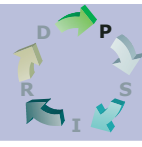


CLIMATE CHANGE





MK - NI 010

GREENHOUSE GAS EMISSIONS AND REMOVALS

Period of indicator assessment

- September 2007 – April 2008

Explanation

- Justification for indicator selection

Potential impacts of climate change at global level include rising sea levels, increased frequency and intensity of floods and droughts, changes in biotes and food productivity and increase in diseases. There has been constantly growing evidence that greenhouse gas emissions cause increase in global and European surface air temperatures, resulting in climate change (IPCC, 2001, 2007). Efforts to reduce or limit the effects of climate change have been focused on the reduction of the emissions of greenhouse gases covered by the Kyoto Protocol.

At the level of EU Member States, this indicator supports the Commission's annual assessment of the progress in the emission reduction in EU and in individual Member States towards the achievement of the targets specified in the Kyoto Protocol, based on the mechanism for GHG monitoring (Council Decision No. 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol). This indicator illustrates the current trends in man-induced GHG emissions in relation to targets set by the Kyoto Protocol.

In the case of the Republic of Macedonia, the indicator is based on data contained in the National Greenhouse Gases Inventory produced within the process of developing the National Communications towards the United Nations Framework Convention on Climate Change.

Definition

The indicator shows the quantities of greenhouse gas emissions on national level. The emissions are presented by greenhouse gas type. The indicator provides information on emissions in the following sectors: energy, industrial processes, agriculture, land use change and forestry and waste.

Units

- Tonnes CO₂-equivalent

Policy relevance

The Greenhouse Gases Inventory establishes the basis for the analysis of the GHG reduction.

Legal grounds

Republic of Macedonia is a Party to the United Nations Framework Convention on Climate Change and to the Kyoto Protocol. Climate change issues have been incorporated in the Law



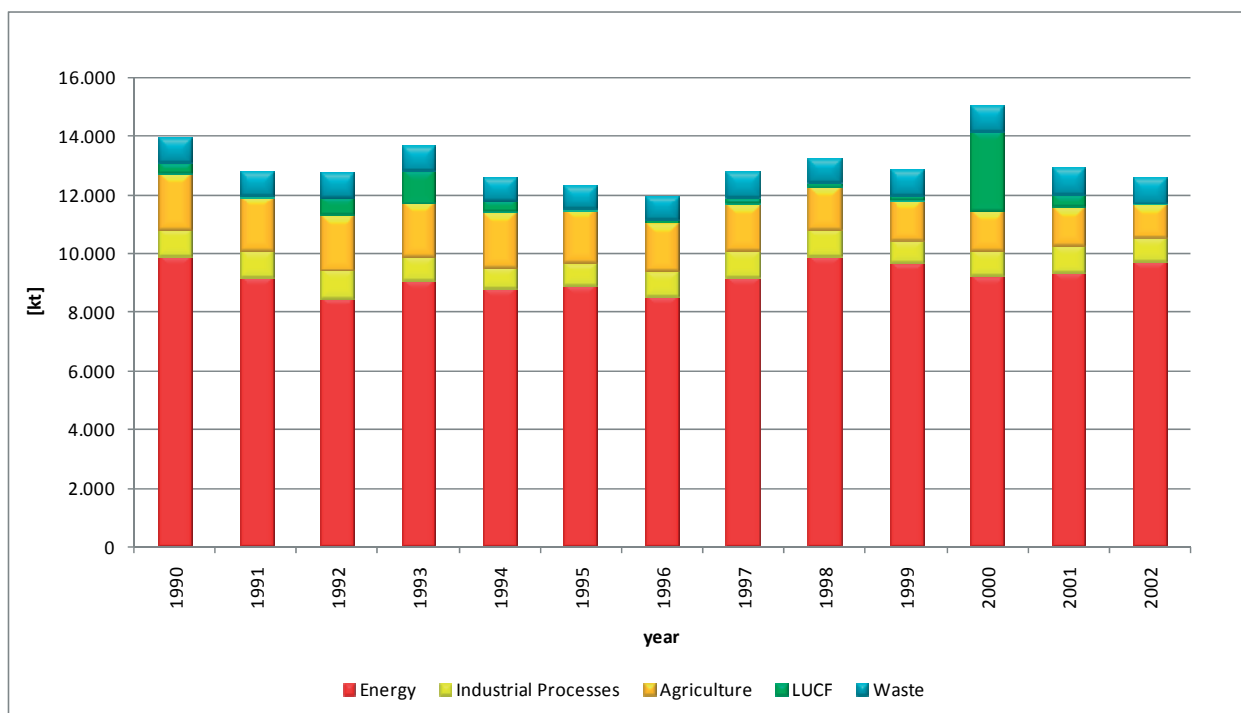


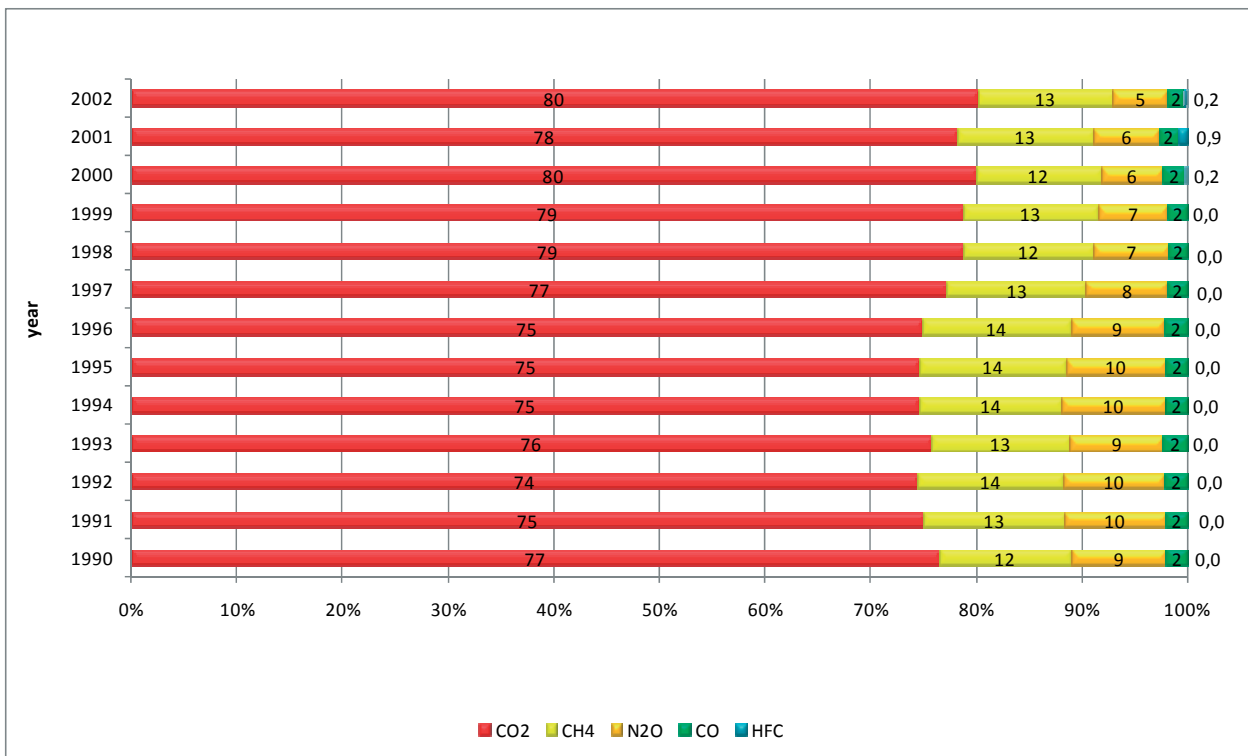
on Environment, including the requirements for preparation of GHG emission inventories and GHG removal via sinks, as well as development of action plan with measures and activities aimed at GHG emissions abatement and climate change impacts mitigation. In addition to this, by means of amendment of the Law on Environment, provision has been made for Designated National Authority (DNA) to approve the projects under the Kyoto Protocol Clean Development Mechanism (CDM).

Key message

This indicator provides information on the trends in total GHG emissions, which is in direct correlation with energy intensity of the economy in the country, as well as with the quality of fuels. The establishment of national system for regular development and updating of GHG inventories is vital.

The diagrams below present the contribution of individual sectors and pollutants that are also greenhouse gases, in kilotons per year and in percentage.







Assessment

Subject of analysis are the following gases: CO₂, CH₄ и N₂O, CO and HFC, and the total emission is expressed in CO₂-eq. This indicator provides information on GHG emissions from the following sectors: energy, industrial processes, agriculture, land use change and forestry (LUCF) and waste.

The Inventory of Greenhouse Gases prepared under the Second National Communication on Climate Change (scheduled for adoption in September 2008) is summarized in Table 1. The first part of the table presents the amounts of GHG emissions by sectors, as well as total emissions for the period 1990 – 2002 (*). The second part of the table shows absolute and percentile values of CO₂-equivalent for all sectors. Detailed analysis of individual sectors and of each GHG separately shows that GHG emissions note certain decrease, namely in the sectors of industrial processes (by 35%) and agriculture (by 22%), while the trend in the LUCF sector is varying and the emissions show no change in the waste sector. Rise in GHG emissions has been observed only in the energy sector (by 6%). Comparatively, the share of the energy sector in total GHG emissions is very high (almost 3/4), followed by agriculture, waste and industrial processes sectors (the share being 10, 8 and 7%, respectively), while the share of the LUCF is below 2%. The falling trend of GHG emissions from industrial processes and agriculture sectors is due to their declining activities within the national economy in the assessed period.

Methodology

- Methodology for the indicator calculation

GHG emissions are calculated as aggregate of input data and the relevant emission factors. No measurements are required. The 1996 IPCC Methodology for GHG Inventories development was used, in line with the guidelines under the United Nations Framework Convention on Climate Change (UNFCCC).

Data specification

Title of the indicator	Source	Reporting obligation
Greenhouse gases emissions and removals	<ul style="list-style-type: none">– Greenhouse Gas Emissions Inventory in: the First National Communication of Macedonia under the United Nations Framework Convention on Climate Change (UNFCCC), Ministry of Environment and Physical Planning, p. 29-46, 2003;– Second National Communication of Macedonia under the United Nations Framework Convention on Climate Change (UNFCCC), Ministry of Environment and Physical Planning; www.unfccc.org.mk	<ul style="list-style-type: none">– UNFCCC





Data coverage (by years): 1990 – 2002

Table 1: GHG Inventory in the Second National Communication (*)

CO₂-eq emissions by sectors

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy	9.939,83	9.190,47	8.484,18	9.068,37	8.839,56	8.925,02	8.578,29	9.198,29	9.939,13	9.716,39	9.226,90	9.355,70	9.755,52
Industry	889,29	908,89	957,78	831,36	716,56	793,28	819,71	910,30	891,78	742,43	885,70	929,02	784,05
Agriculture	1.908,27	1.866,08	1.881,62	1.858,08	1.888,54	1.825,04	1.682,11	1.571,02	1.462,96	1.377,56	1.379,52	1.313,29	1.073,39
LUCF	283,66	24,07	424,06	758,82	273,29	5,67	51,49	177,63	89,16	99,57	1.973,70	336,53	36,49
Waste	786,29	794,97	806,08	808,37	753,66	778,67	785,13	822,21	827,12	828,38	844,23	836,38	840,59
Total	13.807,34	12.784,47	12.553,72	13.324,99	12.471,61	12.327,68	11.916,72	12.679,45	13.210,15	12.764,34	14.310,05	12.770,92	12.490,04
Energy	71,99	71,89	67,58	68,06	70,88	72,40	71,99	72,54	75,24	76,12	64,48	73,26	78,11
Industry	6,44	7,11	7,63	6,24	5,75	6,43	6,88	7,18	6,75	5,82	6,19	7,27	6,28
Agriculture	13,82	14,60	14,99	13,94	15,14	14,80	14,12	12,39	11,07	10,79	9,64	10,28	8,59
LUCF	2,05	0,19	3,38	5,69	2,19	0,05	0,43	1,40	0,67	0,78	13,79	2,64	0,29
Waste	5,69	6,22	6,42	6,07	6,04	6,32	6,59	6,48	6,26	6,49	5,90	6,55	6,73
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

Contribution of CO₂, CH₄, N₂O and HFC in the total CO₂-eq emissions from all sectors

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO ₂	10.545,33	9.598,08	9.321,21	10.048,55	9.290,20	9.213,08	8.928,41	9.793,79	10.408,98	10.055,09	11.283,60	9.959,41	10.059,08
CH ₄	1.732,78	1.703,43	1.747,30	1.775,03	1.697,21	1.695,97	1.666,20	1.675,40	1.630,70	1.628,35	1.741,23	1.656,67	1.621,23
N ₂ O	1.253,22	1.218,64	1.221,40	1.199,10	1.224,80	1.173,38	1.057,27	970,94	936,79	845,36	959,99	813,94	570,40
CO	276,01	264,33	263,80	302,31	259,40	245,25	264,85	239,32	233,68	235,54	300,03	220,44	208,62
HFC	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	25,20	120,47	30,71
Total	13.807,34	12.784,47	12.553,72	13.324,99	12.471,61	12.327,68	11.916,72	12.679,45	13.210,15	12.764,34	14.310,05	12.770,92	12.490,04
CO ₂	76,37	75,08	74,25	75,41	74,49	74,73	74,92	77,24	78,80	78,77	78,85	77,99	80,54
CH ₄	12,55	13,32	13,92	13,32	13,61	13,76	13,98	13,21	12,34	12,76	12,17	12,97	12,98
N ₂ O	9,08	9,53	9,73	9,00	9,82	9,52	8,87	7,66	7,09	6,62	6,71	6,37	4,57
CO	2,00	2,07	2,10	2,27	2,08	1,99	2,22	1,89	1,77	1,85	2,10	1,73	1,67
HFC	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,18	0,94	0,25
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

*- The adoption of the Second National Communication on Climate Change has been scheduled for September 2008





General metadata

Code	Title of the indicator	Compliance with CSI/ EEA or other indicators		Classification by DPSIR	Type	Linkage with area	Frequency of publication
MK NI 010	Greenhouse gases emissions and removals	CSI 010 CC5	Greenhouse gas emissions and removals	P	B	Greenhouse gases emissions and removals	Annually

Data source(s): Input data: Yearbooks of the State Statistical Office; other publications/projects of Ministries (environment, agriculture, forestry, etc.), Emission factors: 1996 IPCC – Emission factors base

Geographical coverage: Republic of Macedonia

Temporal coverage: 1990 – 2002

Frequency of data collection: The Inventories have been prepared every three years, in accordance with the specified frequency of national reports development.

Uncertainty

- Uncertainty of data

Lack of adequate data to apply more sophisticated method in the framework of the methodology, inconsistency of data, lack of national emission factors

Activities

- Short-term activities

- Strengthening of capacity for inventories development

- a. **Description of the activity**

- Finalizing activities of preparation of the Second National Communication on Climate Change.

- b. **Required resources**

- Training of staff in the MEPP to be capable of updating the inventory by themselves, including on annual basis if required. Possible employment of additional technical expert to maintain the GHG Inventory.

- Updating and upgrading of existing databases.

Deadline: end of 2008

- Long-term activities

Regular production of GHG Inventories on annual basis.





MK - NI 011

PROJECTIONS OF GREENHOUSE GAS EMISSIONS AND REMOVALS

Period of the indicator assessment

- September 2007 – April 2008

Explanation

- Justification for indicator selection

Potential impacts of climate change at global level include rising sea levels, increased frequency and intensity of floods and droughts, changes in biotes and food productivity and increase in diseases. There has been constantly growing evidence that greenhouse gas emissions cause increase in global and European surface air temperatures, resulting in climate change (IPCC, 2001, 2007). Efforts to reduce or mitigate the effects of climate change have been focused on the reduction of the emissions of all greenhouse gases covered by the Kyoto Protocol.

At the level of EU Member States, this indicator supports the Commission's annual assessment of the progress in the emission reduction in EU and in individual Member States towards the achievement of the targets specified in the Kyoto Protocol, based on the mechanism for GHG monitoring (Council Decision No. 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol).

In the case of the Republic of Macedonia, the indicator is based on data contained in the Report on Climate Change Mitigation in the Republic of Macedonia, produced in the process of development of National Communications towards the United Nations Framework Convention on Climate Change.

Definition

The indicator illustrates projected trends in anthropogenic greenhouse gas (GHG) emissions by means of application of the existing policies and measures and/or additional policies and measures. Projected trends are presented by sector types: energy, industrial processes, agriculture, land use change and forestry and waste.

Units

- Tons CO₂-equivalent.

Policy relevance

This indicator is of vital importance for the national climate change mitigation policy. It is also related to future implementation of projects based on the Clean Development Mechanism (CDM) of the Kyoto Protocol.



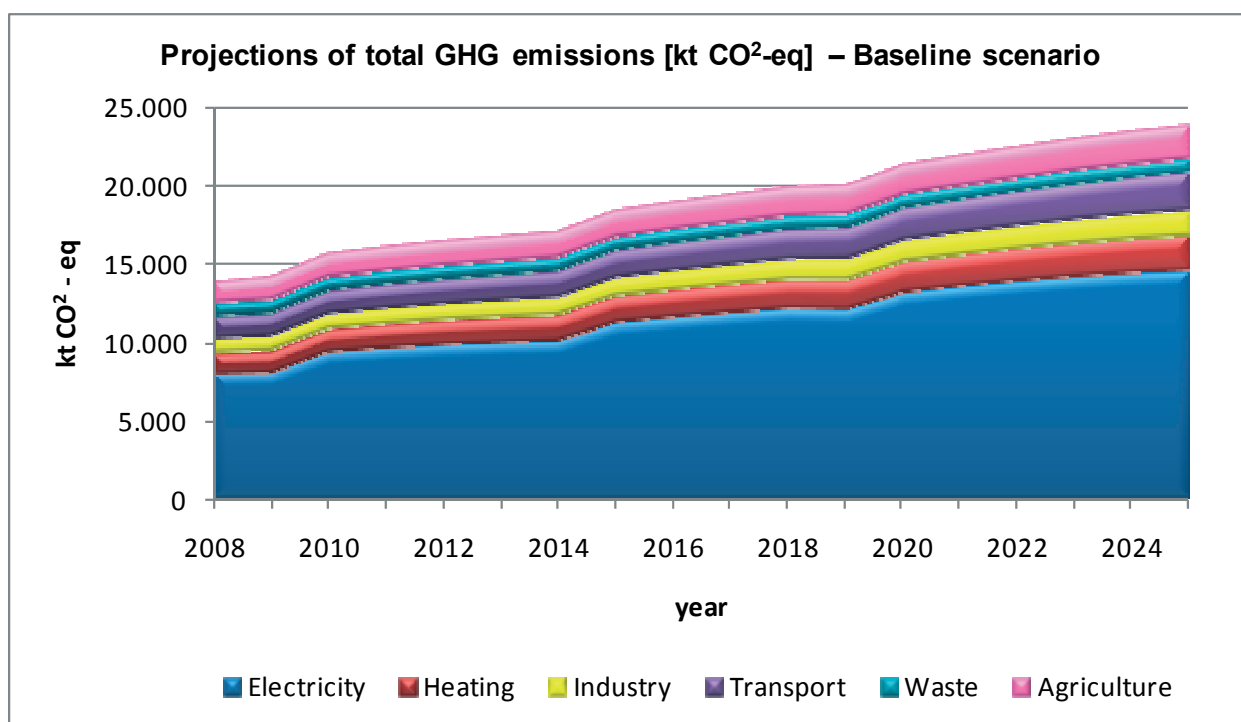


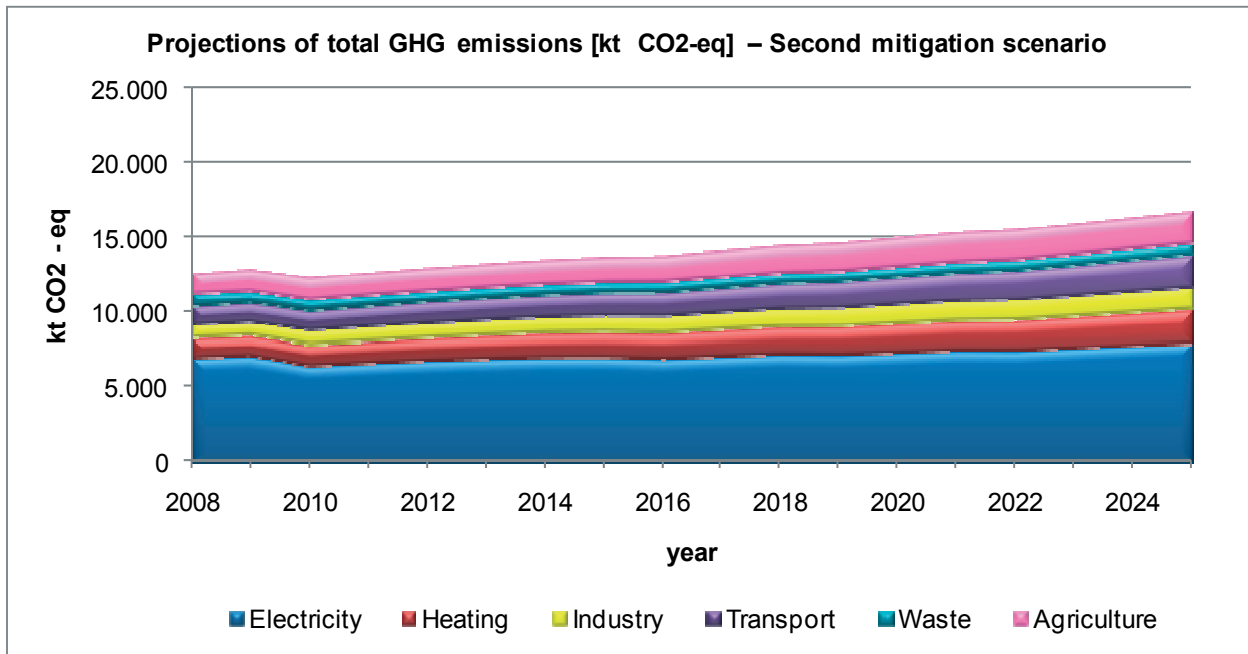
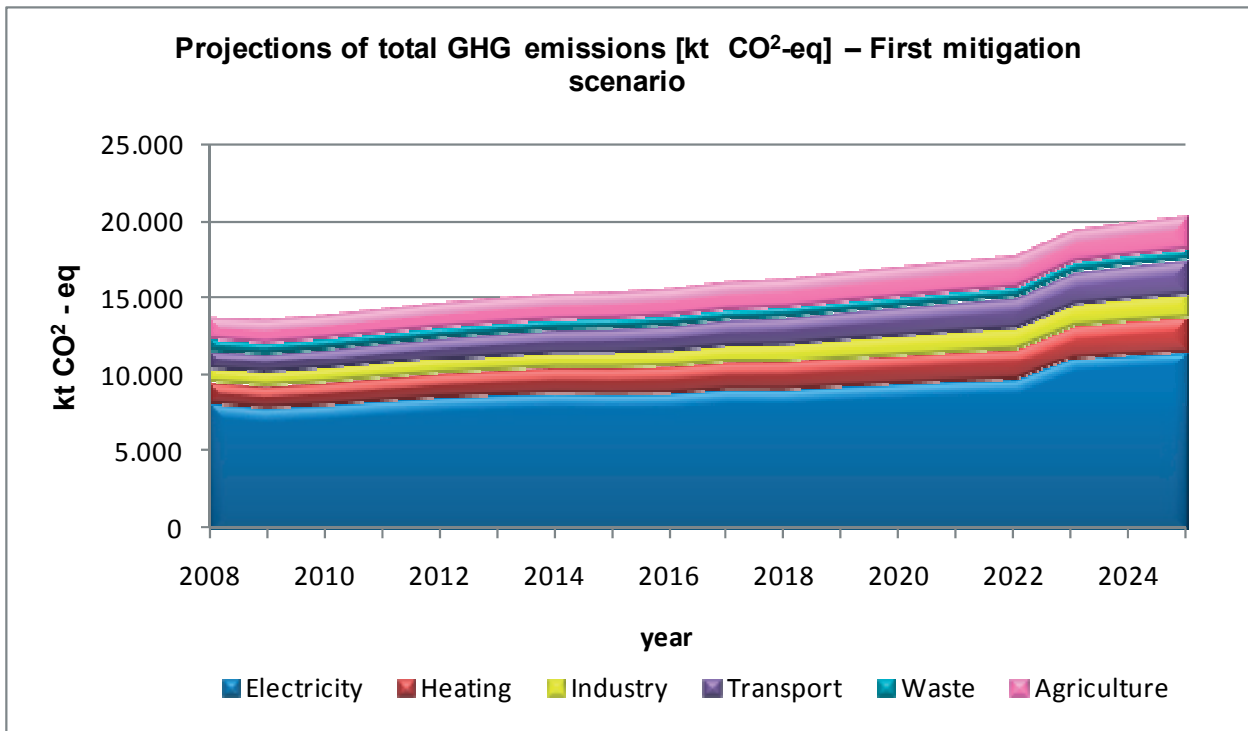
Legal grounds

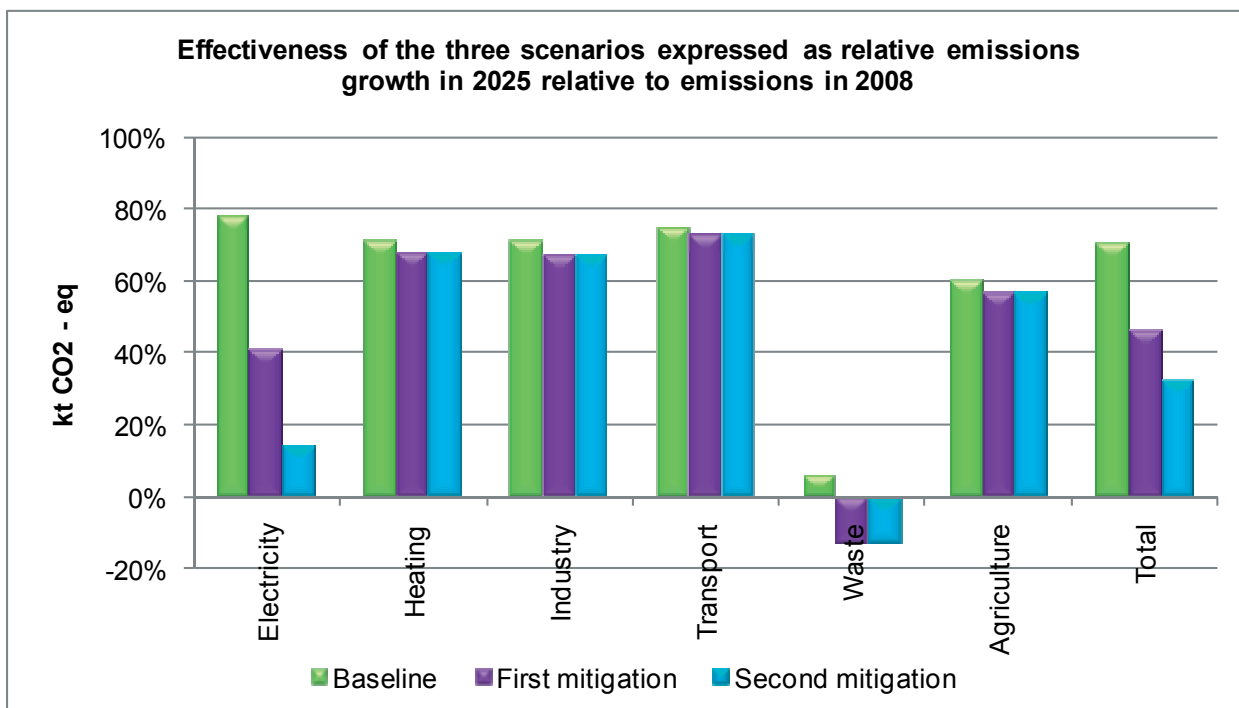
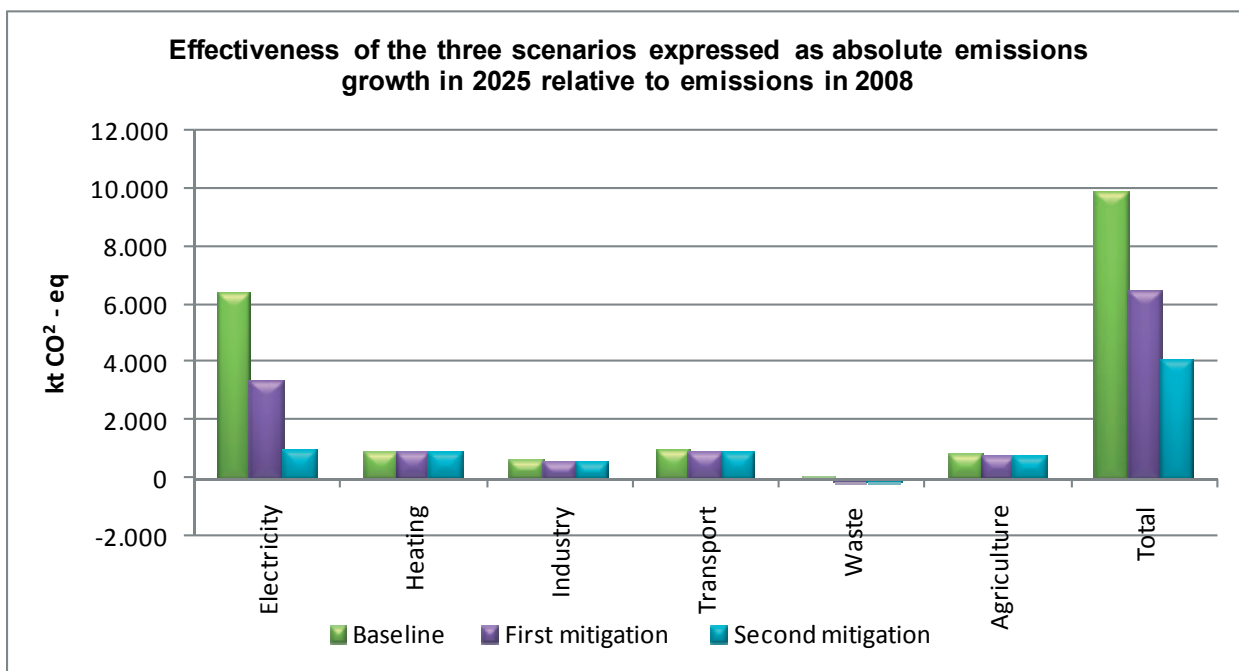
Republic of Macedonia is a Party to the United Nations Framework Convention on Climate Change and to the Kyoto Protocol. Climate change issues have been incorporated in the Law on Environment, including the requirements for preparation of GHG emission inventories and GHG removal via sinks, as well as development of action plan with measures and activities aimed at GHG emissions abatement and climate change impacts mitigation. In addition to this, by means of amendment of the Law on Environment, provision has been made for Designated National Authority (DNA) to approve the projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol.

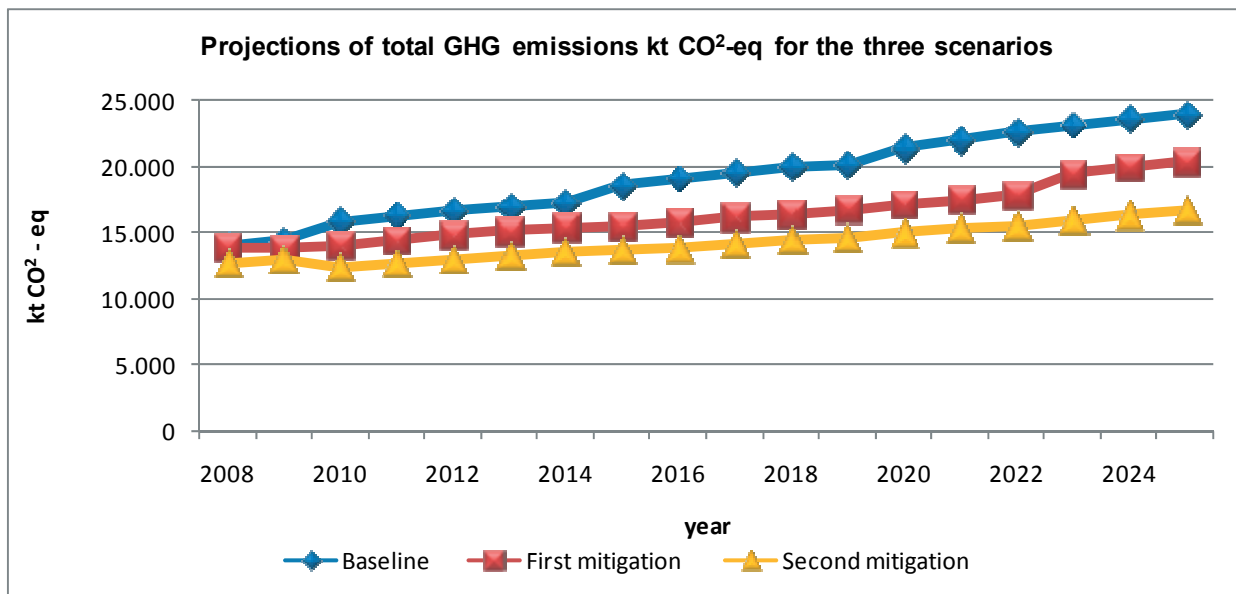
Key message

According to specific emissions (kt CO₂-eq per capita), Macedonia remains among countries with relatively high emissions per capita, mainly due to the use of fossil fuels in electricity production. Compared to the baseline scenario, this parameter notes gradual decline along with the introduction of gas in mitigation scenarios. Considering the close interaction between GHG emissions and the manner of energy production and consumption, the national policy for energy efficiency (EE) and renewable energy sources (RES) will by itself contribute to the climate change mitigation, as achievement of the objectives set in these policies will at the same time reduce the GHG emissions.









Assessment

This Chapter integrates sectoral emissions in order to project total GHG emissions for the period 2008 - 2025 based on adopted scenarios: baseline, first and second mitigation scenarios. It should be noted that the first and the second mitigations scenarios differ only in electric power sector, where the second mitigation scenario includes additional measures for emission abatement, which will, as shown below, contribute significantly to the overall emission abatement. Total emissions at the beginning and at the end of the period by all scenarios are summarized on Table 1. Further on, Table 2 (and Figure 1), Table 3 (and Figure 2) and Table 4 (and Figure 3) present sectoral and total GHG emissions by years, for each scenario, respectively.

Analysis of the baseline scenario: According to projections presented in Table 2 and on Figure 1, there will be significant increase of GHG emissions by 2025 compared to values estimated for 2008 (around 9.900 kt CO₂-eq in absolute value, or around 71% in relative terms), provided that business-as-usual is preserved (Figure 4 and Figure 5, the last group of columns). This increase is mainly connected to the growth in electric power sector (absolute difference of 6.400 kt CO₂-eq and 78% relative growth of the value in 2008), which reflects the so called dark scenario, i.e. development scenario of the national energy sector based on lignite (Figure 4 and Figure 5, first group of columns). Other sectors also show significant growth in GHG emissions, so that values in 2025 compared to values in 2008 are higher by 75% - transport, 71% - heating and industry, 60% - agriculture and 6% - waste (Figure 4 and Figure 5).

Analysis of scenarios of emission abatement: The state could improve if development paths include activities/measures leading to GHG emissions reduction. As a result, the first mitigation scenario (as defined in the analysis by sectors) will lead to increase in total emissions of 46% of the values in 2025 compared to the value in 2008 or absolute difference of around 6.400 kt CO₂-eq. (Table 3 and Figure 2; also Figure 4 and Figure 5, last group of columns). This increase in total emissions decreases further by 32% (absolute difference of around 4.000 kt CO₂-eq) if development paths observe the second mitigation scenario (Table 4 and Figure 3; also Figure 4 and Figure 5, last group of columns).





With regard to emission projections by sectors for the three scenarios, comparison of emissions in 2025 with those in 2008 shows highest rise of emissions in electric energy sector. Namely, the relative increase of 78% in the baseline scenario falls at 41% in the first mitigation scenario due to the introduction of two plants on natural gas for combined electricity and heat production (the first one in 2009 and the second in 2015). The relative increase drops at 14% under the second mitigation scenario, as a result of reduced consumption by major consumers, introduction of renewable energy sources and termination of the thermal power plant (TPP) in Negotino upon the establishment of the new gas power plant (Figure 4 and Figure 5, last group of columns). As far as the sectors are concerned, there is a notable result in the waste sector, where the relative increase of 6% in the baseline scenario reaches negative relative increase (-13%) under both mitigation scenarios. This means that, under the mitigation scenario, the values of emissions in 2025 will be by 13 % lower compared to their values in 2008 (Figure 4 and Figure 5, fifth group of columns), owing to the introduction of technology for landfill gas combustion at several landfills in the country. Other sectors note minor contribution to the reduction of overall emissions, considering the fact that the relative difference between baseline and mitigation scenarios ranges within 2 - 4%. (Figure 5).

Summary of the projections of total GHG emissions by years, in line with the adopted scenarios, is presented in Table 5 and on Figure 6.

According to its country specific emissions (kt CO₂-eq/capita), Macedonia remains among countries with relatively high emissions per capita, owing mainly to the use of fossil fuels in electricity production. Compared to the baseline scenario, this parameter notes gradual decrease with the introduction of gas under mitigation scenarios. The calculated specific emissions for the three scenarios are presented in Table 6.

Table 1 Determining values for the three scenarios

	Total GHG emissions in 2008 [kt CO ₂ -eq]	Total GHG emissions in 2025 [kt CO ₂ -eq]
Baseline scenario	14.040	23.947
First mitigation scenario	13.904	20.348
Second mitigation scenario	12.645	16.713





Table 2 Projections of total GHG emissions [kt CO₂-eq]- Baseline scenario

	Electricity	Heating	Industry.	Transport	Waste	Agriculture	Total
2008	8.196	1.328	906	1.390	844	1.376	14.040
2009	8.268	1.375	937	1.432	847	1.517	14.376
2010	9.584	1.423	970	1.475	850	1.553	15.855
2011	9.836	1.472	1.004	1.520	853	1.595	16.280
2012	10.025	1.524	1.039	1.566	856	1.637	16.647
2013	10.154	1.577	1.076	1.614	859	1.679	16.959
2014	10.246	1.632	1.113	1.664	862	1.722	17.239
2015	11.388	1.690	1.152	1.715	865	1.764	18.574
2016	11.719	1.740	1.187	1.775	868	1.807	19.096
2017	12.006	1.792	1.222	1.838	871	1.851	19.580
2018	12.261	1.846	1.259	1.902	875	1.894	20.037
2019	12.199	1.902	1.297	1.970	878	1.937	20.183
2020	13.260	1.959	1.336	2.039	881	1.981	21.456
2021	13.628	2.017	1.376	2.112	884	2.025	22.042
2022	13.954	2.078	1.417	2.186	887	2.070	22.592
2023	14.241	2.140	1.459	2.264	891	2.114	23.109
2024	14.463	2.205	1.503	2.344	894	2.159	23.568
2025	14.600	2.271	1.548	2.427	897	2.204	23.947

Table 3 Projections of total GHG emissions [kt CO₂-eq]- First mitigation scenario

	Electricity	Heating	Industry	Transport	Waste	Agriculture	Total
2008	8.196	1.328	902	1.258	844	1.376	13.904
2009	7.922	1.353	931	1.296	769	1.517	13.788
2010	8.093	1.401	961	1.335	757	1.512	14.059
2011	8.354	1.451	993	1.375	741	1.546	14.460
2012	8.575	1.502	1.025	1.416	729	1.588	14.835
2013	8.719	1.556	1.059	1.458	720	1.630	15.142
2014	8.831	1.611	1.094	1.502	700	1.673	15.411
2015	8.784	1.647	1.130	1.547	703	1.715	15.526
2016	8.827	1.697	1.163	1.601	706	1.757	15.751
2017	9.071	1.749	1.196	1.656	709	1.800	16.181
2018	9.055	1.803	1.231	1.714	712	1.844	16.359
2019	9.262	1.859	1.267	1.773	715	1.887	16.763
2020	9.428	1.916	1.304	1.834	718	1.930	17.130
2021	9.580	1.975	1.342	1.897	722	1.974	17.490
2022	9.700	2.035	1.381	1.963	725	2.018	17.822
2023	11.131	2.097	1.422	2.031	728	2.063	19.472
2024	11.367	2.162	1.463	2.101	731	2.107	19.931
2025	11.553	2.228	1.506	2.174	735	2.152	20.348





Table 4 Projections of total GHG emissions [kt CO₂-eq]- Second mitigation scenario

	Electricity	Heating	Industry	Transport	Waste	Agriculture	Total
2008	6.937	1.328	902	1.258	844	1.376	12.645
2009	7.082	1.353	931	1.296	769	1.517	12.948
2010	6.430	1.401	961	1.335	757	1.512	12.396
2011	6.613	1.451	993	1.375	741	1.546	12.719
2012	6.765	1.502	1.025	1.416	729	1.588	13.025
2013	6.881	1.556	1.059	1.458	720	1.630	13.304
2014	6.973	1.611	1.094	1.502	700	1.673	13.553
2015	6.990	1.647	1.130	1.547	703	1.715	13.732
2016	6.878	1.697	1.163	1.601	706	1.757	13.802
2017	7.042	1.749	1.196	1.656	709	1.800	14.152
2018	7.180	1.803	1.231	1.714	712	1.844	14.484
2019	7.143	1.859	1.267	1.773	715	1.887	14.644
2020	7.290	1.916	1.304	1.834	718	1.930	14.992
2021	7.415	1.975	1.342	1.897	722	1.974	15.325
2022	7.398	2.035	1.381	1.963	725	2.018	15.520
2023	7.586	2.097	1.422	2.031	728	2.063	15.927
2024	7.756	2.162	1.463	2.101	731	2.107	16.320
2025	7.918	2.228	1.506	2.174	735	2.152	16.713





Table 5 Projections of total GHG emissions for the three scenarios [kt CO₂-eq]

Year	Baseline scenario	First mitigation scenario	Second mitigation scenario
2008	14.040	13.904	12.645
2009	14.376	13.788	12.948
2010	15.855	14.059	12.396
2011	16.280	14.460	12.719
2012	16.647	14.835	13.025
2013	16.959	15.142	13.304
2014	17.239	15.411	13.553
2015	18.574	15.526	13.732
2016	19.096	15.751	13.802
2017	19.580	16.181	14.152
2018	20.037	16.359	14.484
2019	20.183	16.763	14.644
2020	21.456	17.130	14.992
2021	22.042	17.490	15.325
2022	22.592	17.822	15.520
2023	23.109	19.472	15.927
2024	23.568	19.931	16.320
2025	23.947	20.348	16.713





Table 6 Country Specific GHG emissions in Macedonia kt CO₂-eq/capita

Year	Population projections (1000 inhabitants)	Baseline scenario	First mitigation scenario	Second mitigation scenario
2008	2.055	6,83	6,76	6,15
2009	2.062	6,97	6,69	6,28
2010	2.068	7,67	6,80	5,99
2011	2.074	7,85	6,97	6,13
2012	2.080	8,00	7,13	6,26
2013	2.086	8,13	7,26	6,38
2014	2.093	8,24	7,36	6,48
2015	2.099	8,85	7,40	6,54
2016	2.105	9,07	7,48	6,56
2017	2.112	9,27	7,66	6,70
2018	2.118	9,46	7,72	6,84
2019	2.124	9,50	7,89	6,89
2020	2.131	10,07	8,04	7,04
2021	2.137	10,31	8,18	7,17
2022	2.143	10,54	8,31	7,24
2023	2.150	10,75	9,06	7,41
2024	2.156	10,93	9,24	7,57
2025	2.163	11,07	9,41	7,73

Methodology

- Methodology for the indicator calculation

The electric energy production sector (which contributes more than 50% to the total GHG emissions) has been modeled by application of the WASP software (a tool used in the energy sector development planning), while emissions estimates for other sectors have been made by using the software tool GACMO and expert judgments. Projections of GHG emissions have been made by downscaling analysis made under the national reports.

Data specification

Title of the indicator	Source	Reporting obligation
Projections of GHG emissions and removals	<ul style="list-style-type: none"> – Analysis for GHG emissions reduction in: the First National Communication on Climate Change to UNFCCC, MEPP, UNDP, p. 47-84, 2003 – Second National Communication on Climate Change to UNFCCC, MEPP, www.unfccc.org.mk 	– UNFCCC





General metadata

Code	Title of the indicator	Compliance with CSI/ EEA or other indicators		Classification by DPSIR	Type	Linkage with area	Frequency of publication
MK NI 011	Projections of GHG emissions and removals	CSI 011	Projections of greenhouse gas emissions and removals	P	A	air air quality Climate change	Annually

Data source(s): Yearbooks and other publications of the State Statistical Office, relevant national strategies/programmes/plans

Geographical coverage: Republic of Macedonia

Temporal coverage: 2000 - 2025

Uncertainty

- Uncertainty of data

Lack of national sectoral strategies (especially in energy sector).

Activities

- Short-term activities
 - Adoption of the Second National Communication on Climate Change, with incorporated Report on Climate Change Mitigation. .
 - a. **Description of the activity**
 - Based on the data available on the development of energy, industrial and agricultural sectors, the baseline scenario and additional mitigation scenarios including measures for GHG emissions reduction in the relevant sectors, have been developed.
 - Deadline:** mid of 2008
- Long-term activities
 - Based on adopted national strategies in individual sectors, to create climate change mitigation scenarios with lower uncertainty.

