REPUBLIC OF CROATIA
MINISTRY OF ENVIRONMENTAL PROTECTION, PHYSICAL PLANNING AND CONSTRUCTION

PROJECTIONS OF GREENHOUSE GAS EMISSIONS

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1. INTRODUCTORY NOTES

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

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

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

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

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

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

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

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

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

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

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

2. ENERGY SECTOR

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

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

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

2.1. SCENARIO “WITH MEASURES”

2.1.1. ENERGY CONSUMPTION DATA FOR SCENARIO “WITH MEASURES”

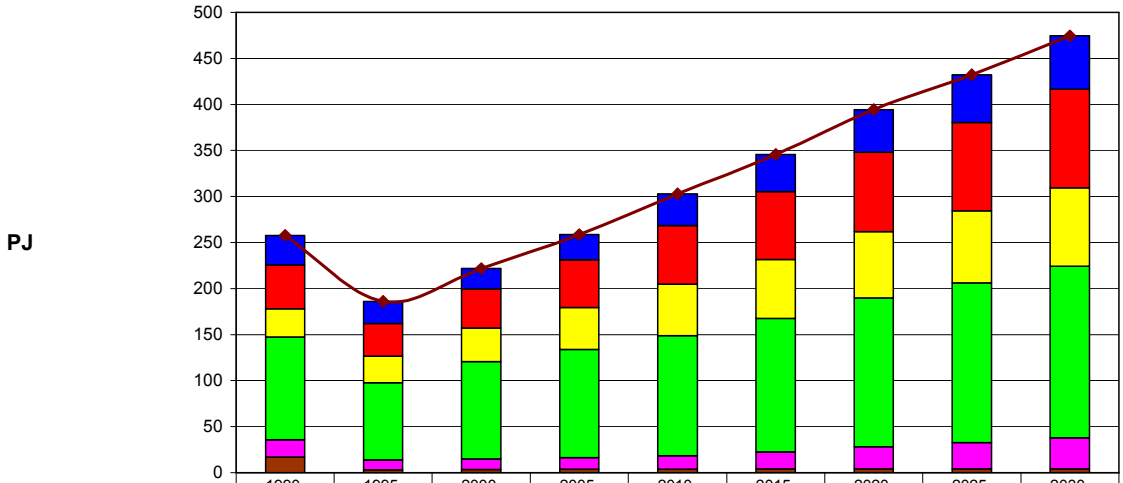
The projection of energy sector development scenario is presented through following energy indicators:

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

2.1.1.1. Final energy demand by energy carriers

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

The steam and hot water consumption will be from 9.9 percent in 2000 to 11.7 percent in 2020. Electric energy participation will grow gradually because of electricity non-heat consumption increase. Gas fuel participation will increase and stabilise on the level of 18 percent. However, the liquid fuel participation and coal will decrease. The renewable resource participation will rise a little and remain on the level of 7 percent.

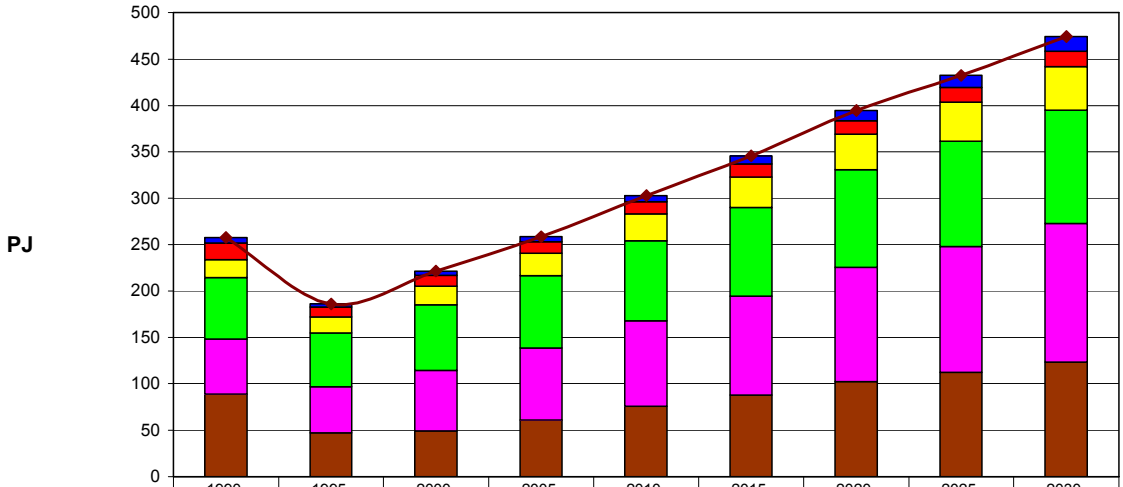


	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Steam&hot water	31.93	23.61	22.01	27.63	34.67	40.06	46.29	51.78	57.93
Electricity	47.76	35.74	42.12	51.79	63.69	74.17	86.37	96.16	107.05
Natural gas	30.80	28.82	36.85	45.56	56.31	63.76	72.19	78.42	85.19
Liquid fuel	111.48	83.78	105.67	117.14	129.86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

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

2.1.1.2. Final energy demand in different sectors

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



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

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

2.1.1.3. Power Supply System

The Croatian power supply system has total installed capacity of around 4045 MW. There are 17 hydro power plants with 2063 MW that share 51.3 percent of total power supply and 6 thermal power plants with 1631 MW that share 40.3 percent of total power supply. One nuclear power plant of 676 MW capacity situated in Slovenia, delivers 50 percent of its production to the Croatia grid.

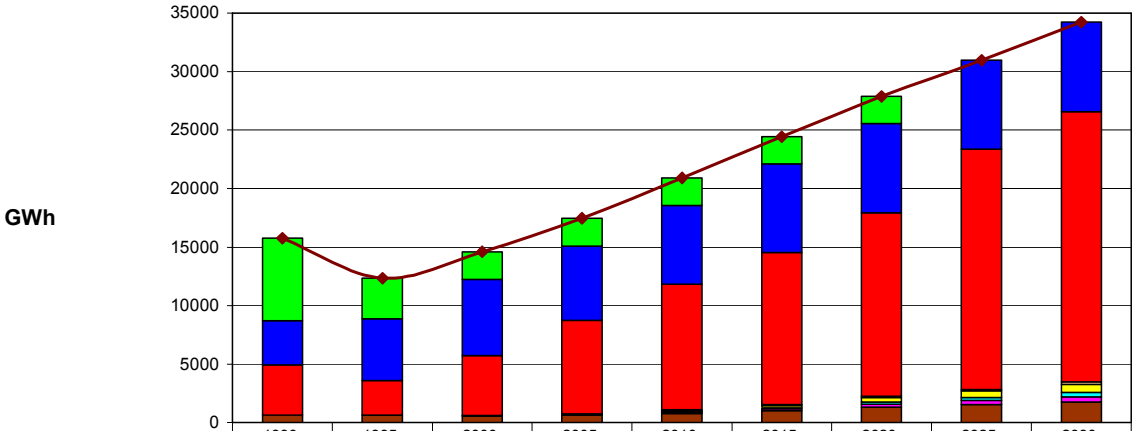
Table 2.1-1: Net Power in Croatian Electricity Utility

Power plants	Net Power (MW)
HPP	2063
Small HPP	13
TPP coal fired	290
TPP on liquid fuel	303
TPP - natural gas + liquid fuel	479
CHP TPP	469
Gas turbine	48
Emergency diesel	29
Emergency gas	13
NPP Krško (50%)	338
Total	**4045**

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

Regarding the hydro power plants, the assumption is that all existing hydro power plants will, with some necessary renewal of some of its parts, operate at least until the end of the planning period (2030). The dynamics of closing down of existing thermal power plants shows that up to year 2020 around 1220 MW of thermal power plants will be closed.

Electric energy generation will be performed on the public network level. A small part of the public network participates in decentralized generation plants e.g. combine heat and power generation, renewable resource and small consumer part (hydrogen in future). Electric energy generation structure is presented in Figure 2.1-3.



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

Figure 2.1-3: Electric energy generation structure

The fundamental act governing country's energy policy and energy system planning is Energy Sector Development Strategy which outlines major guidelines for power system development. Among others, the most important outlines are:

- The strategic interest of the Republic of Croatia is to construct networked energy systems, i.e. natural gas system and power system that have to complement each other.
- Intensive construction of hydro power plants, in line with the National Hydro Construction Program, as multipurpose plants that stimulate the development of national building construction and electro-mechanical industry
- Diversification of electricity resources (natural gas, coal)
- Multidirectional natural gas & electricity supply is required

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

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

Regarding TPP units, the most favourable option is the construction of gas-fired power plants. In techno-economical competition with coal fired plants, this option is in favour by lower environmental impact and positive public attitude towards them. The first candidate plant is a 300 MW gas-fired combined-cycle thermal unit which should enter into operation in 2007. As it was explained earlier, mainly because of diversification criteria, the next TPP should be coal fired 500 MW power plant which should enter into operation in 2010. In 2010 some existing power plants will stop operating. This, together with the rise of the electricity consumption could be compensated with one thermal power plant with the capacity of 500 MW. From 2010 to 2020 one 500 MW coal fired thermal power plant should enter into operation, followed by four gas power plants of 300 MW each. In this planned period (2003 – 2020) 2500 MW of new TPP units should enter into operation and 246 MW of HPP. Dynamic of expected construction of new power plants are shown in Table 2.1-2.

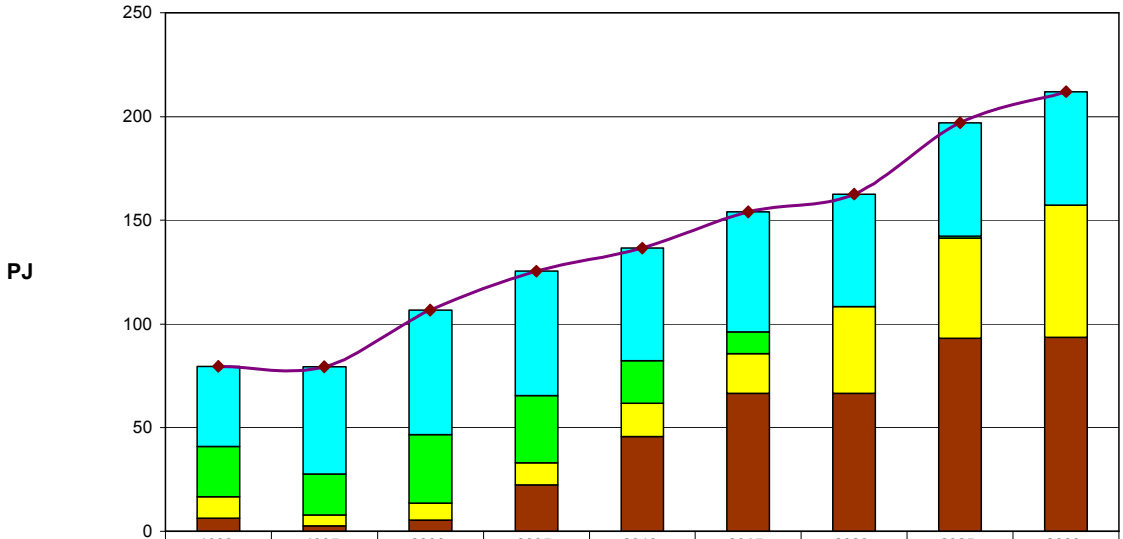
Table 2.1-2: Expected construction of new power plants

Year	Thermo/Hydro Power Plants
2003	
2004	
2005	
2006	HPP Lešće + G300
2007	
2008	HPP Podsused
2009	HPP Drenje
2010	C500
2011	
2012	Acum. + HPP Kosinj
2013	G300
2014	C500
2015	HPP Ombla
2016	G300
2017	
2018	G300 + HPP Krčić
2019	
2020	G300
Total (MW)	**2746**

G - gas burned thermal power plant (combined-cycle gas turbine)
C - coal burned thermal power plant
H - hydro power plant

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

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



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

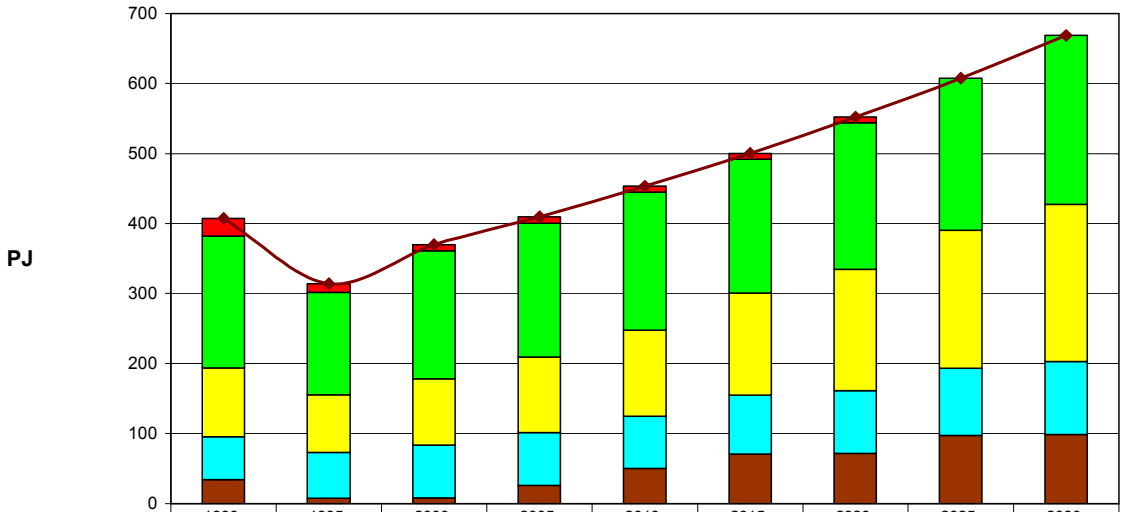
Figure 2.1-4: Structure of fuel used for electricity production

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

2.1.1.4. Energy source structure in total energy demand

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

According to this scenario in the period between 2000 and 2020, total energy demand will increase with the rate of 2 percent (Figure 2.1-5). The increase rates will be different and the structure will change. Equally, liquid fuel decrease will continue from 49.6 percent in 2000 to 37.9 percent in 2020. Natural gas as a second energy source will continue increasing with the end participation of gas demand of approximately 31.3 percent.

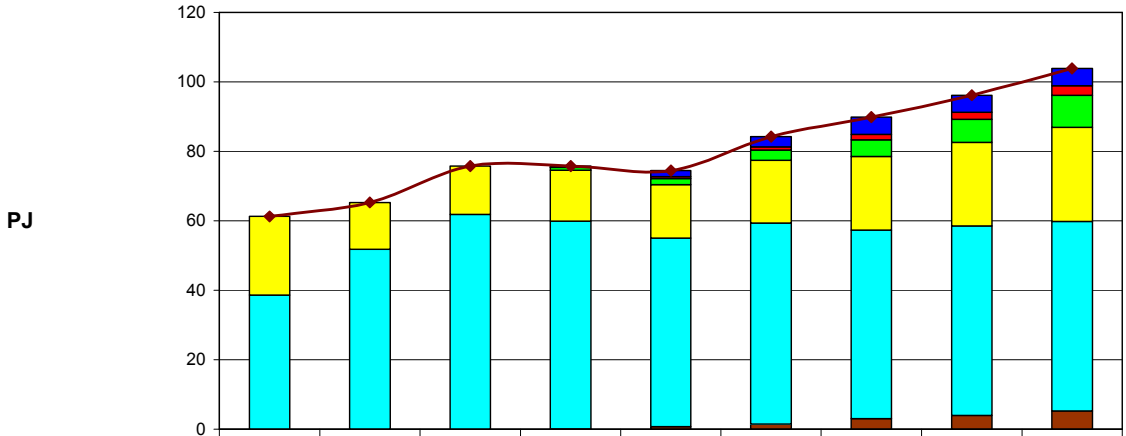


	1990.	1995.	2000.	2005.	2010.	2015.	2020.	2025.	2030.
Electricity	25.42	12.59	8.50	8.64	8.41	8.41	8.41	0.00	0.00
Liquid fuel	188.57	146.03	183.40	191.43	196.86	191.24	209.27	217.36	241.19
Natural gas	98.22	82.77	94.05	107.57	123.05	145.89	172.98	196.98	224.31
Renewables	61.23	65.27	75.79	75.84	74.47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

Figure 2.1-5: Energy source structure in total energy demand, PJ

2.1.1.5. Renewable energy resource structure

In this scenario based on present-day technologies and experiences, new technology contribution in the field of energy efficiency and renewable resource utilisation is planned to increase. It is related to two traditional sources used until now: hydro power plant and biomass (wood for heating). This scenario structure anticipates the increase of geothermal energy after the 2000 with the end at 5.5 percent in total renewable energy consumption. Wind energy utilisation increases in period after the 2000 and it is expected to be 1.7 percent in 2020. In this scenario solar energy will reach 5.4 percent. At the end of the period renewable resource share should be approximately 23.6 percent. Hydro potential should absolutely increase. Hydro potential should decrease from more than 80 percent in 2000 to 60.5 percent in 2020. Biofuel utilisation is expected to begin around 2010 and in 2020 its share is expected to be approximately 3.3 percent (Figure 2.1-6).



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

Figure 2.1-6: Renewable energy resource structure, PJ

2.1.1.6. Import and domestic energy

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

Table 2.1-3: Import and domestic energy, PJ

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

2.1.2. GHG EMISSION FOR SCENARIO "WITH MEASURES"

2.1.2.1. Measures

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

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

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

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

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

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

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

2.1.2.2. Projections

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

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

Table 2.1-5: CO_2 emission from Energy subsectors

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

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

Table 2.1-6: Total GHG emission from Energy sector

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

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

2.1.2.3. Analysis of “With measures” scenario

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

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

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

According to expected values of main indicators for the period from 2000 to 2020, GDP will annually increase by 4.6 percent on average, total energy demand by 2.0 percent, CO_2 emission by 2.8 percent and electricity consumption by 3.0 percent. Indexes of abovementioned indicators, normalized on 1990 values (100% in 1990), are shown in the Figure 2.1-7.

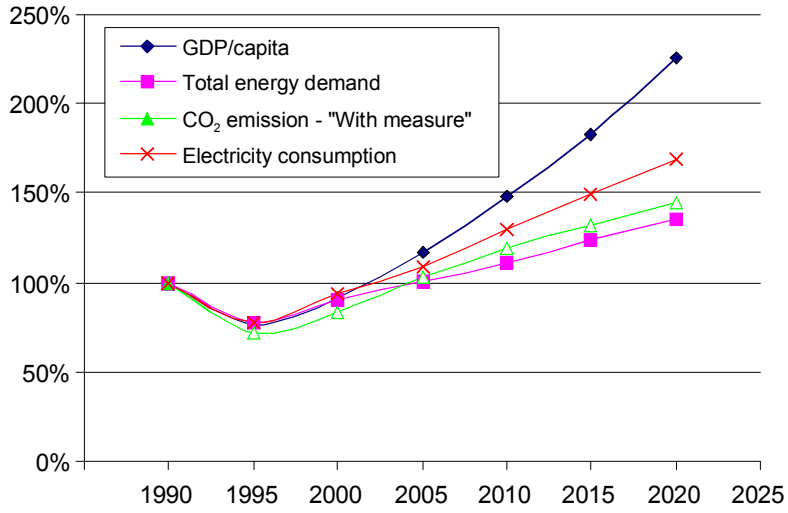


Figure 2.1-7: Indexes of main indicators for "With measure" scenario

2.2. SCENARIO "WITHOUT MEASURES"

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

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

2.3. SCENARIO "WITH ADDITIONAL MEASURES"

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

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

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

2.3.1. POWER SECTOR

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

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

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

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

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

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

2.3.2. ENERGY CONSUMPTION SECTORS

2.3.2.1. Measures in Industry

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

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

2.3.2.2. Measures in Transport

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

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

2.3.2.3. Measures in Services

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

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

2.3.2.4. Measures in Residential sector

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

2.4. GHG EMISSION PROJECTION OF ENERGY SECTOR

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

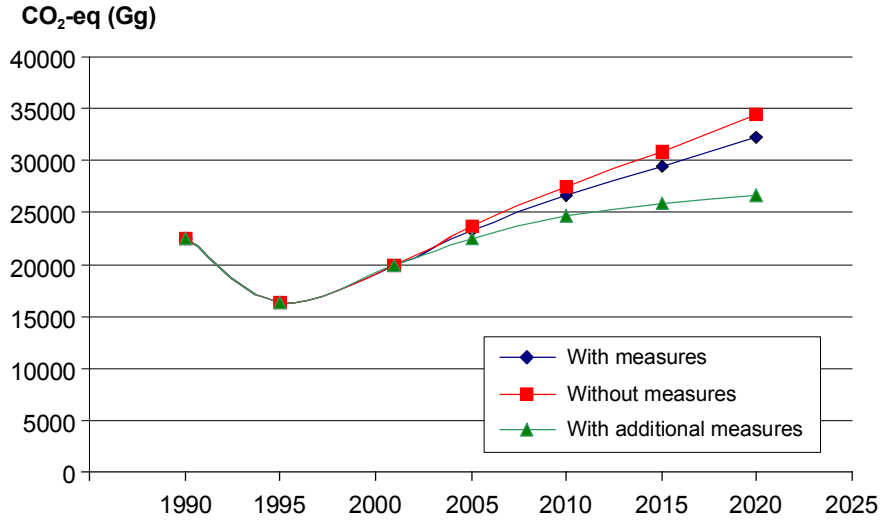


Figure 2.4-1: GHG emission projection for Energy sector

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

3. INDUSTRIAL PROCESSES

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

In respect to classification of measures it should be stressed that there are no currently implemented and adopted policies and mitigation measures in industrial processes in Croatia, and therefore “Without measures” and “With measures” scenarios are identical. The GHG emission projections for analysed scenarios are shown in the Figure 3-1.

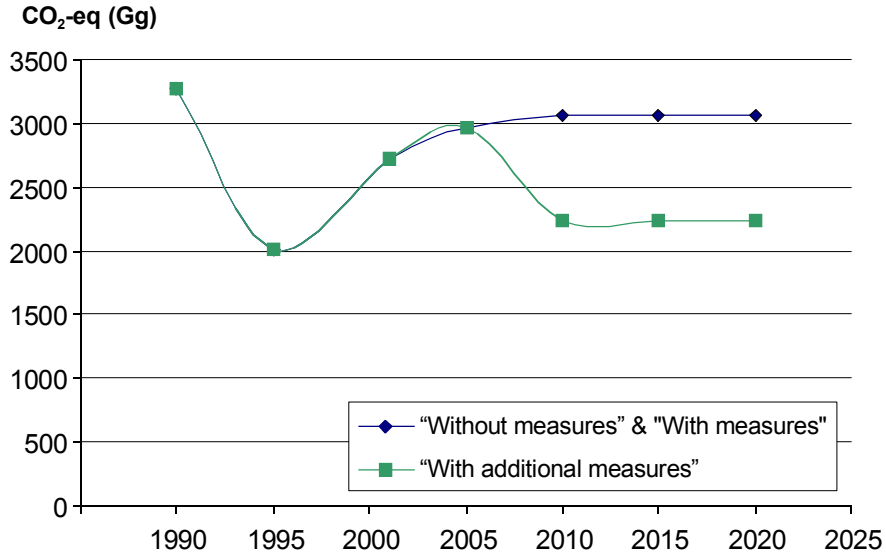


Figure 3-1: GHG emission projections for Industrial processes

3.1. “WITHOUT MEASURES” & “WITH MEASURES” PROJECTIONS

The “Without measures” and “With measures” projections of emission from industrial processes assumes that production of selected processes (cement, ammonia and nitric acid) in the period 2005-2020 will reach its planned capacities, and that no measure for reduction of greenhouse gases will be implemented. For other less important industrial processes frozen GHG emissions were purposed and scenario projection assumes that the emission will be at the 2001 level. The emissions of greenhouse gases for “Without measure” and “With measures” scenarios are presented in table 3.1-1.

Table 3.1-1: CO_2-eq emissions, for scenarios "Without measures" and "With measures," from Industrial processes (Gg)

Industrial processes	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
CO_2 emission	2010.5	1169.5	2011.0	2066.3	2099.0	2099.0	2099.0
CH_4 emission, as CO_2-eq	15.8	8.4	6.4	6.4	6.4	6.4	6.4
N_2O emission, as CO_2-eq	927.6	835.0	718.5	905.2	964.1	964.1	964.1
HFC, PFC & SF_6 em, as CO_2-eq	938.6	7.8	49.0	49.0	49.0	49.0	49.0
Total CO_2-eq emission	**3892.4**	**2020.7**	**2785.0**	**3026.9**	**3118.5**	**3118.5**	**3118.5**

3.2. "WITH ADDITIONAL MEASURES" PROJECTIONS

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

Tables 3.2-1 and 3.2-2 presents difference between "Without/With measures" and "With additional measures" scenario for N_2O emission and CO_2-eq emission from Industrial processes.

Table 3.2-1: N_2O emissions from Industrial processes (Gg)

Nitric acid production	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Without/With measures	2,99	2,69	2,32	2,92	3,11	3,11	3,11
With add. measures	2.99	2.69	2.32	2.92	0.47	0.47	0.47
Mitigation	**0**	**0**	**0**	**0**	**2.64**	**2.64**	**2.64**

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

Industrial processes	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Without/With measures	3892.4	2020.7	2785.0	3026.9	3118.5	3118.5	3118.5
With add. measures	3892.4	2020.7	2785.0	3026.9	2300.1	2300.1	2300.1
Mitigation	**0**	**0**	**0**	**0**	**818.4**	**818.4**	**818.4**

4. AGRICULTURE

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

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

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

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

The GHG emission projections for Agriculture, taken from First national communication to the UNFCCC, are shown in the Figure 4-1. More details about considered scenarios are given in following paragraphs.

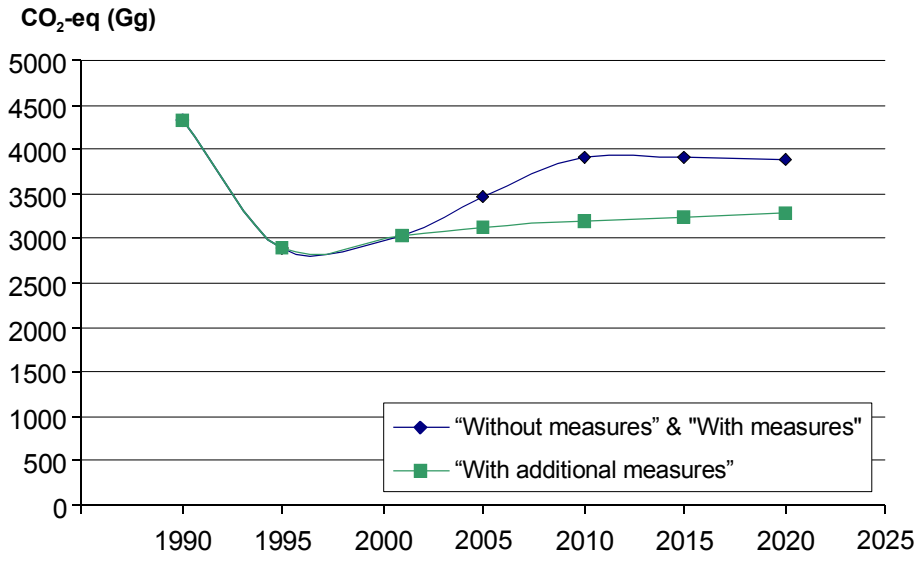


Figure 4-1: GHG emission projections for Agriculture

4.1. "WITHOUT MEASURES" & "WITH MEASURES" PROJECTIONS

The production is oriented towards meeting of the lower demand level, which will be reached under the conditions of the slower increase in purchasing power and a particularly slow development of agriculture. A 25-38 percent lower technical advancement is planned measured by the plant production yield. The animal husbandry production rate, measured by the live weight gain, is about 30 percent lower. The milk production per head is relatively high, since considerable increase is assumed in larger farms share without any additional incentives (2672 kg/year in 2020 on average). In Agriculture is not possible to recognize implemented and adopted measures, accordingly "Without measures" and "With measures" scenarios are the same.

4.2. "WITH ADDITIONAL MEASURES" PROJECTIONS

At the very best, a significant consolidation of farm land is planned, application of modern technology on 70-85 percent of arable land and over 50 percent participation of large farms in animal husbandry. As said, the increase in plant production yield is also anticipated. In animal husbandry, an expected average increase in milkiness to about 3,360 kg milk a year from about 55 percent of milking cows on larger farms. An average increase in animal breeding productivity measured by the live weight gain is about 30 percent (pork, beef and eggs production). With such structure, a well-organized production could meet a maximum domestic demand (increased by tourist demand). All major agricultural projects (plantations, farms, processing facilities) will be highly environmentally oriented, with considerable use of sound practices for removal of the potentially harmful substances.

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

The GHG emission, according to "Without/With measures" and "With additional measures" scenario and difference between above-mentioned scenarios are presented in the Table 4.2-1.

Table 4.2-1: CO_2-eq emissions from Agriculture (Gg)

Agriculture	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Without/With measures	4320.6	2890.7	3035.6	3579.2	3920.3	3909.7	3899.0
With add. measures	4320.6	2890.7	3035.6	3218.5	3197.8	3236.9	3281.1
Mitigation	**0.0**	**0.0**	**0.0**	**360.7**	**722.5**	**672.8**	**617.9**

5. LAND USE CHANGE AND FORESTRY

The baseline scenario for forestry does not envisage any changes in surfaces under the forests and their structure, so the carbon sequestration remains at the present level of 8.069 million tons per year.

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

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

6. WASTE

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

In respect to classification of measures ("With measures" and "With additional measures") it should be stressed that there are no currently implemented and adopted policies and mitigation measures in waste sector in Croatia, accordingly "Without measures" and "With measures" scenarios are identical (Figure 6-1).

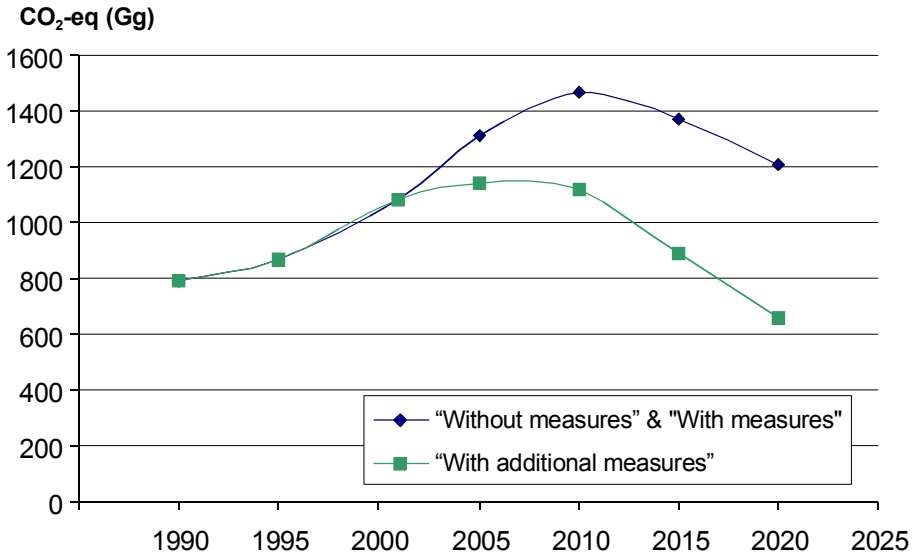


Figure 6-1: GHG emission projections for Waste

6.1. "WITHOUT MEASURES" & "WITH MEASURES" PROJECTIONS

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

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

Table 6.1-1: GHG emissions from Waste "Without/With measures" (Gg)

Waste	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
CH_4 - Solid waste disposal	37.77	41.16	51.33	62.57	69.89	65.37	57.57
N_2O - Human sewage	0.45	0.42	0.28	0.28	0.28	0.28	0.28
CO_2-eq Waste	**932.9**	**994.6**	**1163.2**	**1399.3**	**1553.0**	**1458.1**	**1294.3**

6.2. "WITH ADDITIONAL MEASURES" PROJECTIONS

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

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

Waste	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
CH_4 - Solid waste disposal	37.77	41.16	51.33	54.26	53.36	42.29	31.25
N_2O - Human sewage	0.45	0.42	0.28	0.28	0.28	0.28	0.28
CO_2-eq Waste	**932.9**	**994.6**	**1163.2**	**1224.8**	**1205.9**	**973.4**	**741.5**

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

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

Waste	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Without/With measures	932.9	994.6	1163.2	1399.3	1553.0	1458.1	1294.3
With add. measures	932.9	994.6	1163.2	1224.8	1205.9	973.4	741.5
Mitigation	**0.0**	**0.0**	**0.0**	**174.5**	**347.1**	**484.7**	**552.8**

7. SUMMARY OF SCENARIOS

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

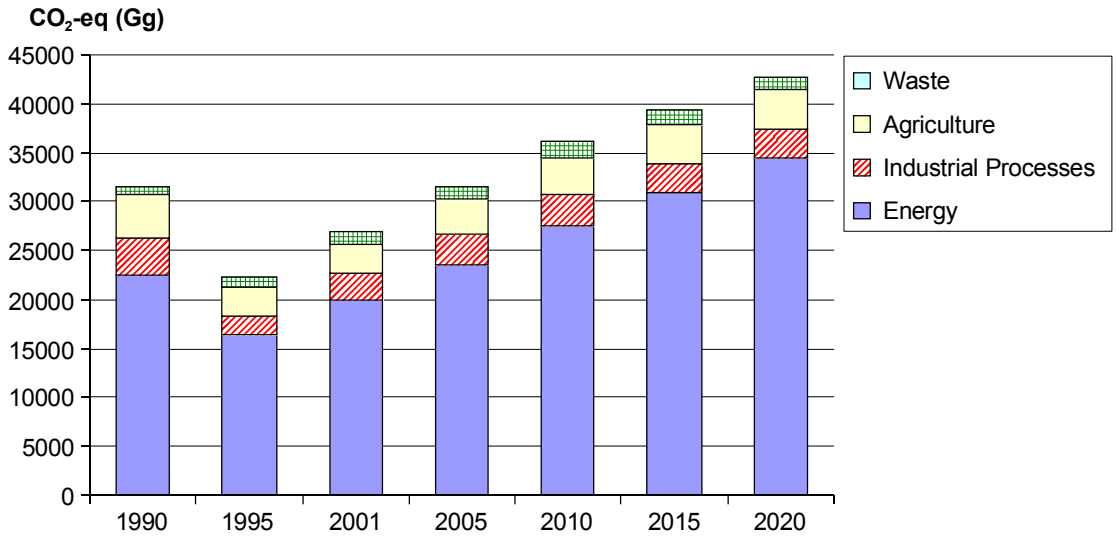


Figure 7-1: Total GHG emission according to "Without measure" scenario

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

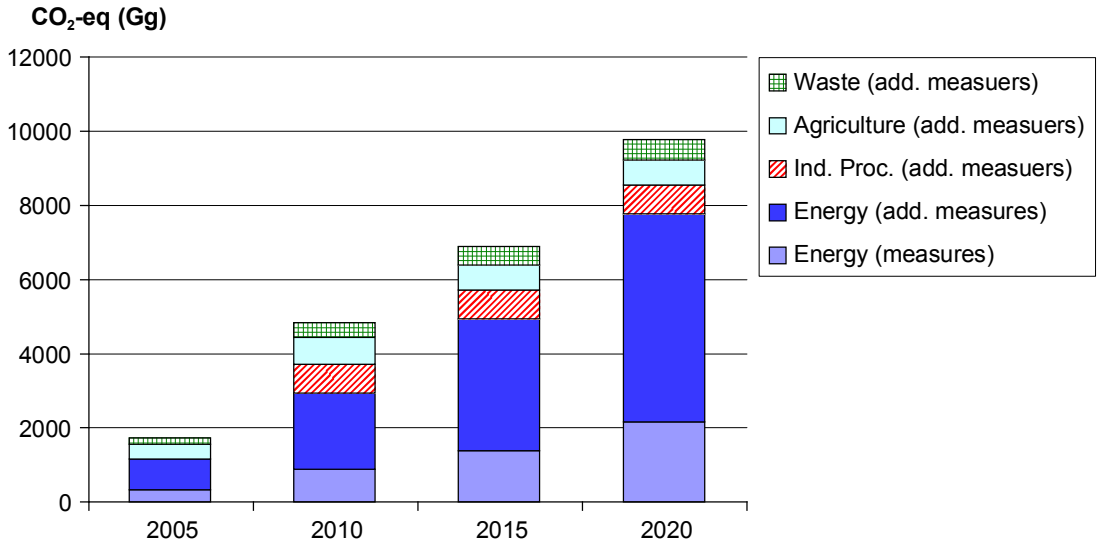


Figure 7-2: Total GHG emission reduction potential of analysed measures

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

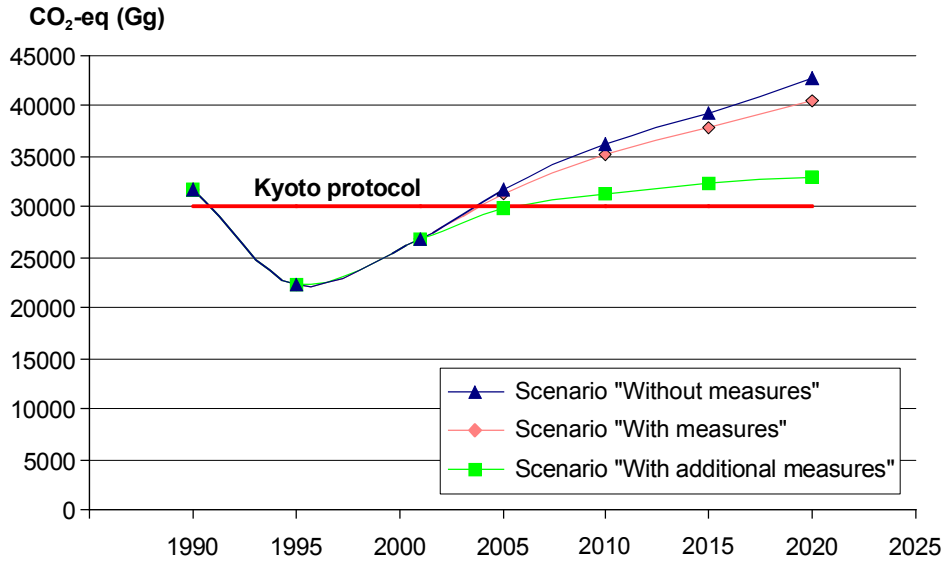


Figure 7-3: Greenhouse gases emission projection for Croatia

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

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

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

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

Scenario “With additional measures”, exceeds Kyoto emission target by 1.3 million tons CO_2-eq. This scenario assumes reduction of emission by 4.8 million of tons comparing to “Without measures” (business as usual) scenario in the year 2010, in 2020 reduction needs to be 10 million tons. National cost calculation curve of mitigation measures shows that in energy sector with approach above 1.5 million of tons reduction, costs reach 30 – 40 US$ per ton of CO_2 *(Ref.3.).* This means that scenario “With additional measures” will have a considerable socio-economic impact, which is not in proportion to the Croatian economic capabilities and its priorities.

Even according to the «Without measures» scenario, Croatia will have per capita GHG emissions among the lowest in EU and EIT countries. According to the «With measures» scenario, total GHG emission in CO_2-eq will amount to 5.22 million tons above the Kyoto Protocol target. Including forest sink amounting to 976 Gg CO_2, (which is 15 percent of the total sink in 1990), the emission of Croatia in 2010 will exceede the Kyoto limit by 4.24 million tons. According to the indicated, if the «With measures» scenario is realized, Croatia would need an increase of the 1990 base year emission quota by **4.46 million tons eq-CO_2,** which corresponds to the exceeding of the Kyoto Protocol target by 4.24 million tons (4.46 Mt x 0.95 = 4.24 Mt).

The new Croatian application for consideration of specific circumstances under Article 4.6 of the Convention is based on the need to increase base year emissions by 4.46 million tons of eq-CO_2. By including this amount into 1990 base year emissions, the emission would increase by

14 percent as compared to the standard IPCC approach. Negotiations on the Croatian application are underway in the framework of the Subsidiary Body for Implementation.

By making reference to the same Article of the Convention (Art. 4.6) some transition countries have realized even larger increase of base year emissions (Poland – 23%; Hungary – 18%; Bulgaria and Romania – 16% each), by selecting a year in the period from 1985 to 1990 as their base year. GHG emissions of the mentioned transition countries in 1990, in the base year and in 2001 as the last year for which inventory was made are shown in fig. 7-4, while the emission values have been taken from the official data base of the Convention on Climate Change, (http://unfccc.int/program/mis/ghg/submis2003.html).

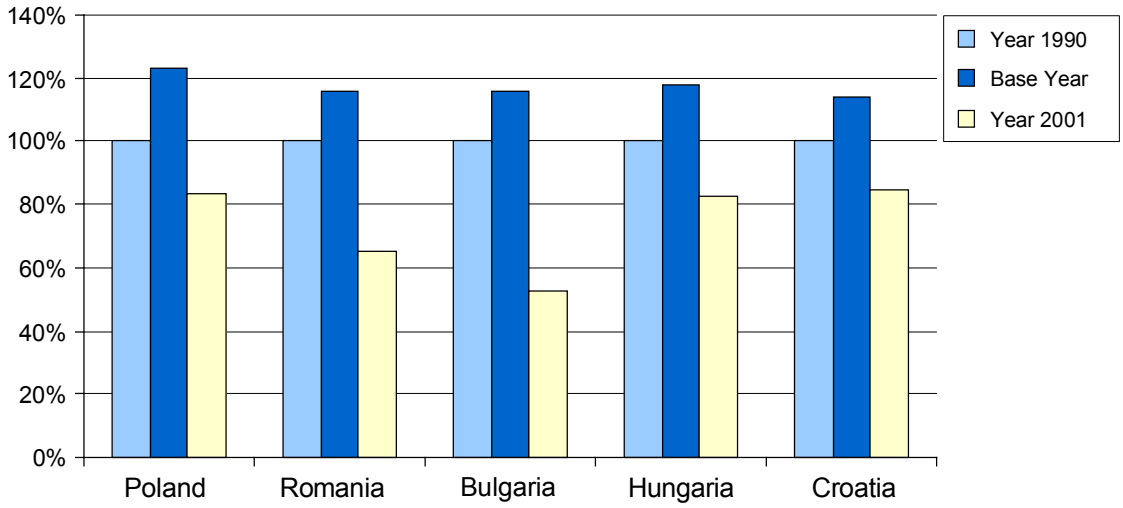


Figure 7-4: Comparison of emissions in Croatia with emissions of some transition countries

In above figure there is a clearly visible departure of base year and 2001 emissions in relation to 1990 emissions (1990 emissions for each country have been represented as 100%). Among the group of indicated transition countries, Croatia has applied for the lowest emission increase, while GHG emissions in 2001 have come closest to 1990 emissions. In other words, Croatia would be in a less favorable position as compared to the mentioned countries, even in case that the Croatian application be approved.

8. REFERENCES

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

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

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

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

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

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

ANNEX 1

GHG EMISSION PROJECTION OF ENERGY SECTOR

Table A1-1: Projection of CO_2 emission for Energy - "With measures" scenario

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

Table A1-2: Projection of CH_4 emission for Energy - "With measures" scenario

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

Table A1-3: Projection of N_2O emission for Energy - "With measures" scenario

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

Table A1-4: Projection of CO_2-eq emission for Energy - "With measures" scenario

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

Table A1-5: GHG mitigation measures involved in scenario "With measures"- Energy sector

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

Table A1-6: Additional measures – Energy sector

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

Table A1-6: Additional measures – Energy sector (continue)

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

Table A1-7: "With measures" scenario for Energy sector

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

Table A1-8: "Without measures" scenario for Energy sector

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

Table A1-9: "With additional measures" scenario for Energy sector

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015	2020
CO_2 Emission (Gg)	20959.4	15200.5	14186.6	15146.1	14235.1	15081.9	15726.6	16607.1	17593.7	17965.9	17447.5	18378.7	20844.5	22919.8	24150.7	24833.7
CH_4 Emission (Gg)	67.806	62.493	58.691	63.448	57.797	58.193	61.220	64.297	56.366	56.097	58.693	63.921	64.673	65.222	66.046	66,841
N_2O Emission (Gg)	0.257	0.177	0.157	0.154	0.147	0.158	0.206	0.257	0.306	0.361	0.443	0.496	0.784	1.017	1.143	1.259
CO_2-eq Emission (Gg)	22462.9	16567.6	15467.7	16526.4	15494.4	16352.7	17076.2	18036.9	18872.3	19255.8	18817.3	19874.9	22445,6	24604,8	25892,1	26627,8

ANNEX 2

TOTAL GHG EMISSION PROJECTION

Total GHG emission projection for "With measures" scenario

Table A2-1: Projection of total CO_2 emission – "With measures" scenario

CO_2 Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	5896.5	4459.9	5650.3	7152.5	8691.5	9403.2	10131.1
Manufact. Ind. and Constr.	6545.9	3617.0	3903.1	4486.3	5095.8	5843.1	6590.3
Transport	4046.0	3337.2	4459.1	5452.4	6345.2	7329.2	8313.1
Commercial/Residential/AFF	4055.0	2970.8	3678.4	3899.6	4138.7	4411.1	4667.4
Fugitive Emission	415.9	696.9	687.6	687.6	687.6	687.6	687.6
Industrial Processes	2010.5	1169.5	2011.0	2066.3	2099.0	2099.0	2099.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**22969.9**	**16251.4**	**20389.7**	**23744.7**	**27057.9**	**29773.2**	**32488.6**

Table A2-2: Projection of total CH_4 emission – "With measures" scenario

CH_4 Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	0.184	0.155	0.150	0.168	0.187	0.173	0.159
Manufact. Ind. and Constr.	0.508	0.284	0.275	0.384	0.466	0.550	0.634
Transport	0.777	0.600	0.809	1.083	1.260	1.456	1.651
Commercial/Residential/AFF	7.528	3.763	3.565	3.944	4.260	4.885	5.509
Fugitive Emission	58.810	53.391	59.124	59.124	59.124	59.124	59.124
Industrial Processes	0.752	0.400	0.305	0.305	0.305	0.305	0.305
Agriculture	75.322	48.061	43.091	58.984	64.605	63.731	62.857
Waste	37.774	41.148	51.328	62.570	69.890	65.370	57.570
Total	**181.654**	**147.802**	**158.646**	**186.561**	**200.096**	**195.593**	**187.810**

Table A2-3: Projection of total N_2O emission – "With measures" scenario

N_2O Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	0.045	0.032	0.047	0.068	0.089	0.097	0.106
Manufact. Ind. and Constr.	0.066	0.034	0.033	0.038	0.043	0.048	0.053
Transport	0.040	0.030	0.354	0.618	0.837	0.967	1.097
Commercial/Residential/AFF	0.106	0.061	0.062	0.067	0.070	0.078	0.087
Fugitive Emission	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial Processes	2.992	2.694	2.318	2.920	3.110	3.110	3.110
Agriculture	8.835	6.069	6.873	7.550	8.270	8.295	8.319
Waste	0.450	0.421	0.275	0.275	0.275	0.275	0.275
Total	**12.534**	**9.341**	**9.962**	**11.537**	**12.693**	**12.870**	**13.047**

Table A2-4: Projection of total HFC, PFC & SF_6 (CO_2-eq) emission – "With measures" scenario

CO_2-eq Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
HFC Emission	0.000	7.800	48.998	48.998	48.998	48.998	48.998
PFC Emission	938.600	0.000	0.000	0.000	0.000	0.000	0.000
SF_6 Emission	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	**938.600**	**7.800**	**48.998**	**48.998**	**48.998**	**48.998**	**48.998**

Table A2-5: Projection of total CO_2-eq emission – "With measures" scenario

CO_2-eq Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	5914.2	4473.2	5667.9	7177.1	8723.1	9437.1	10167.2
Manufact. Ind. and Constr.	6576.9	3633.5	3919.1	4506.1	5118.8	5869.4	6620.1
Transport	4074.9	3359.0	4586.0	5666.8	6631.2	7659.5	8687.7
Commercial/Residential/AFF	4245.9	3068.8	3772.6	4003.4	4249.7	4538.0	4810.1
Fugitive Emission	1651.0	1818.1	1929.2	1929.2	1929.2	1929.2	1929.2
Industrial Processes	3892.4	2020.7	2785.0	3026.9	3118.5	3118.5	3118.5
Agriculture	4320.6	2890.7	3035.6	3579.2	3920.3	3909.7	3899.0
Waste	932.9	994.6	1163.2	1399.3	1553.0	1458.1	1294.3
Total	**31608.9**	**22258.7**	**26858.6**	**31288.0**	**35243.8**	**37919.4**	**40526.1**

Total GHG emission projection for "With additional measures" scenario

Table A2-6: Projection of total CO_2 emission – "With additional measures" scenario

CO_2 Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	5896.5	4459.9	5650.3	6779.5	7964.1	8404.0	8905.7
Manufact. Ind. and Constr.	6545.9	3617.0	3903.1	4311.4	4837.0	5368.8	5794.8
Transport	4046.0	3337.2	4459.1	5452.4	6285.8	6987.1	7402.9
Commercial/Residential/AFF	4055.0	2970.8	3678.4	3613.5	3145.1	2703.2	2042.7
Fugitive Emission	415.9	696.9	687.6	687.6	687.6	687.6	687.6
Industrial Processes	2010.5	1169.5	2011.0	2066.3	2099.0	2099.0	2099.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**22969.9**	**16251.4**	**20389.7**	**22910.8**	**25018.8**	**26249.7**	**26932.7**

Table A2-7: Projection of total CH_4 emission – "With additional measures" scenario

CH_4 Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	0.184	0.155	0.150	0.159	0.173	0.157	0.144
Manufact. Ind. and Constr.	0.508	0.284	0.275	0.374	0.453	0.534	0.615
Transport	0.777	0.600	0.809	1.083	1.256	1.426	1.581
Commercial/Residential/AFF	7.528	3.763	3.565	3.934	4.216	4.805	5.378
Fugitive Emission	58.810	53.391	59.124	59.124	59.124	59.124	59.124
Industrial Processes	0.752	0.400	0.305	0.305	0.305	0.305	0.305
Agriculture	75.322	48.061	43.091	47.855	47.571	47.548	47.524
Waste	37.774	41.148	51.328	54.260	53.360	42.290	31.250
Total	**181.654**	**147.802**	**158.646**	**167.093**	**166.458**	**156.189**	**145.920**

Table A2-8: Projection of total N_2O emission – "With additional measures" scenario

N_2O Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	0.045	0.032	0.047	0.064	0.081	0.086	0.091
Manufact. Ind. and Constr.	0.066	0.034	0.033	0.036	0.039	0.041	0.041
Transport	0.040	0.030	0.354	0.618	0.837	0.953	1.062
Commercial/Residential/AFF	0.106	0.061	0.062	0.065	0.061	0.064	0.065
Fugitive Emission	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial Processes	2.992	2.694	2.318	2.920	0.470	0.470	0.470
Agriculture	8.835	6.069	6.873	7.140	7.093	7.221	7.365
Waste	0.450	0.421	0.275	0.275	0.275	0.275	0.275
Total	**12.534**	**9.341**	**9.962**	**11.119**	**8.856**	**9.109**	**9.369**

Table A2-9: Projection of total HFC, PFC & SF_6 (CO_2-eq) emission - "With additional measures" sc.

CO_2-eq Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
HFC Emission	0.000	7.800	48.998	48.998	48.998	48.998	48.998
PFC Emission	938.600	0.000	0.000	0.000	0.000	0.000	0.000
SF_6 Emission	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	**938.600**	**7.800**	**48.998**	**48.998**	**48.998**	**48.998**	**48.998**

Table A2-10: Projection of total CO_2-eq emission – "With additional measures" scenario

CO_2-eq Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy Industries	5914.2	4473.2	5667.9	6802.7	7992.8	8433.9	8936.9
Manufact. Ind. and Constr.	6576.9	3633.5	3919.1	4330.4	4858.7	5392.7	5820.3
Transport	4074.9	3359.0	4586.0	5666.8	6571.6	7312.4	7765.4
Commercial/Residential/AFF	4245.9	3068.8	3772.6	3716.3	3252.5	2823.9	2175.9
Fugitive Emission	1651.0	1818.1	1929.2	1929.2	1929.2	1929.2	1929.2
Industrial Processes	3892.4	2020.7	2785.0	3026.9	2300.1	2300.1	2300.1
Agriculture	4320.6	2890.7	3035.6	3218.5	3197.8	3236.9	3281.1
Waste	932.9	994.6	1163.2	1224.8	1205.9	973.4	741.5
Total	**31608.9**	**22258.7**	**26858.6**	**29915.7**	**31308.6**	**32402.4**	**32950.6**

Total GHG emission projection for "Without measures» scenario

Table A2-11: Projection of total CO_2 emission – "Without measures" scenario

CO_2 Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy	20959.4	15081.9	18378.7	22016.5	25828.3	29051.8	32557.8
Industrial Processes	2010.5	1169.5	2011.0	2066.3	2099.0	2099.0	2099.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**22969.9**	**16251.4**	**20389.7**	**24082.8**	**27927.3**	**31150.8**	**34656.8**

Table A2-12: Projection of total CH_4 emission – "Without measures" scenario

CH_4 Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy	67.806	58.193	63.921	64.715	65.334	66.250	67.181
Industrial Processes	0.752	0.400	0.305	0.305	0.305	0.305	0.305
Agriculture	75.322	48.061	43.091	58.984	64.605	63.731	62.857
Waste	37.774	41.148	51.328	62.570	69.890	65.370	57.570
Total	**181.654**	**147.802**	**158.646**	**186.574**	**200.134**	**195.656**	**187.913**

Table A2-13: Projection of total N_2O emission – "Without measures" scenario

N_2O Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy	0.257	0.158	0.496	0.795	1.048	1.204	1.364
Industrial Processes	2.992	2.694	2.318	2.920	3.110	3.110	3.110
Agriculture	8.835	6.069	6.873	7.550	8.270	8.295	8.319
Waste	0.450	0.421	0.275	0.275	0.275	0.275	0.275
Total	**12.534**	**9.341**	**9.962**	**11.540**	**12.703**	**12.884**	**13.068**

Table A2-14: Projection of total HFC, PFC & SF_6 (CO_2-eq) emission – "Without measures" sc.

CO_2-eq Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
HFC Emission	0.000	7.800	48.998	48.998	48.998	48.998	48.998
PFC Emission	938.600	0.000	0.000	0.000	0.000	0.000	0.000
SF_6 Emission	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	**938.600**	**7.800**	**48.998**	**48.998**	**48.998**	**48.998**	**48.998**

Table A2-15: Projection of total CO_2-eq emission – "Without measures" scenario

CO_2-eq Emission (Gg)	**1990**	**1995**	**2001**	**2005**	**2010**	**2015**	**2020**
Energy	22462.9	16352.7	19874.9	23622.0	27525.1	30816.4	34391.2
Industrial Processes	3892.4	2020.7	2785.0	3026.9	3118.5	3118.5	3118.5
Agriculture	4320.6	2890.7	3035.6	3579.2	3920.3	3909.7	3899.0
Waste	932.9	994.6	1163.2	1399.3	1553.0	1458.1	1294.3
Total	**31608.9**	**22258.7**	**26858.6**	**31627.4**	**36116.9**	**39302.6**	**42703.0**

Trend of total GHG emission

Table A2-16: Trend of total CO_2 emission

Emission of CO_2 (Gg)	1990	1995	1996	1997	1998	1999	2000	2001
Energy Industries	5896.5	4459.9	4310.0	4874.9	5530.9	5698.8	5155.9	5650.3
Manufact. Ind. and Constr.	6545.9	3617.0	3762.9	3714.1	4008.3	3729.4	3804.6	3903.1
Transport	4046.0	3337.2	3668.1	4013.2	4162.6	4394.4	4396.0	4459.1
Commercial/Residential/AFF	4055.0	2970.8	3341.6	3405.2	3302.8	3618.1	3457.9	3678.4
Fugitive Emission	415.9	696.9	644.0	599.8	589.2	525.2	633.0	687.6
Industrial Processes	2010.5	1169.5	1249.5	1449.8	1362.4	1712.8	1931.7	2011.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**22969.9**	**16251.4**	**16976.1**	**18056.9**	**18956.1**	**19678.6**	**19379.1**	**20389.7**

Table A2-17: Trend of total CH_4 emission

Emission of CH_4 (Gg)	1990	1995	1996	1997	1998	1999	2000	2001
Energy Industries	0.184	0.155	0.143	0.153	0.180	0.188	0.137	0.150
Manufact. Ind. and Constr.	0.508	0.284	0.288	0.312	0.316	0.271	0.277	0.275
Transport	0.777	0.600	0.668	0.727	0.776	0.817	0.822	0.809
Commercial/Residential/AFF	7.528	3.763	4.585	4.547	4.004	4.072	4.546	3.565
Fugitive Emission	58.810	53.391	55.536	58.558	51.090	50.747	52.910	59.124
Industrial Processes	0.752	0.400	0.378	0.340	0.316	0.273	0.288	0.305
Agriculture	75.322	48.061	45.336	44.503	43.113	43.950	42.572	43.091
Waste	37.774	41.148	42.887	45.334	47.747	51.099	51.328	51.328
Total	**181.654**	**147.802**	**149.821**	**154.475**	**147.542**	**151.418**	**152.880**	**158.646**

Table A2-18: Trend of total N_2O emission

Emission of N_2O (Gg)	1990	1995	1996	1997	1998	1999	2000	2001
Energy Industries	0.045	0.032	0.028	0.035	0.041	0.042	0.043	0.047
Manufact. Ind. and Constr.	0.066	0.034	0.035	0.036	0.037	0.032	0.033	0.033
Transport	0.040	0.030	0.070	0.112	0.163	0.219	0.292	0.354
Commercial/Residential/AFF	0.106	0.061	0.074	0.073	0.065	0.068	0.075	0.062
Fugitive Emission	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial Processes	2.992	2.694	2.508	2.636	1.985	2.342	2.756	2.318
Agriculture	8.835	6.069	7.227	8.206	7.357	7.610	7.770	6.873
Waste	0.450	0.421	0.268	0.266	0.255	0.283	0.271	0.275
Total	**12.534**	**9.341**	**10.210**	**11.365**	**9.903**	**10.596**	**11.240**	**9.962**

Table A2-19: Trend of total HFC, PFC & SF_6 (CO_2-eq) emission

Emission of CO_2-eq (Gg)	1990	1995	1996	1997	1998	1999	2000	2001
HFC Emission	0.000	7.800	60.150	91.190	17.590	9.080	23.100	48.998
PFC Emission	938.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SF_6 Emission	-	-	-	-	-	-	-	-
Total	**938.600**	**7.800**	**60.150**	**91.190**	**17.590**	**9.080**	**23.100**	**48.998**

Table A2-20: Trend of total CO_2-eq emission

Emission of CO_2-eq (Gg)	1990	1995	1996	1997	1998	1999	2000	2001
Energy Industries	5914.2	4473.2	4321.8	4889.1	5547.4	5715.8	5172.1	5667.9
Manufact. Ind. and Constr.	6576.9	3633.5	3779.7	3731.9	4026.3	3745.1	3820.8	3919.1
Transport	4074.9	3359.0	3703.7	4063.1	4229.4	4479.4	4503.9	4586.0
Commercial/Residential/AFF	4245.9	3068.8	3460.8	3523.4	3407.1	3724.6	3576.4	3772.6
Fugitive Emission	1651.0	1818.1	1810.3	1829.5	1662.0	1590.9	1744.1	1929.2
Industrial Processes	3892.4	2020.7	2095.1	2365.3	2001.9	2453.5	2815.1	2785.0
Agriculture	4320.6	2890.7	3192.4	3478.5	3186.2	3282.0	3302.8	3035.6
Waste	932.9	994.6	983.8	1034.5	1081.8	1160.8	1161.9	1163.2
Total	**31608.9**	**22258.7**	**23347.5**	**24915.2**	**25142.2**	**26152.1**	**26097.1**	**26858.6**

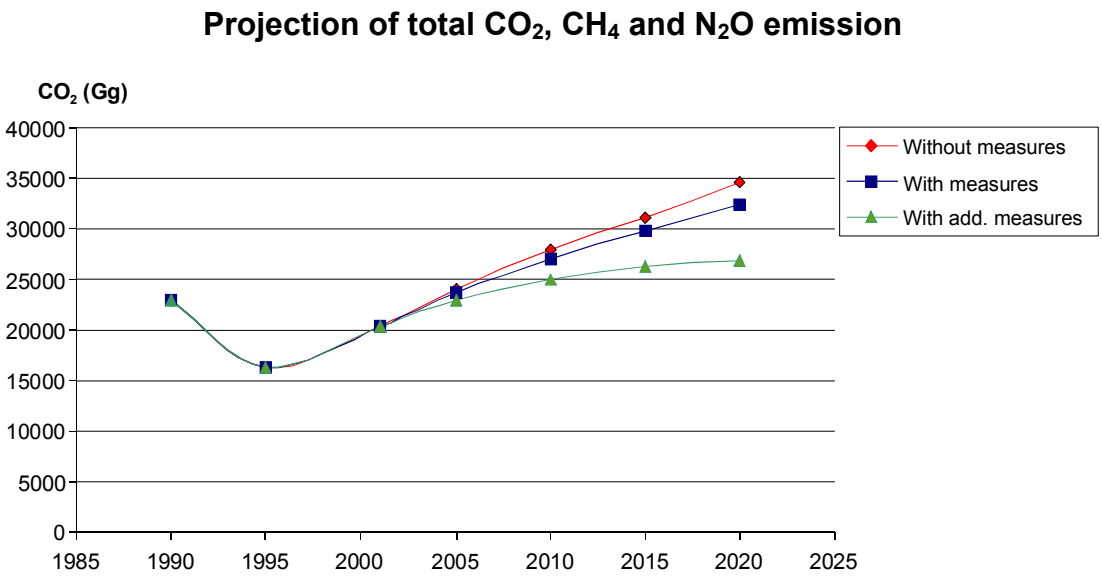


Figure A2-1: Projection of total CO_2 emission

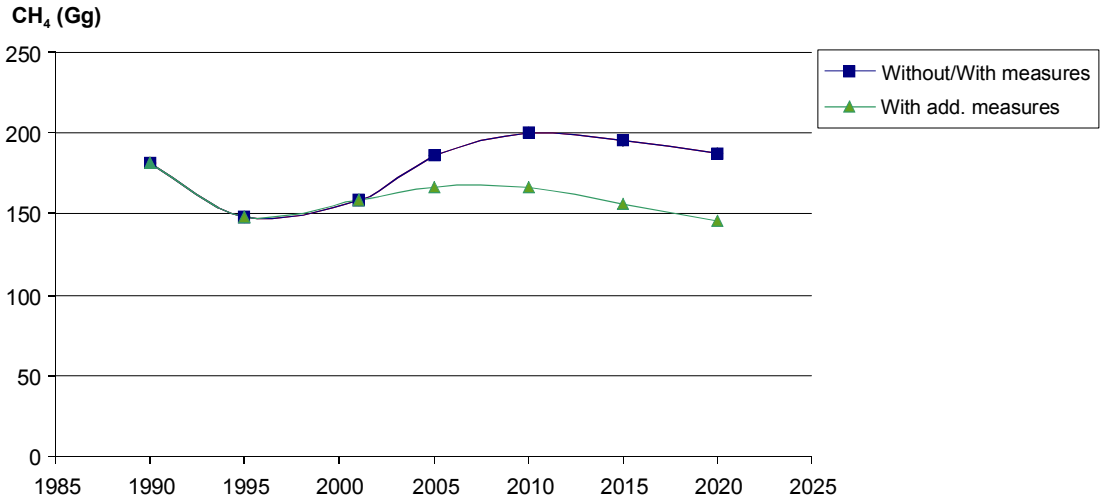


Figure A2-2: Projection of total CH_4 emission

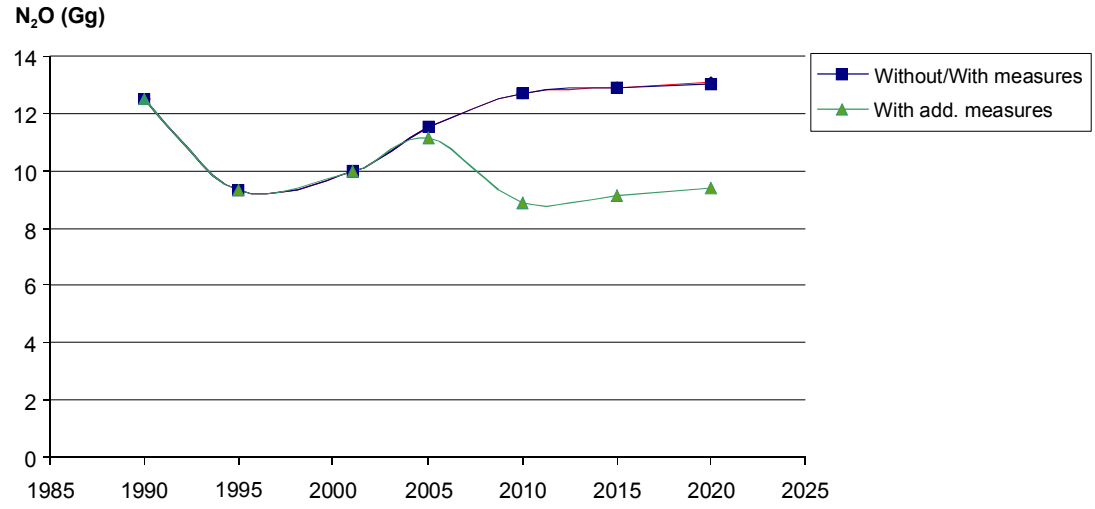


Figure A2-3: Projection of total N_2O emission