**	**7.98**	**2473.63**	**NO**	**3329.09**	**11.83**
A. Enteric Fermentation	NO	33.20	697.23	0.00	0.00	NO	697.23	2.48
B. Manure Management	NO	7.53	158.22	0.70	217.22	NO	375.45	1.33
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.28	2256.41	NO	2256.41	8.02
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-8205.61**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-8205.61**	**-29.17**
A. Forest Land	-8205.61	0.00	0.01	0.00	0.00	NO	-8205.61	-29.17
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**27.47**	**576.81**	**0.31**	**95.30**	**NO**	**672.15**	**2.39**
A. Solid Waste Disp. on Land	NE,NO	21.29	447.14	0.00	0.00	NO	447.14	1.59
B. Waste-water Handling	0.00	6.17	129.66	0.31	95.30	NO	224.97	0.80
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**13644.94**	**135.42**	**2843.87**	**10.78**	**3340.39**	**62.94**	**19926.86**	**70.83**
Total Emissions without LUCF	**21850.55**	**135.42**	**2843.87**	**10.78**	**3340.39**	**62.94**	**28132.46**	**100.0**
Share of Gasses in Total Em./Rem.	**68.48**		**14.27**		**16.76**		**100.00**	
Share of Gasses in Total Em.	**77.67**		**10.11**		**11.87**		**100.00**	
Memo Items:								
International Bunkers	236.22	0.01	0.13	0.01	1.61	NO	237.96	
Aviation	162.99	0.00	0.02	0.00	1.43	NO	164.44	
Marine	73.24	0.00	0.10	0.00	0.18	NO	73.52	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1331.36	NO	NO	NO	NO	NO	1331.36	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2003	**Gg**	**Gg**	**Gg CO_2eq**	**Gg**	**Gg CO_2eq**	**Gg CO_2eq**	**Gg CO_2eq**	**%**
1. Energy	**20840.84**	**68.42**	**1436.89**	**0.62**	**190.72**	**NO**	**22468.45**	**75.08**
A. Fuel Comb (Sectoral Appr.)	20156.80	6.37	133.81	0.91	190.72	NO	20481.33	68.44
1. Energy Industries	7877.18	0.22	4.53	0.09	19.70	NO	7901.41	26.40
2. Man. Ind. and Constr.	3162.62	0.27	5.77	0.04	9.33	NO	3177.72	10.62
3. Transport	5196.90	1.32	27.69	0.66	137.82	NO	5362.41	17.92
4. Comm./Inst. Resid.. Agric.	3920.10	4.56	95.83	0.11	23.86	NO	4039.79	13.50
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	684.04	62.05	1303.08	NO	NO	NO	1987.12	6.64
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	684.04	62.05	1303.08	NO	NO	NO	1987.12	6.64
2. Industrial Processes	**2492.91**	**0.31**	**6.59**	**1.84**	**570.01**	**178.00**	**3247.52**	**10.85**
A. Mineral Products	1595.17	NE,NO	NE,NO	NE,NO	NE,NO	NO	1595.17	5.33
B. Chemical Industry	871.96	6.59	6.59	1.84	570.01	NO	1448.56	4.84
C. Metal Production	25.78	NE,NO	NE,NO	NO	NO	NO	25.78	0.09
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	178.00	178.00	0.59
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**118.80**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**153.52**	**0.51**
4. Agriculture	**NO**	**42.69**	**896.58**	**7.41**	**2295.80**	**NO**	**3192.38**	**10.67**
A. Enteric Fermentation	NO	34.80	730.72	0.00	0.00	NO	730.72	2.44
B. Manure Management	NO	7.90	165.86	0.73	226.46	NO	392.32	1.31
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	6.68	2069.34	NO	2069.34	6.91
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6276.50**	**0.00**	**0.02**	**0.00**	**0.01**	**NO**	**-6276.47**	**-20.97**
A. Forest Land	-6276.50	0.00	0.02	0.00	0.01	NO	-6276.47	-20.97
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**36.70**	**770.76**	**0.30**	**93.27**	**NO**	**864.08**	**2.89**
A. Solid Waste Disp. on Land	NE,NO	22.86	479.97	0.00	0.00	NO	479.97	1.60
B. Waste-water Handling	0.00	13.85	290.79	0.30	93.27	NO	384.06	1.28
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**17176.09**	**148.14**	**3110.85**	**10.16**	**3149.81**	**178.00**	**23649.47**	**79.03**
Total Emissions without LUCF	**23452.59**	**148.13**	**3110.85**	**10.16**	**3149.81**	**178.00**	**29925.94**	**100.0**
Share of Gasses in Total Em./Rem.	**72.63**		**13.15**		**13.32**		**100.00**	
Share of Gasses in Total Em.	**78.37**		**10.40**		**10.53**		**100.00**	
Memo Items:								
International Bunkers	230.13	0.01	0.12	0.01	1.58	NO	231.83	
Aviation	161.46	0.00	0.02	0.00	1.41	NO	162.90	
Marine	68.67	0.00	0.10	0.00	0.17	NO	68.93	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1714.51	NO	NO	NO	NO	NO	1714.51	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2004	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20266.24**	**69.63**	**1462.17**	**0.65**	**201.39**	**NO**	**21929.81**	**73.53**
A. Fuel Comb (Sectoral Appr.)	19556.24	6.24	131.08	0.96	201.39	NO	19888.72	66.68
1. Energy Industries	6836.32	0.21	4.40	0.08	17.76	NO	6858.48	23.00
2. Man. Ind. and Constr.	3551.93	0.32	6.76	0.05	11.12	NO	3569.81	11.97
3. Transport	5334.47	1.29	27.02	0.71	149.32	NO	5510.81	18.48
4. Comm./Inst. Resid.. Agric.	3833.52	4.42	92.90	0.11	23.20	NO	3949.62	13.24
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	710.00	63.39	1331.09	NO	NO	NO	2041.09	6.84
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	710.00	63.39	1331.09	NO	NO	NO	2041.09	6.84
2. Industrial Processes	**2602.07**	**0.31**	**6.41**	**2.24**	**695.54**	**203.77**	**3507.78**	**11.76**
A. Mineral Products	1693.35	NE,NO	NE,NO	NE,NO	NE,NO	NO	1693.35	5.68
B. Chemical Industry	908.33	6.41	6.41	2.24	695.54	NO	1610.28	5.40
C. Metal Production	0.39	NE,NO	NE,NO	NO	NO	NO	0.39	0.00
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NO	NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	203.77	203.77	0.68
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**143.40**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**178.12**	**0.60**
4. Agriculture	**NO**	**44.35**	**931.41**	**7.92**	**2454.11**	**NO**	**3385.52**	**11.35**
A. Enteric Fermentation	NO	35.84	752.59	0.00	0.00	NO	752.59	2.52
B. Manure Management	NO	8.52	178.82	0.76	235.19	NO	414.01	1.39
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.16	2218.92	NO	2218.92	7.44
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7899.85**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-7899.85**	**-26.49**
A. Forest Land	-7899.85	0.00	0.00	0.00	0.00	NO	-7899.85	-26.49
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**34.90**	**732.80**	**0.29**	**91.27**	**NO**	**824.12**	**2.76**
A. Solid Waste Disp. on Land	NE,NO	24.56	515.76	0.00	0.00	NO	515.76	1.73
B. Waste-water Handling	0.00	10.34	217.05	0.29	91.27	NO	308.32	1.03
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**15111.90**	**149.18**	**3132.80**	**11.10**	**3442.31**	**203.77**	**21925.50**	**73.51**
Total Emissions without LUCF	**23011.75**	**149.18**	**3132.80**	**11.10**	**3442.31**	**203.77**	**29825.34**	**100.0**
Share of Gasses in Total Em./Rem.	**68.92**		**14.29**		**15.70**		**100.00**	
Share of Gasses in Total Em.	**77.16**		**10.50**		**11.54**		**100.00**	
Memo Items:								
International Bunkers	260.46	0.01	0.13	0.01	1.82	NO	262.41	
Aviation	187.39	0.00	0.03	0.01	1.64	NO	189.06	
Marine	73.06	0.00	0.10	0.00	0.18	NO	73.35	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1704.33	NO	NO	NO	NO	NO	1704.33	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2005	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20623.66**	**69.67**	**1463.17**	**0.65**	**201.72**	**NO**	**22288.54**	**73.24**
A. Fuel Comb (Sectoral Appr.)	19932.66	6.32	132.68	0.96	201.72	NO	20267.05	66.60
1. Energy Industries	6866.82	0.20	4.26	0.09	18.45	NO	6889.53	22.64
2. Man. Ind. and Constr.	3650.27	0.29	6.13	0.05	10.14	NO	3666.53	12.05
3. Transport	5548.63	1.54	32.42	0.72	150.90	NO	5731.95	18.83
4. Comm./Inst. Resid.. Agric.	3866.95	4.28	89.86	0.11	22.24	NO	3979.04	13.07
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	691.00	63.36	1330.49	NO	NO	NO	2021.49	6.64
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	691.00	63.36	1330.49	NO	NO	NO	2021.49	6.64
2. Industrial Processes	**2631.83**	**0.29**	**6.01**	**2.19**	**679.04**	**364.91**	**3681.80**	**12.10**
A. Mineral Products	1736.87	NE,NO	NE,NO	NE,NO	NE,NO	NO	1736.87	5.71
B. Chemical Industry	894.63	6.01	6.01	2.19	679.04	NO	1579.67	5.19
C. Metal Production	0.34	NE,NO	NE,NO	NO	NO	NO	0.34	0.00
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NA.NO	NA.NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	364.91	364.91	1.20
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**168.66**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**203.38**	**0.67**
4. Agriculture	**NO**	**45.19**	**948.98**	**8.11**	**2515.16**	**NO**	**3464.13**	**11.38**
A. Enteric Fermentation	NO	37.77	793.14	0.00	0.00	NO	793.14	2.61
B. Manure Management	NO	7.42	155.84	0.74	229.71	NO	385.55	1.27
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.37	2285.45	NO	2285.45	7.51
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7726.37**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-7726.37**	**-25.39**
A. Forest Land	-7726.37	0.00	0.00	0.00	0.00	NO	-7726.37	-25.39
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.03**	**33.62**	**705.99**	**0.29**	**89.33**	**NO**	**795.35**	**2.61**
A. Solid Waste Disp. on Land	NE,NO	26.81	563.07	0.00	0.00	NO	563.07	1.85
B. Waste-water Handling	0.00	6.81	142.92	0.29	89.33	NO	232.25	0.76
C. Waste Incineration	0.03	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.03	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**15697.81**	**148.77**	**3124.14**	**11.24**	**3485.24**	**364.91**	**22706.83**	**74.61**
Total Emissions without LUCF	**23424.18**	**148.77**	**3124.14**	**11.24**	**3485.24**	**364.91**	**30433.20**	**100.0**
Share of Gasses in Total Em./Rem.	**69.13**		**13.76**		**15.35**		**100.00**	
Share of Gasses in Total Em.	**76.97**		**10.27**		**11.45**		**100.00**	
Memo Items:								
International Bunkers	305.13	0.01	0.14	0.01	2.18	NO	307.45	
Aviation	226.15	0.00	0.03	0.01	1.98	NO	228.16	
Marine	78.98	0.01	0.11	0.00	0.19	NO	79.29	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1586.57	NO	NO	NO	NO	NO	1586.57	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2006	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**20594.39**	**76.34**	**1603.10**	**0.71**	**218.76**	**NO**	**22416.24**	**72.85**
A. Fuel Comb (Sectoral Appr.)	19931.39	6.26	131.36	1.04	218.76	NO	20281.50	65.91
1. Energy Industries	6641.98	0.19	3.90	0.08	16.86	NO	6662.75	21.65
2. Man. Ind. and Constr.	3746.32	0.29	6.01	0.05	10.12	NO	3762.45	12.23
3. Transport	5913.19	1.55	32.49	0.81	169.87	NO	6115.56	19.88
4. Comm./Inst. Resid.. Agric.	3629.88	4.24	88.96	0.10	21.90	NO	3740.75	12.16
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	663.00	70.08	1471.74	NO	NO	NO	2134.74	6.94
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	663.00	70.08	1471.74	NO	NO	NO	2134.74	6.94
2. Industrial Processes	**2737.31**	**0.37**	**7.74**	**2.17**	**671.40**	**447.11**	**3863.56**	**12.56**
A. Mineral Products	1866.54	NE,NO	NE,NO	NE,NO	NE,NO	NO	1866.54	6.07
B. Chemical Industry	870.40	7.74	7.74	2.17	671.40	NO	1549.55	5.04
C. Metal Production	0.37	NE,NO	NE,NO	NO	NO	NO	0.37	0.00
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NA.NO	NA.NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	447.11	447.11	1.45
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**196.57**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**231.29**	**0.75**
4. Agriculture	**NO**	**46.40**	**974.36**	**7.88**	**2443.79**	**NO**	**3418.15**	**11.11**
A. Enteric Fermentation	NO	38.84	815.70	0.00	0.00	NO	815.70	2.65
B. Manure Management	NO	7.56	158.66	0.73	226.34	NO	385.00	1.25
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.15	2217.45	NO	2217.45	7.21
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-7490.30**	**0.00**	**0.00**	**0.00**	**0.00**	**NO**	**-7490.29**	**-24.34**
A. Forest Land	-7490.30	0.00	0.00	0.00	0.00	NO	-7490.29	-24.34
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.04**	**35.84**	**752.66**	**0.28**	**87.28**	**NO**	**839.98**	**2.73**
A. Solid Waste Disp. on Land	NE,NO	26.68	560.32	0.00	0.00	NO	560.32	1.82
B. Waste-water Handling	0.00	9.16	192.35	0.28	87.28	NO	279.63	0.91
C. Waste Incineration	0.04	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.04	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**16038.01**	**158.95**	**3337.86**	**11.04**	**3421.23**	**447.11**	**23278.93**	**75.66**
Total Emissions without LUCF	**23528.31**	**158.95**	**3337.86**	**11.04**	**3421.23**	**447.11**	**30769.22**	**100.0**
Share of Gasses in Total Em./Rem.	**68.89**		**14.34**		**14.70**		**100.00**	
Share of Gasses in Total Em.	**76.47**		**10.85**		**11.12**		**100.00**	
Memo Items:								
International Bunkers	290.81	0.01	0.12	0.01	2.16	NO	293.09	
Aviation	229.82	0.00	0.03	0.01	2.01	NO	231.87	
Marine	60.98	0.00	0.08	0.00	0.15	NO	61.22	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1586.18	NO	NO	NO	NO	NO	1586.18	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

Croatia	CO_2	CH_4		N_2O		HFC. PFC.SF_6	Total	Share
Year 2007	Gg	Gg	Gg CO_2eq	Gg	Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%
1. Energy	**21824.72**	**82.72**	**1737.17**	**0.78**	**240.67**	**NO**	**23802.55**	**73.50**
A. Fuel Comb (Sectoral Appr.)	21159.72	5.68	119.37	1.15	240.67	NO	21519.75	66.45
1. Energy Industries	7638.81	0.22	4.64	0.09	18.79	NO	7662.24	23.66
2. Man. Ind. and Constr.	3874.22	0.33	6.83	0.05	10.81	NO	3891.86	12.02
3. Transport	6345.27	1.55	32.51	0.92	192.26	NO	6570.03	20.29
4. Comm./Inst. Resid.. Agric.	3301.42	3.59	75.40	0.09	18.81	NO	3395.63	10.49
5. Other	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	665.00	77.04	1617.80	NO	NO	NO	2282.80	7.05
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	665.00	77.04	1617.80	NO	NO	NO	2282.80	7.05
2. Industrial Processes	**2842.08**	**0.34**	**7.14**	**2.39**	**741.61**	**481.79**	**4072.62**	**12.58**
A. Mineral Products	1896.72	NE,NO	NE,NO	NE,NO	NE,NO	NO	1896.72	5.86
B. Chemical Industry	945.00	7.14	7.14	2.39	741.61	NO	1693.75	5.23
C. Metal Production	0.35	NE,NO	NE,NO	NO	NO	NO	0.35	0.00
D. Other Production	NE	NO	NO	NO	NO	NO	NE	NE
E. Prod. of Halocarbons & SF_6	NO	NO	NO	NO	NO	NO	NA.NO	NA.NO
F. Cons. of Halocarbons & SF_6	NO	NO	NO	NO	NO	481.79	481.79	1.49
G. Other	NO	NO	NO	NO	NO	NO	NA.NO	NA.NO
3. Solvent and Other Product Use	**197.80**	**NO**	**NO**	**0.11**	**34.72**	**NO**	**232.52**	**0.72**
4. Agriculture	**NO**	**45.47**	**954.85**	**7.92**	**2454.81**	**NO**	**3409.66**	**10.53**
A. Enteric Fermentation	NO	37.52	787.92	0.00	0.00	NO	787.92	2.43
B. Manure Management	NO	7.95	166.93	0.72	222.83	NO	389.75	1.20
C. Rice Cultivation	NO	NO	NO	0.00	0.00	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	7.20	2231.99	NO	2231.99	6.89
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agr. Residues	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**-6302.65**	**0.00**	**0.01**	**0.00**	**0.00**	**NO**	**-6302.63**	**-19.46**
A. Forest Land	-6302.65	0.00	0.01	0.00	0.00	NO	-6302.63	-19.46
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NE,NO	NO
G. Other	NE	NE	NE	NE	NE	NO	NE	NE
6. Waste	**0.08**	**37.25**	**782.33**	**0.27**	**85.19**	**NO**	**867.60**	**2.68**
A. Solid Waste Disp. on Land	NE,NO	28.70	602.71	0.00	0.00	NO	602.71	1.86
B. Waste-water Handling	0.00	8.55	179.61	0.27	85.19	NO	264.81	0.82
C. Waste Incineration	0.08	NE,NO	NE,NO	NE,NO	NE,NO	NO	0.08	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO
Total Em./Rem. with LUCF	**18562.03**	**165.79**	**3481.49**	**11.36**	**3522.29**	**481.79**	**26082.32**	**80.54**
Total Emissions without LUCF	**24864.67**	**165.78**	**3481.49**	**11.36**	**3522.29**	**481.79**	**32384.95**	**100.0**
Share of Gasses in Total Em./Rem.	**71.17**		**13.35**		**13.50**		**100.00**	
Share of Gasses in Total Em.	**76.78**		**10.75**		**10.88**		**100.00**	
Memo Items:								
International Bunkers	318.34	0.01	0.21	0.01	3.37	NO	321.92	
Aviation	242.68	0.01	0.11	0.01	3.19	NO	245.98	
Marine	75.65	0.00	0.10	0.00	0.19	NO	75.94	
Multilateral Operations	C	C	C	C	C	NO	C	
CO_2 Emissions from Biomass	1430.99	NO	NO	NO	NO	NO	1430.99	

NO (*not occurring*) ; **NE** (*not estimated*); **IE** (*included elsewhere*); **C** (*confidential*)

ABBREVIATIONS

CEA – *Croatian Environment Agency*

GDP – *Gross Domestic Product*

CADSES - *Central, Adriatic, Danubian and South-Eastern European Space*

CCS - *Carbon Capture and Storage*

CDM - *Clean Development Mechanism*

CEFTA - *Central European Free Trade Agreement*

CMP – *Conference of Meetings of Parties*

COP - *Conference of Parties*

CRONFI - *Croatian National Forest Inventory*

DIC - *Dissolved Inorganic Carbon*

DOOR – Society Društvo za oblikovanje održivog razvoja

DSR - *Daily Severity Rating*

EFBCC - *Enforcement Branch of Compliance Commmittee*

EOR - *Enhanced Oil Recovery*

EPEEF – *Environment Protection and Energy Efficiency Fund*

ETS - *European Trading Scheme*

FEE - *Foundation for Environmental Education*

FIA - *Fédération Internationale de l'Automobile*

GCOS - *Global Observing System for Climate*

GEF - *Global Environment Facility*

GEOSS - *Global Earth System of Systems*

GLOBE - *Global Learning and Observation to Benefit the Environment*

GWP - *Global Warming Potential*

HBOR – Croatian Bank for Hrvatska banka za obnovu i razvitak

HEP – *Croatian Electricity Company*

HERA – *Croatian Energy Regulatory Agency*

HROTE – *Croatian Energy Market Operator*

IBRD - *International Bank for Reconstruction and Development*

IET *- International Emission Trading*

IPCC - *Intergovernmental Panel on Climate Change*

JI *- Joint implementation*

LULUCF - *Land Use, Land Use Change and Forestry*

MELE – *Ministry of Economy, Labour and Entrepreneurship*

MEPPPC – *Ministry of Environement Protection, Physical Planning and Construction*

MHS – *Meteorological and Hydrological Service*

MSR - *Monthly Severity Rating*

NIR - *National Inventory Report*

NMVOC – *non-methane volatile organic compounds*

NSCR - *Non-Selective Catalitic Reduction*

OECD - *Organization for Economic Cooperation and Development*

QA/QC - *Quality assurance/Quality Control*

REC – *Regional Centre for Environment Protection for Central and Eastern Europe*

RDF -Refuse Derived Fuel

SSR - *Seasonal Severity Rating*

TSO/DSO - *Transport System Operator/Distribution System Operator*

UNDP - *United Nations Development Programme*

UNDP - *United Nations Development Programme*

UNEP - *United Nations Environment Programme*

UNFCCC - *United Nations Framework Convention on Climate Change*

WTO - *World Trade Organization*

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