REPORT ON PROJECTIONS OF GREENHOUSE GAS EMISSIONS

REPUBLIC OF CROATIA

June 2017

CROATIAN AGENCY FOR THE ENVIRONMENT AND NATURE

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REPORT ON PROJECTIONS OF GREENHOUSE GAS EMISSIONS

REPUBLIC OF CROATIA

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CHAPTER 1: INTRODUCTION

'Report on projections of greenhouse gas emissions' (hereinafter: the Report) is an integral part of the national system for monitoring the implementation of policies and measures for greenhouse gas emissions reduction and projections of greenhouse gas emissions related to the fulfilment of commitments under the United Nations Framework Convention on Climate Change (hereinafter: the Convention) and the Kyoto Protocol. The Republic of Croatia is required to report to the European Commission on monitoring the implementation of these policies and measures and emission projections, based on the regulations that apply to the Member States of the European Union.

The legal basis for preparation of the Report in the national legislation is primarily in Article 75 Paragraph 3 of the Air Protection Act (OG 130/11, 47/14).

Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision 280/2004/EC (hereinafter: Regulation) and Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council (hereinafter: Implementing Regulation) are applicable regulations of the European Union which prescribe the obligations and the way of reporting for Member States.

Article 14 of the aforementioned Regulation prescribes the content of the report. The report includes projections of greenhouse gas emissions by sources and their removal by sinks, composed of the following components:

- 'without measures', 'with existing measures' and 'with additional measures' projections, organized by sector and by gas,
- projections of ETS and non-ETS emissions,
- policies and measures included in projections,
- descriptions of methodologies, models, underlying assumptions and key input and output parameters,
- sensitivity analysis of projections on input data.

The method and conditions for implementation of the regulation governing the monitoring of greenhouse gas emissions are regulated by the Implementing Regulation, which in Article 23 further defines the scope of Report. The required parameters for projections, which must be included in the Report, and recommended parameters for projections are defined in Annex XII of the aforementioned Implementing Regulation.

Accordingly, the Report includes:

- assumptions for general economic parameters,
- assumptions for energy sector,
- assumptions for industry sector,
- assumptions for transport sector,
- assumptions in agriculture sector,
- assumptions in waste management sector,
- assumptions in LULUCF sector (LULUCF – eng. *Land use, land use change and forestry*).

The Report includes projections of greenhouse gas emissions by sources and their removal by sinks for the years 2015, 2020, 2025, 2030 and 2035.

Below are listed data sources used for the Report:

CRF CATEGORY	DATA TYPE	DATA SOURCE
General parameters	GDP – yearly growth rate Population Coal price Crude oil price Natural gas price	European Commission recommendations
Energy	Fuel consumption Electricity generation Electricity imports Final energy demand	National energy balance Draft of Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050
Transport	Number of passenger kilometres Number of tonne-kilometres Energy demand in transport sector	ODYSSEE database Draft of Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050
Industry	Production index	Sectorial studies (cement, glass and nitric acid production) National Bureau of Statistics
	Use of solvents	Inventory Report of air pollutants on the Croatian territory under the Convention on Long-range Transboundary Air Pollution (CLRTAP)

CRF CATEGORY	DATA TYPE	DATA SOURCE
Agriculture	Number and type of livestock	National Bureau of Statistics Croatian Agricultural Agency Faculty of Agriculture FAOSTAT database
	Plant production	National Bureau of Statistics Statistical reports on plant production FAOSTAT database
LULUCF	Land area of each sub-category	NIR 2017
	The assumed emission factors by sinks	CFR 2017
Waste	The amount of municipal waste The amount of municipal waste disposed of at landfill The organic fraction of municipal solid waste	Sustainable Waste Management Act Waste Management Plan of the Republic of Croatia

CHAPTER 2: PROJECTION OF GREENHOUSE GAS EMISSIONS

This chapter presents the historical greenhouse gas emissions in the period from 1990 to 2014 and projections of greenhouse gas emissions for the period from 2015 to 2035. The emissions are presented as total emissions of greenhouse gases by sectors and by gases.

Since greenhouse gases have different irradiation properties and consequently different contribution to the greenhouse effect, emissions of each gas are multiplied by their Global Warming Potential (abb. GWP). In this case, the emission of greenhouse gases is presented as equivalent emission of carbon dioxide (CO_2 eq). In case of removing emissions of greenhouse gases, it refers to outflows (sinks) of greenhouse gas emissions and the amount is shown as negative value. The global warming potentials of individual gases that are used in the report are presented below.

GAS	GWP
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298
HFC-23	14800
HFC-32	675
HFC-125	3500
HFC-134a	1430
HFC-143a	4470
HFC-152a	124
HFC-227ea	3220
HFC-236fa	9810
CF_4	7390
C_3F_8	8830
C_2F_6	12200
SF_6	22800

Source: 2006 IPCC Guidelines

Sectors are identified according to the Guidelines for the preparation of National Communications by Parties included in Annex I to the Convention (FCCC/CP/1999/7, Part II):

- energy,
- transport,
- industry,
- agriculture,
- waste management,
- LULUCF.

Particularly the emissions of certain greenhouse gases are presented:

- CO_2,
- CH_4,
- N_2O,
- HFCs and PFCs,
- SF_6.

According to the Guidelines for the preparation of National Communications by Parties included in Annex I to the Convention, projections are presented for three scenarios: 'without measures' scenario, 'with existing measures' scenario and 'with additional measures' scenario. Scenario 'without measures' assumes that implementation of adopted policies and measures as well as implementation of planned policies and measures will not happen. Scenario 'with existing measures' assumes a consistent application of policies and measures, which application is already in progress and application of adopted policies and measures, which application is likely, but still not begun. Scenario 'with additional measures' is based on application of planned policies and measures.

Emission projections start from the inventory of greenhouse gas emissions (NIR 2017) which includes an inventory of emissions and sinks of greenhouse gases for the period 1990 – 2015. Reference year for projection is 2014.

2.1. PROJECTIONS OF GREENHOUSE GAS EMISSIONS BY SECTORS

Historical and projected trends in greenhouse gas emissions by sectors are presented in Figures 2-1 to 2-3. Emissions are presented for 'without measures' scenario, 'with existing measures' scenario and 'with additional measures' scenario for the period from 1990 to 2035.

Figure 2-1: Historical and projected greenhouse emissions by sectors, 'without measures' scenario

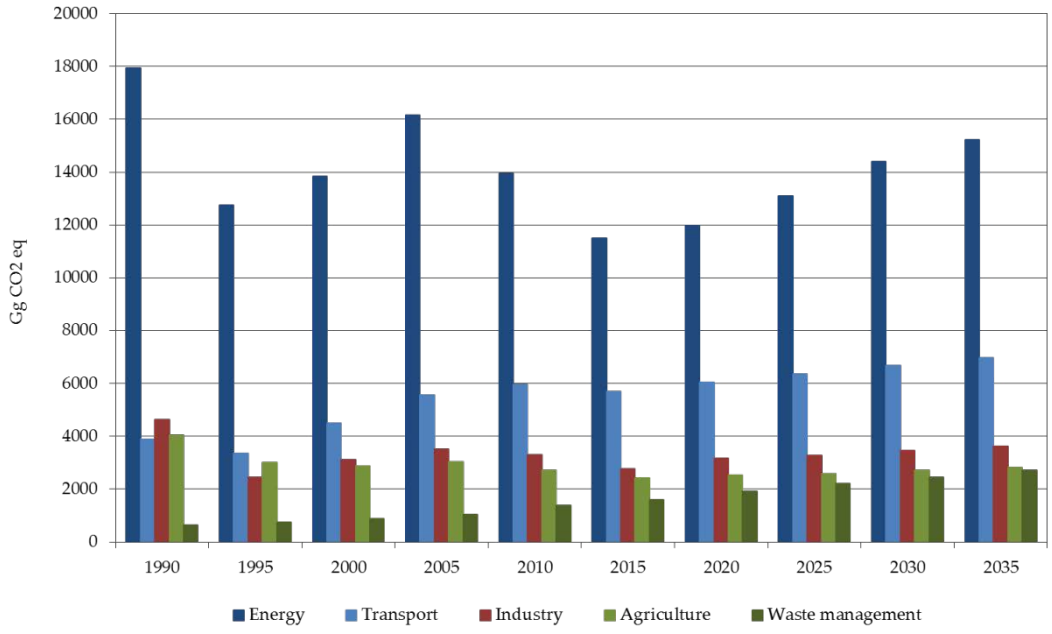


Figure 2-2: Historical and projected greenhouse emissions by sectors, 'with existing measures' scenario

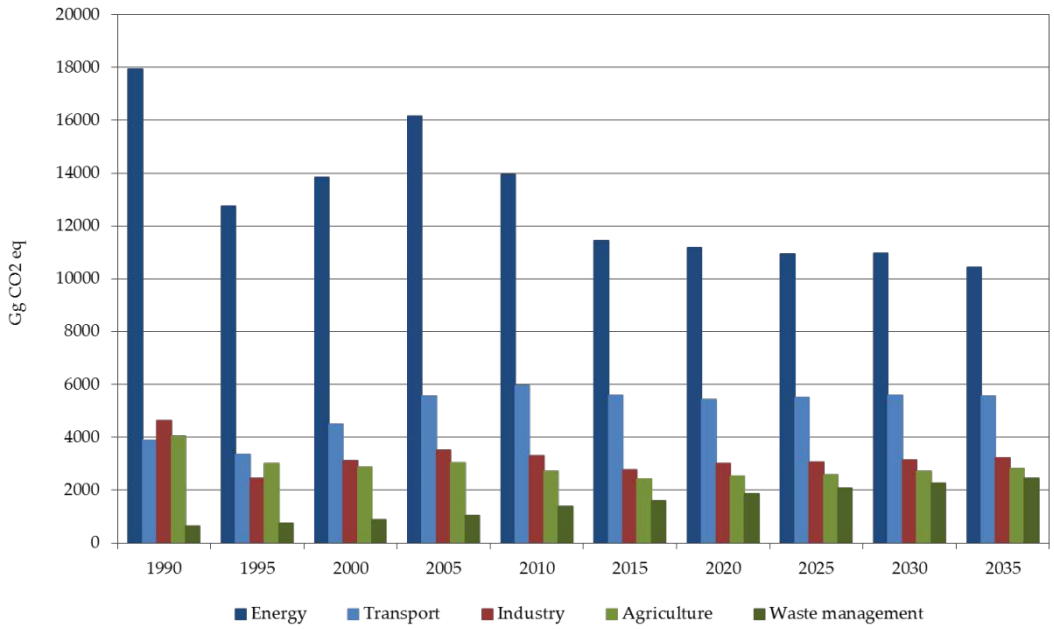
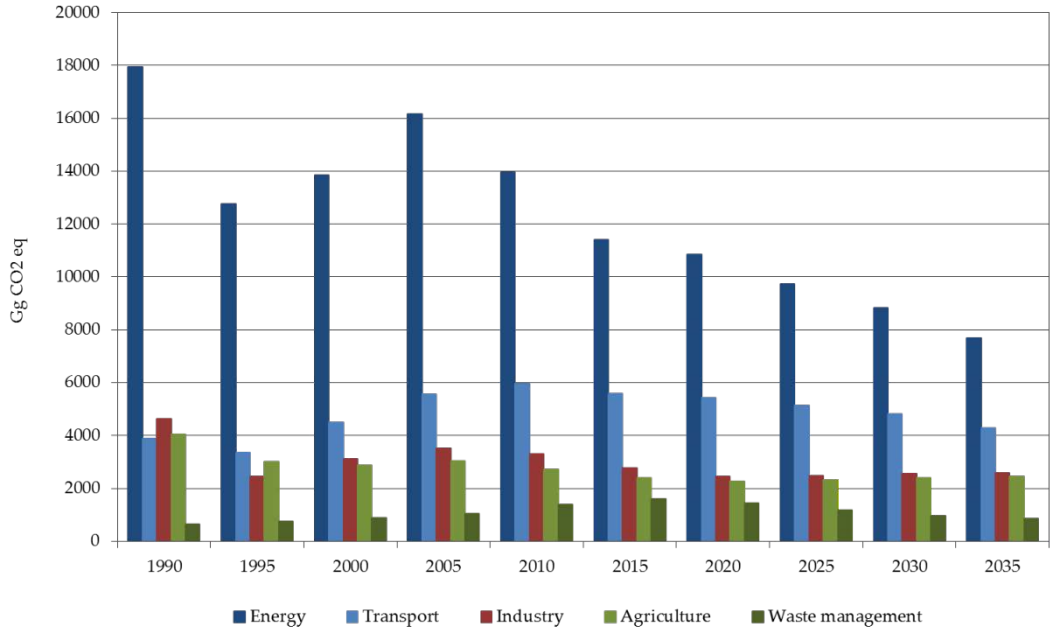


Figure 2-3: Historical and projected greenhouse emissions by sectors, 'with additional measures' scenario



The energy sector covers all activities that involve fuel combustion from stationary sources and fugitive emission from fuels. The emission from energy sector in 2014 amounted to 10,817 $GgCO_2$ and it is the main source of anthropogenic emission of greenhouse gases, it accounts approximately 46.9% of the total greenhouse gases emission in 2014. In scenario 'without measures', i.e. without implementation of energy efficiency measures and renewable energy policy and with the increase in a number of fossil fuel power plants to reduce the import of electricity by 2030, projections show steady growth until 2035. In the 'with existing measures' scenario, projections show stagnation of emissions until 2020 as the growth of demand is mainly satisfied by the development of the renewable energy sources and energy efficiency. In the period from 2020 to 2035, this scenario shows a slight decrease due to expected development of the renewable energy sources even without the additional measures, only due to market competitiveness and impact of the EU ETS. Most measures to reduce emissions in the energy sector are defined by 2020, so it has not yet been determined which will be implemented after 2020. In scenario 'with additional measures', all measures planned in the energy sector were taken into account and projections show a steady trend of emission reduction.

The transport sector includes emissions from fuel combustion in road transportation, civil aviation, railways and navigation. The emission from transport sector in 2014 amounted to 5,642 $GgCO_2$ eq, which makes about 24.5% of total Croatia's greenhouse gases emission. In scenario 'without measures', projections show a continuous trend of growth of emissions by 2035, primarily due to strong ties with expected increase in GDP and transport activity. In the 'with existing measures' scenario in the period from 2015 to 2035, projections indicate stagnation of emissions. Factors that encourage the growth of emissions are expected increase in economic activities and living standards, while the emission reductions are primarily affected by the measures to increase energy efficiency and use of renewable sources in transport. Most of the existing measures have defined duration by 2020 so in this scenario not many measures are simulated after 2020. In scenario 'with additional measures', projections show a continuous trend of reducing emissions by 2035, primarily due to expected measures to increase rail transport and development of electric vehicles, which will be the key condition for the strong reduction of emissions in transport sector in long term.

The industry sector includes the process emission from industrial processes and product use, while emission from fuel combustion in industry is included in the Energy sector. The emission from

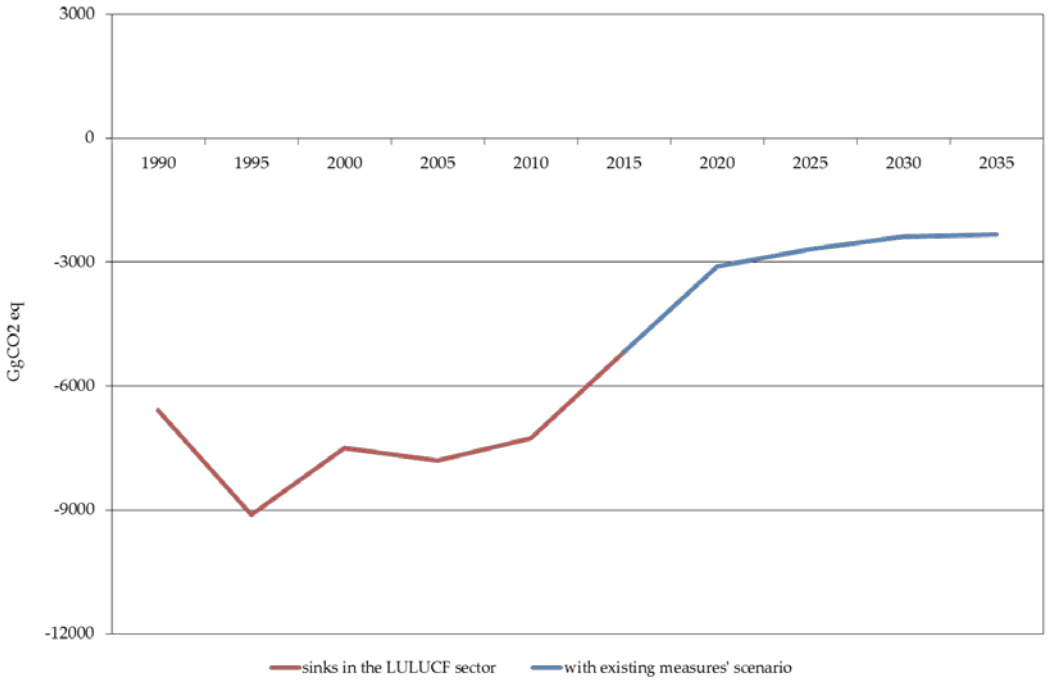
industry sector in 2014 amounted to 2,688 $GgCO_2$ eq, which makes about 11.7% of total Croatia's greenhouse gases emission in 2014. The projections of emissions indicate an increase in 'without measures' and 'with existing measures' scenarios due to expected increase in production to the maximum utilization of existing productive capacity in the period until 2035. The differences between 'without measures' and 'with existing measures' scenarios relate to the degree of the implementation of process measures in 'with existing measures' scenario prescribed by the sectoral legislation. The projections of emissions indicate a decrease in 'with additional measures' scenario due to the implementation of cost-effective measures to reduce emissions.

The agriculture sector covers about 10.5% of total greenhouse gas emissions in 2014 (emission is 2,427 $GgCO_2$ eq). The projections indicate an increase in emissions after 2015, implying a growth of emissions from the agricultural sector based on the assumed increase in livestock population and crop production (assumption based on expert judgement of University of Zagreb, Faculty of Agriculture experts) and normalization of agricultural production (trend analysis).

The waste management sector participates in the total emission of greenhouse gases with about 6.4% in 2014 (emission is 1,474 $GgCO_2$ eq). The projections of emissions indicate an increase in 'without measures' and 'with existing measures' scenarios due to expected increase of waste quantities in the period until 2035 as a result of higher living standards, despite the effects of measures undertaken to avoid/reduce and recycle waste. The differences between 'without measures' and 'with existing measures' scenarios relate to the degree of the implementation of measures in 'with existing measures' scenario prescribed by the sectoral legislation. The projections of emissions indicate a decrease in 'with additional measures' scenario due to the implementation of cost-effective measures to reduce emissions. The potential of CO_2 emission reduction, which can be achieved by implementing the measures included in the scenarios 'with existing measures' and 'with additional measures' is balanced in the Energy sector.

In the year 2014, removals by sink in the LULUCF sector were -6,591.28 $GgCO_2eq$. Projections of removals up to 2035 amount -2,338.29 $GgCO_2eq$ sinks per year. These projections are made by sectorial sub-categories 'Forest land', 'Cropland', 'Grasslands', 'Wetlands', 'Settlements', 'Other land' and 'Harvested wood products' for the scenario with existing measures and their aggregated trend is shown in Figure 2- 4.

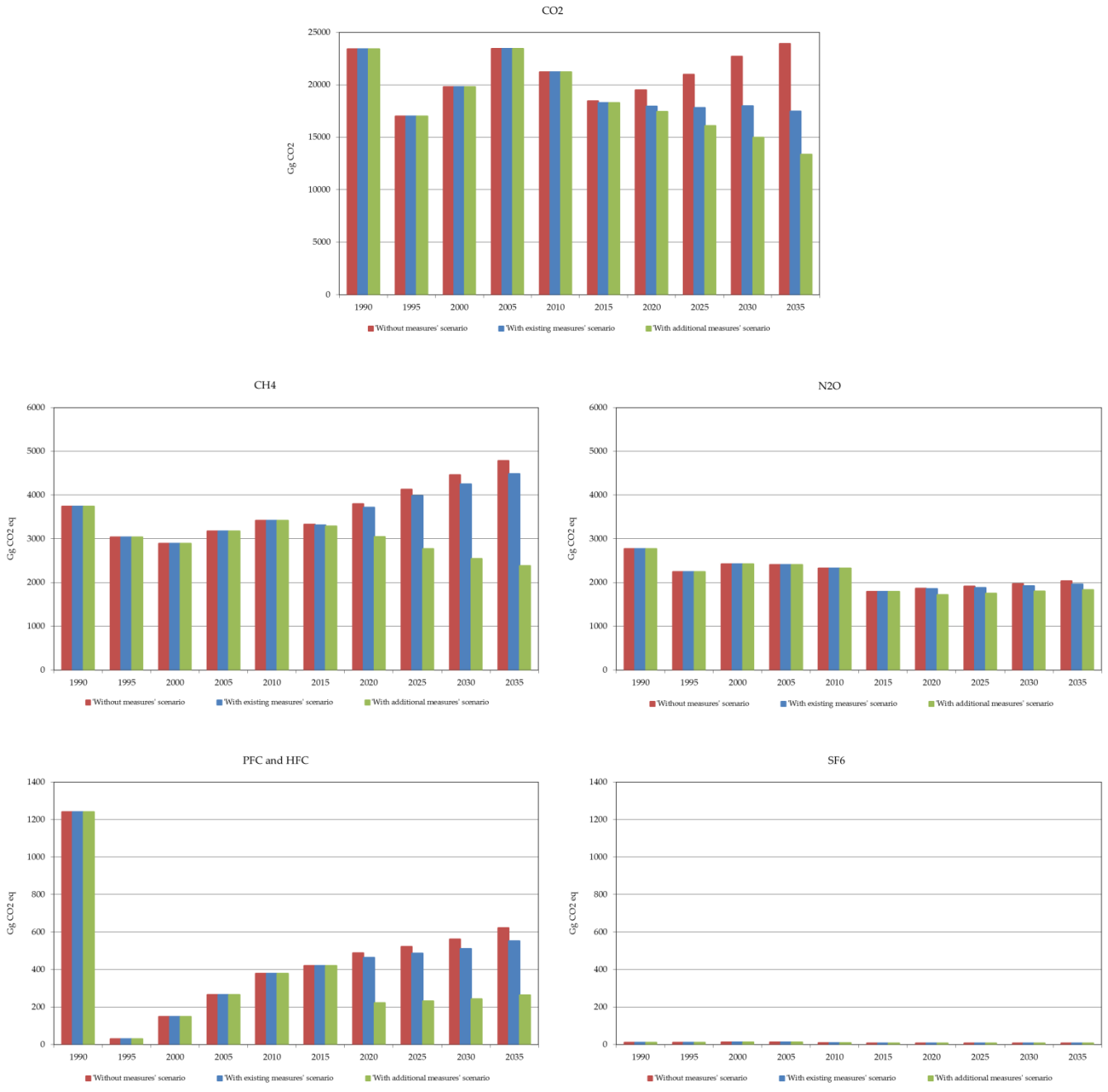
Figure 2-4: Historical and projected greenhouse removals in the LULUCF, 'with existing measures' scenario



2.2. PROJECTIONS OF GREENHOUSE GAS EMISSIONS BY GASES

Trends in emissions, by greenhouse gases (CO_2, CH_4, N_2O, HFCs and PFCs, SF_6), for all three scenarios, in the period from 1990 until 2035 are shown in Figure 2-5.

Figure 2-5: Projections of greenhouse gas emissions by gases



Historical emissions and projections of greenhouse gas emissions CO_2, CH_4, N_2O, HFCs and PFCs, SF_6, for all three scenarios, in the period from 1990 until 2035 are shown in Table 2-1.

Table 2-1: Historical emissions and projections of greenhouse gas emissions by gases, $GgCO_2$ eq

CO2	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
'Without measures' scenario	23,390.08	16,992.80	19,789.12	23,451.85	21,203.74	18,455.92	19,478.81	20,981.70	22,700.20	23,896.19
'With existing measures' scenario	23,390.08	16,992.80	19,789.12	23,451.85	21,203.74	18,295.74	17,937.49	17,826.15	17,990.49	17,481.24
'With additional measures' scenario	23,390.08	16,992.80	19,789.12	23,451.85	21,203.74	18,271.93	17,431.88	16,093.41	14,989.61	13,363.06
CH4	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
'Without measures' scenario	3,744.19	3,033.66	2,887.85	3,173.79	3,415.08	3,327.91	3,794.42	4,132.36	4,463.65	4,785.08
'With existing measures' scenario	3,744.19	3,033.66	2,887.85	3,173.79	3,415.08	3,313.14	3,713.89	3,985.90	4,248.31	4,487.82
'With additional measures' scenario	3,744.19	3,033.66	2,887.85	3,173.79	3,415.08	3,285.09	3,045.69	2,768.80	2,546.74	2,385.09
N2O	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
'Without measures' scenario	2,768.74	2,243.31	2,418.77	2,407.93	2,322.33	1,794.47	1,868.01	1,909.88	1,973.65	2,031.41
'With existing measures' scenario	2,768.74	2,243.31	2,418.77	2,407.93	2,322.33	1,794.47	1,854.15	1,878.63	1,920.88	1,957.93
'With additional measures' scenario	2,768.74	2,243.31	2,418.77	2,407.93	2,322.33	1,794.51	1,722.46	1,753.45	1,797.26	1,834.89
PFC and HFC	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
'Without measures' scenario	1,240.24	29.32	147.90	265.80	378.91	419.58	487.10	522.51	562.26	621.97
'With existing measures' scenario	1,240.24	29.32	147.90	265.80	378.91	419.58	463.90	486.06	511.15	552.86
'With additional measures' scenario	1,240.24	29.32	147.90	265.80	378.91	419.58	221.68	231.50	242.88	263.24
SF6	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
'Without measures' scenario	10.45	11.12	11.62	13.03	8.95	6.38	6.59	6.71	6.86	7.08
'With existing measures' scenario	10.45	11.12	11.62	13.03	8.95	6.38	6.59	6.71	6.86	7.08
'With additional measures' scenario	10.45	11.12	11.62	13.03	8.95	6.38	6.59	6.71	6.86	7.08
TOTAL	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
'Without measures' scenario	31,154	22,310	25,255	29,312	27,329	24,006	25,636	27,553	29,707	31,341
'With existing measures' scenario	31,154	22,310	25,255	29,312	27,329	23,830	23,977	24,182	24,677	24,488
'With additional measures' scenario	31,154	22,310	25,255	29,312	27,329	23,777	22,430	20,855	19,583	17,854

The energy sector has the most significant anthropogenic sources of CO_2 emissions, with maximum value from 21,218 $GgCO_2$ (for the 'without measures' scenario) to 11,182 $GgCO_2$ (for the 'with additional measures' scenario) in 2035.

The most important source of N_2O emissions is agriculture sector, which projections in 2035 have the maximum of 2,819 $GgCO_2$ eq for the 'without measures' scenario, or 2,459 $GgCO_2$ eq for the 'with additional measures' scenario.

The sources of HFCs and PFCs and SF_6 emissions are in the industry sector. Although their emissions in absolute terms are not large, due to the large global warming potential (GWP), their contribution is significant. Projections in 2035 have the maximum value of 825 $GgCO_2$ eq for the 'without measures' scenario, 687 $GgCO_2$ eq for the 'with existing measures' scenario and 333 $GgCO_2$ eq for the 'with additional measures' scenario.

2.3. TOTAL PROJECTIONS

Total projections of greenhouse gas emissions (without LULUCF) for all three scenarios, for the period until 2035 are shown in Figure 2-6 and Table 2-2.

Figure 2-6: Total projections of greenhouse gas emissions (without LULUCF) for period until 2035

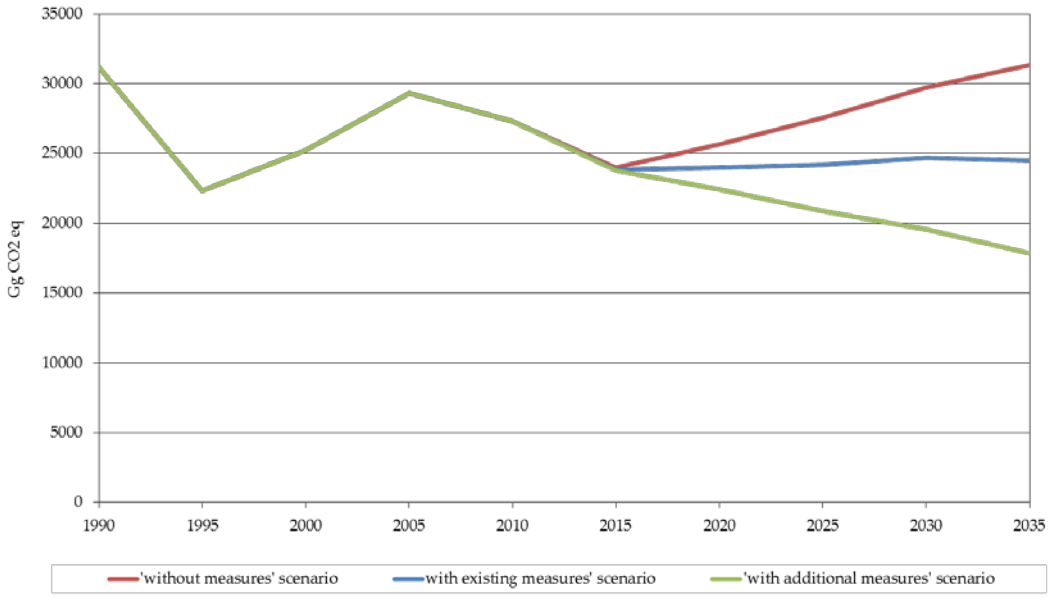


Table 2-2: Historical emissions and projections of greenhouse gas emissions by sectors, $GgCO_2$ eq

'Without measures' scenario	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Energy	17.951	12.754	13.851	16.169	13.952	11.496	11.975	13.098	14.395	15.215
Transport	3.881	3.368	4.499	5.561	5.952	5.703	6.050	6.373	6.692	6.973
Industry	4.629	2.441	3.128	3.508	3.315	2.781	3.157	3.287	3.457	3.626
Waste management	654	740	889	1.045	1.392	1.612	1.931	2.205	2.450	2.708
Agriculture	4.039	3.008	2.888	3.030	2.718	2.414	2.523	2.591	2.713	2.820
TOTAL	**31.154**	**22.310**	**25.255**	**29.312**	**27.329**	**24.006**	**25.636**	**27.553**	**29.707**	**31.341**
'With existing measures' scenario	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Energy	17.951	12.754	13.851	16.169	13.952	11.433	11.169	10.944	10.967	10.434
Transport	3.881	3.368	4.499	5.561	5.952	5.603	5.422	5.514	5.595	5.561
Industry	4.629	2.441	3.128	3.508	3.315	2.781	3.009	3.060	3.147	3.229
Waste management	654	740	889	1.045	1.392	1.599	1.854	2.072	2.256	2.444
Agriculture	4.039	3.008	2.888	3.030	2.718	2.414	2.523	2.591	2.713	2.820
TOTAL	**31.154**	**22.310**	**25.255**	**29.312**	**27.329**	**23.830**	**23.977**	**24.182**	**24.677**	**24.488**
'With additional measures' scenario	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Energy	17.951	12.754	13.851	16.169	13.952	11.412	10.847	9.741	8.840	7.677
Transport	3.881	3.368	4.499	5.561	5.952	5.599	5.421	5.128	4.827	4.286
Industry	4.629	2.441	3.128	3.508	3.315	2.781	2.447	2.484	2.547	2.586
Waste management	654	740	889	1.045	1.392	1.597	1.449	1.185	974	845
Agriculture	4.039	3.008	2.888	3.030	2.718	2.387	2.266	2.318	2.395	2.459
TOTAL	**31.154**	**22.310**	**25.255**	**29.312**	**27.329**	**23.777**	**22.430**	**20.855**	**19.583**	**17.854**

Projections show that compared to 1990, in 2035 the emission remains approximately the same as in 1990 in the 'without measures' scenario. In the 'with existing measures' scenario, in 2035 the emission is reduced by 21.4% compared to 1990, while in the 'with additional measures' scenario emission is reduced by 42.7% compared to 1990.

In the 'with existing measures' scenario, projections show stagnation of emissions until 2020. In the period from 2020 to 2035, this scenario shows a slight increase of emission.

In the 'with additional measures' scenario, projections show a steady downward trend of emissions.

In 'with existing measures' scenario, in relation to the 'without measures' in 2035, the greenhouse gas emissions will be reduced by 21.9%, while in the scenario 'with additional measures' by 43%.

In scenario 'with additional measures' in relation to the scenario 'with existing measures' in 2035, greenhouse gas emissions will be reduced by 27.1%.

2.4. TOTAL EFFECTS OF POLICIES AND MEASURES

Total effects of applied policies and measures to reduce greenhouse emissions are shown in Table 2-3.

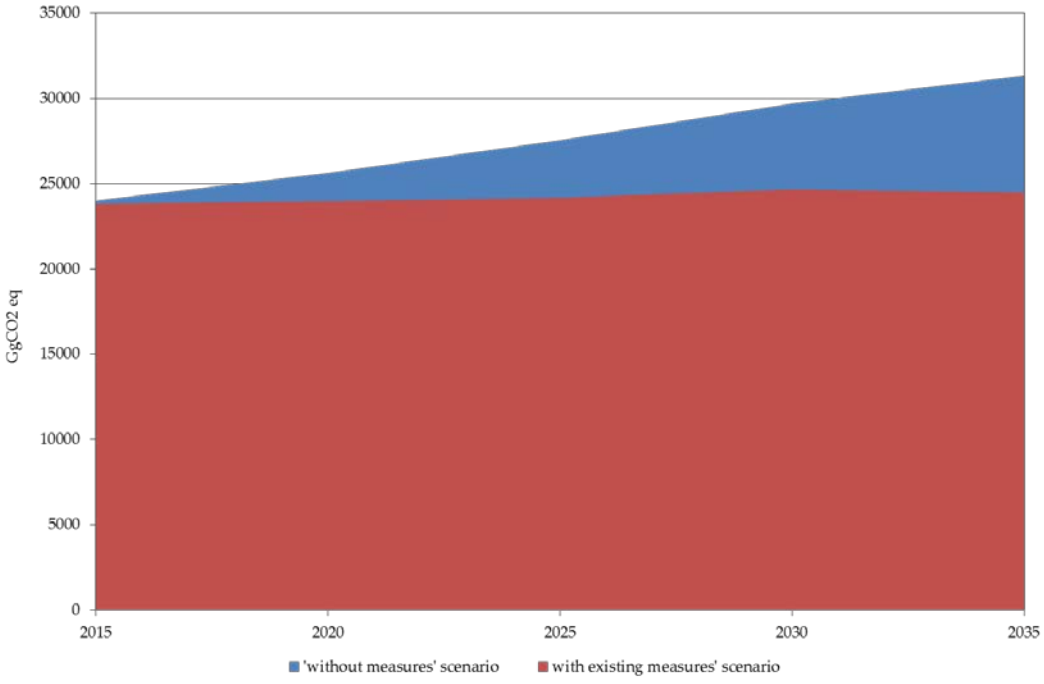
Table 2-3: Total effects of policies and measures, $GgCO_2$ eq

	2015	2020	2025	2030	2035
'Without measures' scenario	24,006	25,636	27,553	29,707	31,341
'With existing measures' scenario	23,830	23,977	24,182	24,677	24,488
TOTAL	176	1,659	3,371	5,029	6,853

Source: EKONERG

By comparing the 'without measures' scenario with scenario that includes the application of relevant policy and measures which implementation is already in progress, or application of policy and measures that have already been adopted ('with existing measures' scenario), total effects of applied policies and measures have been determined. Emission is reduced by 176 $GgCO_2$ eq in 2015 to 6,853 $GgCO_2$ eq in 2035 (Figure 2-7).

Figure 2-7: Total effects of policies and measures



Source: EKONERG

2.5. EMISSIONS OF ETS AND ESD SECTORS

Historical emissions and projections of greenhouse gas emissions in ETS and ESD sectors for three scenarios are shown in Table 2-4.

Table 2-4: Historical emissions and projections of greenhouse gas emissions in ETS and ESD sectors, $GgCO_2$ eq

	2010	2015	2020	2025	2030	2035
'Without measures' scenario	27,329	24,006	25,636	27,553	29,707	31,341
ETS	8,710	8,772	9,452	10,546	11,881	12,693
ESD	18,587	15,201	16,142	16,963	17,774	18,594
'With existing measures' scenario	27,329	23,830	23,977	24,182	24,677	24,488
ETS	8,710	8,731	8,707	8,515	8,630	8,155
ESD	18,587	15,066	15,228	15,622	15,996	16,277
'With additional measures' scenario	27,329	23,777	22,430	20,855	19,583	17,854
ETS	8,710	8,712	8,098	7,342	6,848	6,024
ESD	18,587	15,033	14,290	13,469	12,686	11,780

Source: [7.], [27.], EKONERG

Emissions within the ETS in 2010 encompassed 32% of total emissions, amounting to 8,710 $GgCO_2$ eq. Projections indicate that in 2015 the ETS cover approximately 36.6% of total emissions, while in 2035, according to the 'with additional measures' scenario, 33.7% of emissions will be included, 33.3% of emissions will be included according to the 'with existing measures' scenario and 40.5% of total emissions will be included in the 'without measures' scenario.

In the 'without measures' scenario, compared to 2010, emission projections show an increase in emissions of 0.7% in 2015 up to 45.7% in 2035. The reason of this increase is primarily due to no improvements in energy efficiency and production of electricity from fossil fuel plants as a result of the assumption of reduced dependency on electricity imports and assumption that all new electricity demands in this scenario will be covered by fossil fuel power plants.

In the 'with existing measures' scenario, projections show stagnation of emissions until 2020. In the period from 2020 to 2035, this scenario shows a slight decrease of emission (by 6.4% in 2035 compared to 2010).

In the 'with additional measures' scenario, projections show a steady downward trend, primarily due to planned actions to promote usage of renewable energy sources and energy efficiency. Compared to 2010, emission projections show a decrease in emissions of 30.8% in 2035.

In 2010, emissions within ESD sector amounted to 18,587 $GgCO_2$ eq, which represents 68% of total emissions.

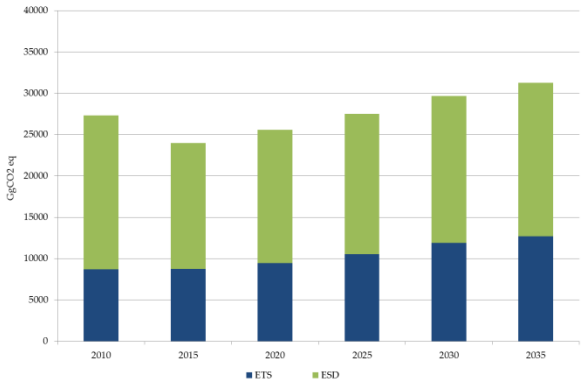
In the 'without measures' scenario, increase in emissions is expected in the whole observed period from 2015 to 2035, and it is expected that in 2035 the emission will be at the 2010 level.

In the 'with existing measures' scenario, projections show a slight increase of emission in period from 2015 to 2035 (by 8% in 2035 compared to 2015). Compared to 2010, emission projections show a decrease in emissions of 12.4% in 2035. Compared to 2005, emission projections show a decrease in emissions of 12.6% in 2035.

In the 'with additional measures' scenario, further reduction of emissions is expected, by 36.6% in 2035 compared to 2010.

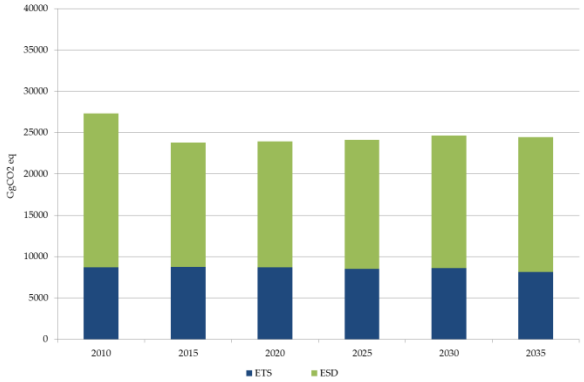
Historical emissions and projections of greenhouse gas emissions in ETS and ESD for three scenarios are shown in Figures 2-8 to 2-10.

Figure 2-8: Historical emissions and projections of emissions within ETS and ESD, scenario 'without measures'



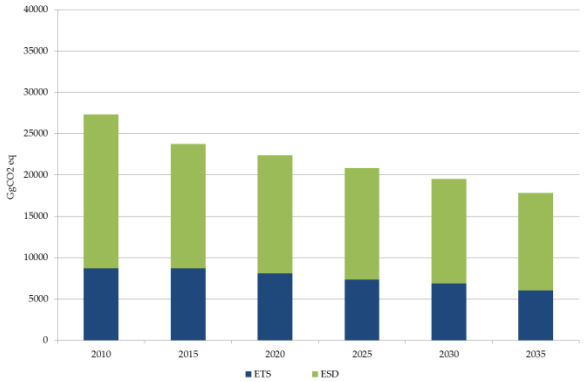
Source: [7.], EKONERG

Figure 2-9: Historical emissions and projections of emissions within ETS and ESD, scenario 'with existing measures'



Source: [7.], EKONERG

Figure 2-10: Historical emissions and projections of emissions within ETS and ESD, scenario 'with additional measures'



Source: [7.], EKONERG

CHAPTER 3: POLICIES AND MEASURES INCLUDED IN THE PROJECTIONS

Policies and measures to reduce emissions from sources and increase sinks of greenhouse gases that are included in the projections are shown separately by sectors. Within each sector there are measures listed for the 'without measures', 'with existing measures' and 'with additional measures' scenarios without presenting the potential to reduce greenhouse gas emissions. The potential for these policies and measures, as quantified effects of their implementation, are presented in the 'Report on the implementation of policies and measures to reduce emissions of greenhouse gases' that was prepared as a separate document.

Projections cover the period until 2035, with five-year steps.

The observation time horizon until 2035 can be divided into three periods: 1) First commitment period of the Kyoto Protocol from 2008 to 2012, which has ended; 2) Second commitment period from 2013 to 2020; and 3) Third period after 2020. The second commitment period until 2020 is characterized by the regulation of the transfer of the EU acquis, mostly the climate and energy package adopted in 2009. After 2020, the trend should be towards the established long-term goals defined by the EU document Roadmap for moving to a competitive low-carbon economy in 2050 (the aim of the European Union to reduce greenhouse gas emissions by 85 % - 95 % until 2050).

Republic of Croatia is in the process of adopting of the Low-Carbon Development Strategy of the Republic of Croatia for the period until 2030 with a view to 2050 where a range of possible measures and scenarios for achieving this objective will be closely considered in it. The current legal framework and policies and measures as well as guidelines and recommended parameters of the European Commission from 14th June 2016 which comply with EU baseline scenario 2016 were taken into account while preparing the scenarios.

3.1. ENERGY

The projections of greenhouse gas emissions in the energy sector are based on assumptions, objectives, measures and guidelines provided by the draft of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050.

The Strategy provided projections of the final energy consumption and gross final energy consumption until 2030, with a view of 2050, for the reference scenario and two scenarios with additional measures. The Strategy was based on the assumption of macroeconomic indicators as defined by The Recommended parameters of the EC for 2017 [19].

The 'without measures' scenario is illustrative scenario which was not considered in the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050. It is developed for the needs of this report. It assumes no implementation of existing or additional measures after 2014. That scenario leads to increased energy demands due to no improvements in energy efficiency and production of electricity from fossil fuel plants as a result of the assumption of reduced dependency on electricity imports and assumption that all new electricity demands in this scenario will be covered by fossil fuel power plants.

The 'with existing measures' scenario represents a group effect of measures that are under implementation or adopted with enforcement of existing instruments and measures arising from the transfer of the EU acquis. The detail list and description of measures included is listed in the separated Report on Policy and Measures.

The 'with existing measures' scenario is equivalent of the Reference scenario of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050.

The 'with additional measures' scenario is based on the application of the planned policy and measures, as listed in the Report on Policy and Measures. It is equivalent of the Low-Carbon Scenario 1 (NU1) from the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050. For some of the goals from the Strategy the instruments are not yet defined but it is expected that they will be defined by the Action plan for Strategy implementation.

3.2. TRANSPORT

In total final energy consumption, the transport sector accounts for approximately 33% [25.], the largest share of energy consumption is in the road transport with almost 90%.

The 'without measures' scenario implies a development of final energy consumption in line with growth in the number of passenger and goods transport, which is caused by increase in GDP. The increase is affected by the increasing number of vehicles, increased distance travelled per car and fewer passengers per car. For this illustrative scenario it is assumed that there would be no improvements in efficiency of vehicles nor use of alternative fuels.

The 'with existing measures' scenario represents a group effect of measures that are under implementation and adopted with enforcement of existing instruments and measures arising from the transfer of the EU acquis. The detail list and description of measures included are listed in the separated Report on Policy and Measures.

The 'with existing measures' scenario is equivalent of the Reference scenario of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050.

The 'with additional measures' scenario is based on the application of the planned measures as listed in the Report on Policy and Measures. It is equivalent of the Low-Carbon Scenario 1 (NU1) from the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050. For some of the goals from the Strategy the instruments are not yet defined but it is expected that they will be defined by the Action plan for Strategy implementation.

3.3. INDUSTRY

Industry sector that includes the process emission from industrial processes and product use contributes to total greenhouse gases emission with 11.7% in 2014 [7.], of which 93% comes from the key emission sources: Cement Production, Ammonia Production, Nitric Acid Production, Petrochemical and Carbon Black Production, Non-energy Products from Fuels and Solvent Use and Consumption of HFCs in Refrigeration and Air Conditioning Equipment.

The projections of greenhouse gas emissions in the industry sector are based on assumptions, objectives and measures provided by the draft of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050.

The 'without measures' scenario is not considered in the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050. It assumes no implementation of existing or additional measures.

The 'with existing measures' scenario assumes that production in industrial processes will reach planned, maximum values until 2035, which will affect the increase in emissions. It is equivalent of the Reference scenario of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (NUR).

The differences between 'without measures' and 'with existing measures' scenarios relate to the degree of the implementation of process measures in 'with existing measures' scenario prescribed by the sectoral legislation.

The 'with additional measures' scenario includes implementation of cost- effective measures to reduce greenhouse gas emissions from energy consumption by industry branch and process emissions in the production of cement, glass and nitric acid and the reduction of emissions of volatile organic compounds, controlled substances and fluorinated greenhouse gases. The scenario comprises process emission. Emission from fuel combustion is included in the Energy sector.

The 'with additional measures' scenario is equivalent of the Low-Carbon Scenario 1 (NU1) from the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050. It is based on the application of the planned measures as listed in the Report on Policy and Measures.

Process measures for the reduction of greenhouse gases from industry processes and product use include:

- reduction of clinker factor in cement production;
- increase of recycled glass in the glass production;
- reduction of N_2O emission in nitric acid production (catalytic decomposition);
- reducing emissions of volatile organic compounds in solvent use sector;
- handling of substances that deplete the ozone layer and fluorinated greenhouse gases;
- technical and organizational measures for collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases;
- capacity building and strengthening knowledge of authorized repairers;
- leakage detection of controlled substances and fluorinated greenhouse gases.

3.4. AGRICULTURE

The agriculture sector in total greenhouse gas emissions has a share of about 10% in 2016 [7]. The most important sectoral emissions are emissions of CH_4 with approximately 37% of total emissions and N_2O with approximately 65% of total emissions. Emissions are caused by different agricultural activities. The CH_4 emission source is animal husbandry (enteric fermentation), which accounts for about 82% of the sectoral CH_4 emissions.

In the period until 2035, a recovery of agricultural production and increase of the number of animals is expected.

The 'without measures' scenario is equal to 'with existing measures' scenario.

Both scenarios: 'with existing measures' and 'with additional measures' assume that there will be an increase in agricultural production (restoration of the livestock fund in the period from 2015 to 2020 and continued population increase until 2035, with the of crop production based on indicative trends in the period from 2000 to 2009) and sustainable consumption of fertilizer (on the level of the 2007-2014 period average).

Policies and measures included in the development of the 'with existing measures' scenario:

- executing the Rural Development Programme for the period 2014-2020, including changing the system of cattle farming (manure removal system and genetic improvement) and diet (increasing digestibility, improving the quality of voluminous forage, improving grazing systems, use of additives in animal feed)

Scenario 'with additional measures' assumes implementation of additional measures:

- Change in diet of cattle and pigs and animal feed quality,
- Changes in animals waste management systems, including aerobic decomposition of manure and biogas production
- Improvements in synthetic fertilizer application methods,
- Hydromeliorative field interventions,
- Introduction of new cultivars, varieties and cultures.

3.5. WASTE MANAGEMENT

The waste management sector contributes to total greenhouse gas emission with 6.4% in 2014 [7], of which 80% comes from the solid waste disposal at landfills, which is the key source of this sector.

The projections of greenhouse gas emissions in the waste management sector are based on assumptions, objectives and measures provided by the draft of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050.

The 'without measures' scenario is not considered in the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050. It assumes no implementation of existing or additional measures.

The 'with existing measures' scenario includes projections of greenhouse gas emissions from solid waste disposal, biological treatment (composting) of solid waste, incineration of waste and wastewater treatment and discharge. It is equivalent of the Reference scenario of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (NUR).

The 'without measures' and 'with existing measures' scenarios assume a continuous increase of waste quantities in the period until 2035 as a result of higher living standards, despite the effects of measures undertaken to avoid/reduce and recycle waste. The differences between 'without measures' and 'with existing measures' scenarios relate to the degree of the implementation of measures in 'with existing measures' scenario prescribed by the sectoral legislation.

The 'with additional measures' scenario includes projections of greenhouse gas emissions from solid waste disposal and biological treatment (composting) of solid waste since the rest of the activities do not provide measures to reduce greenhouse gas emissions. The scenario includes a more intensive application of measures defined by sectoral strategic documents, in relation to the 'with existing measures' scenario. In the period until 2035, greenhouse gas emission reduction in waste management could be achieved by implementing the measures that are defined by the waste management priority order. The scenario assumes implementation of measures defined by the Sustainable Waste Management Act (OG 94/13) and Waste Management Plan of the Republic of Croatia for the period 2017 – 2022 (OG 3/17).

The 'with additional measures' scenario is equivalent of the Low-Carbon Scenario 1 (NU1) from the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050. It is based on the application of the planned measures as listed in the Report on Policy and Measures. Measures for reducing greenhouse gas emissions from waste management include:

- preventing the generation and reducing the amount of municipal waste;
- increasing the amount of separately collected and recycled municipal waste;
- methane flaring;
- reducing the amount of disposed biodegradable municipal waste;
- use of biogas for electricity and heat generation.

By applying measures to prevent the generation and reduce the amount of municipal waste, increase the amount of separately collected and recycled municipal waste, methane flaring and reduce the amount of disposed biodegradable municipal waste, reduction of CH_4 emission is achieved that is calculated in the Waste management sector. The implementation of the measure for use of biogas for electricity and heat generation creates potentials for the reduction of CO_2 emission that is calculated in the Energy sector.

3.6. LULUCF

In the LULUCF sector, projections were made according to sectoral categories: 'Forest land', 'Cropland', 'Grassland', 'Wetland', 'Settlements' 'Other land' and Harvested wood products. The projections were done for the 'with existing measures' (WEM) scenario only. The 'without measures' (WOM) and 'with additional measures' (WAM) scenarios have been omitted due to a lack of capacity of Croatia for development of these projections, which is in accordance with Article 14, Paragraph 1, Item a), Regulation (EU) 525/2013 of the European Parliament and of the Council of May 21, 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC. The projections were made based on statistical analysis of the trend of activity data and implied emission factors for the period 2005-2014, which included measures that were in force in 2009. These measures are prescribed by the Forest management plan of Croatia for the period 2006-2015 for forests and forest land. Based on this document, for afforestation of bare productive forest land on an annual basis of about 2 kha, thereby increasing the surface in the category 'Forest land' ('Grassland converted to Forest land') is planned. According to the expert judgment, this conversion will be carried out over an area of 1.8 kha annually (including both afforestation seeding and the natural expansion of forests). Since the 'Wetlands' have already been partially protected by the Law on Nature Protection and on the basis of past trend, it is not assumed that there will be a significant increase in the area under the said category. The measures included in the national LULUCF Action plan and Rural Development Programme Croatia did not affect the projections for the 'Cropland' and 'Grassland' category, because these documents were drafted in 2014 or 2015, and the assessment of their effect requires a significant capacity building at the national level.

CHAPTER 4: DESCRIPTIONS OF METHODOLOGIES, MODELS, UNDERLYING ASSUMPTIONS AND KEY INPUT AND OUTPUT PARAMETERS FOR PROJECTIONS

Projections were made in accordance with the Guidelines for preparation of national reports by Parties included in Annex I to the Convention.

The potential for mitigation of national greenhouse gas emissions is analysed and assessed at the sectoral level. This assessment takes into account the previous trends and the current state as well as the future projections of parameters that determine the potential for mitigating emissions. The model and methodology used in preparing the projections are described by sector, in this chapter.

A list of assumptions and input data is provided in tabular form (Tables 4-6 to 4-15). The list contains general parameters and parameters related to the sectors and sub-sectors (energy, transport, buildings, industry, agriculture, waste management and LULUCF), in accordance with Annex XII of Implementing Regulation.

The 'with existing measures' and 'with additional measures' scenarios included policies and measures for reduction of emissions from sources and increase greenhouse gases sinks. In order to determine the contribution of each individual policy and measure for emissions reduction, the reduction potential was determined. In cases where the emission reduction potential of individual policies and measures cannot be expressed separately, reports are aggregated with other potential policies and measures.

4.1. DESCRIPTIONS OF MODELS AND METHODOLOGIES FOR PROJECTIONS

Energy and transport

In preparing the projections, a software package LEAP (eng. Long-range Energy Alternatives Planning System)[1] was used, in which was created a model of the energy sector in Croatia. For the needs of detailed modelling of the development and optimization of the power sector, more advanced model were used, whose outputs were the inputs for the energy model in LEAP. Output data are structured in accordance with the structure of inventory of the United Nations Framework Convention on Climate Change. It is the engineering simulation model in which are the scenarios simulated and certain processes and decisions optimized in regard to the assumptions and limitations. The model is detailed to the level of individual production units, present and future.

Projections were made until 2035, with a single step every year. The model is of 'bottom-up' type, because it starts from the sectoral data and individual emission sources in the power sector and calculates CO_2, CH_4 and N_2O emissions.

Assumptions and input parameters used in the preparation of projections are shown in Tables 4-1, 4-7, 4-8 and 4-11.

Table 4-1: Assumptions for projections – energy and transport

ENERGY and TRANSPORT	
As described in the Chapter 3, projections of GHG emissions for this report are taken from the draft of the Low-Carbon Development Strategy of Croatia until 2030 with a view to 2050. Below is a more detailed description of the methodology used.	
1. Final energy demand	Final energy demand is projected in different sectors - industry, transport, services, households and agriculture, fisheries and forestry. The bases for projections of activities are macroeconomic parameters and guidelines provided by the EC to Member States to harmonize the key parameters. For the projections of energy intensities, a development of technology and changing of lifestyles was taken into account. The scenarios 'with existing measures' and 'with additional measures' modelled the impacts of each measure. The analyses were performed by sub-sectors: – industry - by industry and type of fuel used, – transport – by type of transport (road, air, marine and rail) and types of means of transport (cars, buses, motorcycles, light and heavy vans) and by type of technology and fuel used – services – by branches (tourism, trade, education, health), climatic zone

[1] More information available at http://www.energycommunity.org/default.asp?action=47

ENERGY and TRANSPORT	
	(coastal or continental Croatia), purpose (heating, water heating, cooking, cooling, electrical appliances and lighting), type of fuel used, heating demand is modelled on the level of useful and final energy – households – by climatic zone (coastal or continental Croatia), purpose (heating, water heating, cooking, cooling, electrical appliances and lighting) and by type of fuel, heating demand is modelled on the level of useful and final energy – agriculture, fisheries and forestry - by type of fuel
	Demographic trends - assumes a scenario of average fertility and average migration, in accordance with the guidelines of the EC.
1.1. 'Without measures' scenario	
1.1.1. Energy demand in industry	Assumptions: – development of industrial production will not be based on energy-intensive industries, as market mechanisms will direct the balanced development to the less energy-intensive industry where Croatia is not in need of resources, – trends in gross value added in industry are based on harmonized parameters for projection given by the EC [21], – for this scenario, it is assumed that the energy intensity per unit of gross value added and fuel mix in industry will be as in 2014, – Emissions in the industry sub-sector is growing along with economic growth, but growth is moderate as in other sub-sectors considering a decreasing dependence of energy consumption on GDP growth and assumption that there will be no construction of major new energy-intensive industries.
1.1.2. Energy demand in transport	Assumptions: – it is assumed that there will be the increase in number of cars from the 328 cars per 1000 citizens as in 2012 to 520 cars per 1000 citizens in 2050. The average number of cars per 1000 citizens in EU in 2012 was 501 [ODYSSEE] – efficiency of cars assumed as in 2014, no development of alternative fuels; – existing road infrastructure was mainly built; – the transport of passengers will have fastest growth in air traffic; – stagnation in development of rail infrastructure.
1.1.3. Energy demand in general consumption	Assumptions: Households: – according to the existing data, in Croatia in 2012 was 142.2 million m^2 of residential buildings and houses (Long-term strategy for the promotion of the investments of buildings, OG 74/14). It is assumed that the living area will grow slowly with the recovery of economic activity, despite the fall of number of people, by 8,5% until 2030 and by 10,6% until 2050. Most of the new surfaces will refer to a block of flats in urban areas, – no improved efficiency and renovation of building are assumed for this scenario, – consumption of electricity to power household appliances and devices for cooling (air conditioning) will grow, – specific energy consumption for cooking in households will stagnate. Services:

ENERGY and TRANSPORT	
	– no change in the structure, used forms of energy – increase of electricity consumption, decrease in the usage of petroleum products and their replacement with natural gas, – on the islands and parts of Croatia not covered with a natural gas grid, the share of liquefied petroleum gas will be increased – In the services and households sub-sector, projections in the 'without measures' scenario show an increase in the final energy consumption because of the GVA growth of the service sector as well as increase in income of households. Agriculture, forestry and fisheries: – there will be no changes in energy intensity.
1.2. 'with existing measures' scenario	
	In the period until 2020, energy efficiency improvements are in line with the existing measures listed in the National Action Plan for Energy Efficiency for the Period 2017-2019 (listed in the Report on Policy and Measures), while for the post-2020 period, there are no yet implemented measures, so only assessed market improvements are integrated: – market driven improvements of energy efficiency and fuel switches in industrial sector; – renovation of 0,5% surface are of the buildings annually to the standard as listed in the Technical regulation on rational use of energy in buildings (OG 97/14) ; – all new buildings built according to the same Regulation; – it is assumed that all emissions from the new vehicles will be in line with the Regulation EU no. 333/2014 for the personal vehicles, i.e. average emissions of new vehicles will be below 95 g CO_2/km and Regulation EU no. 510/2011 to reduce the average emissions of light duty vehicles below 174 g CO_2/km after 2017 and below 147 gCO_2/km after 2020; – it assumed that there will be stagnation in the use of rail and inland waterways transport; – it is assumed that 6% of the vehicles will be electric vehicles in 2050 (based on the EU Reference scenario 2016).
1.3. 'With additional measures' scenario	
	Continued support to energy efficiency after 2020, with the following key assumptions: - renovation of 2% of the buildings annually to the nearly-zero energy standard (include the use of renewable sources); - support for the development of the share of electric vehicles to 25% of the personal vehicles in 2050; - intermodal shift with the goal to shift 7% of the transport of passengers and goods to rails until 2030 and 20% until 2050; - improvements of energy efficiency in industry together with fuel switch towards the use of renewable energy and electricity.
2. Energy transformations and resources	The power system was analysed by the simulation of market development with the software for the hourly optimization of operation and development of the power system. The price of the emission allowances in the EU ETS was

ENERGY and TRANSPORT	
	assumed as in the EU Reference scenario 2016. The simulation of the operation of the refineries was done to satisfy the domestic demand as possible with the existing capacities, which mean without building new refineries in 'without measures' scenario, and reducing production in 'with existing measures' and 'with additional measures' scenarios.
2.1. 'Without measures' scenario	
	Assumptions: – all electricity needs will be met from domestic sources (except nuclear power plant Krško) after 2030, which significantly increases the generation in Croatian power plants since import amounted to 25 - 35%. – no new capacity of renewable resources, – all new electricity demands and replacement of old capacity are settled by production from fossil power plants; about 50% gas-fired power plants and about 50% coal-fired power plants, – Nuclear power plant Krško continues delivering 50% of energy to Croatia and operates up to 2043. – fuel production in refineries driven by the domestic demand; – improvements of environmental performance and lifetime of power plants in line with the Directive 2010/75/EU on industrial emissions.
2.2. 'with existing measures' scenario	
	Assumptions: - Until 2020, installed capacities of renewable energy sources power plants are as defined by the National Action Plan for Renewable Energy Sources by 2020 and Tariff system for renewable energy and efficient cogeneration (OG 133/2013, 151/2013, 20/2014, 107/2014 i 100/2015); - for the post-2020 period the simulation of the market development with the software for the hourly optimization of operation and development of the power system was done. The price of the emission allowances in the EU ETS was assumed as in the EU Reference scenario 2016. The analysis showed that renewable energy sources will be competent to certain extent without the need of the public support for the solar PV system and wind. - no new coal power plants; - no net imports of electricity after 2030.
2.3. 'With additional measures' scenario	
	Assumptions include continuous development of renewable energy policy even after 2020: - the simulation of the market development with the software for the hourly optimization of operation and development of the power system was done. The price of the emission allowances in the EU ETS was assumed as in the EU Reference scenario 2016. - Due to lower demand for energy compared to the 'with existing measures' due to the energy efficiency improvements, the costs to achieve higher shares of renewable energy are lower. - no new coal power plants; - no net imports of electricity after 2030.

Industry

In preparing the projections, a model derived in tabular Calculation interface was used. The model is structured in accordance with the table structure of the inventory of United Nations Framework Convention on Climate Change. It is the engineering simulation model.

The model is detailed to the level of individual production units, the present and future ones.

Projections are made until 2035, in steps of five years. The model is of 'bottom-up' type, because it starts from the sectoral data and individual emission sources and calculates CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 emissions.

Assumptions and input parameters used in the preparation of projections are presented in Tables 4-2 and 4-10.

Table 4-2: Assumptions for projections – industry

INDUSTRY	
	The projections were carried out based on the expected development of certain industries, which includes the production goals by 2035. Emission projections start from the situation and projections of macroeconomic parameters in 2015 (The 2015 Ageing Report) - the projected dynamics of the annual growth rate of gross domestic product and gross value added and the decline of population, as well the results of sectoral analysis and studies (cement, ammonia and nitric acid production). The 'without measures' scenario is illustrative scenario; it is developed for the needs of this report. It assumes no implementation of existing or additional measures. Assumptions for 'with existing measures' scenario: – no installation of additional capacity; – production will reach the maximum value by 2035. The Industrial Strategy of the Republic of Croatia 2014 – 2020 defines objectives of industrial development and key indicators of the Croatian industry in the period 2014 – 2020. According to the "realistic scenario", by the year 2020 achieving the level of physical volume of industrial production on the level of 2008 is expected, when it reached the highest level of economic activity in Croatia. Process emissions from economic activities, as defined by IPCC methodology, included in the sector Industrial processes and product use were estimated on the basis of detailed sectoral projections of production of cement, ammonia and nitric acid and the projected macroeconomic indicators of gross value added by other industrial branches, annual increase rate in GDP and decline of population. The scenario includes the implementation of measures defined in the strategic and sectoral planning documents included in the business policy of cement and nitric acid manufacturers, conditioned by market demands, laws and regulations and the requirements of the application of

INDUSTRY	
	best available techniques in the production process. Assumptions for 'with additional measures' scenario: – the application of cost- effective measures to reduce greenhouse gas emissions in the production of cement, glass and nitric acid and the reduction of emissions of volatile organic compounds, controlled substances and fluorinated greenhouse gases. According to *good practice,* the projections were made for activity data and emission factors: – activity data – applying grade of 1, 2 and 3 methods (projections of macroeconomic parameters, effects of policies and measures, sectoral analysis and studies); emission factors – applying grade of 1 and 2 methods (projections based on average values for the previous five-year period, effects of policies and measures, sectoral analysis and studies). –

Agriculture

In preparing the projections, a model derived in tabular Calculation interface was used. The model is structured in accordance with the table structure of the inventory of United Nations Framework Convention on Climate Change. It is the engineering simulation model.

The model is detailed to the level of individual sources, the present and future ones.

Projections are made by 2020, indicative until 2035, in steps of five years. The model is of 'bottom-up' type, because it starts from the sectoral data and individual emission sources and calculated emissions of CH_4 and N_2O.

Assumptions and input parameters used in the preparation of projections are presented in Tables 4-3 and 4-12.

Table 4-3: Assumptions for projections - agriculture

AGRICULTURE	
	The projections were carried out based on the expected future state of key parameters. In order to determine the key parameters for projections (number and types of livestock, crop production), the extrapolation of historical input data was used and expert assessment that includes historical data and sectoral strategic and development documents. Assumptions: – uncertainties due to the lack of adequate and reliable statistics and economic indicators.

Waste management

In preparing the projections, a model derived in tabular Calculation interface was used. The model is structured in accordance with the table structure of the inventory of United Nations Framework Convention on Climate Change. It is the engineering simulation model.

The model is detailed to the level of individual sources, the present and future ones.

Projections are made until 2035, in steps of five years. The model is of 'bottom-up' type, because it starts from the sectoral data and individual emission sources and calculated emissions of CO_2, CH_4 and N_2O.

Assumptions and input parameters used in the preparation of projections are presented in Tables 4-4 and 4-13.

Table 4-4: Assumptions for projections – waste management

WASTE MANAGEMENT	
	The projections were carried out on the basis of expected development and future state of parameters relating to the amount of produced solid waste, share of municipal bio waste, amount of waste disposed at landfills, and the share of landfilled biodegradable waste. The scenarios assume a continuous increase of municipal solid waste as a result of higher living standards, which will slow down due to the application of measures defined in the strategic documents. The objectives are defined by sectoral strategic documents – Sustainable Waste Management Act and Waste Management Plan of the Republic of Croatia for the period 2017 – 2022. Emission projections start from the situation and projections of macroeconomic parameters in 2015 (The 2015 Ageing Report) - the projected dynamics of the annual growth rate of gross domestic product and gross value added and the decline of population, which includes the goals by 2035. The 'without measures' scenario is illustrative scenario; it is developed for the needs of this report. It assumes no implementation of existing or additional measures. Assumptions for 'with existing measures' scenario: – includes projections of greenhouse gas emissions from solid waste disposal, biological treatment (composting) of solid waste, incineration of waste and wastewater treatment and discharge; – assumes a continuous increase of waste quantities in the period until 2035 as a result of higher living standards, despite the effects of measures undertaken to avoid/reduce and recycle waste. Greenhouse gas emissions which, according to the IPCC methodology, are included in the waste management sector were estimated on the basis of sectoral analysis and projected macroeconomic indicators on the annual increase in gross domestic product, gross value added and decline of

WASTE MANAGEMENT	
	population. The scenario includes the implementation of measures defined in the strategic and planning sectoral documents. Assumptions for 'with additional measures' scenarios: – includes projections for solid waste disposal on land and biological treatment (composting) of solid waste; – continuous growth of the quantity of municipal solid waste will be slowed down due to application of the measures defined in the strategic documents; – quantitative targets for the amount and composition of municipal waste and other parameters in the model for estimating CH_4 emissions from landfills, which are not defined by the strategic documents, are estimated by expert judgment. According to *good practice,* the projections were made for activity data and parameters included in the models for GHG emission calculation: applying grade of 1, 2 and 3 methods (projections of macroeconomic parameters, effects of policies and measures, sectoral analysis and studies, expert judgement).

LULUCF

In the 'with existing measures' scenario, for all sectoral components, the Projections Guide (A: General Guidelines and B: Sectoral Guide, [23]) was used. The most of sub-categories of this sector in the Report of the National Inventory of Croatia for 2017 have been recognized as the key ones, whether the trend or level. These are:

- 4(III).Direct N2O emissions from N mineralization/immobilization
- 4(V) Biomass Burning
- 4.A.1 Forest Land Remaining Forest Land
- 4.A.2 Land Converted to Forest Land
- 4.B.1 Cropland Remaining Cropland
- 4.B.2 Land Converted to Cropland
- 4.C.2 Land Converted to Grassland
- 4.D.2 Land Converted to Wetlands
- 4.E.2 Land Converted to Settlements
- 4.G Harvested Wood Products

If possible, for the aforementioned sub-categories it is recommended to use Grade 2 or 3 when making projections. However, because of insufficient capacities in the system for making projections

in the LULUCF sector at the national level, Grade 1 was applied. Emissions and removals are calculated by multiplying the projected activity data on and implied emission factors based on historic for the period from 2005 to -2014 for each carbon pool. Alternative 1 was used, whereat the activity data (in this case the size of the sub-categories of land) and emission factors for the period from 2015 to 2035, in this case the size of the sub-categories of land, were estimated using the linear extrapolation (or average values – e.g. for Wildfires) within the past ten years, from 2005 to 2014. For estimation of the projections for the biomass pool under subcategory Forest land remaining Forest land data on wood increment and wood removals from Forest management area plan for the period 2016-2025 [29] were taken into account. We need to clarify that this document is still in draft version. Also, for Harvested wood products pool, reference historical period for projection estimate was 1994-2012, because of large fluctuation in input data. In cases where the extrapolation had unrealistic extreme values (for example, negative values on areas in "Land converted to wetlands"), the arithmetic means of information on specific activity or implied emission factor for the past years were used. Expert assessment to predict the annual volume of afforestation ("Land converted to forest land'). All pools estimated in NIR 2017 have been taken into account when compiling projections of GHG emissions/removals. Some pools (e.g. dead wood) have been omitted because of insufficient data (same as in NIR 2017 also). Croatia is planning significant improvements in estimation of projections of GHG emissions/removals in the future period. Main steps of planned projects and activities should be oriented in modelling of projections estimation for key source subcategories and pools mentioned above. Results should decrease uncertainty in estimation and further use of Grade 2.

Assumptions and input parameters used in the preparation of projections for this year's Report are presented in Table 4-5.

Table 4-5: Assumptions for projections – LULUCF

LULUCF	
	The projections were carried out based on the expected future state of the parameters that determine a potential for emissions mitigation. Key parameters for screening were determined based on the parameters in the relevant Guideline for projections (land area of each subcategory, emission factors assumed by sinks) and expert judgment for surface renovated and forest land. Assumptions: – Total area of 'forest land' and 'settlements' will be increased – Land conversion to forest land will remain at the annual level (1.8 kha / year) – Areas of 'wetlands' will not increase – Areas of burned areas will not increase.

4.2. PARAMETERS ON PROJECTIONS

Table 4-6: Parameters on projections – general economic parameters

Parameter		2014	2015	2020	2025	2030	2035
GDP – annual growth rate	%	-0.4	1,6	1.8	1.2	1.3	1.9
Population	million people	4.238	4.229	4.194	4.140	4.081	4.018
Coal prices	Euro/GJ	2.5	2.2	2.2	2.6	3.2	3.4
Oil prices (1% S)	Euro/GJ	8.1	7.8	11.6	13.2	14.5	15.1
Gas prices	Euro/GJ	6.5	6.7	7.5	8.1	8.8	9.4

Source: [16.], [19.], [28.]

Table 4-7: Parameters on projections – energy sector: total energy consumption, total electricity generation, 'with existing measures' scenario

Parameter		2014	2015	2020	2025	2030	2035
Total energy consumption							
Coal	PJ	31.6	31.7	24.3	23.1	22.0	16.5
Oil	PJ	125.8	130.7	125.9	122.3	118.5	116.2
Gas	PJ	84.6	91.8	104.7	109.2	118.7	119.7
Renewable	PJ	146.0	137.8	171.2	198.1	218.9	239.4
Total electricity generation							
Coal	TWh	2.0	2.2	1,5	1.4	1.3	0.7
Oil	TWh	IE	IE	IE	IE	IE	IE
Gas	TWh	1.5	1.8	2.4	2.6	1.6	3.4
Renewable	TWh	10.1	7.2	9.5	12.2	14.3	16.4
Electricity imports	TWh	4.0	6.8	6.4	4.6	2.9	2.6

Source: [9], [10.], EKONERG

Table 4-8: Parameters on projections – energy sector: final energy consumption

Parameter		2014	2015	2020	2025	2030	2035
Final energy consumption							
Industry	PJ	40.6	10.9	44.9	46.4	48.0	50.4
Transport	PJ	84.5	84.5	87.3	89.8	92.9	93.3
Households	PJ	92.0	112.5	11.9	112.0	111.9	111.6
Agriculture, forestry and fisheries	PJ	9.7	9.4	9.5	9.2	8.9	8.7
Services	PJ	29.5	31.3	33.1	35.1	37.0	38.9
Other	PJ	4.2	4.2	4.7	4.7	4.8	5.0

Source: [9], [10], EKONERG

Table 4-9: Parameters on projections – weather parameters

Parameter	
Heating degree days	2,228
Cooling degree days	NE

Source: [16.]

Table 4-10: Parameters on projections – industry

Parameter		1990	2010	2015	2020	2025	2030	2035
Production index for industry*								
Cement industry	%	2,642,764 t	5	-4	33	36	40	41
Glass industry		275,490 t	-16	2	14	21	29	41
Nitric acid industry	%	332,460 t	1	-13	-13	-13	-10	-10
CO_2 emissions**								
Solvent use	%	93.994 Gg CO_2 eq	49	62	58	56	54	50
HFC emissions***								
Consumption of HFCs in refrigeration and air conditioning equipment.	%	(1995) 29.320 Gg CO_2 eq	1292	1431	1582	1658	1743	1885

*,**,*** the percentage change in relation to 1990

Source: Manufacturers of cement, glass and nitric acid, [7], [19], [21]

Table 4-11: Parameters on projections – transport

Parameter		2014	2015	2020	2025	2030	2035
Number of passenger kilometres, all modes	10^9 pkm	40.56	40.98	43.09	45.32	47.58	49.05
Transport of goods	10^9 tkm	11.59	11.64	11.90	12.16	12.42	12.69
Energy consumption in road transport	PJ	74.17	75.59	76.84	78.73	80.61	80.45

Source: [16]

Table 4-12: Parameters on projections – agriculture

Parameter		2014	2015	2020	2025	2030	2035
Dairy cattle	1000 heads	179	165	168	175	180	185
Non-dairy cattle	1000 heads	264	240	270	285	320	340
Sheep	1000 heads	605	590	620	650	675	700
Goats	1000 heads	65	65	68	70	72	75
Horses	1000 heads	20	20	22	23	24	25
Mules/asses	1000 heads	4	2,0	2,2	2,5	3,0	3,5
Swine	1000 heads	551	480	504	528	600	672
Poultry	1000 heads	5327	6048	6231	6414	6597	6719
Wheat	t	648,917	758,638	879,847	1,002,001	1,042,030	1,178,645
Maize	t	2,046,966	1,709,152	2,187,640	2,205,554	2,239,040	2,256,114
Potatoes	t	160,847	171,179	203,239	160,630	132,738	104,879
Sugar beets	t	1,392,000	756,509	1,428,948	1,408,317	1,471,355	1,497,069
Tobacco	t	9,164	10,132	11,766	12,041	12,794	13,712
Sunflowers	t	99,489	94,075	92,333	109,745	114,592	129,556
Rape seed	t	71,228	56,783	70,866	70,933	90,782	99,821
Tomatoes	t	19,374	36,273	44,884	41,278	50,494	53,804
Barley	t	175,592	193,451	228,296	243,098	250,955	278,746
Oats	t	56,555	71,743	61,295	76,089	74,009	82,453
Cabbages and other brassicas	t	24,703	38,413	61,109	57,412	63,091	63,099
Garlic	t	4,272	4,634	4,912	4,534	5,288	5,757
Onions	t	24,160	26,204	33,438	33,475	40,069	44,763
Rye	t	2,800	3,356	0	0	0	0
Sorghum	t	1,205	1,205	1,554	1,891	2,357	2,761
Watermelons	t	25,598	15,771	32,599	31,346	33,683	35,274
Soybeans	t	131,424	196,431	153,926	174,867	185,521	190,140
Beans, dry	t	1,329	1,156	0	0	0	0
Cabbages and other brassicas	t	1,413	1,346	2,210	3,050	3,903	4,708
Lentils	t	83	83	13	0	0	0
Peas, dry	t	579	194	356	98	0	0
Vetches	t	1,500	1,500	1,923	1,585	1,512	1,462
Clover	t	70,873	82,992	147,241	143,473	148,600	157,171
Alfalfa	t	128,702	112,876	226,824	247,731	283,849	317,840
Applying nitrogen	kg	80,707,112	99,000,000	99,000,000	99,000,000	99,000,000	99,000,000

Source: [16], [17], [23], [6], [7]

Table 4-13: Parameters on projections – waste management

Parameter		1990	2010	2015	2020	2025	2030	2035
Waste generation per head of population	t/ per cap	0.209	0.380	0.393	0.436	0.463	0.494	0.542
Organic fraction of municipal solid waste ('with existing measures' scenario)	%	67	68	65	65	65	65	65
Organic fraction of municipal solid waste ('with additional measures' scenario)	%	67	65	65	24	18	12	9
Municipal solid waste disposed to landfills ('with existing measures' scenario)	t	590,000	1,599,358	1,323,134	1,462,892	1,532,761	1,611,885	1,743,430
Municipal solid waste disposed to landfills ('with additional measures' scenario)	t	590,000	1,599,358	1,323,134	797,425	297,805	148,176	107,134

Source: [7], [13], [14], [18], [19], [22]

Table 4-14: Parameters on projections – LULUCF

Parameter – Activity Data	AD units	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
4.A.1. Forest land remaining forest land	(kha)	2,312.18	2,313.05	2,313.60	2,313.15	2,311.95	2,311.66	2,310.97	2,310.28	2,309.59	2,308.90
4.A.2. Land converted to forest land	(kha)	3.54	3.78	4.16	7.76	24.94	52.37	54.17	55.97	57.77	59.57
4.B.1. Cropland remaining cropland	(kha)	1,616.00	1,583.79	1,573.69	1,572.73	1,574.07	1,578.28	1,581.67	1,585.05	1,588.43	1,591.82
4.B.2. Land converted to cropland	(kha)	7.77	11.83	15.90	20.04	20.88	18.63	17.24	15.85	14.46	13.07
4.C.1. Grassland remaining grassland	(kha)	1,168.86	1,168.72	1,178.22	1,154.85	1,137.53	1,124.78	1,110.56	1,096.35	1,082.14	1,067.92
4.C.2. Land converted to grassland	(kha)	32.20	47.56	53.27	46.11	54.47	62.56	71.73	80.90	90.07	99.23
4.D.1. Wetlands remaining wetlands	(kha)	68.41	69.39	70.37	71.35	72.32	73.31	74.29	75.27	76.25	77.24
4.D.2. Land converted to wetlands	(kha)	6.98	5.46	3.93	2.29	0.61	0.49	0.49	0.49	0.49	0.49
4.E.1. Settlements remaining settlements	(kha)	188.41	192.38	196.37	200.35	204.32	209.13	213.63	218.14	222.64	227.15
4.E.2. Land converted to settlements	(kha)	16.45	15.00	13.54	40.91	47.65	51.69	55.52	59.34	63.17	67.00
4.F.1. Other land remaining other land	(kha)	235.27	244.36	231.49	224.24	203.73	176.50	169.13	161.76	154.39	147.02
4.III.B Cropland	(kha)	7.77	11.83	15.90	20.04	20.88	18.63	17.24	15.85	14.46	13.07
4.III.D Wetland	(kha)	6.98	5.46	3.93	2.29	0.61	0.49	0.49	0.49	0.49	0.49
4.III.E Settlements	(kha)	16.45	15.00	13.54	40.91	47.65	51.69	55.52	59.34	63.17	67.00
4.V.A Forest land remaining forest land	(ha)	482.15	3,010.79	37,363.79	912.50	687.67	4,462.52	4,462.52	4,462.52	4,462.52	4,462.52
4.V.A Land converted to forest land	(ha)	NO	9.92	78.14	17.50	18.00	65.03	65.03	65.03	65.03	65.03
4.V.B Cropland remaining cropland	(ha)	NO	NO	NO	NO	NO	33.42	33.42	33.42	33.42	33.42
4.V.C Grassland remaining grassland	(ha)	461.10	2,193.25	41,569.27	2,425.00	502.23	4,810.66	4,810.66	4,810.66	4,810.66	4,810.66

Table 4-14: Parameters on projections – LULUCF – continued

Parameter – Emissions factors - Biomass	**EF units**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
4.A.1. Forest land remaining forest land	(tC/ha)	0.79	1.12	1.01	0.98	0.90	0.64	0.39	0.33	0.29	0.28
4.A.2. Land converted to forest land	(tC/ha)	2.28	2.01	2.03	-0.01	0.41	0.65	0.92	1.19	1.45	1.72
4.B.1. Cropland remaining cropland	(tC/ha)	-0.01	-0.01	-0.04	-0.02	-0.01	0.00	0.01	0.02	0.03	0.04
4.B.2. Land converted to cropland	(tC/ha)	0.19	0.35	0.43	0.47	0.53	0.61	0.71	0.81	0.91	1.01
4.C.1. Grassland remaining grassland	(tC/ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C.2. Land converted to grassland	(tC/ha)	-0.41	-0.77	-0.36	-0.27	-0.57	-0.89	-1.21	-1.53	-1.85	-2.17
4.D.1. Wetlands remaining wetlands	(tC/ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.D.2. Land converted to wetlands	(tC/ha)	-0.38	-0.06	-0.08	-0.07	-0.15	-0.21	-0.28	-0.36	-0.44	-0.52
4.E.1. Settlements remaining settlements	(tC/ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.E.2. Land converted to settlements	(tC/ha)	-0.57	-0.22	-0.23	-1.08	-0.25	-0.40	-0.40	-0.40	-0.40	-0.40
4.V.A Forest land remaining forest land	CO2 (t/AD unit)	18.64	18.64	18.64	18.64	18.64	18.64	18.64	18.64	18.64	18.64
4.V.A Forest land remaining forest land	CH4 (t/AD unit)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
4.V.A Forest land remaining forest land	N2O (t/ADunit)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.V.A Land converted to forest land	CO2 (t/AD unit)	NO	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07
4.V.A Land converted to forest land	CH4 (t/AD unit)	NO	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
4.V.A Land converted to forest land	N2O (t/ADunit)	NO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.V.B Cropland remaining cropland	CO2 (t/AD unit)	NO	NO	NO	NO	NO	31.07	31.07	31.07	31.07	31.07
4.V.B Cropland remaining cropland	CH4 (t/AD unit)	NO	NO	NO	NO	NO	0.09	0.09	0.09	0.09	0.09
4.V.B Cropland remaining cropland	N2O (t/ADunit)	NO	NO	NO	NO	NO	0.01	0.01	0.01	0.01	0.01
4.V.C Grassland remaining grassland	CO2 (t/AD unit)	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00
4.V.C Grassland remaining grassland	CH4 (t/AD unit)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.V.C Grassland remaining grassland	N2O (t/ADunit)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4-14: Parameters on projections – LULUCF – continued

Parameter – Emissions factors - Soil	**EF units**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
4.A.1. Forest land remaining forest land	(tC/ha)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.A.2. Land converted to forest land	(tC/ha)	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
4.B.1. Cropland remaining cropland	(tC/ha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.B.2. Land converted to cropland	(tC/ha)	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07
4.C.1. Grassland remaining grassland	(tC/ha)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.C.2. Land converted to grassland	(tC/ha)	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
4.D.1. Wetlands remaining wetlands	(tC/ha)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.D.2. Land converted to wetlands	(tC/ha)	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
4.E.1. Settlements remaining settlements	(tC/ha)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.E.2. Land converted to settlements	(tC/ha)	-2.89	-2.89	-2.89	-2.89	-2.89	-2.89	-2.89	-2.89	-2.89	-2.89
4.F.1. Other land remaining other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.III.B Cropland	(kg N2O–N/ha)	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
4.III.D Wetland	(kg N2O–N/ha)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
4.III.E Settlements	(kg N2O–N/ha)	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88

CHAPTER 5: SENSITIVITY ANALYSIS OF PROJECTIONS

Some of the main uncertainties and their impact on the achievement of projected emissions are discussed below.

GDP growth

The increase of GDP is assumed by 2050 in all analysed scenarios in average of 1.66% by 2050 which makes a nominal increase of 78% compared to 2010.

In an optimistic macroeconomic scenario, Croatian economy is expected to grow at an average annual rate of 2.15% by 2050 (demographic projection remains the same as in the main scenario). The resulting increase in real GDP per capita by 2050 is about 138% in comparison with 2012. A faster closure of the development gap than the EU average can be expected. Therefore, Croatia reaches 91% of the EU average development level by 2050 in an optimistic scenario. However, according to the pessimistic macroeconomic scenario, an average annual growth rate of 0.8% and a cumulative rise in real GDP per capita of only 44% is expected by 2050. The assumption is that growth would be slower than the growth of the total EU, thus real per capita income in Croatia could drop to 55% in comparison to current EU average level of about 60%.

The optimistic scenario of economic growth expects the emission to be about 7.1% higher in 2030 and about 18.1% by 2050 compared to the presented scenarios, assuming the same carbon intensity of the economy. However, the implementation of emission reduction measures will reduce and cut the link between GDP and emissions in the long term. Thus, the GDP growth can also contribute to emissions reduction when it comes to investments in low carbon technology, industry and services.

The pessimistic scenario has an average GDP growth of 0.97% by 2050, so greenhouse gas emissions would be lower than the average scenario. However, the problem of financing the transition could occur in this scenario, thus any additional financing for the implementation of the measures may be questionable.

Influence of change in temperature on heating and cooling energy demand

Change in temperature will affect the decrease in heating energy demand, but on the other side, it will increase the cooling energy demand. The goal of climate policy is to keep the global temperature rise within 2°C. The temperature increase has been determined in Croatia since the measurements have been carried out. An increase of about 1°C is assumed by 2050.

Heating requirements. The indoor temperature in buildings is mainly 20°C but the temperature of the heated rooms is usually maintained at the level up to 24°C. In addition to these assumptions, the reduction in heat required for heating could be between 7.7 and 11.3% in the continental part of Croatia and between 12.7 and 24.2% in the coastal part of Croatia.

Cooling requirements. Unlike heating requirements, there is no such dependence between the need for comfortable cooling and the outdoor air temperature, since in the influence of heat gains due to solar radiation is dominant in this case. At the moment it is not possible to estimate the influence of external temperature change on cooling requirements due to data availability. The only possible estimation suggests that the impact will be less expressed comparing to heating requirements.

Other impacts on energy. Changes in temperature, precipitation and wind energy will affect the production of renewable energy sources. These impacts need to be quantified and embedded in operational planning, especially at the regional and local level where large variations are possible.

Hydrology in the production of hydroelectric power

Generation from large hydropower plants varies from 4 TWh to 8 TWh, depending on hydrology. This represents 20% or 40% of the total electricity generation in Croatia. Emissions from the electroenergy sector can vary considerably based on the cycles of dry and humid years that can last for several years.

The lack of generation from hydropower plants is supplemented by increased production from thermal power plants or by increased imports. In the case of extreme drought, the increase in emission could occur in 2030 in the scenario with additional measures in amount of 4.2% of the total emissions in Croatia respectively.

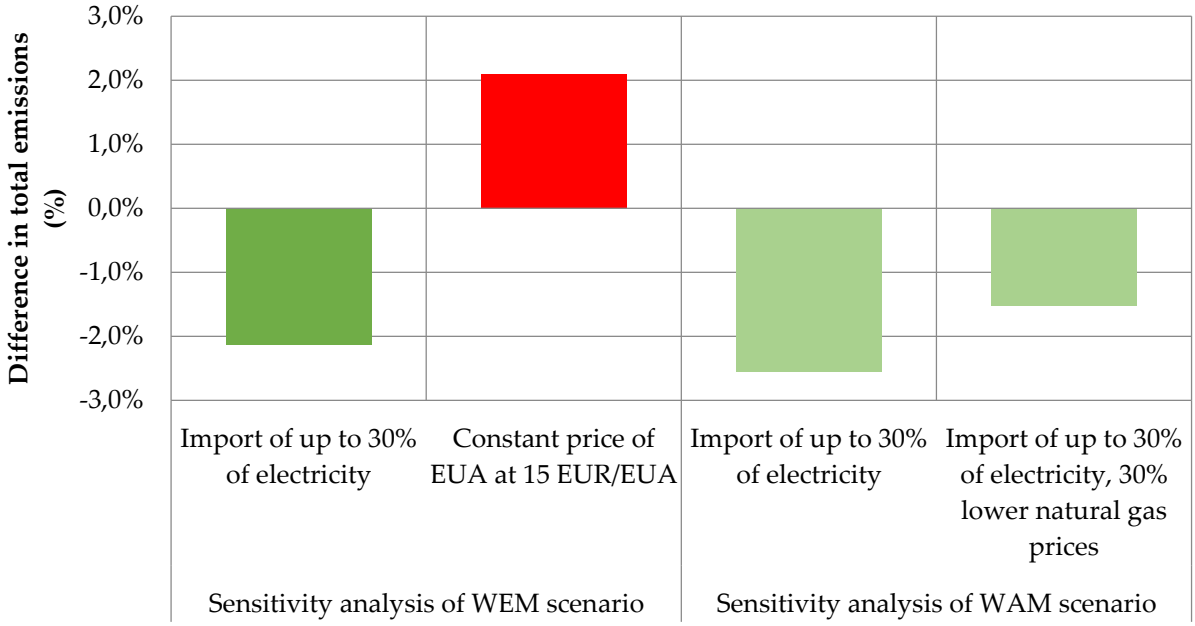
Input parameters in the power sector

Along with the sensitivity analysis of the hydrology, the sensitivity analysis was performed also for the other parameters in the power sector. The analysis showed:

- in WEM scenario:
  - import of up to 30% of electricity, instead of zero net imports (except imports from the nuclear power plant Krško), would lead to reduction of domestic emissions by 2,1% in 2030;
  - constant price of EUA at 15 EUR/EUA, instead of growth of prices of allowances as in EU Reference scenario 2016, would lead to increase in total emissions by 2,1% in 2030;
- in WAM scenario:
  - import of up to 30% of electricity, instead of zero net imports (except imports from the nuclear power plant Krško), would lead to reduction of domestic emissions by 2,6% in 2030;
  - import of up to 30% of electricity, instead of zero net imports (except imports from the nuclear power plant Krško), but in combination with the 30% lower natural gas prices (compared to EU Reference scenario 2016) would lead to reduction of domestic emissions by 1,5% in 2030.

The overview of analysis is shown in the figure 5-1.

Figure 5-1: Sensitivity analysis of total emissions for some of the input parameters in power sector



Development of agriculture

The characteristics of agriculture in Croatia are extremely small estates; the average family farm has only 2 hectares. According to the 2003 Agriculture Census, only 20% of the processed land is in private ownership with an average of 159 hectares. The similar situation is in the field of cattle breeding. Thus, for example, 96% of all diary producers own only 15 cows while 90% of pork production is handled by 200,000 small farms where 170,000 farms have less than 10 pigs. Such fragmentation and predominantly old populations prevent faster development. Agriculture will change slowly thus Croatia will have a big challenge in emissions.

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