Climate Change Mitigation Report

Image source: Climate Change (OBCE)

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UNFCCC National Focal Point

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Abbreviations and acronyms

AFOLU	Agriculture, Forestry and Other Land Use
CHP	Combined Heat and Power Plants
EC	European Commission
EU	European Union
FBUR	First Biennial Update Report
GAP	Good agricultural practice
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HPP	Hydropower Plant
HEV	Hybrid Electric Vehicle
ICA	International consultation and analysis
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MARKAL	(MARKet ALlocation)
MEMO	Memo item
NCSP	National Communication Supporting Programme
NDC	Enhanced Nationally Determined Contributions
OECD	Organization for Economic Co-operation and Development
PHEV	Plug-in Hybrid Electric Vehicle
RES	Renewable energy sources
SBUR	Second Biennial Update Report
SDG	Sustainable Development Goals
STUGRES	Study on the Heating in the City of Skopje Analysis of Policies and Measures
SOM	Soil Organic Matter
TNC	Third National Communication
TMR	Total Mix Ration
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WAM	With additional measures
WEM	With existing measures
e-WAM	Extended mitigation scenario
WEO	World Energy Outlook
WOM	Without measures
TPP	Thermal Power Plant

Chemical symbols

CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide equivalents
N_2O	Nitrous Oxide

Units and Metric Symbols

UNIT	Name	Unit for		Metric Symbol	Prefix	Factor
g	gram	mass		P	peta	10^{15}
W	watt	power		T	tera	10^{12}
J	joule	energy		G	giga	10^{9}
m	meter	length		M	mega	10^{6}
Wh	watt hour	energy		k	kilo	10^{3}
toe	ton of oil equivalent	energy		h	hecto	10^{2}
				da	deca	10^{1}
Mass Unit Conversion				d	deci	10^{-1}
1g				c	centi	10^{-2}
1kg	= 1 000 g			m	milli	10^{-3}
1t	= 1 000 kg	= 1 Mg		µ	micro	10^{-6}
1kt	= 1 000 t	= 1 Gg		n	nano	10^{-9}
1Mt	= 1 000 000 t	= 1 Tg		p	pico	10^{-12}

Executive summary

This report was prepared during the COVID-19 pandemic and the biggest energy crisis. In addition to these two crises, the military conflict in Ukraine also started, which contributed to prolonging and complicating the energy crisis. Because of that, the scenarios and some of the input data changed when compared to the recent reports and strategies as the events in the region and Europe changed. In the meantime, certain measures were adopted in the energy sector by a large number of countries, which include an increase in electricity production. This included activation of fossil fuel power plants that had been forgotten, as was the case with the Negotino power plant, but also an increase in coal production and/or coal imports. All these policies should be seen as short-term and quick solutions because the main goals for 2030 and 2050 at the EU level are not being corrected, and the goal of the energy transition is to reduce import dependence, by utilizing renewable energy sources.

Within this report, a large number of scenarios have been created, but the results of three scenarios have been presented, i.e. a scenario without measures, a scenario with existing measures and a scenario with additional measures. All the measures, which have the same names as the measures from the NDC, are tabulated, but the difference is that some are improved and are more ambitious, and some measures or part of measures are postponed or moved from one scenario to another. In energy sector, the introduction of hydrogen is being considered for the first time in the industry sector, besides the transport sector. Additionally, batteries for electricity storage are also included, which will have an important role in balancing the system with a huge share of renewable energy sources. Furthermore, for the first time, a measure has been made in the IPPU sector that refers to the implementation of the Kigali Amendment to the Montreal Protocol, which is an international agreement to gradually reduce the consumption and production of hydrofluorocarbons (HFCs). A measure was also added in the waste sector, which refers to the treatment of industrial wastewater. For the AFOLU sector, the measures proposed in the TBUR are again assumed, and their effect is projected up to 2050, as in the Long-term Strategy for climate change.

The Republic of North Macedonia has signed (2015) and ratified (January 2018) the Paris Agreement, with the following contribution to the global efforts for GHG emissions reduction (**Macedonian NDC**): “To reduce the CO_2 emissions from fossil fuels combustion for 30%, that is, for 36% at a higher level of ambition, by 2030 compared to the business as usual (BAU) scenario.” North Macedonia became the twenty-third country in the world that submitted its Intended Nationally Determined Contributions for Climate Change (INDC). The focus of the Macedonian NDC is put on climate change mitigation, that is, on policies and measures which lead to GHG emissions reduction, and particularly to CO_2 emissions from fossil fuels combustion which covers almost 80% of the total GHG emissions in the country. The following sectors are of dominant share: energy supply, buildings and transport.

Since then, few documents in the field of Energy and Climate Change were prepared and adopted, i.e. the Second Biennial Update Report – SBUR (submitted to UNFCCC in 2018), the Strategy for Energy Development up to 2040 (adopted by the Government in 2019), Third Biennial Update Report – 3rd BUR – Mitigation Report (2020), the draft version of the National Energy and Climate Plan –NECP (2020) and the draft version of the Long Term Strategy on Climate Change (2020), which subsequently build upon each other in terms of the policies and measures (PAMs) and the scenarios for mitigation of GHG emissions (*Figure 1*).

North Macedonia is the first country of the Energy community which besides PAMs from the Energy sector, analyzes and incorporates in its scenarios PAMs from Transport, Industry, Agriculture, Forestry and Other Land Use (AFOLU) and Waste sectors, which also are important target sectors for climate action. In that way, the Energy and Climate are brought closer together, gaining momentum for integrated Energy and Climate planning.

Figure 1. Documents prepared after the adoption of Intended Nationally Determined Contributions

Compared to the other documents, in the Mitigation Report under the Fourth National Communication (NC4) detailed results from two scenarios are presented, a Baseline scenario (scenario without measures - WOM) and a Mitigation scenario (scenario with additional measures – WAM). In addition to these two scenarios, scenario with existing measures (WEM) is created too, but only few results are presented from this scenario in order to avoid confusion. It was found that when more scenarios are presented the readers are confused. The scenarios presented in the mitigation report takes into account the latest climate and energy policy documents specified in the picture above.

A Monitoring, Reporting and Verification (MRV) system to monitor the implementation of climate actions has not yet been established in the country. Still, there are other mechanisms which can help MRV of climate actions. Two of them (top-down and bottom-up) are applied in the process of 4th National Energy Efficiency Action Plan (NEEAP) development. These methodologies are given in the Rulebook for energy audit and Rulebook for the characteristic of buildings. The draft version of the 4th NEEAP 2016-2021, presents a total of 41 energy efficiency policies and measures that have been implemented in the period 2015-2019, which also contribute to the climate change mitigation. Almost all of them are also defined in the NDC. Based on the 4th NEEAP, the total final energy savings in 2018 are 180 ktoe, which is about 20% above the target for 2018 set in the 3rd NEEAP. Also, these policies and measures in the period 2016-2018 have contributed to the reduction of around 760 kt CO_2 emissions. Compared to the goals defined in the INDC for 2030 (a reduction of 3166 kt CO_2) this is an achievement of 23% of the goal in a period of only three years.

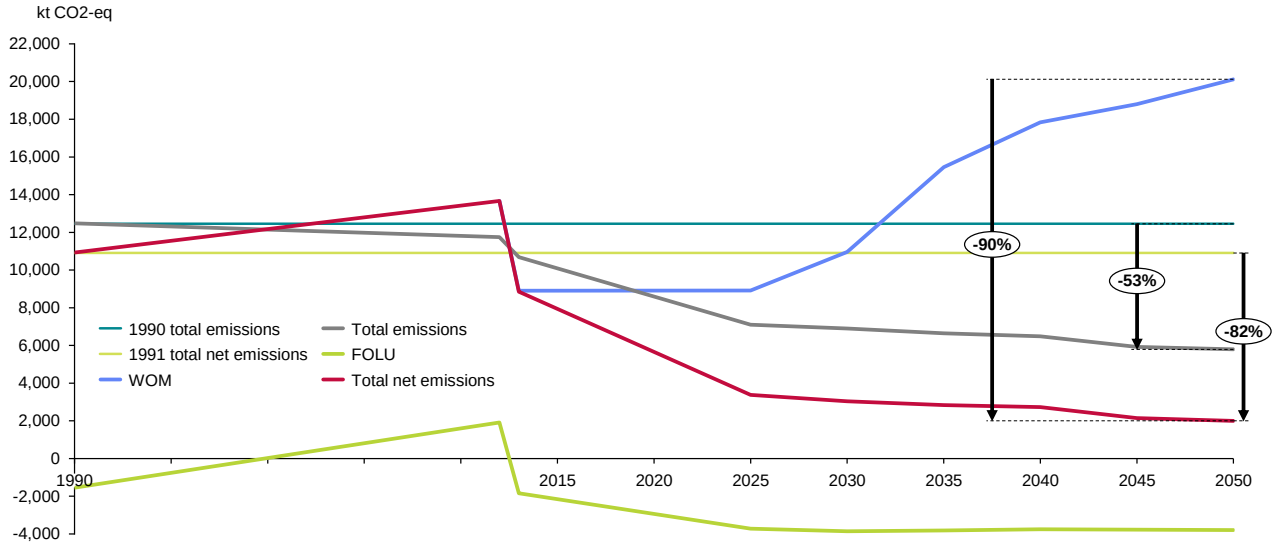
In the Mitigation report, 63 climate change mitigation measures/policies are considered in the higher ambition scenario, out of which 32 in the Energy sector, 11 in AFOLU (4-Agriculture, 2- Forestry, 5- Land use change), 4 in Waste and there are 16 additional PAMs which are enablers of mitigation actions.

The target for climate change mitigation in Macedonia is expressed as a reduction of greenhouse gas emissions and a reduction of net greenhouse gas emissions. The difference is that the FOLU sector is included in the GHG net emissions. The **goal** for 2050 are expressed in relation to 1990, as a base year and are:

- **53% GHG emissions reduction**
- **82% net GHG emissions reduction**

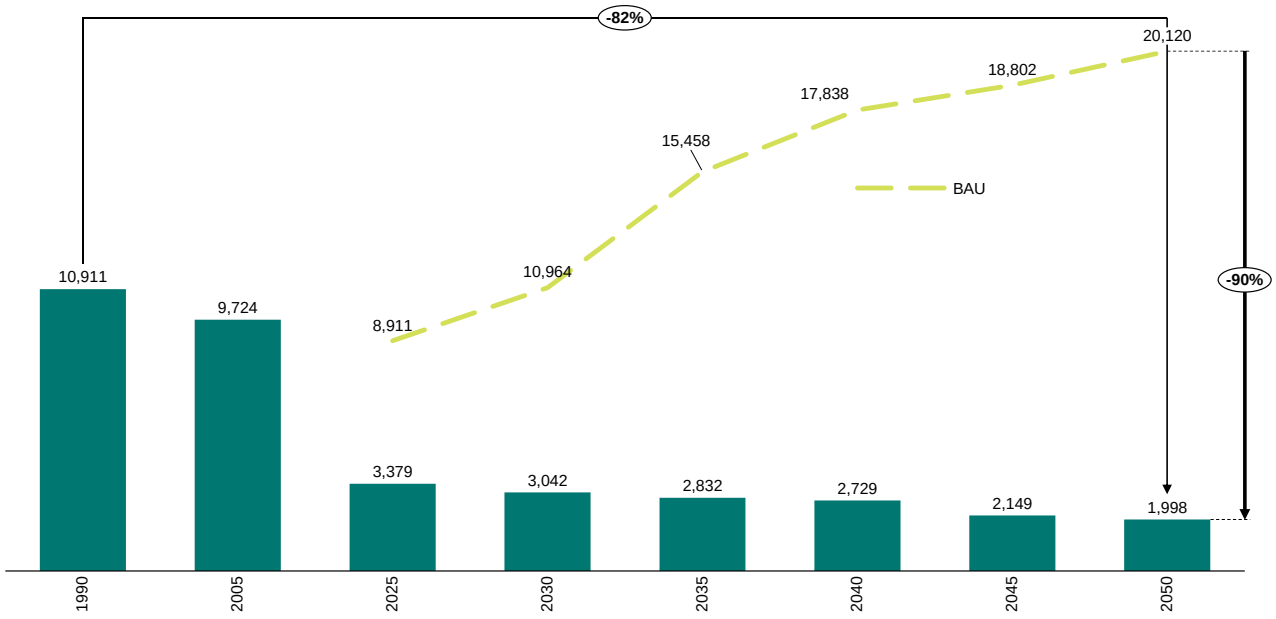
Additionally, compared to the WOM scenario, the economy-wide GHG emission reduction **target** for Macedonia **is 90%** in 2050 (***Figure 2***). The indicative trajectory shows that by 2025, Macedonia will reach 70% of the total GHG reduction target in 2030, and 31% of the target in 2050 (***Figure 3***). After 2030, there is an increase in the GHG emissions in WOM scenario, that are mainly result of the transport sector (increase in the transport of goods), as well as electricity production sector where new lignite power plants are considered.

Figure 2. Trajectory of GHG emissions (in Gg CO_2-eq) and indicative reduction targets (in %)



Note: 2000 is removed from the figure for better presentation of the results

Figure 3. Trajectory of net GHG emissions (in Gg CO2-eq) and indicative reduction targets (in %)

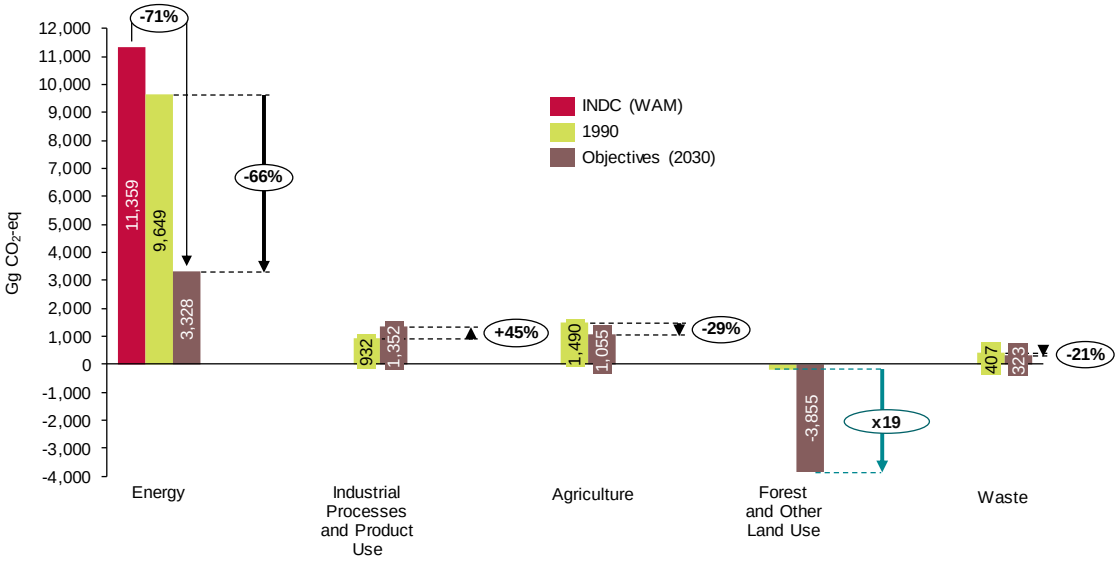


Source: Results from the Strategy for energy development up to 2040 and TBUR, project team analyses

The GHG goal for 2030 calculated as a part of the NDC and TBUR was based on 1990 figures. In order to achieve the target for GHG emissions reduction in 2030 defined in these two documents, sectoral **objectives** were set for each sector (Figure 4):

- Energy sector – 66% (6,321 Gg CO_2-eq) GHG emissions reduction (mainly through decommissioning of coal-fired TPP Oslomej in 2021 and TPP Bitola up to 2027)
- Industrial Processes and Product Use – 45% (420 Gg CO_2-eq) GHG emissions increase
- Agriculture – 29% (435 Gg CO_2-eq) GHG emissions reduction
- Forest and Other Land Use – 18 times (2,647 Gg CO_2-eq) GHG removals increase
- Waste – 21% (84 Gg CO_2-eq) GHG emissions reduction

Figure 4. Sectoral objectives for 2030 relative to 1990 level, and comparison with INDC target



Source: Results from the Strategy for energy development up to 2040 and TBUR, project team analyses

In the latest National inventory on climate change, 1990 was revised and it was found that the value for the Forestry sector should be more than seven times higher compared to the previous value (sink of 200 kt CO_2-eq was replaced with 1540 kt CO_2-eq). This has a big impact on the net GHG emission reduction for 2030. This report takes into account the new figure for Forestry sector in 1990. The changes in the other sector are minor.

At the same time, the emissions from the energy sector in 2018 decreased by 23% compared to 1990, as a result of the reduced electricity production from coal, almost complete removal of the use of heavy fuel oil for electricity generation and the introduction of natural gas.

Because there are significant changes in greenhouse gas emissions during the years 1990-2018, and in order to be clearer to the general public, the emissions and net emissions targets in 2030, in addition to 1990 are expressed in relation to other years. In this document, the emission reduction are expressed relative to 2005, 2014 and 2016..

The results (*Figure **5***) of the comparison show that emissions in 2050 will decrease by:

- 51% in relation to 2005
- 45% in relation to 2014
- 42% in relation to 2016

The results (*Figure **6***) of the comparison show that net emissions in 2050 will decrease by:

- 79% in relation to 2005
- 73% in relation to 2014
- 77% in relation to 2016

Figure 5. 2050 GHG emission target compared to 1990, 2005, 2014 and 2016

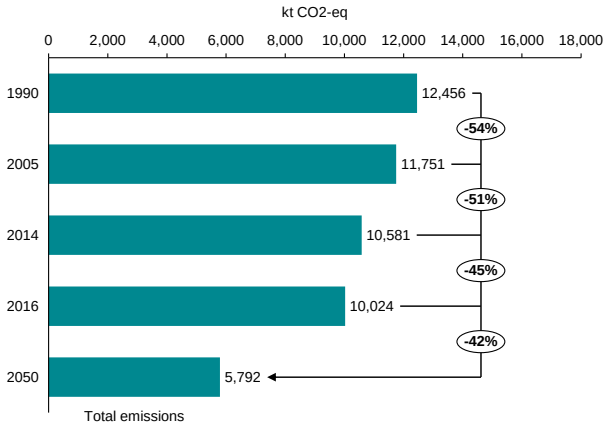
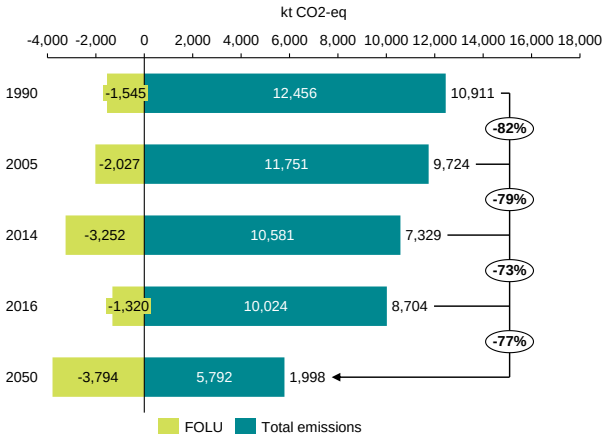


Figure 6. 2050 net GHG emission target compared to 1990, 2005, 2014 and 2016



If comparisons are made with 1990 in terms of net emissions, it should be noted that in 2014 about 60% of the target for 2050 has already been achieved (*Figure **7***). The comparison in terms of only emissions shows that in 2014 about 72% of the goal was achieved (*Figure **8***).

Figure 7. Achievement in 2014 compared to 2050 target – net GHG emissions

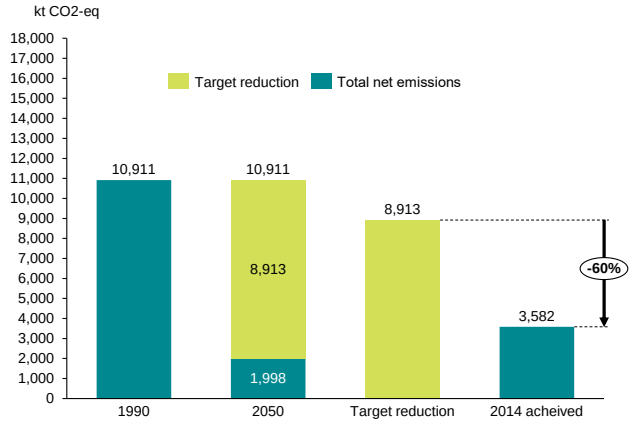
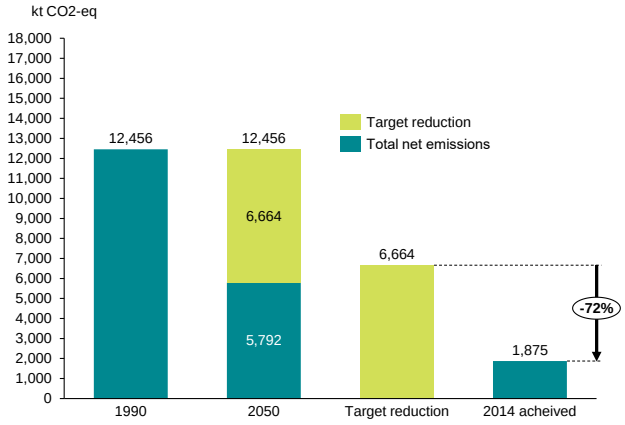


Figure 8. Achievement in 2014 compared to 2050 target – emissions



Regardless of the year in which the comparisons of emissions and net emissions are made, what is important is that a **green agenda** is planned that will contribute to the continuation of the downward trend of emissions that has already begun and additionally intensify it, especially in the period after 2025. Particular attention needs to be paid to sectors where emissions are expected to increase, such as the Transport sector.

The results obtained from the analyses in the enhanced NDC cannot be directly compared with the goals defined in the INDC because:

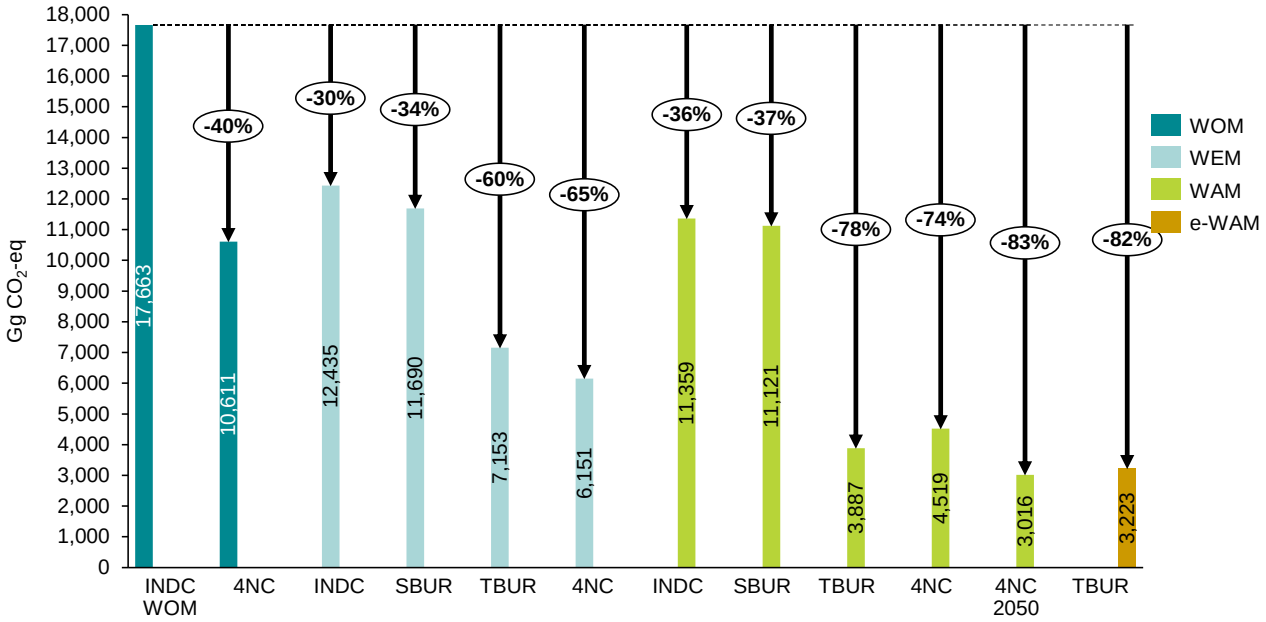
- besides CO_2 emissions, the climate change mitigation analyses under enhanced NDC include the emissions of CH_4 and N_2O, which were not considered in the INDC,
- an emission factor has been attributed to the import of electricity, to take into account that in reality, this could not be considered as an emission-free measure,
- as a result of the developments in the modelling, like the change of input parameters (prices of fuels, Gross Domestic Product (GDP) growth, population growth etc.), the scenario without measures (WOM) in NDC is different from the WOM scenario in the INDC,

- The mitigation analyses include measures across all relevant sectors, i.e. in Energy, AFOLU and Waste sectors, including policy measures to improve the research and development activities in these areas.

If one makes a realistic comparison with the INDC targets, only the CO_2 emissions should be taken into account, while disregarding the emissions related to electricity import. Additionally, a comparison with the INDC WOM scenario should be made to assess the relative decreases with respect to that scenario. The results from the comparison are displayed in Figure 9, which shows that in 2030:

- the projected CO_2 emissions in the 4NC WOM scenario are 40% lower compared to the INDC baseline (WOM scenario).
- the targeted emissions in the 4NC mitigation scenario (WAM) are by 74% lower compared to the INDC WOM scenario, which is around three times more ambitious than the WAM scenario in the INDC.

Figure 9. Comparison of the SBUR, TBUR and 4NC, WOM, WEM and WAM scenarios from the Energy sector with the INDC Reference scenario, 2030 (in Gg CO_2-eq)



The economic and environmental aspects of the climate change mitigation policies and measures are analyzed through the following two parameters, Economic effectiveness (or specific cost) and Environmental effectiveness (or mitigation potential). The results show that 70% of the reduction can be achieved with a "win-win" policies and measures, which means that these measures are reducing the emissions by negative specific costs (total cost of the proposed measure are lower compared to the costs of the WOM scenario). Furthermore, an additional 20% of the reduction is realized by measures with specific costs in a range from 0-5 €/t CO2-eq.

In addition to the economic and environmental effectiveness of the proposed policies and measures, the social aspect is analyzed through the number of newly created green jobs. The maximal number of green jobs is in the WAM scenario in 2040 with 10877 green jobs, from which 64% are from the energy efficiency and the remaining are from RES. Regarding the contribution by measures, the ones that have the highest share in the number of new domestic green jobs under the WAM scenario in 2040 are: Retrofit of existing residential buildings (35%), RES without incentives (16%), Construction of passive houses (15%), and Solar thermal collectors (10%) (*Figure 10*). Based on the types of jobs, very basic analyses are done concerning the gender issue. It is found that at least around 28% of the maximum number of job positions in 2050 can be assigned to women (*Figure 10*).

The anticipated costs of the mitigation scenario are ~ 21 bill €, of which about 99% for investments in the energy sector. The average yearly investments are approximately 7.7% of the total average annual GDP (Figure 11). If all of the measures are implemented in parallel, and the "Energy efficiency first" principle is applied, then, the total investment can be reduced up to 7% compared to the situation when each of the measures are implemented separately.

Figure 10. Number of domestic green jobs by measure in WAM

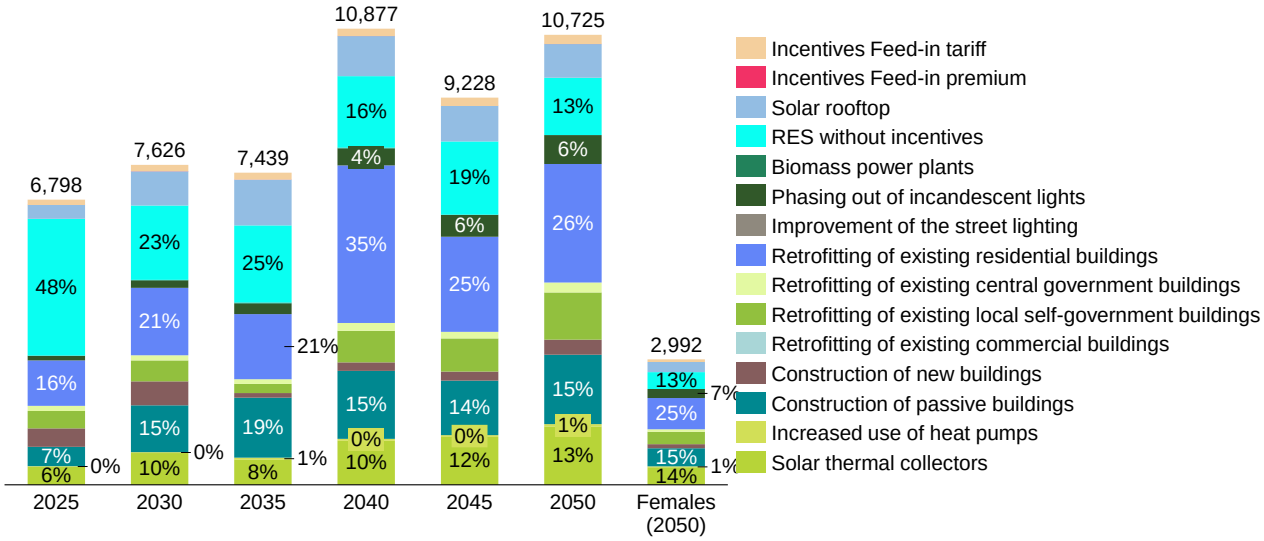
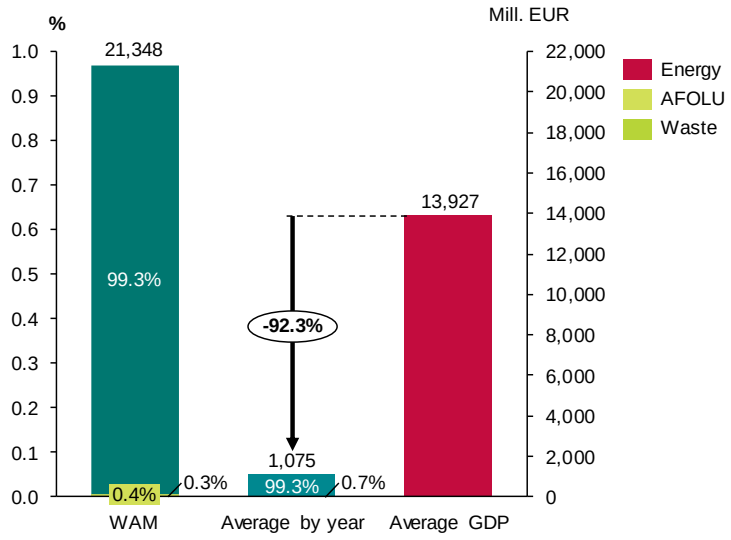


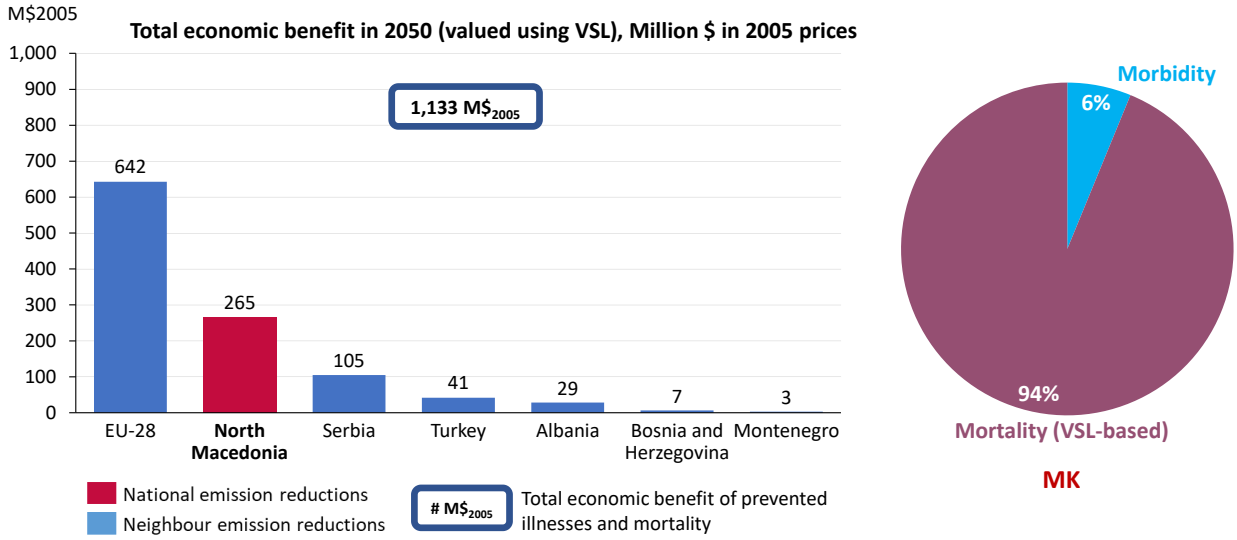
Figure 11. Investments in WAM and annual investments compared to average GDP



By examining the health and economic co-benefits using the Carbon Reduction Benefits on Health (CaRBonH) calculation tool, the results show that the reduction of GHG emissions and air pollutants achieved in 2050 with the energy-related carbon mitigation interventions, would translate into a reduction of the population exposure to $PM_{2.5}$ concentrations for 1.027 μg/m³. The preventable mortality from air pollutant emissions in 2050 in North Macedonia is 133 deaths, representing approximately 3.9% of the 3,400 premature deaths in 2019, attributed to exposure to average annual $PM_{2.5}$ concentrations at a level of 20.9 μg/m³, estimated by the European Environment Agency (EEA) [2]. The benefit of reduced air pollution in terms of years of life lost will result in 1,468 years gained in 2050 at national level, or approximately 4.3% of the years of life-lost (YLL) attributable to $PM_{2.5}$ exposure in the country in 2019, estimated to be around 33,900 YLL [2]. Additionally, the improved air quality results in fewer cases of illnesses (morbidity) in the country, such as 589 prevented cases of bronchitis in children and 2,611 fewer asthma symptom days in children, 92 fewer cases of chronic bronchitis in adults, and 6,528 averted work lost days (WLD or absenteeism) in adult employed population, 170,692 restricted activity days (RAD) avoided plus 105 fewer cases of hospital admissions (HA)

The results also show that the overall economic benefit of the prevented illnesses and mortality in 2050 in the case of North Macedonia is 265 million US$2005 (expressed in 2005 prices), evaluated using the value of the statistical life (VSL) (i.e., the value of the prevented premature death) (***Figure 12***). These costs represent 1 2.8% of the country's GDP in 2019 (in 2005 prices). The welfare improvements, attributed to the averted premature deaths, account for 249 million US$2005, or 94% of the total economic benefits (valued using VSL metric) for the country. The economic benefit of the total avoided morbidity cases is 16 million US$2005, of which around 68% are because of the avoided restricted activity days, nearly 25% from prevented bronchitis in adults, and 4% from work lost days, and the remaining 3 from the reduced hospital admissions and avoided cases of bronchitis and asthma in children.

Figure 12. *Total economic benefit (valued using VSL) of emission reductions in 2050, in million US$ in 2005 prices*



Finally, an Action Plan for mitigation of climate change is given (in Appendix 2), in which the stakeholders relevant for the implementation of all 63 measures and policies were identified. Furthermore, the plan contains information on each measure's type, source of finance, indicative future emission reductions and necessary investments for the realization of the measures and the potential for green jobs creation. This Action Plan is a solid foundation for creating national policies that would enable the low-carbon sustainable development of North Macedonia.

1 Introduction

This report was prepared during the COVID-19 pandemic and the biggest energy crisis. In addition to these two crises, the military conflict in Ukraine also started, which contributed to prolonging and complicating the energy crisis. Because of that, the scenarios and some of the input data changed when compared to the recent reports and strategies as the events in the region and Europe changed. In the meantime, certain measures were adopted in the energy sector by a large number of countries, which include an increase in electricity production. This included activation of fossil fuel power plants that had been forgotten, as was the case with the Negotino power plant, but also an increase in coal production and/or coal imports. All these policies should be seen as short-term and quick solutions because the main goals for 2030 and 2050 at the EU level are not being corrected, and the goal of the energy transition is to reduce import dependence, by utilizing renewable energy sources.

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The Republic of North Macedonia, a **non-Annex I party** to the United Nations Framework Convention on Climate Change (UNFCCC) has signed (2015) and ratified (January 2018) the Paris Agreement, with the following contribution to the global efforts for GHG emissions reduction (**Macedonian NDC**): “To reduce the CO_2 emissions from fossil fuels combustion for 30%, that is, for 36% at a higher level of ambition, by 2030 compared to the business as usual (BAU) scenario.” North Macedonia became the twenty-third country in the world that submitted its Intended Nationally Determined Contributions for Climate Change (INDC). The focus of the Macedonian NDC is put on climate change mitigation, that is, on policies and measures which lead to GHG emissions reduction, and particularly to CO_2 emissions from fossil fuels combustion which covers almost 80% of the total GHG emissions in the country. The following sectors are of dominant share: energy supply, buildings and transport.

Since then, few documents in the field of Energy and Climate Change were prepared and adopted, i.e. the Second Biennial Update Report – SBUR (submitted to UNFCCC in 2018), the Strategy for Energy Development up to 2040 (adopted by the Government in 2019), Third Biennial Update Report – 3rd BUR – Mitigation Report (2020), the draft version of the National Energy and Climate Plan –NECP (2020), the draft version of the Long Term Strategy on Climate Change (2020) which subsequently build upon each other in terms of the policies and measures (PAMs) and the scenarios for mitigation of GHG emissions (Figure 13).

Figure 13. Documents prepared after the adoption of Intended nationally determined contribution

In many aspects, these developments can be considered as a strong entry point to the mitigation analyses within the NDC.

First of all, it **is the capacity, both analytical and institutional**, and **the participatory process**, which has been created, maintained and enhanced over the Energy strategy, SBUR, INDC, FBUR and the three NCCC timelines.

Secondly, Macedonian SBUR goes beyond the requirements from the UNFCCC Guidelines for Non-Annex I Countries since, besides economic and environmental evaluation, it addresses social aspect estimating **co-benefits** from the implementation of mitigation policies and measures (PAMs). This good practice can be utilized and further extended since it provides essential input for prioritization of the PAMs and for informed policy design and decision-making. Worth mentioning in this regard, is the Study on the Heating in the City of Skopje (**STUGRES**) and Study on Transport (**STUTRA**) conducted also under SBUR, which certainly have a significant role to play when it comes to mitigation action at local level. In TBUR the role of the private sector in the mitigation action is particularly analyzed in the Study on Industry Analysis of Policies and Measures (**STUIND**). In this study more disaggregated and additional PAMs in the Industry sector that contribute to (i) increasing energy efficiency, (ii) increasing renewable sources utilization for electricity production and (iii) improving waste management are considered. Moreover, these studies can serve as good practice showcasing that in the face of an air quality emergency and the climate crisis, solutions that tackle one or the other cannot be afforded. But solutions that tackle both are the way to go.

Representation of the PAMs in a tabular form, with elements prescribed in UNFCCC Guidelines for BUR preparation, is yet another element which is broadly implemented in the mitigation analyses. Indeed, this practice of representation of the PAMs with description, steps taken or envisaged, results achieved and estimated outcomes, estimated emission reductions, timeframe, costs, implementing entity, as well as progress indicator, provides solid base for monitoring, reporting and verification (MRV) of the achievement of each the PAMs, but also of the achievement of national energy and climate targets (RES share, EE improvements, GHG emissions reductions). The later assumes appropriate MRV institutional setting and communication flows at the national level are established and operational.

Finally, Macedonian NDC besides PAMs from the Energy supply and buildings sectors analyzes and incorporates in its scenarios **PAMs from Transport, Industry, Agriculture, Forestry and Other Land Use (AFOLU) and Waste sectors**, which also are important target sectors for climate action. In that way, the Energy and Climate are brought closer together gaining momentum for **integrated Energy and Climate planning**, which were duly applied in TBUR, National Energy and Climate Plan and the forthcoming revision of the NDC.

Compared to the other documents, in the Mitigation Report under the Fourth National Communication (NC4) detailed results from two scenarios are presented, a Baseline scenario (scenario without measures - WOM) and a Mitigation scenario (scenario with additional measures – WAM). In addition to these two scenarios, scenario with existing measures (WEM) is created too, but only few results are presented from this scenario in order to avoid confusion. It was found that when more scenarios are presented the readers are confused. The scenarios presented in the mitigation report takes into account the latest climate and energy policy documents specified in the picture above. In each document, different names of the scenarios have been used.

2 National circumstances

2.1 Macroeconomic content

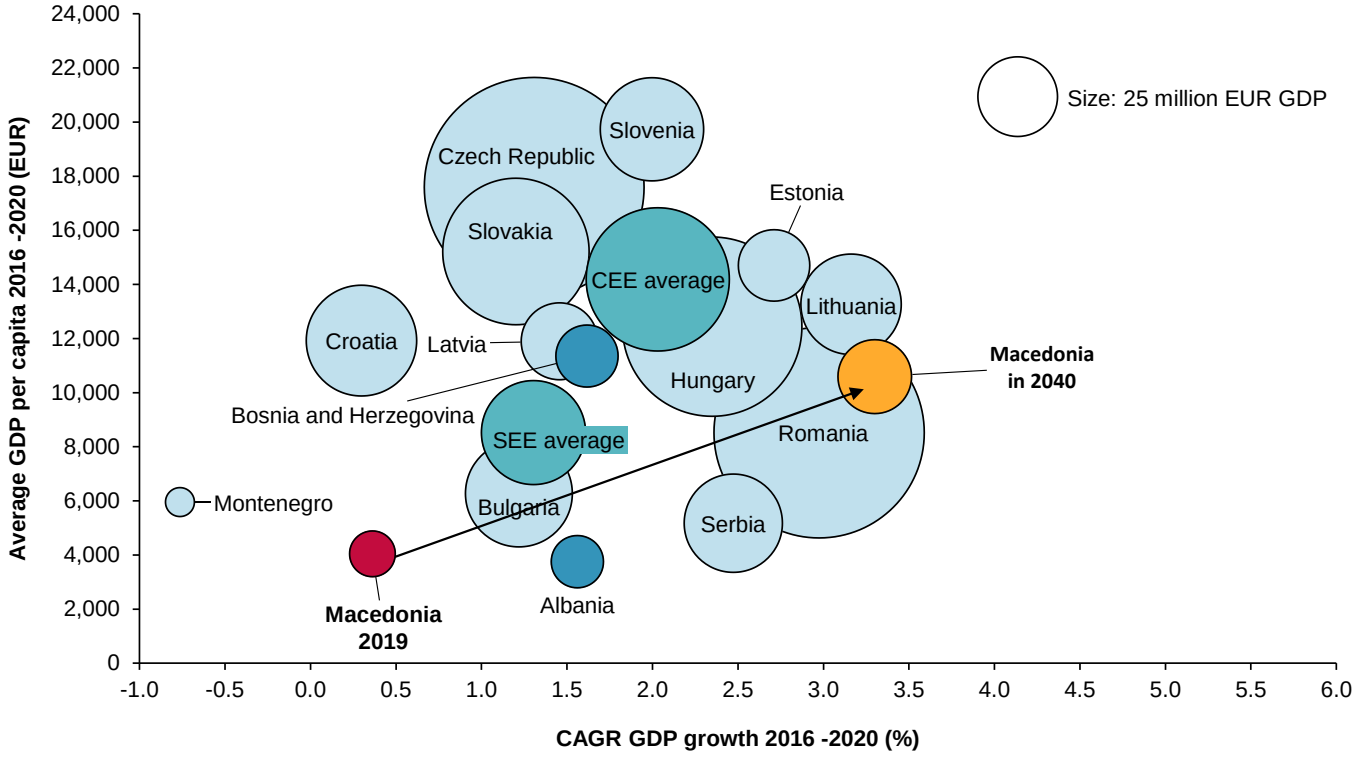
2.1.1 Introduction

The Republic of North Macedonia as Energy Community Contracting Party and EU candidate country is willing to follow the European energy policy and is obliged to transpose and implement the EU energy directives and regulations. North Macedonia was granted the candidate status for entering the European Union in 2005. Since 2009, the Commission has recommended to the Council to open accession negotiations with North Macedonia. In March 2020, the General Affairs Council of EU decided to open accession negotiations with North Macedonia and the members of the European Council endorsed the decision. However, the country is still on the list to be granted with an access to the EU.

2.1.2 Gross domestic product and unemployment

GDP growth till 2040 is projected to position North Macedonia closer to today's CEE region economies. GDP, as the most important measure of a country's economic activity, shows that today North Macedonia lags behind the SEE average, as well as the CEE region. Taking into account the projections of the International Monetary Fund and Ministry of Finance, it is projected that until 2040 the Macedonian real GDP growth rate will grow at an average rate of 3.3%. Such GDP growth rate could be expected for a developing country, and should lead to convergence towards levels of GDP per capita that are common for developed CEE countries today (*Figure 14*).

Figure 14 CEE and SEE GDP trends



Note: SEE includes AL, BA, BG, HR, MK, RS, ME, SI and RO; CEE includes HU, LV, LT, CZ, EE and SK; GDP growth projections for North Macedonia take into consideration growth rates of 3.3% per annum.

Source: Eurostat, Government of North Macedonia GDP projections, Expert analysis

North Macedonia has the third highest unemployment rate in the region, but it is showing a positive trend over the years (Figure 15, Figure 16). Besides, employment is characterized with unfavourable gender structure, which has remained unchanged over a longer period due to unstable economic and social

conditions, as well as the imbalance between the available and required profiles on the labour market. The employment rate in women population in 2020 was 49% (318 thousand women), significantly lower than the man employment rate of 68.9% (460 thousand men), of the active population aged from 20 to 64 years.

Figure 15 Unemployment rate in North Macedonia, 2015 – 2020, %

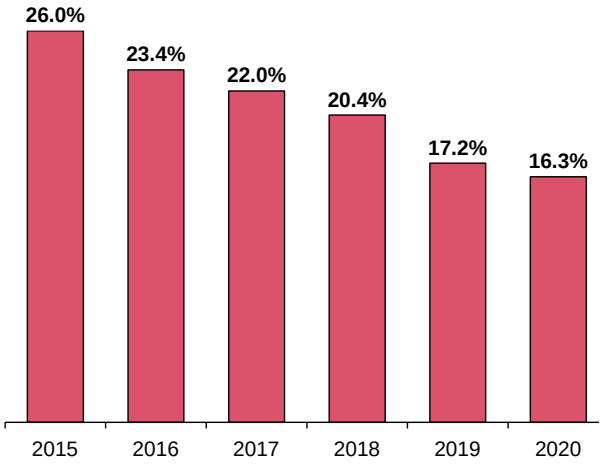
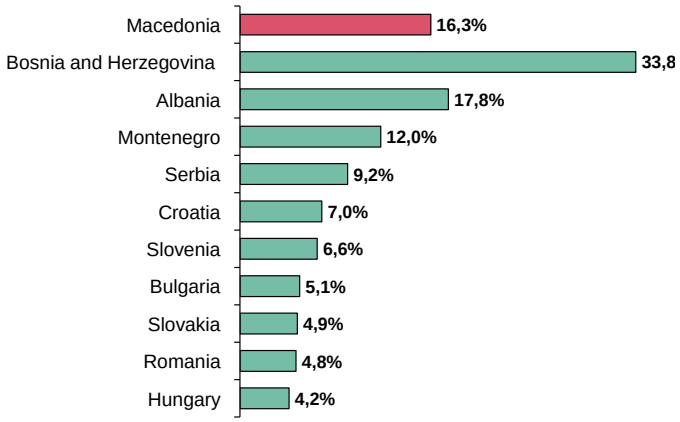


Figure 16. Unemployment rate CEE and SEE, 2020, %



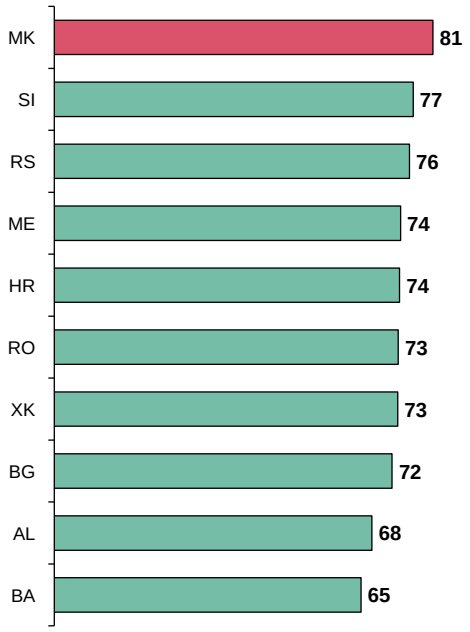
Source: Eurostat, ec.europa.eu reports; Trading Economics; Expert analysis

North Macedonia has a positive business environment to provide opportunities for small and medium enterprises in RES and energy efficiency. According to The World Bank Doing Business 2020 report, North Macedonia has the highest cumulative index for business environment compared to countries in the region, and in particular stands out in the fields of protecting minority investors and dealing with construction permits. Still, there is room for improvement in the other categories, especially in trading across borders as their ranking is lagging behind the countries in the region (*Figure 17*, *Figure 18*). It is expected that future investments, including the investments in the energy sector (especially RES and energy efficiency), could have a positive impact on decreasing county's unemployment rate as well as the economic growth.

Figure 17 Business environment per category, 2019

Category	Description	Global ranking (out of 190)
Starting a business	Procedures required from an entrepreneur to start a business (time and cost)	78
Dealing with construction permits	Procedures required to comply with building regulations (time and cost)	15
Getting Electricity	Time and cost to obtain electricity connection as well as supply reliability and tariff transparency	69
Registering property	Effective administration of land, necessary for formal property transfer	48
Getting loan	Considers the depth of loan information and strength of legal rights	25
Protecting minority investors	Protection from conflict of interest and shareholders rights in corp. govern.	12
Paying taxes	Considers tax rates and tax administration complexity	36
Trading across Borders	Time and cost associated with the logistical process of export and import	32
Enforcing contracts	Time and cost for resolving standardized commercial dispute through local first-instance court	47
Resolving Insolvency	Time, cost and outcome of insolvency proceedings involving local legal entities	30

Figure 18 Business environment compared to countries in the region, 2019 (the ease of doing business score)



Source: The World Bank – Doing Business 2020 report, Expert analysis

Note: The World Bank Group management discontinued the Doing Business report In September 2021.

2.1.3 Foreign direct investment

The energy sector can contribute to attract foreign direct investments. The process of globalization has increased the importance of foreign direct investments, especially for developing countries such as North Macedonia. Due to the limited internal financial and investment capacity the interest of all developing countries

is to achieve a more favourable investment climate and better operating conditions. Additionally, entrance of new foreign companies can stimulate domestic companies to improve their business and consequently contribute in boosting overall market development. In the long run, such economic trends create positive externalities. Foreign direct investments in North Macedonia amounted 240 million EUR per year or 160 EUR per capita which is substantially lower than the region (*Figure 19*, *Figure 20*).

Figure 19 Foreign direct investments in North Macedonia, 2015 – 2020, mil. EUR

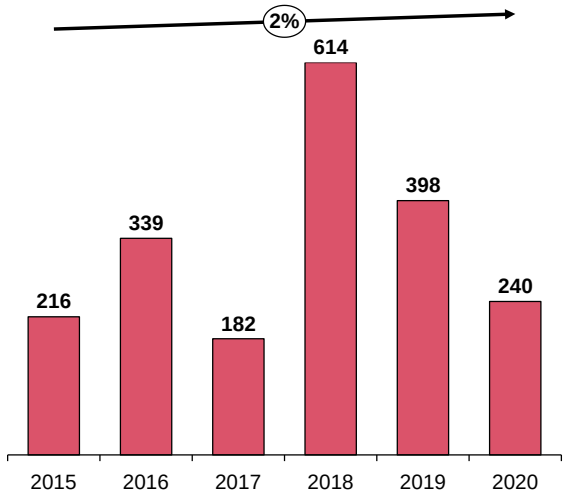
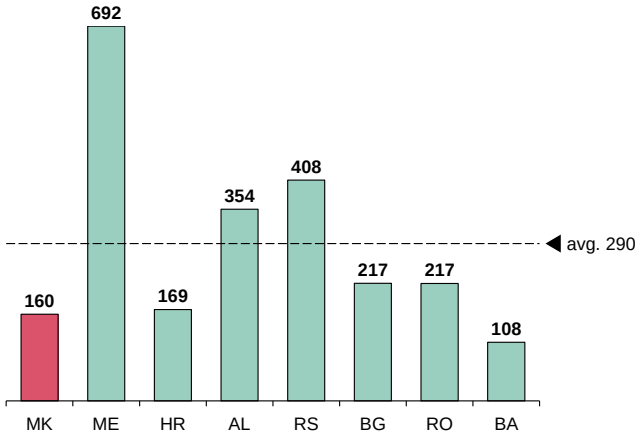


Figure 20 Foreign direct investments per capita – Region inflow, average 2015 – 2020, EUR



Note: Countries analysed for the region are BA, RO, BG, RS, AL, HR and ME

Source: United Nations – World Investment Report 2021, Eurostat, Expert analysis

2.2 Energy sector

Compared to the other sectors, the Energy sector by far has the largest share in the GHG emissions in Macedonia. This is because this sector is mainly based on fossil fuels, primarily coal, which accounts for 75.4% of the total energy demand in 2019. In the last few years, a certain decreasing trend of the share of fossil fuels can be noted, primarily due to an increase in the electricity import, which additionally increases the import dependence of the country, estimated at 58.5%. There is also an increasing trend of the share of renewable energy in the gross final energy consumption, which from 18% in 2009 has increased to 20% in 2017, after which is decreasing to 16.8% in 2019. The efficiency of the Macedonian energy system (conversion from the total required energy into final energy) is about 70%. This value is the same level as the member countries of the Organization for Economic Co-operation and Development (OECD) Europe, where it is about 70%.

As a result of the low GDP, Macedonia falls in the category of countries with high gross inland consumption and high final energy consumption per unit of GDP despite the low energy consumption per capita.

2.2.1 Primary and final energy consumption

In general, a decreasing trend can be noticed in primary energy consumption while final energy consumption remained stable. In the period 2010 – 2020, the primary energy consumption decreased for 10%

mainly due to higher import of electricity and petroleum products, as well as the implementation of energy efficiency measures and increased RES electricity production. The final energy consumption remained stable with few variations (a small increase of 2%) mainly due to fluctuation of industry consumption and increased consumption of fuels in the transport sector (Figure 21, Figure 22).

Figure 21 Primary energy consumption by fuel, 2010 – 2020, Mtoe*

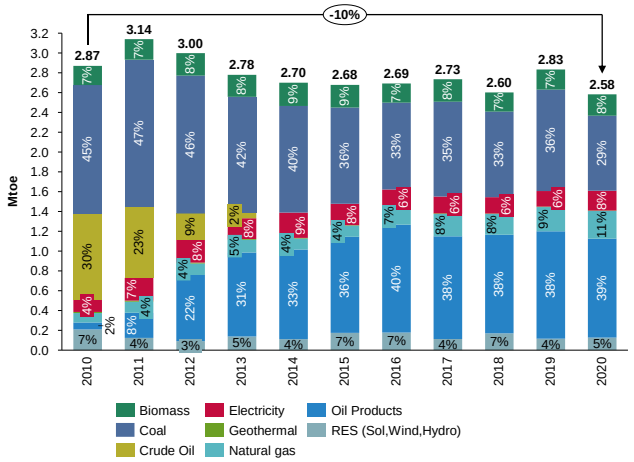
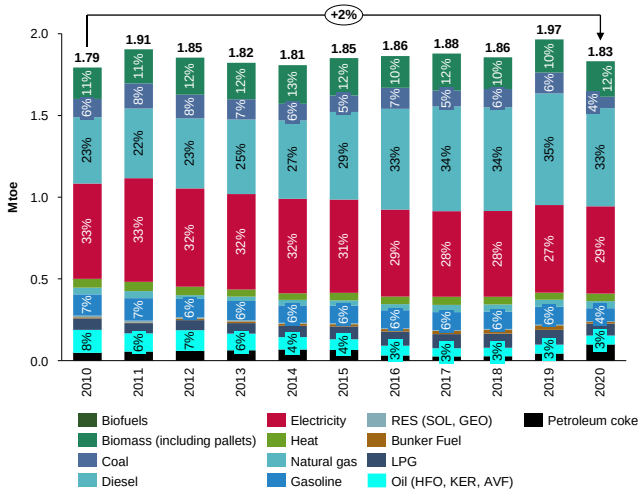


Figure 22 Final energy consumption by fuel, 2010 – 2018, Mtoe*



**Note: Preliminary data for 2020*

Source: State Statistical Office, Energy Balances, 2010 – 2020 (MAKStat Database)

2.3 Industrial Processes and Product Use

The GHG emissions from Industrial Processes and Product Use (IPPU) in Macedonia originate from production industries and the use of ozone-depleting substances for air conditioning. The metal industry is the main contributor to the emissions of this sector with a dominant level of emissions from the production of ferroalloys. Cement production is the second largest contributing category to GHG emissions. The rest of the emissions are result of the use of substituents of ozone-depleting substances.

2.4 Agriculture, Forestry and Other Land Use

Forests and forest lands are the main CO_2 sinks in Macedonia. According to the data from the project "TCPF Assessment of the methodology for implementation of the forest inventory (TCP/MCD/3604)" the total area of forest, forest land and barren land (estimated in the 2019) is 1.122.258 ha out of which 1.042.534 ha are forest, 109.126 ha forest land and 11.643 barren land. This generally is in line with the official data from the State Statistical Office, Forestry management plans (PE "Macedonian forests", other subjects that manage forests and Ministry of Agriculture, Forestry and Water Economy). Furthermore, according to the findings of the project TCP/MCD/3604 in the period of 2009 to 2017 year about 43.252 ha of other wood land were changed to forest. This process of land cover changes (especially from other land cover to forest) is very important for planning of

mitigation measures and adaptation to climate change. In terms of the ownership, around 90% of the forests are state-owned and the rest are private forests.

In Macedonia, the activities related to livestock production emit greenhouse gases mainly as a result of enteric fermentation and management of manure. On the other hand, greenhouse gas emissions from crop production are a consequence of several major sources, such as inadequate and excessive fertilization with mineral fertilizers, which in the long term causes a serious reduction in organic matter in soils and significant CO_2 emissions, rare and inadequate application of manure, conversion to land use from extensive to an intensive plant production system, inadequate management of arable land and improper management when fertilizing.

2.5 Waste

According to the Macedonian GHG inventory, the emissions in the waste sector are increased by 56% between 1990 and 2019, making this sector the fastest growing. Considering the fact that most of the emissions are from Solid Waste Disposal Sides, as well as the forecasts for their growth as a result of the increased amount of waste that citizens are increasingly creating, special attention should be paid to this sector. The following categories act as contributors to the GHG emissions: Solid Waste Disposal, Biological Treatment of Solid Waste, Incineration and Open Burning of Waste, and Wastewater Treatment and Discharge. The GHG emissions from this sector follow a monotonously growing trend. Solis waste disposal is the category with the highest share of GHG emissions in this sector.

3 Monitoring reporting and verification

To follow the realization of the climate change documents, monitoring, reporting and verification process is very important. As a part of the NDC document development a separate chapter was created. Having in mind the importance of this issue, that chapter is added in this document too.

Although Monitoring, Reporting and Verification (MRV) system to monitor the implementation of climate actions has not yet been established in the country, there are other mechanisms which can help MRV of climate actions. Two of them (top-down and bottom-up) are applied in the process of 4th National Energy Efficiency Action Plan (NEEAP) development. These methodologies are given in the Rulebook for energy audit and Rulebook for characteristic of buildings. According to the draft version of the 4th NEEAP 2016-2021, a total of 41 energy efficiency policies and measures, which also contribute to climate change mitigation, have been implemented in the period 2015-2019. Almost all of them are also defined in the INDC.

The Republic of North Macedonia as a party to Energy Community regularly prepares National Energy Efficiency Action Plans (NEEAPs), which includes information on the progress towards the national energy efficiency target. Hence, the estimated annual savings achieved with the energy efficiency measures could serve as an indicator to track the progress of implementation of the mitigation measures between the two NDCs (Table 1). A total of 41 measures are reported in the 4th NEEAP, of which for 34 there are detailed data, and for 7 partial data. The total final energy savings in 2018 are 180 ktoe which is about 20% above the target for 2018 which is set in the 3rd NEEAP. Only in the period 2016-2018, final energy savings of around 100 ktoe were achieved.

With the implementation of 18 measures (marked with green in Table 1), larger energy savings were achieved than those planned in the 3rd NEEAP, while with 6 measures, smaller savings were achieved than planned (marked in red in Table 1). What is important and should be emphasized is that the implementation of most of the measures is aimed at fulfilling the Green Scenario of the Energy Strategy and that is one of the reasons why in the NDC the WAM scenario is presented.

Measures that achieve the greatest energy savings are increased use of heat pumps (inverter air conditioners), as well as renovation and construction of new buildings.

These measures used to achieve final energy savings, also contributed to the reduction of primary energy consumption. However, in addition to these measures, there are measures whose implementation achieves savings only on primary energy, 212 ktoe (Table 2).

Table 1. Measures used to achieve final energy savings and comparison with the projected savings from the third NEEAP

	Measure	Corresponding measure in the 3rd NEEAP	Cumulative (3rd NEEAP)	Achieved annual energy savings - final energy (ktoe)			Achieved cumulative savings including the savings from the 3rd NEEAP	Expected cumulative savings according to 3rd NEEAP
			2015	2016	2017	2018	2018	2018
1	EE obligation schemes						0	
2	Public awareness campaigns and network of energy efficiency (EE) info centers	R.4.	2.7	0.82	0.82	0.97	5.31	3.85
3	Solar rooftop power plants	R.3., P.4., C.3.	7.77				33.66	15.72
4	Solar thermal collectors			0.53	0.4	0.25		
5	Increased use of heat pumps			7.2	9.04	8.47		
6	Labeling of electric appliances and equipment	R.2.	0.7	0.2	0.21	0.24	1.35	0.86
7	Replacement of windows			0	0.14	0.12	0.26	
8	Retrofitting of existing buildings (res+comm)	B.1., R.1., C.1., P.1.	19.4	0.2	0.16	0.13	32.31	30.05
9	Construction of new residential buildings			2.93	2.86	2.58		
10	Construction of new commercial buildings			0.79	0.91	0.94		
11	Retrofitting of existing central and local self-government buildings			0.18	0.07	0.08		
12	Construction of new central and local self-government buildings			0.41	0.41	0.26		

13	EE certificates for buildings			0.29	0.54	0.15	0.98	
14	Construction of passive buildings			0	0.02	0	0.02	
15	Phasing out of incandescent lights			1.35	3.37	5.4	10.12	
16	Improvement of the street lighting in the municipalities	P.3.	1.69	0.56	0.56	0.56	3.37	2.34
17	"Green procurements"	P.5.	0.22	0.05	0.05	0.1	0.42	0.36
18	Energy management in manufacturing industries	I.2.	2.98	0.5	0.5	0.5	4.48	5.3
19	Introduction of efficient electric motors	I.3.	1.42	0.2	0.2	0.2	2.02	1.77
20	Introduction of more advanced technologies	I.1., I.4.	13.7	1.8	1.8	1.8	19.1	16.1
21	Increased use of the railway	T.4.	5.16	0	1.36	0.76	7.28	18.76
22	Renewing of the national car fleet	T.1.	6.45	1.8	1.68	2.01	11.94	9.95
23	Renewing of other national road fleet (light duty and heavy goods vehicles and buses)			0.16	0.4	0.38	0.94	
24	Advanced mobility	T.3.	2.36	0.24	0.2	0.27	3.07	4.21
25	Construction of the railway to Republic of Bulgaria			0	0	0	0	
26	Electrification of the transport			0.02	0	0.01	0.03	
27	Biomass power plants (CHP optional)						0	
28	Increased use of more efficient biomass stoves	R.5.	0	0.18	0.32	0.73	1.23	1.12
29	Increased use of central heating systems			0.13	0.16	0.18	0.47	
30	Reduction of network losses	E.2.	3.4				3.4	7.2
	Additional measures reported in the annual reports							
31	Inspection of boilers/air conditioning systems	B.2.	0.06	0	0	0	0.06	0.1
32	Energy management - public buildings	P.2.	0.96	0.2	0.2	0.2	1.56	1.56
33	Rehabilitation of water supply systems and sewage systems	P.6.	0	0.05	0.05	0.1	0.2	0.02
34	Energy management	C.2.	0.75	0.15	0.15	0.2	1.25	1.45
35	Cogeneration	I.5.	5.1	8.7	5.7	8	27.5	18.2
36	Heat cost allocators	E.1.	0	0	0	0	0	0.04
37	Promotion of sustainable urban transport systems	T.2.	5.55	0.8	0.8	0.8	7.95	9.75
	Total savings of the additional measures reported in the annual reports		12.42	9.9	6.9	9.3	38.52	31.12

Table 2. Measures used to achieve only primary energy savings

	Measure	Corresponding measure in the 3rd NEEAP	Cumulative (3rd NEEAP)	Achieved annual energy savings - final energy (ktoe)			Achieved cumulative savings including the savings from the 3rd NEEAP
			2015	2016	2017	2018	2018
38	Incentives Feed-in tariff			5.61	5.61	3.67	14.89
39	RES without incentives			0.04	0.25	0.37	0.66
40	Reduction of network losses			1.44	3.17	5.28	9.89

In addition to the energy savings calculations, as part of 4th NEEAP, the reduction of greenhouse gas emissions is also calculated. It is not easy to compare with INDC savings because there are some differences in the methodology. Using the MARKAL model (methodology applied in INDC) it is calculated what exactly will happen with the energy system if a certain measure is implemented, i.e. sometimes instead of saving coal for electricity production there is a reduction in electricity imports. In contrary, the methodology applied in NEEAP calculates emissions in such a way that it is assumed that the energy would have been produced in the country. However, the deviations are not high and can only occur in some of the measures. It is important to see that there is a downward trend. The results show that in the period 2016-2018 the PAMs have contributed to the reduction of around 760 kt CO_2 emissions. Compared to the goals defined in the INDC for 2030 (reduction by 3166 kt CO_2) this is achievement of 23% of the goal in a period of only 3 years.

Table 3. GHG emissions reduction achieved of the INDC measures (as reported in the 4th NEEAP)

Intended Nationally Determined Contributions	4th National Energy Efficiency Action plan	
Measure	Measure	GHG reduction 2016-2018
Energy		
Energy Industries		
Reduction of distribution losses	Reduction of network losses	43.2
Large hydro power plants	Large hydro power plants	0
Small hydro power plants **Solar power plants** **Wind power plants** **Biogas power plants**	Incentives Feed-in tariff	67.3
	Incentives feed-in premium	0
	RES without incentives	3
	Solar rooftop power plants	0
Biomass combined heat and power plants	Biomass power plants (CHP optional)	0
Central heating of Bitola	Not considered	n/a
More natural gas power plants	Not considered as mitigation measure	n/a
Geothermal power plants	Not considered	n/a
	Introduction of CO2 tax	n/a
Residential, Non-Specified (commercial and service sector)		
Solar thermal collectors	Solar thermal collectors	18.1
Labeling of appliances	Labeling of electric appliances and equipment	3.8
Phasing out resistive heating devices	Increased use of heat pumps	255.5
	EE obligation schemes	
Public awareness campaigns and network of EE info centers	Public awareness campaigns and network of energy efficiency (EE) info centers	15.1
Retrofitting of building **Construction of new buildings**	Retrofitting of existing central and local self-government buildings	11.6
	Construction of new central and local self-government buildings	
	Retrofitting of existing buildings (res+comm)	48.6
	Construction of new commercial buildings	
	Replacement of windows	
	Construction of new residential buildings	
Construction of passive buildings	Construction of passive buildings	3.1
	EE certificates for buildings	
Phasing out of incandescent lights	Phasing out of incandescent lights	156.5
	Improvement of the street lighting in the municipalities	26.1
	“Green procurements”	3.1

Gasification of households and of the commercial sector		
	Increased use of central heating systems	19.5
	Increased use of more efficient biomass stoves	
Manufacturing Industries and Construction		
	Energy management in manufacturing industries	11.2
	Introduction of efficient electric motors	9.3
	Introduction of more advanced technologies	40.4
Transport		
Biofuels 5%	Not considered, only Biofuels 10% is considered	n/a
Biofuels 10%	Development of the biofuels market	0
Increased use of the railway	Increased use of the railway	6.6
Renewing the car fleet	Renewing of other national road fleet (light duty and heavy goods vehicles and buses)	2.9
	Renewing of the national car fleet	17.1
Increased use of bicycles, walking and introduction of parking policy	Advanced mobility	2.7
Railway to Bulgaria	Construction of the railway to Republic of Bulgaria	0
Electrification of transport	Electrification of the transport	0.1

4 Scenario without measures (WOM)

4.1 Energy

4.1.1 Key assumptions

In general, most of the assumptions in the Energy sector are based on the updated version of the Strategy for Energy Development up to 2040. These include projections of:

- GDP, an average growth rate of 3.8% (Figure 23)
- Population, decline for 0.25% (Figure 24)
- Prices of domestic fuels for the period 2012- 2020 (Energy Regulatory Commission)
- Fuel prices – gas, coal, oil (World Energy Outlook (WEO) 2017-2021)
- CO_2 emissions price (UNDP Study on CO2 tax in North Macedonia 2021 and WEO 2017-2021)
- The import price of electricity for the period 2012- 2021 (HUPX)

Figure 23 Macedonia GDP projections

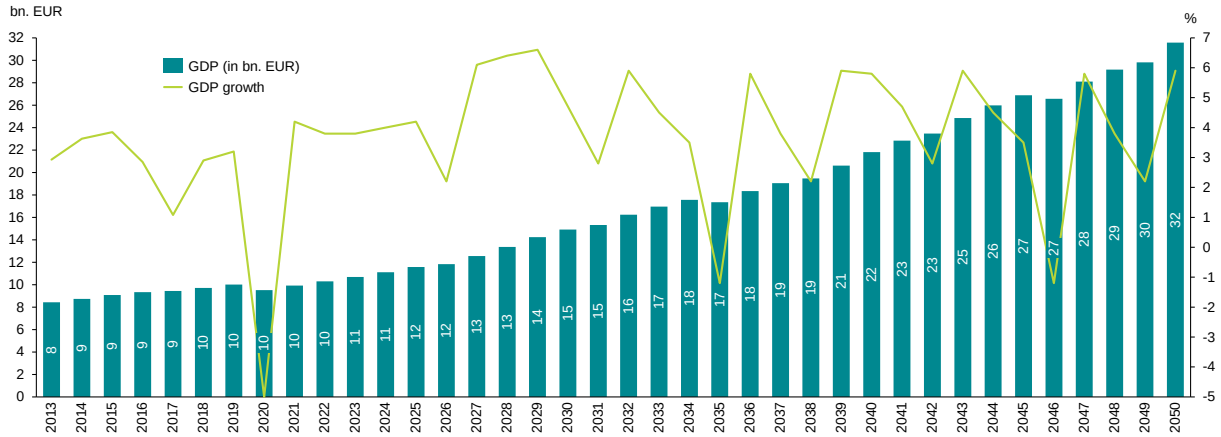
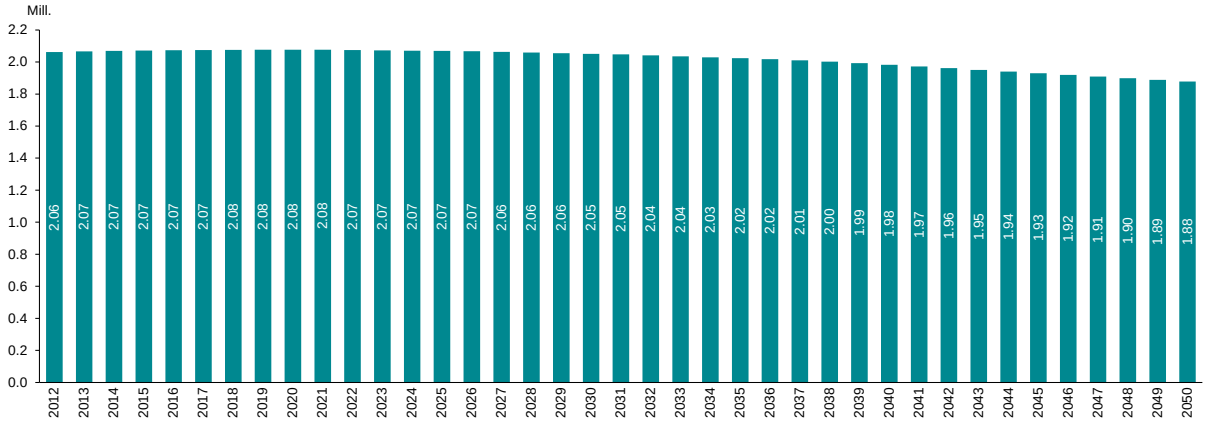


Figure 24 Macedonia population growth



Moreover, the good practices established in the previous reports are implemented in this report with upgraded data for the period 2018-2020, such as:

- Dependence of production index growth of each industry to the GDP,
- Dependence of the transport sector on the number of vehicles (new and old) bought in Macedonia, the average number of kilometers traveled, the average number of tones of goods transported, etc.,
- Dependence of the residential and non-specified sector on the detailed data about Number of households; Members per household, total area, heated area, information about the construction of the buildings (windows, insulation, year of construction, etc.), appliances used for heating and cooling and the degree of their use, number of refrigerators and other appliances, heating and cooling degree days.

All these data are updated with the most recent data used in the update version of the Strategy for Energy Development up to 2040.

4.1.2 Method

As support and help in forecasting the energy demand in the period until 2050, the MARKAL (MARKet ALlocation) program package is used. MARKAL is a complex model for planning the development of the overall energy sector at local, national and/or regional level.

According to the IPCC methodology, it is important to mention that the Energy sector includes all sub-sectors that have energy consumption, i.e., in the Energy sector the emissions from fuel consumption are reported. It often happens that the Industry subsector (Manufacturing, Industry and Construction) is equated with the IPPU sector. The IPPU sector includes emissions which are result from certain industrial processes, while the Industry sub-sector in the Energy sector includes emissions from fuel consumption in the Industry. The same applies to the Agriculture subsector, which is present as a subsector in Energy, but also as a separate sector AFOLU.

To meet the electricity demand, the MARKAL model chooses those technologies that have the lowest cost of electricity generation, which includes the investment costs of a particular energy facility, the fixed and variable maintenance costs as well as the costs of fuel consumed by a certain power plant or if the electricity from imports is cheaper the model imports electricity. In the process of optimization, MARKAL implements the balance of both, the power and the electricity produced.

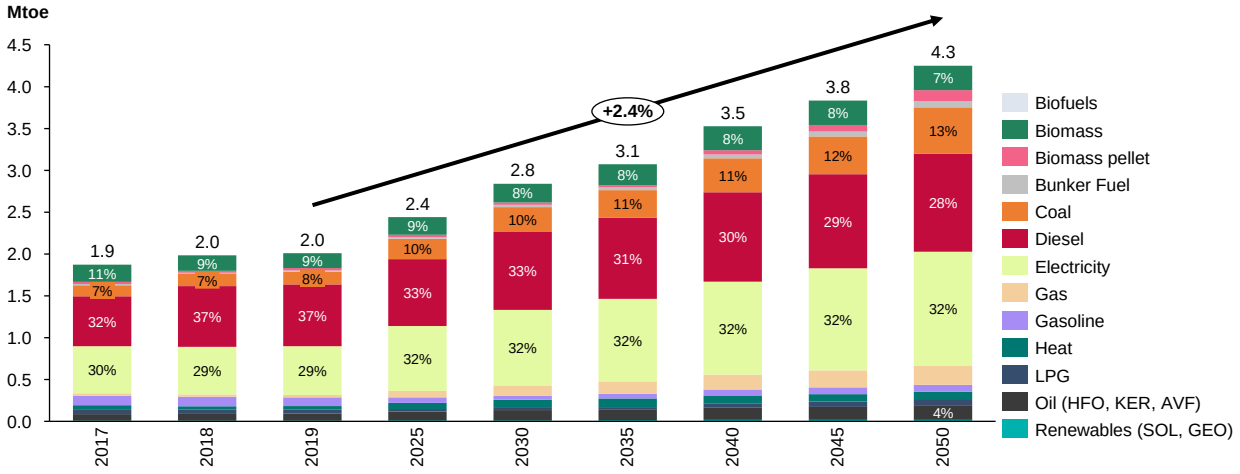
The emission factor of imported electricity

The method developed as a part of the SBUR and TBUR process regarding the GHG emission from the imported electricity is also used for this report. Namely, in previous reports, under the IPCC methodology, the import of electricity, did not have an emission factor. That means that the total national GHG emissions depend on the inverse proportion to the import of electricity. Hence, the experiences from these practices are negative, mainly because the import of electricity can be treated as a climate change mitigation measure. To avoid such a situation and to obtain more real decreases of emissions based on mitigation measures (not made up through import), CO_2, CH_4 and N_2O emission factors for the imported electricity are set up.

4.1.3 Results

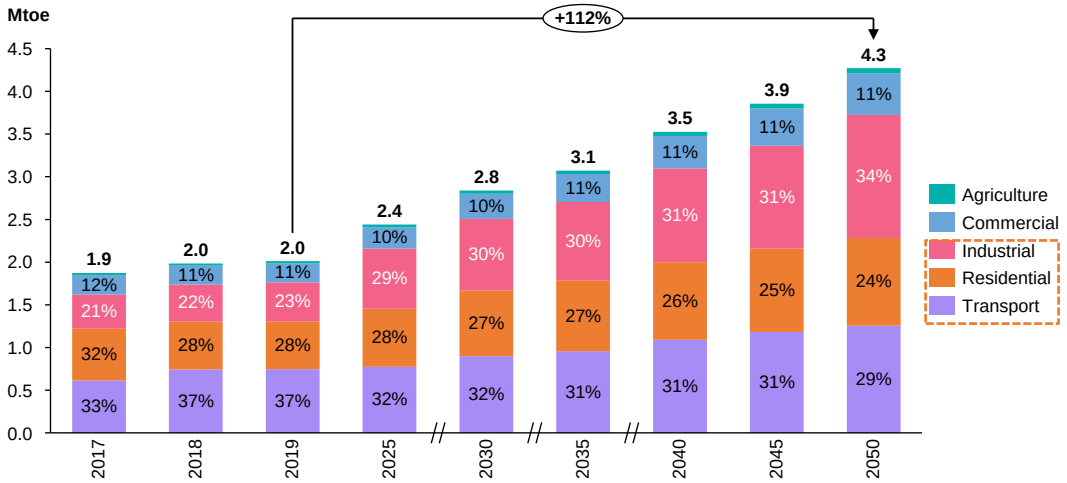
On one hand, the increase in the useful energy demand and on the other hand, not investing in energy efficiency leads to an increase in final energy consumption, which is growing at a rate of 2.4% per year in the period 2019-2050 (Figure 25). Electricity and diesel will continue to play an important role in the final energy consumption participating with around 60%. If the biomass consumption is excluded, the share of the other RES (solar, geothermal) is negligible. However, the share of coal and gas is going to increase, achieving 18% in 2050.

Figure 25. Final energy consumption by fuels



Regarding the final energy consumption by sectors, the Manufacturing Industries and Construction, Residential and the Transport sector are the most dominant ones during the whole period (Figure 26). The largest growth is in the Manufacturing Industries and Construction sector (more than 3 times higher in 2050 compared to 2019).

Figure 26. Final energy consumption by sectors



The increase of the final energy consumption, as well as not investing in RES will double the primary energy consumption in the considered period (Figure 27). Coal will still dominate, but to a much higher extent in the period after 2035, reaching a share of 46% in 2050. Oil products are the second largest contributors with an average share of around 30%. The fastest-growing fuel is natural gas, whose consumption is increased around 3.5 times in 2050 compared to 2019. The increase of the primary energy consumption which is based on fossil fuels will increase GHG emissions in the analyzed period by 114% in 2050 relative to 2019 (

Figure 28).

Compared to the 1990 level, emissions will be increased by 122% in 2050. It is important to note that the emissions presented in

Figure 28

for the period 2014-2050 also include the emissions from electricity import and international aviation, which are not reported in the national total emissions in the GHG Inventory (according to the IPCC methodology). In this report, electricity import is included to properly evaluate the proposed mitigation policies and measures, and not include electricity import as a mitigation option.

Figure 27. Primary energy consumption by fuels

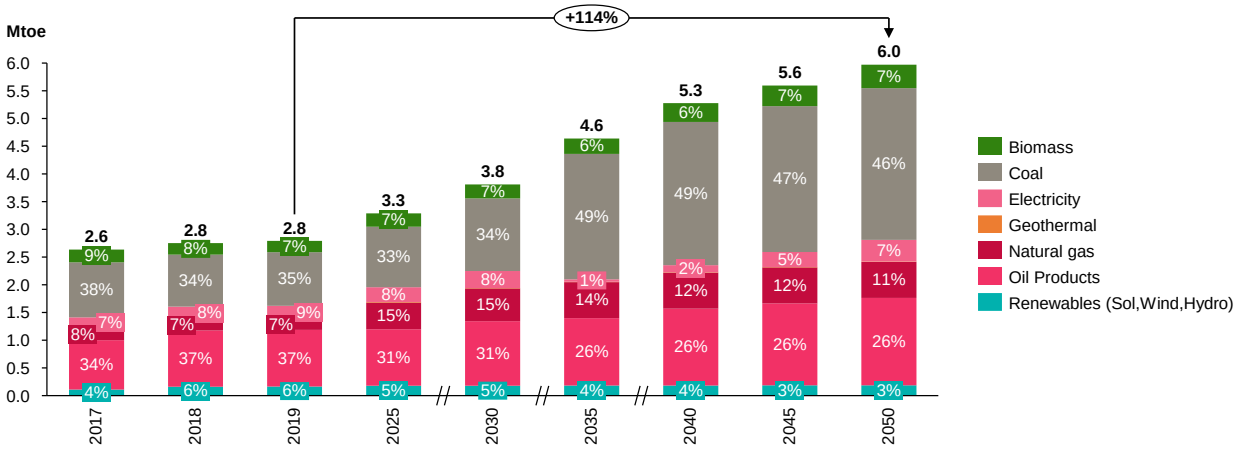
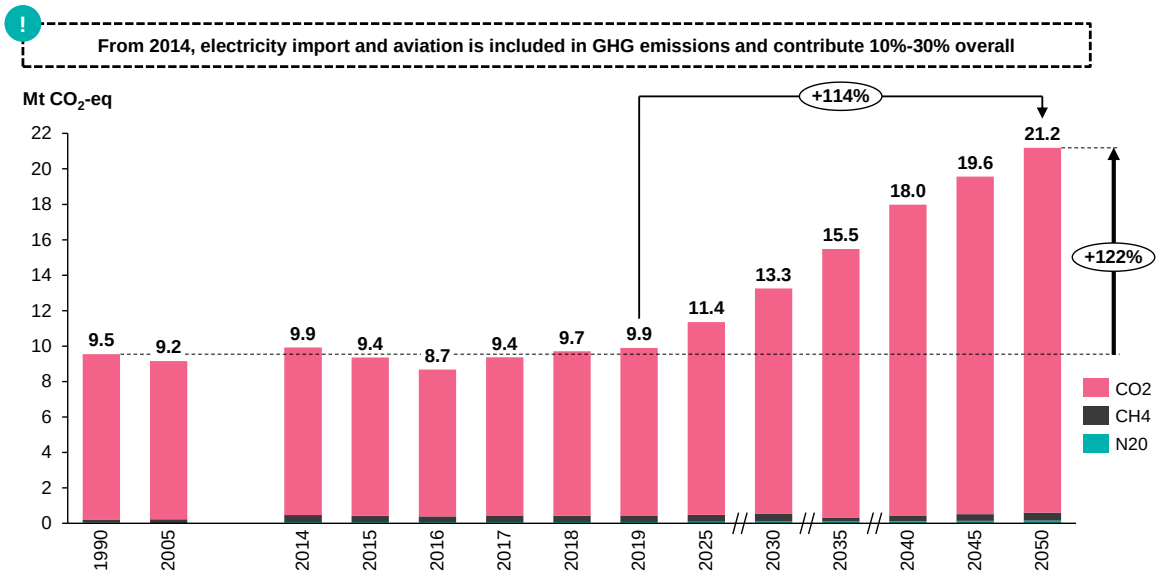
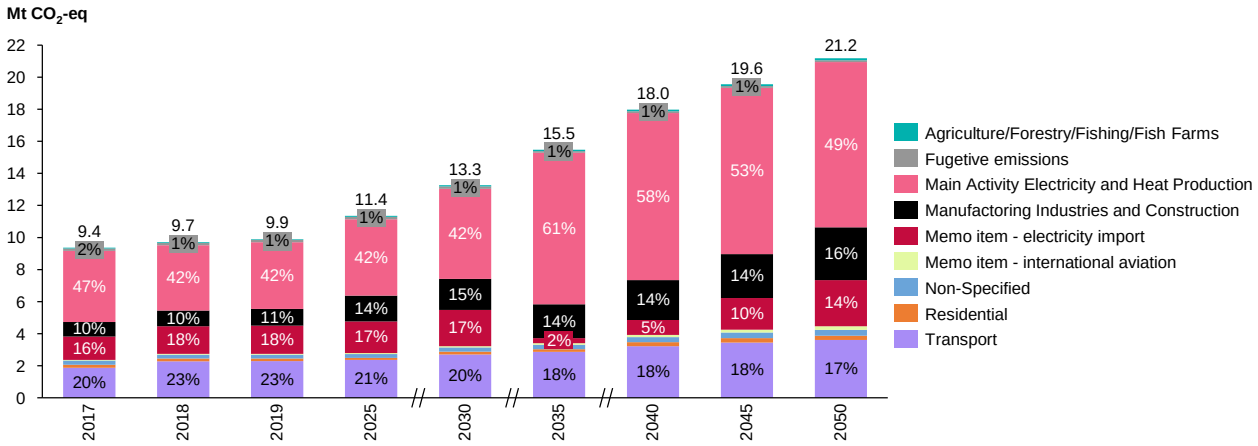


Figure 28. GHG emissions by gas



The consumption of coal makes the Main Activity Electricity and Heat Production sector the greatest producer of GHG emissions (a share of 49% in 2050). As can be noted, electricity import significantly affects GHG emissions with a share of around 14% in 2050 (Figure 29).

Figure 29. GHG emissions by sector



4.2 Industrial Processes and Production Use

4.2.1 Key assumptions

In the IPPU sector there are emissions from the following categories: Mineral Industry, Metal Industry and Product Uses as Substitutes for ODS.

The fundamental assumption used to plan the GHG emissions in this sector is that they are mainly dependent on the increase of the production index growth in the specific industry. Based on this assumption, an analysis of the correlation between the emissions and the added value in each industry category is made. However, this assumption does not apply to the category Product Uses as Substitutes for ODS, where the main source of emissions is from imported appliances (such as refrigerators and air conditioners). For this category it is assumed that the import of appliances depends on GDP, in the WOM scenario.

4.2.2 Method

To determine the dependence of the historical emissions from the production index growth in the Metal industry, a correlation between them is calculated (Figure 30). From the figure, the equation on their dependence is obtained, which is then used to estimate the emissions from these categories up to 2050. The emissions in the Mineral industry are very constant in the previous ten years, so it is assumed that similar trend will continue in the years up to 2050.

For the emissions from the Product Uses as Substitutes for ODS category, a correlation with the total GDP in Macedonia was made, and the obtained equation, together with the planned GDP growth are used to plan the emissions from this category for the period up to 2050, in the WOM scenario (Figure 31).

Figure 30. Dependence between GHG emissions and value added in the Metal industry

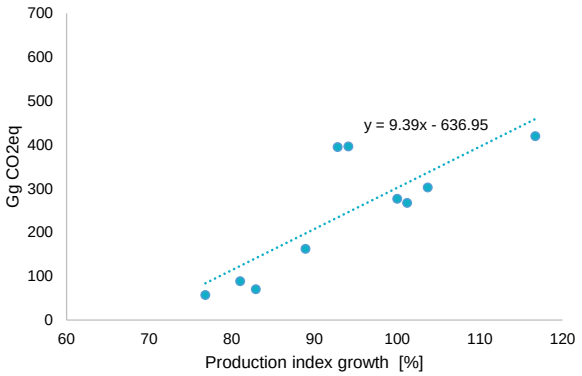
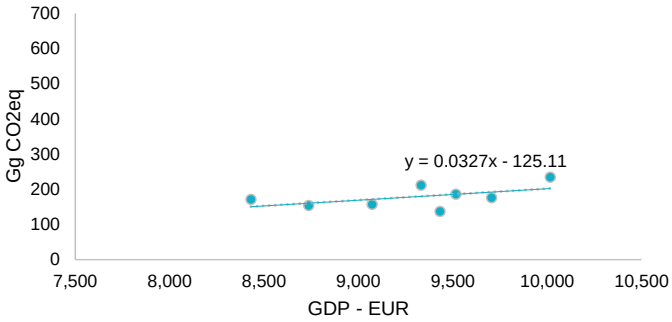


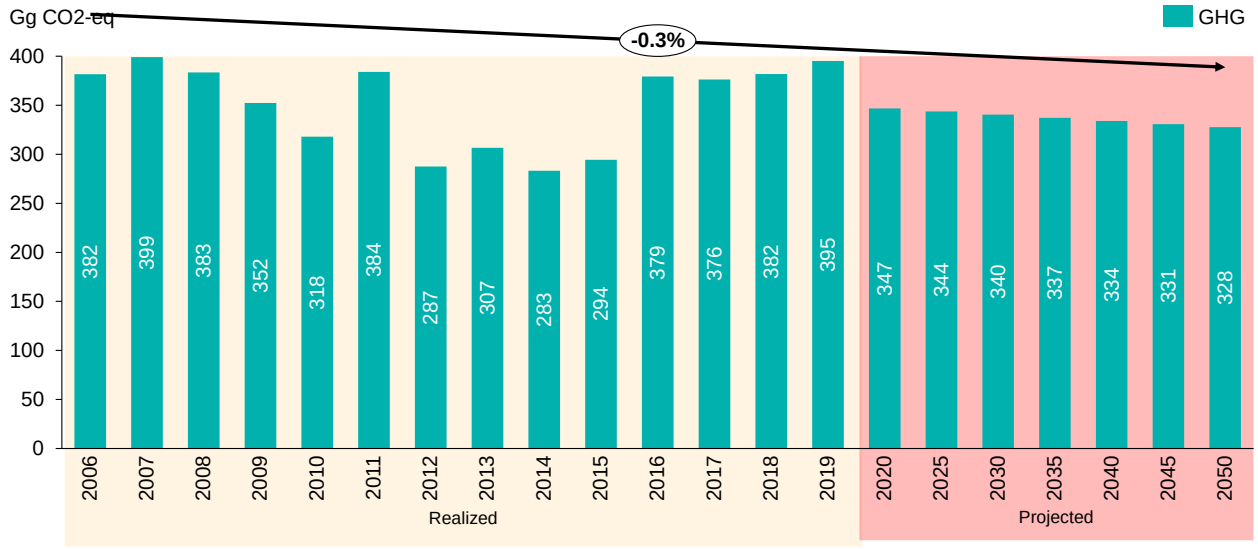
Figure 31. Dependence between GHG emissions in the category Product Uses as Substitutes for Ozone Depleting Substances and total GDP



4.2.3 Results

It is projected that GHG emissions from the Mineral industry, in the period up to 2050 will continue to be mainly constant, with a slight reduction in 2050 when compared to the average value in the period 2006-2019 (Figure 32).

Figure 32. Historic and projected GHG emissions and value added in the Mineral industry (in Gg CO_2-eq)



The emissions in the Metal industry are positively correlated to the production index growth in this category, so the emissions increase with annual rate of 2.9% up to 2050 (which corresponds to the increase in the production index growth), reaching around 900 Gg CO2-eq in 2050 (Figure 33).

The emissions in the category Product Uses as Substitutes for ODS follow the growth of the GDP in Macedonia, and in 2050 they will achieve around 900 Gg CO_2-eq or around 3 times more compared to 2019 (

Figure 34).

Figure 33. Historic and projected GHG emissions and value added in the Metal industry (in Gg CO_2-eq)

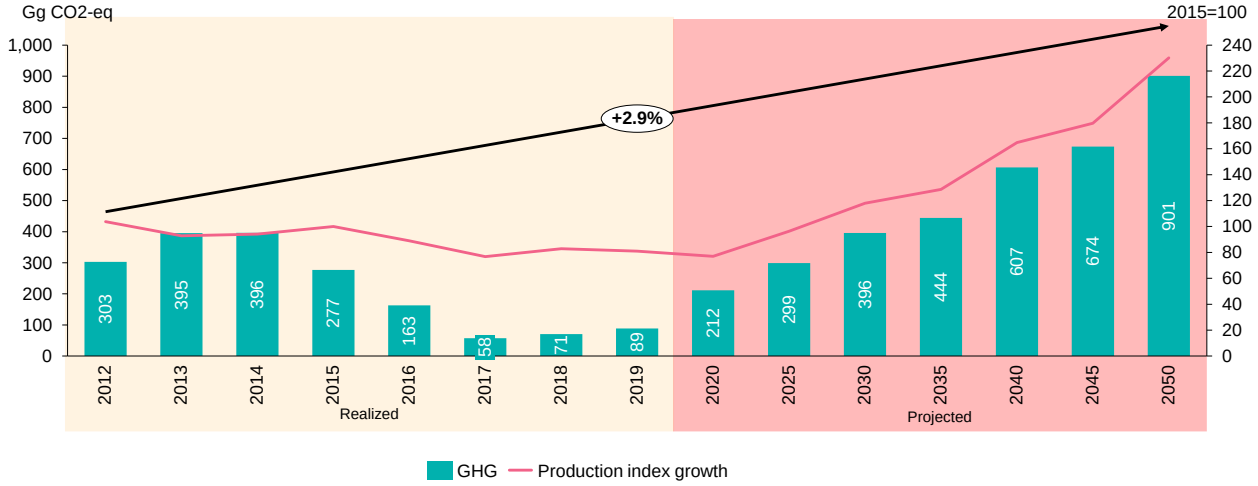
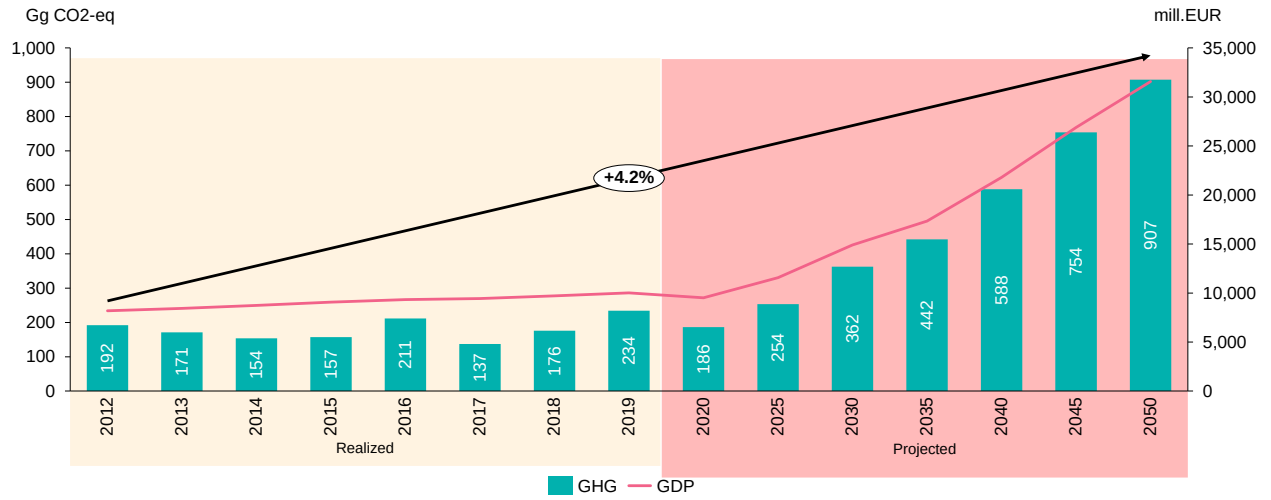
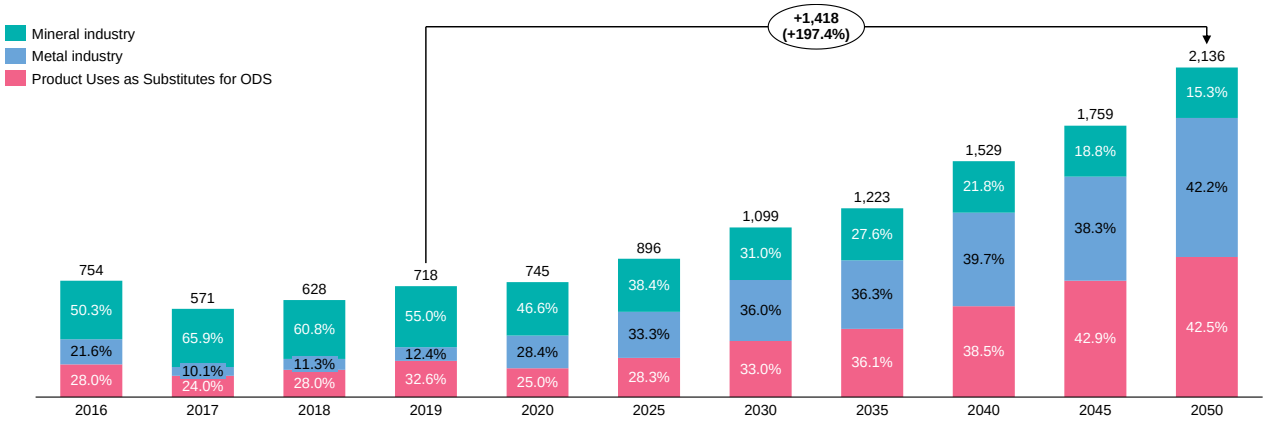


Figure 34. Realized and projected GHG emissions in the category Product Uses as Substitutes for Ozone Depleting Substances and GDP (in Gg CO_2-eq)



Summing up the projections of the emissions in the IPPU sector shows that there is an increase of about 2 times in 2050, compared to 2019 (Figure 35). The emissions will reach 2,136 Gg CO_2-eq in 2050. Product Uses as Substitutes for ODS will be the most dominant category with an emission share of 42.5% in 2050 (32.6% in 2019). The share of the Metal Industry is also increasing, reaching 42.2% in 2050. Since the emissions in the Mineral industry are almost constant, their share is reduced to 15.3% in 2050.

Figure 35. Total GHG emissions in Industrial processes and product use sector by categories (in Gg CO_2-eq)



4.3 Agriculture, Forestry and Other Land Use

4.3.1 Key assumptions

The major drivers of GHG emissions in the AFOLU sector explained by IPCC (increased livestock numbers, increased area under agriculture, increased use of fertilizer, increased area under irrigation, increased human and animal populations etc.) are not noticed in the country, quite the opposite, the official data show that the livestock number decreased, as well as utilized agricultural area and irrigated area. In addition, there is no evidence on increasing in fertilizer use. Moreover, the population in the country is almost stable in the last 30 years. However, this situation can easily change as a result of country NATO membership, advances in the EU approximation process and other processes making the country more attractive for investments in the agricultural sector. The scenario used in predicting the GHG emission from the AFOLU sector was based on the present situation of decreasing trends. Nevertheless, such a situation can quickly change and become outdated as a result of significant investments in the sector.

In defining the WOM scenario for the AFOLU sector, the hypothesis is that the rate of conversion of the land for the period 2000-2019 will keep the same trend by 2050. The assessment of the values for the period 2013-2050 was prepared employing a simple extrapolation method. Still, it is very difficult to make forecasts for the land use trends and change in land use for such a long period. However, CO_2 emissions are calculated according to the basic dynamics of the past changes in land use. Besides, in this scenario, it was assumed

that no mitigation measures will be applied, i.e. the usual practice in land use will be continued. In the Livestock sector the size of the population is expected to be reduced. This decrease began in the early '90s of the last century. It strikes the most the cattle, sheep, goats and horses. In contrast, in pig breeding and poultry, the reduction in the number is not so pronounced, primarily because of the specific mode of production, which is usually intense. Also, it is assumed in the case of dairy farms, their number will be reduced while efficiency in milk production will be increased, due to economic logic.

4.3.2 Method

Livestock

To anticipate GHG emissions from the activities related to livestock production, a Reference scenario is prepared initially without the application of mitigation measures. The projection is based on: a) Trends in the number of heads; b) Forecasts of changes in production systems for each species of domestic animals, and c) Changes in the level of productivity in each production system and for each species of domestic animals, separately. In the Reference scenario, the current state of productivity and management method of the farms was taken to be maintained over the whole planning period.

The data used in the forecasts GHG emissions emitted as a result of activities related to livestock production are taken from different sources for each type and production system separately. For ruminants and horses, official statistics for the period 1990-2014 were used. With these data, extrapolation equations for the number of heads were derived. However, for the number of pigs and poultry, the predictions about the size of the population are based on expert opinion. For all types of domestic animals in the Reference Scenario, the official statistics were used.

Cattle group consists of two different production groups, e.g. dairy cows and other cattle. The presence of organized farms with more than 50 milk cows is very low (about 1-2%). However, from an economic, productive point of view, and the aspect of efficiency in the work, it is realistic to expect that many of the existing small farms (farms with fewer than 10-15 heads) will disappear in the future, against the increase in the number of organized dairy farms with more heads. The projection assumes that the participation of organized farms with more than 50 dairy cows will be 5% of the total dairy farms in 2020. Every 5 years subsequently, an additional 5% of dairy farms will be transformed into organized. On these farms advanced techniques of nutrition and improved management and treatment of manure would be implemented. In this way, even if the current descending trend of dairy population remains (a drop of about 25% by 2050), milk production is expected to increase, primarily due to the increased production per head. Other cattle are also expected to experience a moderate decrease in the population, primarily due to the cross-breeding of the local with more productive breeds, but it is also expected that some of the very extensive farms in the remote mountain regions will completely disappear.

Production systems in sheep and goat breeding are under strong pressure due to a lack of skilled labor, but also because of low productivity. Most of the sheep breeders are older family members. Unless some rapid demographic changes occur, the reduction in the sheep and goat population will continue. If the current trend starting from 1990 continues, then it is realistic to expect a decrease in the population by 2050, except for goats which have a sharp downward trend until 2040 and whose number is projected to remain at the same level as in 2040 (Table 4).

The population of ungulates (horses and donkeys) counts nearly 20,000 heads. This population contributes insignificantly to GHG emissions and is expected to remain stable in the coming period up to 2050.

The number of pigs in the coming period is expected to remain stable, due primarily to the specific intensive system. At the same time, it is expected that the productivity and structure of the herds will change as well as the number of farms that will use modern breeding technologies. Therefore, the projection is that by 2050 the population of pigs will decrease (from 26,574 in 2017 to 18,600 in 2050), but at the same time, the number of pigs for fattening will decrease from 202,197 (2017) to 194,400 (2050).

Poultry is also expected to follow the trend as pig breeding, where the total population would be slightly reduced, while the number of intensive farms for laying hens, broilers and turkeys would increase.

Table 4. Statistical and foreseen data on the number of domestic animals used in forecasting GHG emissions in Livestock

Types and categories	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
Dairy cows	164,781	163,514	133,740	144,814	140,534	136,381	132,350	128,438	124,223	120,129
Other cattle	90,255	92,667	84,050	93,671	92,405	91,318	90,367	87,656	86,863	85,456
Sheep	607,622	613,300	570,887	480,725	461,817	442,910	424,002	405,093	386,186	367,278
Sheep up to 1 year	116,933	113,690	113,671	120,756	116,096	112,043	108,457	104,101	100,006	95,911
Goats	90,673	98,854	70,255	44,462	36,559	28,655	20,752	12,849	4,946	2,954
Horses	17,951	10,041	8,952	19,921	19,926	19,931	19,936	19,941	19,946	19,951
Swine	26,574	23,729	16,956	22,000	21,000	20,000	20,000	20,000	19,100	18,600
Fattening pigs	202,197	195,538	135,770	165,000	168,000	170,000	180,000	185,000	189,200	194,400
Poultry	1840,173	1,828,287	1,562,089	1,820,645	1,910,712	2,005,922	2,106,577	2,201,888	2,296,654	2,392,489
Laying hens	1770,504	1,736,208	1,385,743	1,790,075	1,879,578	1,973,557	2,072,235	2,166,288	2,259,872	2,354,380
Broilers	3,363	4,215	19,786	6,532	7,839	9,406	11,288	12,873	14,427	16,040
Turkeys	5,053	6,620	4,806	5,535	6,642	7,971	9,565	10,908	12,225	13,592
Other poultry	36,039	49,178	43,452	18,503	16,653	14,988	13,489	11,818	10,130	8,477

Forestry

In the preparation of this scenario, it was assumed that in the future, except for forest fires, there will be no other losses on forest land. In doing so, the forest land in 2013 was taken and the average annual losses from fires for the period 1999-2015 and their share in the balance of carbon from forests were calculated.

Agriculture and Land Use

Several modeling options were evaluated, but as a most appropriate, IPCC methodology was selected However, using the IPCC methodology, the changes in output data can be initiated by modifying the input data (by altering the land use change areas or by modifying parameters and coefficients required accordingly to the management practices prevailing in the country).

Moreover, the research on available options for future modeling improvement was conducted. The model AFOLU-B (bottom-up approach) (Hasegawa et al, 2017, Pradah et al, 2019) was determined as an advanced tool for development mitigation analyses in AFOLU sector, but for implementing such a model, the scenario for agricultural production is required as well as many other datasets that are still not available in the country. Moreover, The Joint Research Center of the European Commission published the technical paper Mitigation measures in the Agriculture, Forestry, and Other Land Use sector in 2016 (Leip et al, 2017). This paper provides information on data requirements, for evaluating the mitigation measures and options. However, once again the lack of datasets with decent quality was a major shortcoming for implementation of some advanced approach in modelling. According to the JRC report data sources are mainly developed by observation and research for establishing the parameters required. Therefore, high priority should be given on capacity building for research and observations required for the development of the dataset on national emission coefficients during the next period.

Therefore, the IPCC methodology was the method of choice combined with empirical modelling to estimate trends in Agriculture and land-use changes. However, this hybrid approach can be improved and certain steps should be taken for the development of the datasets required for more advanced modeling.

4.3.3 Results

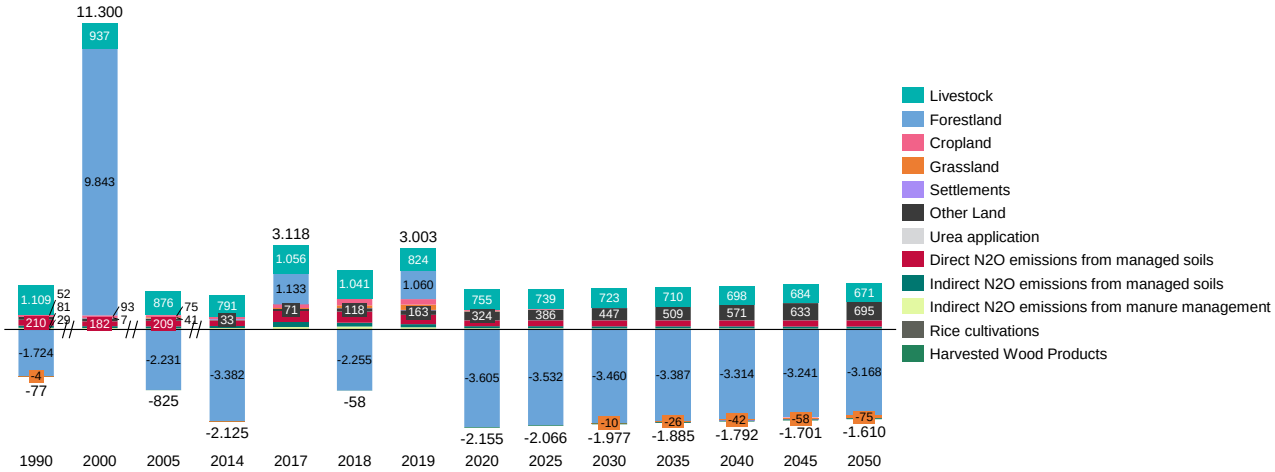
In the period 2014 to 2050 the AFOLU sector emissions in the WOM scenario will increase by 7% (Table 5). The main reason is decreasing of the forest carbon sink for almost 10%. At the same time, the emissions from the other land use are increased by around 30%. Dairy cows and other cattle are the main emitters of GHG emissions in livestock production, while other species (sheep, goats, horses, pigs and poultry) participate

considerably less. Enteric fermentation will remain the main source of methane emissions. However, it is projected that emissions from the Livestock sub-sector will reduce mainly due to the reduction in the number of animals. The GHG emissions from the sub-sector Aggregate sources and non-CO_2 emissions sources on land in 2050 will decrease by 50% compared to 2017, while the sinks from the sub-sector Other are increased although the share of this sector in total sinks is negligible.

Table 5. Estimated total emissions for the period 2017-2050 in the AFOLU sector

	2017	2018	2019	2020	2025	2030	2035	2040	2045	2050
AFOLU	**3,118.0**	**-58.5**	**3,002.7**	**-2,155.5**	**-2,066.4**	**-1,976.9**	**-1,885.4**	**-1,791.8**	**-1701.3**	**-1609.8**
Livestock	**1,056.1**	**1,040.9**	**824.0**	**754.7**	**738.8**	**723.3**	**709.8**	**698.5**	**684.0**	**670.5**
Land	**1,361.3**	**-1,761.2**	**1,634.4**	**-3,226.5**	**-3,118.7**	**-3,010.9**	**-2,903.0**	**-2,795.2**	**-2,687.4**	**-2,579.5**
Forestland	1,133.2	-2,255.4	1,059.6	-3,605.2	-3,532.4	-3,459.6	-3,386.8	-3,313.9	-3,241.1	-3,168.3
Cropland	122.6	265.9	198.7	28.1	19.2	10.4	1.5	-7.3	-16.2	-25.0
Grassland	26.7	103.8	195.9	22.2	6.1	-10.0	-26.2	-42.3	-58.4	-74.5
Settlements	7.4	6.8	16.8	4.6	2.8	1.0	-0.8	-2.6	-4.4	-6.2
Other Land	71.4	117.7	163.4	323.8	385.6	447.4	509.2	571.0	632.8	694.5
Aggregate sources and non-CO_2 emissions sources on land	**699.0**	**663.5**	**544.3**	**342.4**	**341.8**	**341.2**	**340.6**	**340.0**	**339.4**	**338.8**
Urea application	2.8	2.6	2.7	3.1	2.7	2.4	2.0	1.6	1.3	0.9
Direct N_2O emissions from managed soils	433.7	412.8	343.3	214.5	216.9	219.3	221.7	224.2	226.6	229.0
Indirect N_2O emissions from managed soils	148.3	139.5	114.3	76.0	75.8	75.6	75.4	75.2	75.0	74.8
Indirect N_2O emissions from manure management	98.1	93.7	67.5	25.9	25.0	24.1	23.2	22.4	21.5	20.6
Rice cultivations	16.3	15.0	16.5	22.9	21.3	19.8	18.2	16.6	15.0	13.5
Other	**-1.6**	**-1.7**	**0.0**	**-26.0**	**-28.3**	**-30.5**	**-32.8**	**-35.0**	**-37.3**	**-39.5**
Harvested Wood Products	-1.6	-1.7	0.0	-26.0	-28.3	-30.5	-32.8	-35.0	-37.3	-39.5

Figure 36 Total GHG emissions in AFOLU sector by subcategories (in Gg CO2-eq)



4.4 Waste

4.4.1 Key assumptions

The approach established as a part of the SBUR and TBUR is also used in this 4th National Communication. In the Waste and Energy sectors, the same key drivers are used, i.e. GDP and population (explained in the section on macroeconomic drivers). To calculate the GHG emissions from Municipal Solid Waste Disposal,

one of the key parameters, besides population, is the amount of waste per capita. For that purpose, the comparison of the amount of waste per capita in Macedonia with the countries in the nearby region as well as with the European Union 28 (EU28) was made. It is interesting to note that for example in Austria the quantity of waste during the period 2008-2017 is stable. The same situation is with Greece and Croatia, while in Bulgaria the amount of waste per capita is reduced by about 30%. At the EU 28 level there is a downward trend, presented with the black dotted line, while in Macedonia, there is a trend of growth, presented with the red dotted line in Figure 37. It is assumed that these trends will continue up to around 2030, after which there is a decreasing trend in North Macedonia, which corresponds to the EU 28 trend.

In the reference scenario it is also assumed that the composition of waste going to solid waste disposal will remain the same during the whole period as they are for 2018, i.e. food – 36.7%, garden – 10.7%, paper – 10.8%, wood – 0.4%, textile – 3.7%, nappies – 5.0% and plastic, other inert – 32.6%. Additionally, the distribution of waste-by-waste management treatment will be equal to the distribution in 2018, for the whole period. For calculating the industrial waste, the data for the value added for the industry from the MARKAL model are used

4.4.2 Method

A completely new Excel model able to calculate the GHG emissions from the Waste sector was developed in the SBUR, and used in the TBUR, as well as in this National Communication. This model is based on the methodology implemented in the IPCC software and thus covering all subcategories of the Waste sector. With the help of this software and the assumptions made, the emissions for the period until 2050 are calculated.

In the reference scenario mechanical and biological treatment with composting is included (Figure 37). Based on the historical data for the period 2011-2019, an equation for the trendline of the emissions from composting is obtained. Based on this equation, the emissions for the period from 2020 to 2050 are calculated.

Figure 37. Quantity of municipal waste per capita in Macedonia, EU28 and countries in the SEE region (in kg/capita)

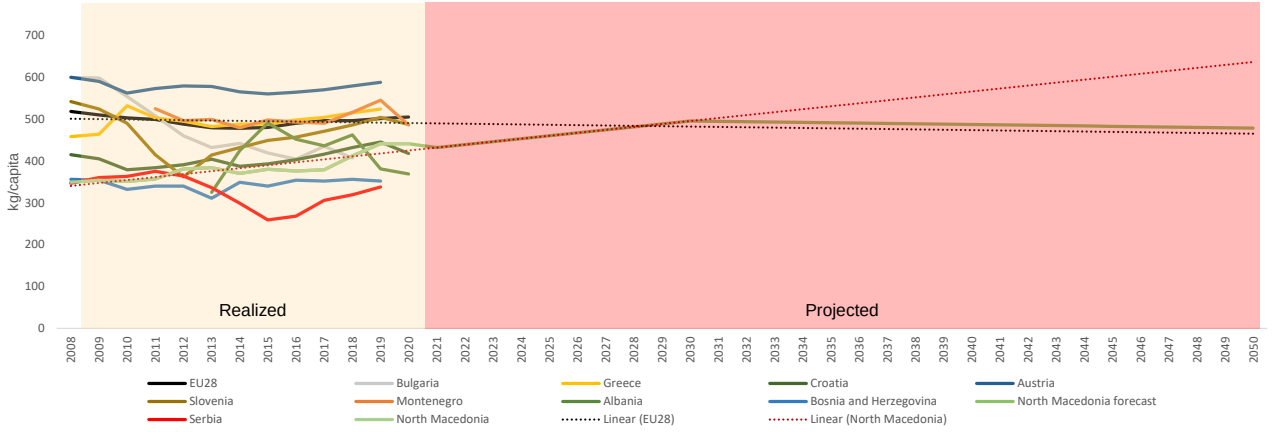
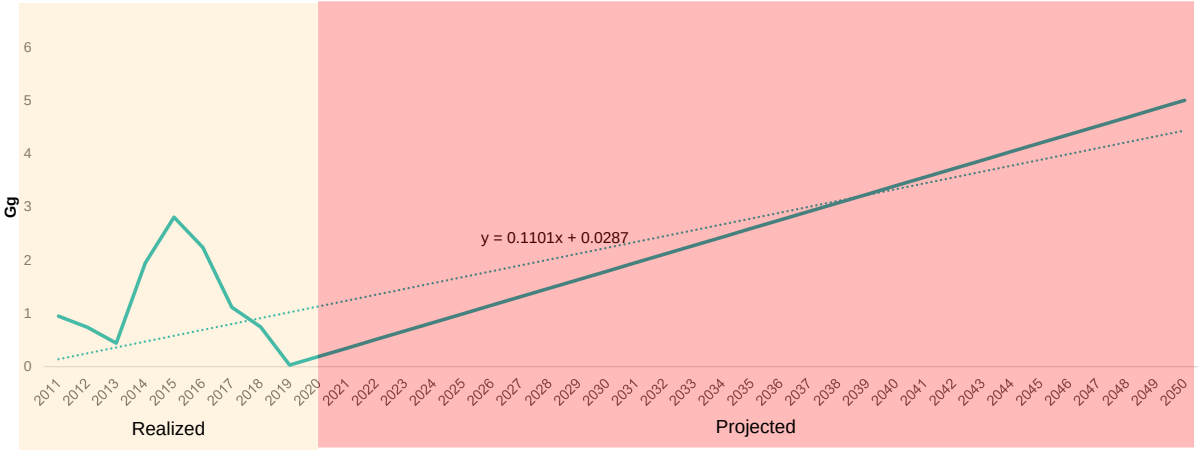
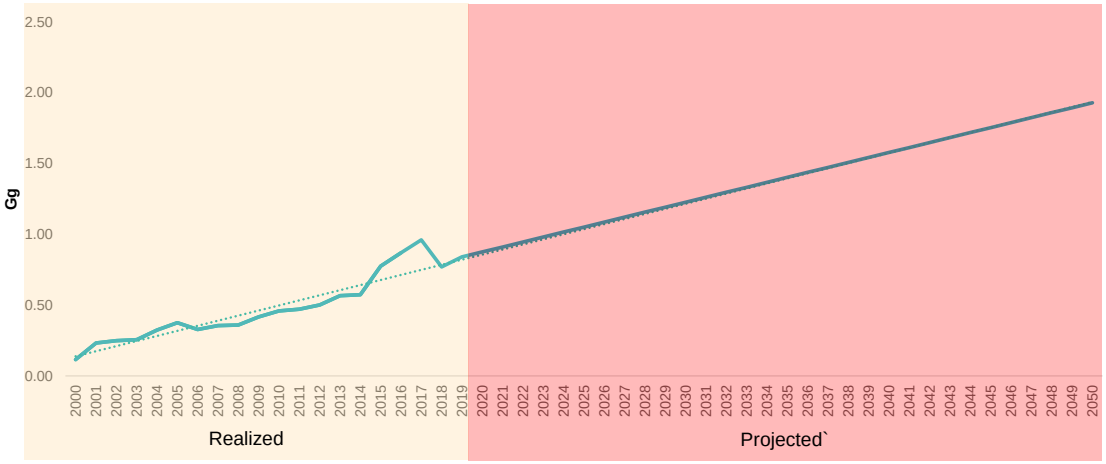


Figure 38. Calculation of waste treated by biological treatment facilities



The emissions from waste incineration are also considered in the WOM scenario, and again a trendline is calculated based on the available historical data for the period 2000-2019 (Figure 39). Using the trendline, emissions from incineration of waste up to 2050 are calculated.

Figure 39. Calculation of the total amount of waste incinerated



In order to estimate the emissions from the industrial wastewater sector, a correlation is made between the Total organic degradable material in wastewater with the value added in the industry for the period from 2014-2018 (Figure 40). The derived equation for the correlation is used to calculate the total organic degradable material in wastewater for the period up to 2050 (Figure 41).

Figure 40. Correlation between the total organic degradable material in wastewater and production index growth in the industry for the period 2014-2018

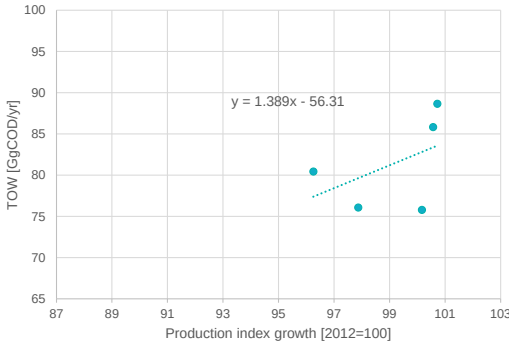
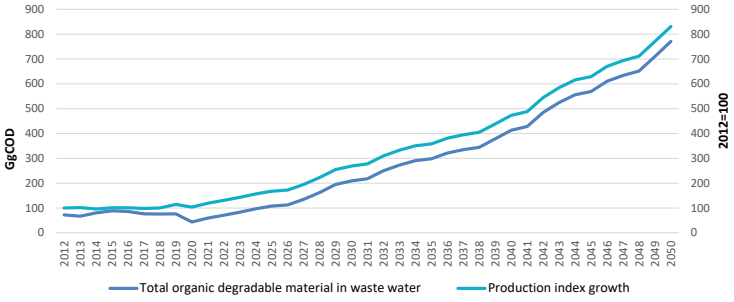


Figure 41. Total organic degradable material in wastewater and production index growth in the industry for the period 20012-2050



4.4.3 Results

The results for the Waste sector in the WOM scenario show that the total GHG emissions from this sector will increase by 50% in 2040 (914 Gg CO_2-eq) compared to 2016 (Figure 42). The subcategory with the largest

share of emissions (81% in 2040) remains the Solid waste disposal for the whole period, followed by the subcategory Industrial Wastewater (10% in 2040) and Domestic Wastewater (6% in 2040). Concerning the emissions by gases, by far the largest amount is from CH_4, with a share of 95% in 2040 (Figure 43).

Figure 42. Total GHG emissions in the Waste sector by subcategories (in Gg CO_2-eq)

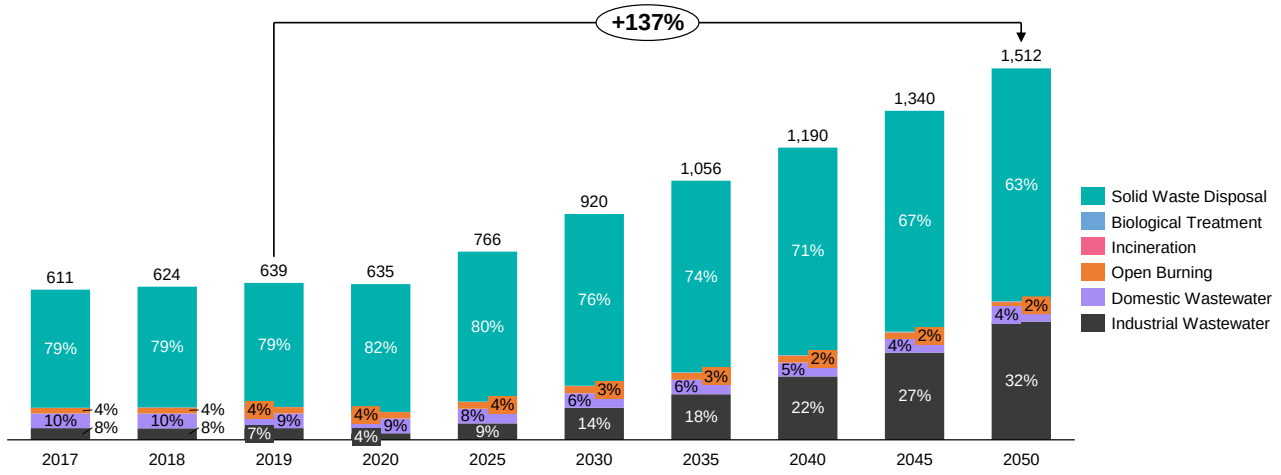
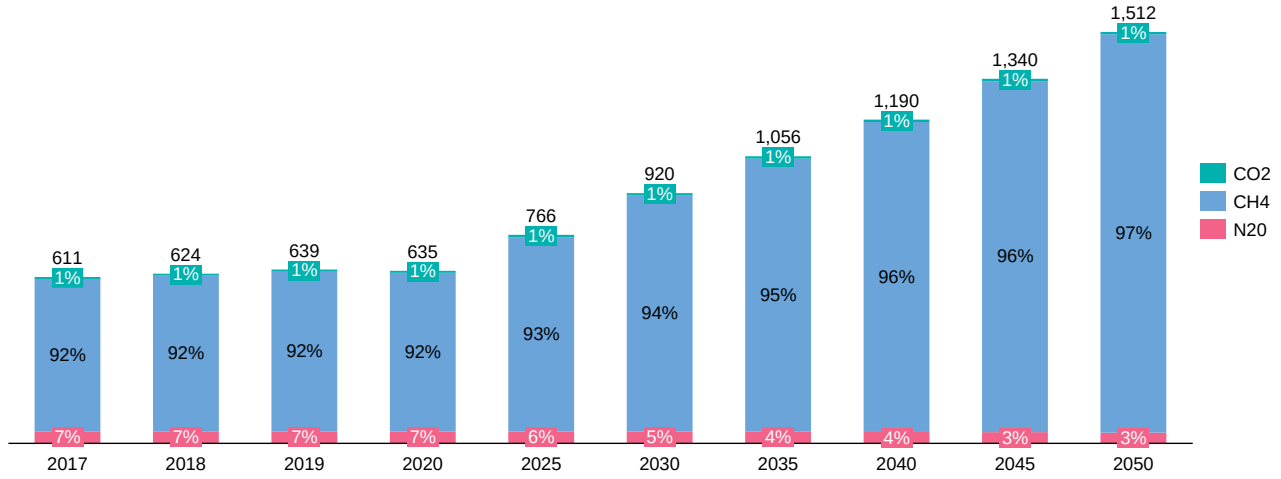


Figure 43. Total GHG emissions in the Waste sector by gasses (in Gg CO_2-eq)

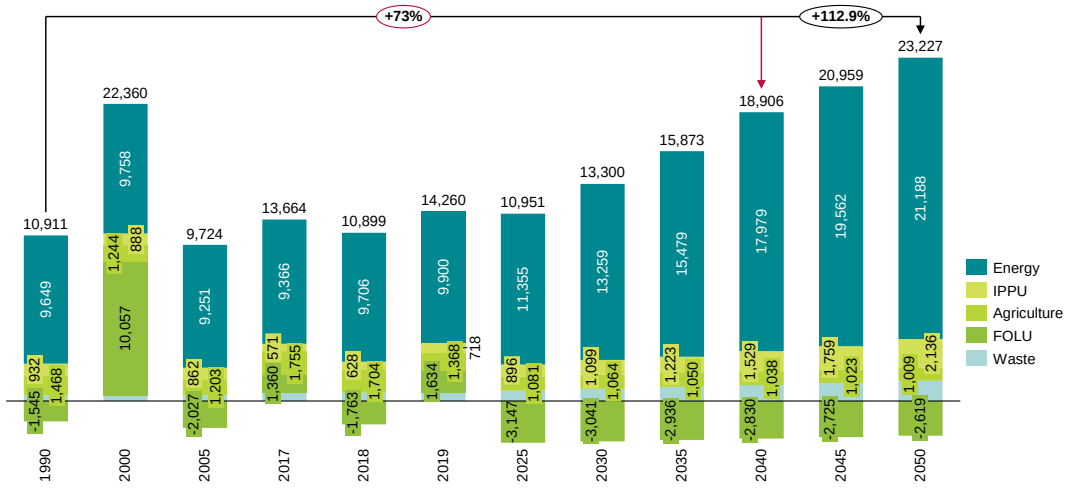


4.5 Total emissions

The total net GHG emissions from all sectors in the WOM scenario is expected to increase by 113% in 2050 compared to 1990, reaching 23,227 Gg CO_2-eq in 2050 (Figure 44). Compared to 2040, the net emissions are increased by 73%. When analyzing the total GHG emissions without the FOLU sector, this increase is also noticeable, i.e.+75% in 2040 and +108% in 2050 compared to 1990 (Figure 45). From these emissions, the largest amount is from the Energy sector, which increases its share by up to 82% in 2050. Additionally, the fastest growing sector in terms of emissions is the Waste sector, where the emissions in 2050 are almost 4 times larger than in 1990. On the other hand, the only sector that is absorbing CO_2 emissions (has negative emissions) is the FOLU sector, and the amount of emissions absorbed is increased by about 50% in 2050 compared to 2018.

The IPCC methodology does not include emissions from electricity imports, as well as from international aviation. To compare the results with the GHG inventory of Macedonia, but also with the results from the other countries, in this report the results without electricity import and international aviation (MEMO) are also presented (Figure 46). Using this approach, in 2040 the net emissions are increased by 63%, while in 2050 by 84.4% compared to 1990. The difference between these two approaches is mainly due to the import of electricity, which in the IPCC approach reduces the GHG emissions.

Figure 44. Total GHG emissions by sectors - WOM scenario (in Gg CO_2-eq)



Note: Due to the large area affected by fires in 2000, FOLU instead of sinks, contributed to the increase of the GHG emissions.

Figure 45. Total GHG emissions by sectors (without FOLU) - WOM scenario (in Gg CO_2-eq)

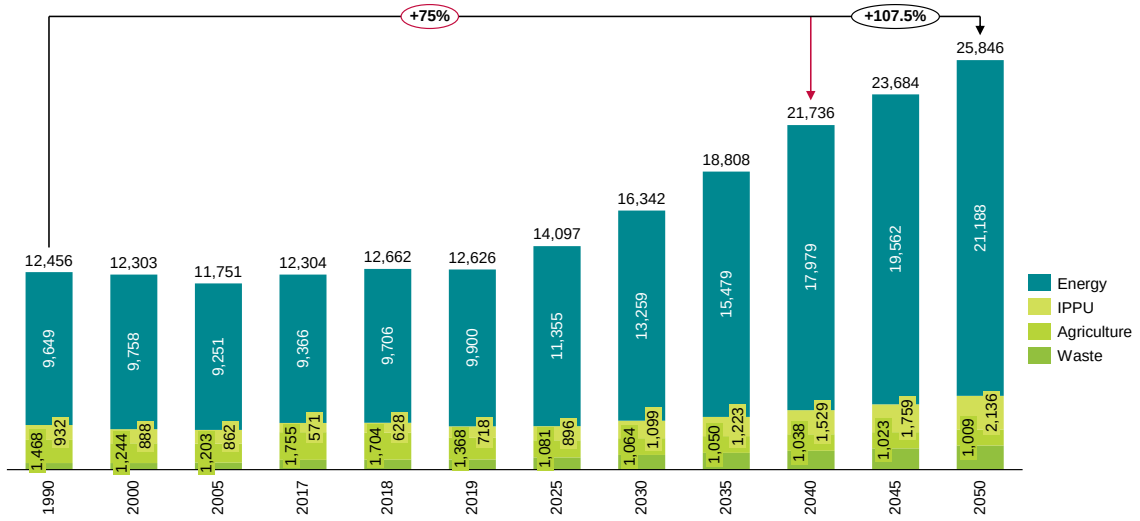
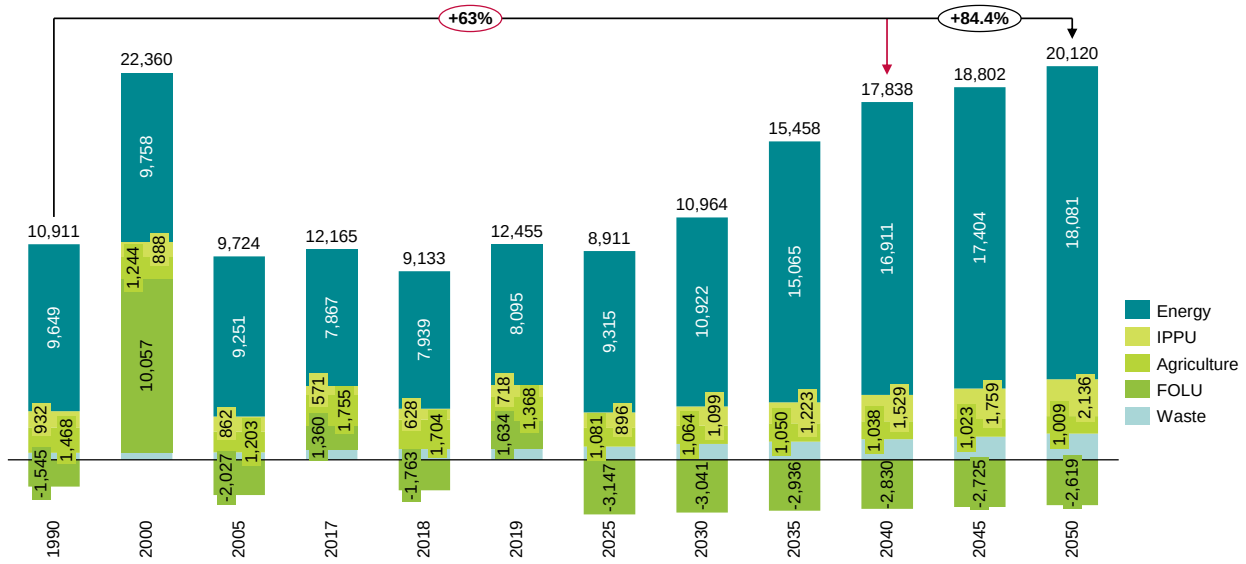


Figure 46. Total GHG emissions by sectors without MEMO - WOM scenario (in Gg CO_2-eq)



5 Mitigation measures and their individual effect

63 climate change mitigation measures/policies are considered in this scenario of which 32 in the Energy sector, 11 in AFOLU (4-Agriculture, 2- Forestry, 5- Land use change), 4 in Waste and there are 16 additional PAMs which are enablers of mitigation actions. All PAMs are presented in this chapter in tabular form and are providing information on:

1 Mitigation action;
2 Main objective;
3 Description;
4 Information: Type; Sector; Relevant Planning documents, legal and regulatory acts; Gases; Methodology; Assumption;
5 Progress of implementation: Steps taken or envisaged to achieve the action; Energy savings (Final Energy and Primary Energy); Estimated emission reductions; Timeframe; Finance (Budget, Costs[1] and Specific Costs[2]); Implementing entity;
6 Progress indicators;
7 Contribution to the achievement of the SDGs.

The effect of the mitigation measures regarding energy savings, emissions reduction and costs are presented in relation to the WOM scenario. The final energy consumption, primary energy consumption and GHG emissions for the Energy sector, in the WOM scenario, are presented on *Figure 25* and *Figure 26* , respectively.

[1] Annual cost includes: Fuel Supply costs, Delivery costs, O&M costs, Annual Investment

[2] Specific cost (Economic effectiveness) - shows the number of investments required in order to reduce 1 t CO_2-eq by applying the specific policy/measure and it is expressed in €/t CO_2-eq

5.1 Energy

5.1.1 Energy supply

PAM 1 Reduction of network losses

Main objective: Reduction of losses in electricity and heat networks

Description: Technical measures for reducing distribution electricity losses comprise of overhead lines replacement with underground (where possible), transition to 20 kV voltage level, installation of new transformation stations to shorten the low voltage lines, as well as automation and remote network management. All these improvements will contribute to better SAIDI and SAIFI indicators. For the heating sector, technical measures include continuous replacement of existing heat pipelines with pre-insulated ones and optimization of the substation operations through automatic control.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Energy supply	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development up to 2040 • Development plan of MEPSO • Rulebook for the manner and conditions for determining a regulated maximum revenue and regulated average tariffs for electricity transmission, organization and management of the electricity market and electricity distribution • Rulebook on regulation of prices for heat energy and system services • Development plan of Balkan Energy Group (BEG)
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	• Technical interventions will reduce the electricity transmission and distribution losses from 12% to 8%, while the district heating system losses will be reduced from 12% to at least 10.5%.
Status of implementation	Under implementation
Steps taken	• Development plan of the electricity transmission system for the period 2020 – 2029 (MEPSO AD – October 2019) • Development plan of the electricity distribution system for the period 2021-2025 (Elektrodistribucija Ltd. Skopje - October 2020) • A General investment plan in electricity distribution network is developed for the next 20 years. • Implementing measures for operation improvement and losses reduction in the heat distribution system
Steps envisaged	• Replacement of obsolete and unreliable 400 kV and 110 kV primary equipment with an average age of over 30 years (switches, circuit breakers, measuring transformers and surge arresters) and replacement of secondary equipment (relay protection, remote control systems and management, power supply, electricity metering) • Replacement old electric transformer with new transformers at 20 kV voltage level • Reduction of the reactive power in the power network • Rehabilitation of the hot water distribution network, replacement of the existing pumps in the heating substations with new energy efficient pumps and other measures for energy efficiency improvement (modernization of the SCADA system, integration of the distribution networks). • Installation of modern equipment for regulation and monitoring in the heating substations for control and reduction of the consumed heat • Implementations of the Strategy for reconstruction/revitalization of the electricity transmission network developed by MEPSO. (Sopotnica-Bitola, Kicevo-Sopotnica, Oslomej-Kicevo • Oslomej-Gostivar, Strumica 1-Strumica 2, Valandovo-Strumica 2, Dubrovo-Valandovo)

Indicators	Value in the last reporting year	Target value
	2016-2018	2030
Progress — Network losses reduced (%)	14.2% for electricity 12.5% heat	10.5% for electricity 10% heat

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

		104.4	168.5	168.5
	Other Primary energy savings (ktoe)	15.0	24.2	24.2
Finance	Budget	170 M€		
	Source of finance	Electricity and heat distribution companies, MEPSO (16 M€)		
Implementing entity		• Electrcity transmission System Operator • Electricity distribution system operators • Heat distribution companies		
Monitoring entity		Energy Regulatory Commission, Energy Agency, Ministry of Economy		
Contribution for the achievement of the SDGs		direct	indirect	
				

PAM 2 Large hydro power plants

Main objective: Increase of the domestic generation capacity from renewable energy sources
Description: Construction of new large hydro power plants taking into account environmental and social impacts

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Energy supply	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Macedonia up to 2040 • National Water Strategy • Development plan of ESM AD (JSC Macedonian Power Plants). • Energy Law • Water Law • Law on environment • Law on concession and public private partnership
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	It is envisaged construction of large hydro power plants according to the following dynamics: • Chebren – 2029 • Vardar valley – 2025-2030 • Tunnel Vardar – Kozjak, Veles and Gradec • Globochica II – 2035 Only Chebren and small hydro on Vardar Valley are available in the WEM scenario
Status of implementation	Under implementation
- Steps taken	• Feasibility/pre-feasibility studies developed • Chebren feasibility study • Prequalification tender for Chebren published
- Steps envisaged	• Invitation for tenders for the construction of the other hydropower plants, selection of the best bidder and commencement of the construction • Analyses by MEPSO and ERC for the implementation of the Capacity Mechanism according to the Regulation 2019/943 on the internal market for electricity and according to state aid rules

Indicators	Value in the last reporting year	Target value
	2018	2030
Progress – Additional installed capacity (MW)	/	808

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	617.7	757.8	1556.7

Other	Primary energy savings (ktoe)	8.5	10.4	21.3
Finance	Budget	1556 M€		
	Source of finance	Public private partnership, ESM		
Implementing entity		• Government of the Republic of North Macedonia • ESM AD (JSC Macedonian Power Plants). • Ministry of Environment and Physical Planning • Energy regulatory commission • MEPSO • Ministry of Economy		
Monitoring entity		Energy Agency, Ministry of Economy, Ministry of Environment and Physical Planning		
Contribution for the achievement of the SDGs		direct	indirect	

* Most critical capacities are Chebren, Veles and Gradec. Latest in 2022, concrete activities for Veles and Gradec should be undertaken. If these capacities are not built the electricity import dependence of the country increase. Another possibility is to substitute the electricity production of Veles and Gradec with production from natural gas power plants, but in this case the set GHG emissions that are coming from the electricity production will increase.

PAM 3 Incentives feed-in tariff

Main objective: Incentives feed-in tariff
Description: Construction of new small hydro power plants, wind and biogas with feed-in tariffs that will stimulate the construction

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Energy supply	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of North Macedonia until 2040 • Renewable Energy Action Plan / National Plan for Energy and Climate • Energy Law • Decree on RES Support Measures • Decision for total installed capacity for preferential producers of electricity • Rulebook on preferential producers that use feed-in tariff • Decision for national mandatory target for share of RE in gross energy consumption
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Through stimulation with feed-in tariffs, it is envisaged that by 2040 additional capacity of: • 124 MW wind power plants • 13 MW biogas power plants • 27 MW small hydro power plants will be constructed.
Status of implementation	Under implementation

- Steps taken	• Decree on the measures for support of electricity generation from renewable energy sources adopted by the Government (5.04.2019).
	• Decision on the total installed capacity for preferential producers of electricity adopted by the Government (5.04.2019).
	• Rulebook on preferential producers that use feed-in tariff adopted by the Energy Regulatory Commission (06.06.2019)
	• Temporary status of preferential producer granted to (28 December 2020)
	  • 114 MW wind power plants (ESM 13 MW Bogdanci, THOR 36 MW, Sveti Nikole/Stip, Kaltun 34 MW Demir Kapija/Gevgelija, EUROING 30 MW Bogdanci)
	  • 4 MW biogas power plants
	  • 27 MW small hydro power plants

- Steps envisaged	• New feed-in tariffs to be granted based on “first come - first served” rule to the producers of electricity from eligible RE technologies until the quota determined for each technology in the Decision on the total installed capacity for preferential producers of electricity is reached

	• Possibility of waiving the granted feed-in tariff in exchange for acquiring ownership or extended concession period of the constructed SHPP to be reviewed and possibly permitted by the relevant law • Construction of power plants

Indicators		Value in the last reporting year		Target value
		2016-2018		2030
Progress	Additional installed capacity (MW)	17.6		159
Emissions reduction (Gg CO_2-eq)		2030	2040	2050
		123.3	147.0	178.9
Other	Primary energy savings (ktoe)	20.3	24.2	29.4

Finance	Budget	557 M€
	Source of finance	Private, incentives through consumer bills
Implementing entity		• Government of the Republic of North Macedonia • Energy Regulatory Commission • Ministry of Environment and Physical Planning • Ministry of Economy, Energy Agency • Private investors
Monitoring entity		Energy Regulatory Commission
Contribution for the achievement of the SDGs		direct:  indirect: 

PAM 4 Incentives feed-in premium

Main objective: Increase of the domestic generation capacity from renewable energy sources
Description: Construction of solar and wind power plants with feed-in premium tariffs to stimulate the construction

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Energy supply	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of North Macedonia up to 2040 • Energy Law • Decree on RES Support Measures • Decision for total installed capacity for preferential producers of electricity • Decision for national mandatory target for share of RE in gross energy consumption • Annual Programme for financial support of production of electricity from RES
Methodology	Through stimulation with feed-in premium, it is envisaged that by 2025 additional capacity will be constructed: • 200 MW solar power plants
Assumptions	Through stimulation with feed-in premium, it is envisaged that by 2040 additional capacity will be constructed: • 200 MW solar power plants • 64 MW wind power plants
Status of implementation	Under implementation
- Steps taken	• Decree on the measures for support of electricity generation from renewable energy sources as well as decision on the total installed capacity for preferential producers of electricity adopted (5.04.2019). • Tender on awarding an agreement for right to use premium for electricity produced from photovoltaic power plants constructed on land owned by the Republic of North Macedonia (21.07.2019) • Tender on awarding the right to use a premium for electricity produced from photovoltaic power plants built on land not owned by the Republic of North

	Macedonia or on land owned by the Republic of North Macedonia on which right to use has been established (2.10.2019) • Based on the conducted tenders, the right to use feed-in premiums was granted for PV power plants with total of 60 MW installed capacity
- Steps envisaged	• Construction of photovoltaic power plants for which the right to use premium has been awarded • Conducting new tenders for awarding agreement for right to use premium for electricity produced from photovoltaic power plant constructed on land owned by the Republic of North Macedonia, on average once per year • Conducting new tenders for awarding the right to use a premium for electricity produced from photovoltaic power plants built on land not owned by the Republic of North Macedonia or on land owned by the Republic of North Macedonia on which right to use has been established, on average once per year

Indicators		Value in the last reporting year	Indicative trajectory	Target value
		2018		2025
Progress	Installed capacity (MW)	/		200
Emissions reduction (Gg CO_2-eq)		2030	2040	2050
		108	108	108
Other	Primary energy savings (ktoe)	21.5	21.5	21.5

Finance – Budget	160 M€
Finance – Source of finance	Private, incentives from the central government budget
Implementing entity	• Government of the Republic of North Macedonia • Ministry of Economy • Private investors
Monitoring entity	Ministry of Economy
Contribution for the achievement of the SDGs	direct: 7 AFFORDABLE AND CLEAN ENERGY indirect: 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 5 Biomass power plants (CHP optional)

Main objective: Increase of the domestic generation capacity from renewable energy sources

Description: This measure considers construction of distributed small sized biomass power plants (CHP optional) with stimulation through feed-in tariffs. Beside increasing the RES share with this CHPs, they should also contribute in increasing the flexibility of the electricity system and ensuring the security of supply. It is envisioned that industrial and municipal solid waste biomass will be used, taking into account the sustainability of the biomass at national level.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Energy supply	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of North Macedonia up to 2040 • Energy Law • Decree on RES Support Measures • Decision for total installed capacity for preferential producers of electricity • Rulebook on preferential producers that use feed-in tariff • Decision for national mandatory target for share of RE in gross energy consumption
Methodology	Through stimulation with feed-in tariffs, it is envisaged that by 2025 biomass power plants with capacity of 5 MW will be constructed
Assumptions	• Through stimulation with feed-in tariffs, it is envisaged that by 2040 biomass power plants with capacity of 15 MW will be constructed
Status of implementation	Under implementation
- Steps taken	• Decree on the measures for support of electricity generation from renewable energy sources adopted by the Government (5.04.2019).

	• Decision on the total installed capacity for preferential producers of electricity adopted by the Government (5.04.2019). • Rulebook on preferential producers that use feed-in tariff adopted by the Energy Regulatory Commission (06.06.2019) • Temporary status of preferential producer granted to 3.15 MW (28 December 2020)
- Steps envisaged	• Amend the Decree on the measures for support of electricity generation from renewable energy sources to provide different treatment (tariff amount, period, etc.) for CHP plants that use industrial and municipal solid waste • Implement the plan for development / construction of regional landfills • Attract the investors trough by meetings through economic chambers of commerce • Construction of power plants

Indicators		Value in the last reporting year		Target value
		2018		2030
Progress	Installed capacity (MW)	/		10
Emissions reduction (Gg CO_2-eq)		2030	2040	2050
		21	21	21
Other	Primary energy savings (ktoe)	3	3	3

Finance – Budget	24.3 M€
Finance – Source of finance	Private, incentives from the central government budget
Implementing entity	• Government of the Republic of North Macedonia • Energy Regulatory Commission • Ministry of Environment and Physical Planning • Ministry of Economy, Energy Agency • Private investors
Monitoring entity	Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs	direct: 7 AFFORDABLE AND CLEAN ENERGY; indirect: 12 RESPONSIBLE CONSUMPTION AND PRODUCTION, 13 CLIMATE ACTION

PAM 6 Solar rooftop power plants

Main objective: Increase of the domestic generation capacity from renewable energy sources

Description: Construction of solar rooftop power plants, on private as well as public buildings, either prosumers or systems from which the overall produced electricity will be used for own purposes or will be stored. One of the possibilities for increasing the installed capacity of solar roof-top systems is through renewable energy communities.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Household, commercial and industry sector	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of Macedonia up to 2040 • Law on Energy • Bylaws on renewable energy • Solar strategy 2022 (European commission)
Methodology [for estimating the emissions]	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	• 800 MW solar capacities are envisioned to be constructed by 2050
Status of implementation [idea, planning phase, under implementation]	Under implementation
- Steps taken	• Rulebook on renewable energy sources adopted. • Distribution grid code adopted • Program for promotion of renewable energy sources and improvement of energy efficiency in household for 2021, adopted (subsidies are planned)

	• Through the project "Design and implementation of photovoltaic systems in rural municipalities" rooftop PV systems were installed on 108 public buildings • Several companies have installed rooftop PV systems (such as Vitaminka, Makprogres, Maks, AgroGama, Maktois, Frotirka, Palteks, Alpinkom, Evropa 92, ABMG, Fikoplast, Birosef) • Few hospitals in Skopje have installed rooftop PV systems (such as Polyclinic Bukurest, hospitals Bit Pazar and Cair)
- Steps envisaged	• Amend the Energy Law, VAT Law and Rulebook on RES to improve the net-billing legal framework and make it in line with EnC guidelines on prosumers • Information campaigns

Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018	2020	2025	2030
Progress	Installed capacity (MW)	3.3			256
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		84.6	214.6		234.9
Other	Primary energy savings (ktoe)	15.4	39.2		42.9

Finance – Budget	699 M€
Finance – Source of finance	Private, donors, subsidies from national and local budget, EE fund
Implementing entity	• Government of the Republic of North Macedonia • Energy Regulatory Commission • Ministry of Economy, Energy Agency • Ministry of Finance • Elektrodustribucija Skopje • Suppliers of electricity • End-users of electricity
Monitoring entity	Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs	direct:  indirect: 

PAM 7 RES without incentives

Main objective: Increase of the domestic generation capacity from renewable energy sources

Description: Construction of wind, solar and biogas power plants on different location in Macedonia carefully selected in order to avoid the impact on environment compared to benefits of generated electricity

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Energy supply	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Electricity Transmission and Distribution networks Development plans • Energy Law • Law on Urban Planning, Law on Construction, Law on Environment, Water Law, and Law on Construction land. • Law on Strategic Investment • Bylaws for renewable energy • Electricity Transmission and distribution Grid codes
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	The following capacities by scenario without incentives are envisioned to be constructed by 2040: • Wind – 950 MW • Solar – 1600 MW • Biogas – 10 MW

Status of implementation		Under implementation
- Steps taken		• Decree on the measures for support of electricity generation from renewable energy sources adopted (5.04.2019). • Decision on the total installed capacity for preferential producers of electricity adopted (5.04.2019). • Electricity grid code adopted • Construction of 100MW Oslomej PV started
- Steps envisaged		• Development of methodology for selection of best for location construction of solar and wind PP • Planning the battery storage capacity and establishing regulatory framework

Indicators		Value in the last reporting year		Target value
		2016-2018		2050
Progress	Installed capacity (MW)	2.7		950,1600,10
Emissions reduction (Gg CO_2-eq)		2030	2040	2050
		74.0	219.8	286.6
Other	Primary energy savings (ktoe)	10.6	31.4	41.0

Finance – Budget	2193 M€
Finance – Source of finance	Private, ESM
Implementing entity	• Government of the Republic of North Macedonia • Ministry of Economy • Ministry of Transport and Communications, • Electricity TSO • Electricity Market Operator • JSC Macedonian Power Plants (ESM AD) • Private investors
Monitoring entity	Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs	direct: 7 AFFORDABLE AND CLEAN ENERGY indirect: 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 8 Development of the biofuels market

Main objective: the RES share in the transport sector is almost zero and it is the main reason for not achieving the country 2020 target. In order to fulfil the 2030 RES target in the transport sector, but also the overall RES target it is necessary to have a functional biofuels market.

Description: Increase the share of biofuels in line with the requirement of the recast on the RES Directive (2018/2001).

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, policy	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Biennial report on the progress of increased utilization of renewable energy sources
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	• Law on biofuels as well as action plan will be adopted in line with the requirements of the RES Directive (2018/2001). • The share of biofuels in 2030 will be 10%
Status of implementation	Under implementation
- Steps taken	• Draft version of the Law on Biofuels developed • Development of study on RES target in transport in 2030 in EnC countries • Development of study on biofuels in Macedonia
- Steps envisaged	• Adoption of the Law on Biofuels • Completion of legal framework on biofuels by adopting the set of bylaws stemming from the Law on Biofuels • Developing and adopting the Action plan on biofuels in which, among other things support measures for domestic producers of biofuels and obligations for oil traders to meet the national target for share of biofuels will be specified • Allocating annual funds in the state budget for supporting the production of biofuels

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress % of biofuels	0	0	5	10

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	96	96	96

Other	Primary energy savings (ktoe)			

Finance	Budget	n/a
	Source of finance	Central government budget, consumers

Implementing entity	• Government of the Republic of North Macedonia • Ministry of economy • Ministry of Finance • Ministry of Environment and Physical Planning • Energy Regulatory Commission • Oil traders
Monitoring entity	• Ministry of economy

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION

5.1.2 Residential and Non-specified

PAM 9 Energy efficiency obligation schemes

Main objective: Fulfilment of the obligation under Article 7 of the EE Directive

Description To set up the scheme the average annual final consumption for the period 2014 – 2016 is used. The measure implements the possibilities from the Article 7 of the EE Directive, i.e. Article 14 of the national Energy Efficiency Law, to exclude the transport sector consumption (paragraph 1) from the sum of the average annual consumption and reduce the consumption in the industry sector (paragraph 2).

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	All sectors (excl. transport and part of the industry according to Annex I of the Directive 2003/87/EC)	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Law on energy efficiency • Directive for EE
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	1. Final energy savings targets of: - 0.35% in 2021 – 2030 - 0.2% in 2031 – 2050 of the average annual energy sales to final customers in the period 2014 – 2016 excluding the customers in the transport sector as well as industries of Annex I of the Directive 2003/87/EC 2. Up to 30% of the costs will be covered through subsidies by the distribution companies or suppliers.
Status of implementation	Under implementation
- Steps taken	• Law on Energy Efficiency adopted
- Steps envisaged	• The Decree for obligation scheme, in which the obligation schemes will be elaborated in details (obligated parties, methodology for calculation of annual energy savings, targets for annual energy savings, measures for achieving the targets, etc.) should be drafted, adopted and implemented by the end of 2021. • One of the recommendations given in Appendix III as a part of the guideline for the development of Building renovation strategy is to Develop an ambitious Energy Efficiency Obligation scheme which focuses on delivering holistic and deep renovation of buildings.

Indicators		Value in the last reporting year		Target value
		2018		2030
Progress indicators	Primary energy savings (ktoe)	2030	2040	2050
		10.3	24.4	58.4
	Final energy savings (ktoe)	10.3	24.4	58.4
Emissions reduction (Gg CO_2-eq)		15.2	35.9	86.0

Finance	Budget	124 M€
	Source of finance	Consumers through their bills
Implementing entity		• Government of the Republic of North Macedonia • Ministry of economy • Energy Agency • Energy Regulatory Commission • Distribution system operators • Suppliersof electricity and gas
Monitoring entity		Ministry of Economy

	direct	indirect

Contribution for the achievement of the SDGs

PAM 10 Solar thermal collectors

Main objective: Reduction of the energy costs and improvement of the efficiency

Description: Hot water electric heaters are one of the biggest energy consumers with a major impact on bills. On the other hand, the reduced investment cost for purchasing and installation of solar thermal collectors is of great importance because it can drop consumer bills for hot water. Also, these systems serve for energy savings and can satisfy at least 50% at annual level, depending on the hot water needs. Furthermore, solar thermal collectors can be used in combination with electricity and district heating systems.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Households and commercial sector	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on Energy • Law on Energy Efficiency • Bylaws for renewable energy • Program for the promotion of renewable energy
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Share of solar thermal collectors in hot water useful demand by 2050 to be 55% in household sector and 40% in commercial sector
Status of implementation	Under implementation
- Steps taken	• Program for promotion of renewable energy sources and improvement of energy efficiency in household for 2021, adopted (subsidies are planned)
- Steps envisaged	• Continuation of adoption and implementation of annual programmes with incentive measures for solar thermal collectors installation

Indicators		Value in the last reporting year	Target value
		2016-2018	2030
Progress	Number of new installed solar collectors	7195*	
	Average area per collector (m^2)	3	

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	14.8	19.9	23.3

Other		2030	2040	2050
	Final energy savings (ktoe)	5.2	7.0	8.1
	Primary energy savings (ktoe)	7.4	9.9	11.6

Finance	Budget	60 M€
	Source of finance	Private, EE fund, incentives from the central government budget, donors
Implementing entity		• Government • Ministry of economy, Energy Agency • End-users • Municipalities and city of Skopje
Monitoring entity		Ministry of Economy, Energy Agency

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

*Just those that applied for subsidies from the Ministry of Economy

PAM 11 Labeling of electric appliances and equipment

Main objective: Increased energy savings in the households, public and commercial buildings
Description: Placing on the market of energy related products that are properly designed and labelled is necessary to ensure that the products sold in Macedonia comply with the EU regulations, as well as to contribute towards greater energy savings by their users (households, public and commercial entities). Proper labelling of energy related products must be observed, so that relevant information on the energy consumption of these products is provided to their buyers and end-users.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory	Households and commercial sector	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• trategy for Energy Development of North Macedonia up to 2040 • Law on Energy Efficiency • Third Energy Efficiency Action Plan • Rulebook on labelling consumption of energy and other resources on devices using energy. • Regulation on eco-design of energy-related products
Methodology [for estimating the emissions]	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	As a result of this measure, it is expected that by 2025 the share of energy efficient technologies (A+++, A++, A+, A or A, B, C according to the new Rulebook for labelling of appliances) will be 10% in the overall stock.
Status of implementation [idea, planning phase, under implementation]	Under implementation
- Steps taken	• Rulebook on labelling consumption of energy and other resources on devices using energy adopted in September 2016 by the Ministry of Economy • Regulation on eco-design of energy-related products adopted by the Government in 2012 • Market inspectors trained on the basic eco-labelling and eco-design rules and requirements stemming from the Energy Efficiency Law
- Steps envisaged	• Adoption of the new Rulebook on labelling consumption of energy and other resources on devices using energy that will incorporate the latest EU technical regulations for certain products • Adoption of the new Decree on eco-design of energy-related products that will incorporate the latest EU technical regulations for certain products • Information campaigns that will target the producers of these products, but more importantly traders and consumers • Continuous education of market and environment inspectors on this subject matter

Indicators		Value in the last reporting year		Target value
		2016-2018		2030
Progress	Number of devices sold (A+++, A++, A+, A)	7789		
Emissions reduction (Gg CO_2-eq)		2030	2040	2050
		42.4	100.5	240.9
Other	Final energy savings (ktoe)	1.6	3.8	9.0
	Primary energy savings (ktoe)	2.3	5.4	12.8

Finance	Budget	48 M€
	Source of finance	Private, EE fund
Implementing entity		• Ministry of economy, Energy Agency • State Market Inspectorate, State Environment Inspectorate • Producers and suppliers of electrical equipment and household appliances • End-users
Monitoring entity		Ministry of Economy, Energy Agency
		direct indirect

Contribution for the achievement of the SDGs		

PAM 12 Increased use of heat pumps

Main objective: More efficient use of electricity

Description: Phasing out heating devices with resistive heaters, as well as inefficient biomass stoves and their replacement with heat pumps in compliance with EU Climate and Energy Policy.

Heating systems also play a major role in the cooling sector and a big savings can be achieved. What is of particularly important and is one of the recommendations of the study on the Green cooling study of the UNDP for Macedonia is to adopt the regulations for labelling the devices. In the study there are 12 other recommendations that are of fundamental importance for these systems and it is necessary to implement all of them.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, policy	Households and commercial sector	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency • Third Energy Efficiency Action Plan • Municipal Energy Efficiency Program • EU Climate and Energy Policy
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	It is assumed that heating devices with resistive heaters will be gradually replaced with heat pumps.
Status of implementation	Planning phase
- Steps taken	• Energy Efficiency Law adopted • Program for promotion of renewable energy sources and improvement of energy efficiency in household for 2021, adopted (subsidies are planned) • Starting from 2019 the City of Skopje and other municipalities (Aerodrom, Kocani, Kavadarci, Bitola) are subsidizing heat pumps. In total 2103 households are subsidized for heat pumps in 2019. • The state-owned power generation company Elektrani na Severna Makedonija (ESM) has allocated funds of € 10 million for subsidizing the households who replace their inefficient stoves and boilers based on firewood, coal, and oil with high-efficiency heat pumps (inverter air conditioners). Hence, each household which replaced their inefficient stoves and boilers with high-efficiency heat pumps will be reimbursed for up to € 1,000. This subsidy is available for households only in the cities with the highest air pollution in the country, including Bitola, Kicevo, Tetovo, and Skopje. Subsidies for purchasing of high-efficiency heat pumps are provided to 5,200 households in Skopje, 2,500 households in Bitola, 1,500 households in Tetovo, and 800 households in Kičevo, during 2020. Project of UNDP for improvement of the air quality with the replacement of the wood stove and introduction of EE measures in at least 100 household from the Aerodrom municipality
- Steps envisaged	• Adopting a Decision to ban the sale of heating devices with resistive heaters. • Adopting a Rulebook for RES Equipment installers • Implementation of the requirements related to Heat Pumps according to the Directive 2018/2001 on the promotion of the use of energy from renewable sources (recast) • Continuation of the program for subsidies (in 2019, about 2100 inverter air conditioners were subsidized, out of a total of about 10000 purchased or 20% of the air conditioners. It is assumed that in the following years again 20% will be subsidized, with a maximum of 50% of the investment from the municipalities and the city of Skopje. Donors participate with about 1% according to the 2020 example from UNDP.) • Campaign for awareness raising for citizens implemented in cooperation with CSOs • Adopting a ban of using coal for household heating

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2016-2018	2020	2025	2030
Progress — Number of heat pump sold	37226			

Emissions reduction (Gg CO_2-eq)		2030	2040	2050
		281.7	430.3	555.9
Other	Final energy savings (ktoe)	106.1	162.1	209.4
	Primary energy savings (ktoe)	142.0	216.9	280.2
Finance	Budget	240 M€		
	Source of finance	Private, EE fund, incentives from the central and local government budget, donors		
Implementing entity		• Ministry of Economy, Energy Agency • End-users • CSOs		
Monitoring entity		Ministry of Economy, Energy Agency		
Contribution for the achievement of the SDGs		direct	indirect	
				

PAM 13 Public awareness campaigns and network of energy efficiency (EE) info centers

Main objective: Implement information campaigns that will raise public awareness about the importance, effects and benefits energy efficiency

Description: Although a large number of campaigns for the promotion of energy efficiency by different stakeholders are provided, still there is a lack of knowledge about the benefits of the EE. Article 12 of the EE Directive stipulates that the country should takes appropriate measures to promote and facilitate an efficient use of energy by small energy customers, including domestic customer. This can be done using different mechanisms. One of them is the establishment of EE info centers in the local self-governments. Following the examples from the EU, besides this measure, several others should be implemented such as:

- Education, starting from the kindergarten,
- Training of the employees in the public institutions at the central and local level,
- Creation of calculation tool that will show the financial and environmental effects from the implementation of a certain measure.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Information	Households and commercial sector	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Investment in public awareness rising campaigns that will increase the share of more efficient appliances (with higher class of efficiency), in the overall stock, by 2050 to 80%
Status of implementation	Under implementation
- Steps taken	• Platform for energy efficiency, for education of the population and journalists and experience sharing of the private sector for successfully implemented EE measures implemented. • Info Center for Energy of the City of Skopje opened. • Free advices to the customers for reasonable consumption of electricity enabled by EVN's Customer Service Centre
- Steps envisaged	• Broadcasting of TV spots, announcements, campaigns and documentary films • Extension of the Platform for energy efficiency • Continuous work of the existing and opening new information centers.

Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018*	2020	2025	2030
Progress	Number of devices sold (A+++, A++, A+, A)	31155			
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		117.9	279.1		669.0
Other	Final energy savings (ktoe)	39.8	94.2		225.8
	Primary energy savings (ktoe)	58.6	138.8		332.7

Finance	Budget	16 M€ + 482 M€ (investment in advanced technologies)
	Source of finance	Private sector, donors, central and local governments
Implementing entity		• Ministry of Economy, Energy Agency • Energy suppliers • End-users
Monitoring entity		Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs		direct:  indirect: 

*In the 4th NEEAP this measure is reported as Public awareness campaigns and network of EE info centers and Increased use of more efficient biomass stoves

PAM 14 Retrofitting of existing residential buildings				
Main objective: To meet the requirements under the Energy Efficiency Law **Description:** The measure considers reconstructions of residential buildings including windows replacement, initiated by the owners and/or supported by commercial banks and funds. This measure will provide issuing of certificates for energy performance of buildings, as a prerequisite for putting the reconstructions into operation.				
Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Households	CO_2, CH_4, N_2O	National
Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency • Rulebook on Energy Performance of Buildings • Rulebook on Energy Audits			
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology			
Assumptions	The existing residential buildings, while meet the standard for at least C class. The annual renovation rate considered is 2%.			
Status of implementation	Under implementation			
- Steps taken	• 31 buildings for collective housing were renovated (EE measures implemented) under the USAID/Habitat Project for residential energy efficiency. • Financial support for rehabilitation of buildings for collective housing with implementation of EE measures provided by some municipalities. • Call for applications for reimbursement of 50% of the costs for windows replacement and installation of PVC and aluminum windows, but not more than 500 €, provided by the Ministry of Economy. • Law on Energy Efficiency adopted. • Program for promotion of renewable energy sources and improvement of energy efficiency in household for 2021, adopted (subsidies for windows replacement are planned) • Project of UNDP for improvement of the air quality with the replacement of the wood stove and introduction of EE measures in at least 100 household from the Aerodrom municipality • The Regional Energy Efficiency Programme (REEP)1 for the Western Balkans was established in June 2017 by the EBRD with the support of the European Union (EU) and in partnership with the Energy Community Secretariat with the aim of addressing financing, legislative, technical, and other barriers to sustainable energy investments in the region. As part of the extension of the REEP programme, the EBRD established the Western Balkans Green Economy Financing Facility (WB GEFF – Residential) with the form of credit lines for a total of up to EUR 85 million extended to Participating Financial Intermediaries in the six countries (North Macedonia, Albania, Bosnia and Herzegovina, Kosovo, Montenegro, and Serbia), for on-lending to eligible Sub-borrowers to finance residential energy efficiency investments. These energy efficiency improvements and/or renewable energy installations undertaken by private individuals in individual apartments or family houses or measures implemented on a building level by housing collectives – groups of individuals, housing associations, housing management companies. The credit lines are supported with a grant funded Investment Incentives up to 20% of the investment cost or the sub-loan amount provided to sub-borrowers to incentivize the uptake of energy efficiency and renewable energy investments. The disbursement of the sub-loans is made through four commercial banks in the country (Ohridska Bank, Sparkasse Bank, Procredit Bank, and NLB Bank). • North Macedonia is a leader in the Western Balkan countries for disbursement of sub-loans and verification of completed sub-projects under WB GEFF. By the end of 2020 there were about 1,670 verified sub-projects from all partner commercial banks in North Macedonia in excess of around EUR 12 million. The average sub-loan amount was about EUR 7,200.			
- Steps envisaged	• Development of building topology • National Building Renovation Strategy to be developed and adopted by the end of 2021 or early 2022 and revised three years later • Bylaws on energy performances of buildings and energy audits to be adopted • System for verification of certificates for energy performance of buildings and Registry of issued certificates to be established and updated by the Energy Agency. • Establishment of an Energy Efficiency Fund.			

		• Continuous Government financial support for reimbursement of costs for windows replacement			
Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018*	2020	2025	2030
Progress	Area retrofitted (m^2)	1481469			
	Energy consumption per heated/cooled area (kWh/m^2)	158			
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		20.5	56.6		90.3
Other	Final energy savings (ktoe)	40.1	110.7		176.4
	Primary energy savings (ktoe)	47.8	131.8		210.0
Finance	Budget	3187 M€			
	Source of finance	Private, donors through commercial EE loans, EE fund			
Implementing entity		• Ministry of Economy, Energy Agency • Donors and financial institutions • Households			
Monitoring entity		Ministry of Economy, Energy Agency			
Contribution for the achievement of the SDGs		direct	indirect		

*The savings are reported together with Retrofitting of existing commercial buildings and Construction of new buildings (in the 4th NEEAP reported as Replacement of windows, Retrofitting of existing buildings (res+com), Construction of new residential buildings and Construction of new commercial buildings)

PAM 15 Retrofitting of existing central government buildings

Main objective: Retrofitting of existing public buildings with aim to meet the objectives of the EE Directive and the Energy Efficiency Law

Description: aving in mind the situation with the energy performance of the public buildings at central level and the role that they should play, it is essential to boost their renovation. Article 10 of the EE Law is of great importance because it can be a starting point for the retrofit expansion.
In absence of recent information about the public building stock, in the calculations the heated area of building stock from the National Program for EE in public buildings (Draft version) is considered (including health care sector, universities, student dormitories, science institutions, social care institutions, centers for social affairs, as well as state administrative sector – Ministry of Economy, Ministry of Education and Science, Ministry of Environment and Physical Planning and Ministry of Transport and Communications). In addition, the specific consumption given in the same document is used (average 214 kWh/m2).
This measure considers reconstruction including windows replacement of existing public buildings under jurisdiction of the central government. The measure will provide issuing of certificates for energy performance of buildings, as a prerequisite for putting the reconstructions into operation.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Central government buildings	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Annual renovation rate of 3% of the existing central government buildings
Status of implementation	Under implementation

- Steps taken		• Draft National Program for energy efficiency in public buildings in the Republic of Macedonia (Phase I) was developed under the GEF Sustainable Energy Project • "Resilient Skopje" – Climate Change Strategy for the City of Skopje developed.
- Steps envisaged		• National Building Renovation Strategy to be developed and adopted. • Bylaws on energy performances of buildings and energy audits to be adopted • List of public sector buildings with at least 250m2 total usable floor area each that do not meet the minimum energy performance criteria be developed and published in 2021 • 3-years Plan for retrofitting of existing central government buildings to be developed and adopted • Establishment of an Energy Efficiency Fund.
Indicators		Value in the last reporting year: 2016-2018* — Target value: 2030
Progress	Area retrofitted (m^2)	151030
Progress	Energy consumption per heated/cooled area (kWh/m^2)	214
Emissions reduction (Gg CO_2-eq)		2030: 20.9 — 2040: 38.6 — 2050: 58.9
Other	Final energy savings (ktoe)	2030: 5.3 — 2040: 9.8 — 2050: 14.9
Other	Primary energy savings (ktoe)	2030: 7.3 — 2040: 13.4 — 2050: 20.5
Finance	Budget	290 M€
Finance	Source of finance	Central government budget, donors
Implementing entity		• Ministry of Economy, Energy Agency • Ministry of Finance • Local self-government • Municipal public enterprises • Donors and financial institutions
Monitoring entity		Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs		direct: 7 AFFORDABLE AND CLEAN ENERGY — indirect: 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

*The savings are reported together with the measure Retrofitting of existing local self-government buildings (in the NEEAP reported as Retrofitting of existing central and local self-government buildings and Construction of new central and local self-government buildings)

PAM 16 Retrofitting of existing local self-government buildings

Main objective: Retrofitting of existing public buildings with aim to meet the objectives of the EE Directive and the Energy Efficiency Law

Description: Local self-government should be encouraged by the central government renovation strategy, so they can put special attention on buildings under their competence.

For the calculations, the heated area of building stock from the National Program for EE in public buildings (Draft version) is considered (including primary and secondary schools, kindergartens, pupils' dormitories, municipalities and the City of Skopje buildings). In addition, the specific consumption given in the same document is used (average 214 kWh/m2).

This measure considers reconstruction including windows replacement of existing public buildings under jurisdiction of the local self-government. The measure will provide issuing of certificates for energy performance of buildings, as a prerequisite for putting the reconstructions into operation

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Local self-government buildings	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Annual renovation rate of 1.5% of the existing local self-government buildings.
Status of implementation	Under implementation
- Steps taken	• Draft National Program for energy efficiency in public buildings in the Republic of Macedonia (Phase I) was developed under the GEF Sustainable Energy Project • "Resilient Skopje" – Climate Change Strategy for the City of Skopje developed. • Law on Energy Efficiency adopted.
- Steps envisaged	• National Building Renovation Strategy to be developed and adopted. • Bylawfstrs on energy performances of buildings, energy audits and municipalities' energy efficiency programmes and plans to be adopted • Regular adoption of energy efficiency programmes and plans by the municipalities and reports on their implementation • Fully-fledged information system on monitoring and management of energy consumption and MVP tool • Establishment of an Energy Efficiency Fund.

Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018	2020	2025	2030
Progress	Area retrofitted (m^2)	See PAM 15			
	Energy consumption per heated/cooled area (kWh/m^2)	See PAM 15			
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		20.9	38.6		58.9
Other	Final energy savings (ktoe)	5.3	9.8		14.9
	Primary energy savings (ktoe)	7.3	13.4		20.5

Finance – Budget	280 M€
Finance – Source of finance	Local self-government budget, donors
Implementing entity	• Ministry of Economy, Energy Agency • Ministry of Finance • Local self-government • Municipal public enterprises • Donors and financial institutions

Monitoring entity	Ministry of Economy, Energy Agency	
Contribution for the achievement of the SDGs	direct	indirect
		

PAM 17 Retrofitting of existing commercial buildings

Main objective: Retrofitting of existing commercial buildings with aim to meet the objectives of the EE Directive and the Energy Efficiency Law

Description: There is lack of data for the commercial building stock, but according to third NEEAP the commercial building area is estimated to nearly 8 million m^2. This measure considers reconstructions of existing commercial buildings including windows replacement initiated by the owners and/or supported by commercial banks and funds. The measure will provide issuing of certificates for energy performance of buildings, as a prerequisite for putting the reconstructions into operation.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Commercial sector	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency
Methodology [for estimating the emissions]	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Annual renovation rate of 1.5% of the existing commercial buildings.
Status of implementation [idea, planning phase, under implementation]	Under implementation
- Steps taken	• Law on Energy Efficiency adopted.
- Steps envisaged	• Bylaws on energy performances of buildings and energy audits to be adopted • Establishment of an Energy Efficiency Fund • One of the recommendations given in Appendix III as a part of the guideline for the development od Building renovation strategy is to undertake a building stock analysis, covering the non-residential stock similar to the survey provided by the SSO for the households

Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018	2020	2025	2030
Progress	Area retrofitted (m^2)	SEE PAM 14			
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		48.6	86.7		150.7
Other	Final energy savings (ktoe)	12.3	21.9		38.1
	Primary energy savings (ktoe)	16.9	30.1		52.3

Finance	Budget	880 M€
	Source of finance	Private, donors through commercial EE loans, EE fund
Implementing entity		• Ministry of Economy, Energy Agency • Ministry of Finance • Commercial building owners
Monitoring entity		Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs		direct: 7 AFFORDABLE AND CLEAN ENERGY indirect: 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 18 Construction of new buildings

Main objective: Construction of new buildings that will meet the minimum criteria set in the Rulebook of energy performance in buildings

Description: An energy efficient building reduces maintenance and utility costs, but, in many cases, improves durability, lessens noise, increases comfort and creates a healthy and safe indoor environment. A further goal of energy efficient construction is to limit damage to the ecosystem and reduce the use of natural resources like energy, land, water, and raw materials. This measure will provide issuing of certificates for energy performance of buildings, as a prerequisite for putting the building into operation.

Timeframe	Type	Sector	Gases	Scope
2020 – 2040	Technical, regulatory	Households	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency
Methodology [for estimating the emissions]	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Construction of new residential buildings, while meeting the minimum energy performance requirements as the first criteria (in accordance with national legislation and cost-optimal calculations)
Status of implementation [idea, planning phase, under implementation]	Under implementation
- Steps taken	• Financial support for construction of new buildings at municipality level • Law on Energy Efficiency adopted.
- Steps envisaged	• Bylaws on energy performances of buildings and energy audits to be adopted • Establishment of an Energy Efficiency Fund

Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018	2020	2025	2030
Progress	Area retrofitted (m^2)	See PAM 14			
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		21.3	32.6		46.3
Other	Final energy savings (ktoe)	12.9	19.8		28.0
	Primary energy savings (ktoe)	15.1	23.1		32.7

Finance	Budget	370 M€
	Source of finance	Private, donors through commercial EE loans, EE fund
Implementing entity		• Ministry of Economy, Energy Agency • Donors and financial institutions • Investors (households)
Monitoring entity		Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs		direct: 7 AFFORDABLE AND CLEAN ENERGY indirect: 1 NO POVERTY, 12 RESPONSIBLE CONSUMPTION AND PRODUCTION, 13 CLIMATE ACTION

PAM 19 Construction of passive buildings

Main objective: After 31.12.2020 all new building should be nearly zero-energy buildings

Description: The measure considers construction of new passive residential buildings in compliance with the EU Directive 2010/31/EU. This measure will provide issuing of certificates for energy performance of buildings, as a prerequisite for putting the building into operation.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	Households	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on energy efficiency
Methodology [for estimating the emissions]	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Construction of new passive buildings, while meeting the standard for at least A+ class (15 kWh/m2) starting from 2020 and continuously increasing their number so that in 2040, more than 90% of new buildings are assumed to be passive.
Status of implementation [idea, planning phase, under implementation]	Under implementation
- Steps taken	• Law on Energy Efficiency adopted.
- Steps envisaged	• National Building Renovation Strategy to be developed and adopted. • Bylaws on energy performances of buildings, energy audits and municipalities' energy efficiency programmes and plans to be adopted • Plan for increasing the number of passive buildings with approximately zero energy consumption to be developed and adopted in 2022 • Establishment of an Energy Efficiency Fund

Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018*	2020	2025	2030
Progress	Area retrofitted (m^2)				
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		16.6	58.2		94.0
Other	Final energy savings (ktoe)	8.3	29.1		47.0
	Primary energy savings (ktoe)	10.3	36.0		58.1

Finance – Budget	1520 M€
Finance – Source of finance	Private, donors through commercial EE loans, EE fund, financial support at municipality level
Implementing entity	• Ministry of Economy, Energy Agency • Ministry of Transport and Communication • Donors and financial institutions • Investors (households)
Monitoring entity	Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs	direct: 7 AFFORDABLE AND CLEAN ENERGY indirect: 1 NO POVERTY, 12 RESPONSIBLE CONSUMPTION AND PRODUCTION, 13 CLIMATE ACTION

* In the 4th NEEAP reported as Construction of passive buildings and EE certificates for buildings

PAM 20 Phasing out of incandescent lights

Main objective: Improve the efficiency of lighting following the EU policies

Description: Governments around the world have passed measures to phase out incandescent light bulbs for general lighting in favour of more energy-efficient lighting alternatives. The goal is to improve energy efficiency, rather than forbid the use of incandescent technology. This measure includes replacing conventional incandescent light bulbs with halogen ones (at the beginning) and later with compact fluorescent (CFL) and LED.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, policy	Households and commercial sector	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on Energy Efficiency • Commision Regulation(EC) No 244/2009 implementing Directive 2005/32/EC of the European Parlament and of the Council with regard to ecodesign requirements for non-directional household lamps
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	As incandescent lights are prohibited in EU since 2012 (and also following countries from EnC, such as Montenegro), it is assumed that the new Decree on eco-design of energy-related products will include prohibit of sales of incandescent light bulbs (with a transitional period of 2-3 years)
Status of implementation	Under implementation
- Steps taken	The price of LED lights is decreasing and is approaching the price of incandescent lights.
- Steps envisaged	• Adoption of new Decree on eco-design of energy-related products in which the most recent EU implementing measures (technical regulations) related to non-directional, fluorescent and high intensity discharge lamps (lights) will be transposed and possibly prohibit sales of incandescent light bulbs in a certain transition period. • Information campaign targeting lamps suppliers and consumers

Indicators		Value in the last reporting year	Indicative trajectory		Target value
		2016-2018	2020	2025	2030
Progress	Number of light bulbs sold (LED, CFL)				
	Installed capacity (MW)				
	Electricity consumption (MWh)				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	114.0	131.9	139.5

Other		2030	2040	2050
	Final energy savings (ktoe)	36.3	42.0	44.4
	Primary energy savings (ktoe)	49.2	56.9	60.2

Finance	Budget	1027 M€
	Source of finance	Central government budget, private
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Economy, Energy Agency • State Market Inspectorate • Lamps suppliers • End-users
Monitoring entity		Ministry of Economy, Energy Agency

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION

PAM 21 Improvement of the street lighting in the municipalities

Main objective: Reduce the costs and increase the quality of street lighting

Description: The cost of street lighting, including electricity and maintenance, can have a huge impact on the budget of the municipalities. In addition, having in mind that a lot of manufactories work on daily bases on the improvement of the light bulbs, new opportunities are being opened for the municipalities. The inefficient light bulbs should be replaced, purchasing new ones that comply with the criteria of belonging to the highest EE class possible (CFL and LED lamps).

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Local self-government	CO_2, CH_4, N_2O	Local

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on Energy Efficiency
Methodology	Replacement of the mercury lamps with sodium and LED lamps. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Improvement rate of 100% of street lighting by 2040.
Status of implementation	Under implementation
- Steps taken	• Street lighting in some municipalities replaced • Tenders completed and/or replacement of street lights ongoing in more than 10 municipalities • Promotional activities for the implementation of public-private partnership (PPP) taken
- Steps envisaged	• Adoption of Decree on energy performance contracts • Energy Agency to develop and publish Instruction for energy performance contracts and tenders for their award • Energy Agency to start keeping list of ESCO and publishing it, as well as other energy performance contract related information on its web site • Continuing the promotional activities for the implementation of public-private partnership

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2016-2018	2020	2025	2030
Progress	Number of light bulbs replaced (LED, CFL)				
	Installed capacity (MW)				
	Electricity consumption (MWh)				
Emissions reduction (Gg CO_2-eq)		2030	2040	2050	
		37.9	37.9	37.9	
Other	Final energy savings (ktoe)	7.8	7.8	7.8	
	Primary energy savings (ktoe)	14.2	14.2	14.2	

Finance	Budget	40 M€
	Source of finance	Central and local government budget, ESCO
Implementing entity		• Government of the Republic of North Macedonia • Energy Regulatory Commission • Ministry of Environment and Physical Planning • Ministry of Economy, Energy Agency • Local self-government
Monitoring entity		Ministry of Economy, Energy Agency
Contribution for the achievement of the SDGs		direct: 7 AFFORDABLE AND CLEAN ENERGY indirect: 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 22 “Green procurements”

Main objective: Application of energy efficiency criteria (“greening”) in public procurement procedures

Description: According to Article 6 from the EE Directive, central governments can purchase only products, services and buildings with high energy-efficiency performance. Intensified activities should take place to ensure legal and technical knowledge and skills of public sector entities for inclusion and evaluation of requirements for energy efficiency in public procurement procedures by applying the criteria of most economically advantageous tender.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory	Public bodies	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on Energy Efficiency
Methodology	Implementation of energy efficiency criteria. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Increased rate of advanced energy efficiency technology due to public procurement by 7%
Status of implementation	Under implementation
- Steps taken	• Law on Energy Efficiency adopted • Law on Public procurements

- Steps envisaged	• Drafting and adopting the following bylaws from the Law on Energy efficiency:
	  ◦ Decree on eco-design of energy related products,
	  ◦ Rulebook on Eco-labelling of energy related products,
	  ◦ Rulebook on energy performance of buildings and
	  ◦ Rulebook on green procurements that will include methodology for determining the energy efficiency level of other products as foreseen in the article 13 of the EE Law
	• Organizing specialized trainings for contracting authorities on this subject matter
	• Developing model technical specifications for purchase of certain energy related products of general use that will include green and energy efficiency criteria, thus facilitating the procurement process

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2016-2018	2020	2025	2030
Progress	Number of devices purchase (A++, A+, A)				
Emissions reduction (Gg CO_2-eq)		2030	2040	2050	
		2.9	6.9	16.5	
Other	Final energy savings (ktoe)	1.4	3.2	7.7	
	Primary energy savings (ktoe)	2.0	4.7	11.3	

Finance – Budget	34 M€
Source of finance	Central and local government budget
Implementing entity	• Ministry of Economy, Energy Agency • Public Procurement Bureau • Local self-government
Monitoring entity	Ministry of Economy, Energy Agency

Contribution for the achievement of the SDGs

direct: 7 AFFORDABLE AND CLEAN ENERGY

indirect: 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 23 Increased use of central heating systems

Main objective: Reduction of local air pollution, as household heating is one of the main sources for local pollution

Description: Increased use of the existing central heating systems through the implementation of information campaigns for connecting new consumers, including those who have been disconnected from the system in the past.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, information	Households and commercial	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of North Macedonia up to 2040 • Law on Energy Efficiency • Energy Law, Law on urban planning, Law on Construction • Study for determining the techno-economic optimal and environmentally sustainable structure of heating and implementation of the central supply of sanitary hot water in the City of Skopje • Energy development program of the Municipality
Methodology	Implementation of information campaigns. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Information campaigns will contribute to maximize the utilization of the existing network as well as to enable construction of new network, which will increase the heat consumption for at least 40%.
Status of implementation	Under implementation
- Steps taken	• Studies for analysis of the central heating system and implementation of central supply of sanitary hot water developed for the city of Skopje • Information campaigns for re-connection of the previously disconnected consumers and attraction of new consumers implemented • Reduced the VAT from 18% to 5%
- Steps envisaged	• Continuing the implementation of the information campaigns • Enlargement of Heat Distribution network in Skopje • Development of the District Heating in Municipality of Bitola • Development of a study for introduction of small cogeneration highly efficient plants in other cities (primarily Tetovo, Kumanovo and Gostivar according to the guidelines from the Annex)

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2016-2018	2020	2025	2030
Progress	Number of new consumers				
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		4.14	16.76		24.81
Other	Final energy savings (ktoe)	3.3	13.5		20.0
	Primary energy savings (ktoe)	4.8	19.3		28.5

Finance	Budget	20 M€
	Source of finance	Private, EE fund, incentives from the central and local government budget
Implementing entity		• Ministry of Economy, Energy Agency • Balkan energy Dooel Skopje • JSC Skopje Sever • “Energetika” –Skopje, subsidiary to JSC Macedonian Power Plants (ESM AD) • Private investors
Monitoring entity		• Energy Regulatory Commission Ministry of Economy, Energy Agency
		direct / indirect

Contribution for the achievement of the SDGs	 

5.1.3 Industry

PAM 24 Energy management in manufacturing industries

Main objective: Efficient management of manufacturing processes in industry aiming to increase production using the same energy consumption.

Description: This measure considers implementation of obligatory energy audits of large companies and implementation of ISO 50001 standard, as well as advanced measurement and introduction of new IT technologies. This will enable prevention of defects, better process control and quicker response times in manufacturing using advanced data analysis and predictive technologies.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, technical	Industry	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on energy efficiency
Methodology	Implementation of information campaigns . Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	Improvement of the systems efficiency in manufacturing industries at annual rate of 0.15%.
Status of implementation	Under implementation
- Steps taken	• Promotion of ISO 50001 standards completed • Training on implementation of energy management in industry organized • Certificates for energy auditors issued • USAID project for energy management in industry realized in 17 companies • UNIDO/GEF Project in which one of the activities is Program for energy management in industrial companies according to ISO 50001 standard and the UNIDO Methodology. Initial results achieved in 12 companies and additionally Program for replications of the energy management systems realized in 5 companies.
- Steps envisaged	• Continuation of the implementation of ISO 50001 standard in more industrial companies (manufacturing industries). • Drafting and adopting the Rulebook on energy audits in large companies based on and with the content prescribed in article 16 of the EE Law • Implementation of obligatory energy audits.

Indicators		Indicator value in the last reporting year		Indicator target value
		2016-2018		2030
Progress				
Emissions reduction (Gg CO_2-eq)		2030	2040	2050
		28.4	35.6	50.8
Other	Final energy savings (ktoe)	7.3	9.2	13.1
	Primary energy savings (ktoe)	9.6	12.0	17.2

Finance	Budget	Negligible (the implementation of ISO 500001 is 0.15 mill. EUR/big company*)
	Source of finance	Private, donors through commercial EE loans
Implementing entity		• Ministry of Economy, Energy Agency • Private companies
Monitoring entity		• Energy Regulatory Commission • Ministry of Economy, Energy Agency
	direct	indirect

Contribution for the achievement of the SDGs

*Study of the Industry Sector - Analysis of Mitigation Policies and Measures (SUTIND), 2020, MANU

PAM 25 Introduction of efficient electric motors

Main objective: Increase the competitiveness of the industrial products through improvement of the efficiency in the production process and reducing the resources.

Description: Electric motors are responsible for a high share of the total electricity consumption in industries. This measure considers replacement of the obsolete machines currently in use, with new more efficient motors

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Industry	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on energy efficiency
Methodology	Implementation of information campaigns . Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	It is envisaged that the share of efficient electric motors by 2040 will be 60%.
Status of implementation	Under implementation
- Steps taken	• New efficient electric motors installed in a number of companies
- Steps envisaged	• Replacement of the existing electric motors from the production processes • in the industry facilities in Macedonia with more efficient ones

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2016-2018	2020	2025	2030
Progress				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	32.98	50.86	102.67
Other – Final energy savings (ktoe)	8.8	13.6	27.5
Other – Primary energy savings (ktoe)	12.6	19.4	39.2

Finance – Budget	172.0 M€
Finance – Source of finance	Private, donors through commercial EE loans
Implementing entity	• Ministry of Economy, Energy Agency • Private companies
Monitoring entity	• Energy Regulatory Commission • Ministry of Economy, Energy Agency

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 26 Introduction of more advanced technologies

Main objective: Introduction of more advanced technologies in the industrial processes that will also enable use of more environmental friendly fuels.

Description: Advanced industrial technologies present major opportunities for further reduction of the energy consumption and potentially lower costs as well as environmental benefits. In addition, they can help various industries to progress at a much faster rate

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Industry	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on energy efficiency
Methodology	Implementation of information campaigns . Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	The share of more advanced technologies by 2040 is 60% from all technologies.
Status of implementation	Under implementation

- Steps taken	• Construction of gas network in Macedonia
	  • Klechovce-Valve station 5 (Stip), finished in 2016
	  • Valve station 5(Stip)-Negotino, finished in 2019

- Steps envisaged	• Finishing the construction of gas network in Macedonia
	  • Negotino (Kavadarci)-Bitola, 76.36% realized November 2019
	  • Skopje-Tetovo-Gostivar, 53.1% realized November 2019
	  • Gostivar-Kicevo, in a process of obtaining building permit (by 2022)
	  • Kicevo-Ohrid (to be finished by 2025)
	  • Valve station 5 (Stip)-Radovis-Strumica
	• Inventory on the companies where coal or natural gas fuel can be replaced
	• Development of strategy for introduction of hydrogen

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2016-2018	2020	2025	2030
Progress Gas energy consumption				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	237.22	747.88	1304.50
Other – Final energy savings (ktoe)	72.1	227.4	396.6
Other – Primary energy savings (ktoe)	75.9	239.3	417.4

Finance	Budget	1414 M€
	Source of finance	Private, donors through commercial EE loans, EE fund
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Environment and Physical Planning • Ministry of Economy, Energy Agency • Private investors
Monitoring entity		• Ministry of Economy, Energy Agency

Contribution for the achievement of the SDGs	direct	indirect
		

5.1.4 Transport

PAM 27 Increased use of the railway

Main objective: Improve the energy efficiency in the transport sector using cheap and efficient railway transport.

Description: Although the rail transport is cheap, official statistical data show that in the last three years there is a downward trend. Using this mode of transport as one of the most efficient can also improve the competitiveness of the companies. Therefore, at least several listed measures should be implemented, aiming to return the utilization level of this transport as of three years ago, and further increase it. The measure includes:

- implement raising awareness campaigns
- invest in stations and improve the "access to the stations"
- increase the network security and expand the network coverage

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, information	Transport	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• National Transport Strategy • Strategy for Energy Development of the Republic of Macedonia up to 2040
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	By 2040, 5% of the passenger kilometers of cars, 1% of passenger kilometers of busses and 10% of tonnes kilometers of heavy duty vehicles will be realized by railway transport.
Status of implementation	Under implementation
Steps taken	• 150 freight cars and six compositions consisting of a locomotive and passenger cars ordered by the Government as part of a project with the European Bank for Reconstruction and Development (EBRD). Some of these have already been received and put into use. • Campaigns for cheaper/free driving of certain categories of passengers (young people, pensioners, etc.) carried out
Steps envisaged	• Implement promotional campaigns for raising public awareness • Continuing the campaigns for cheaper/free driving • Enabling additional conditions for companies • Liberalize the railway passenger transport • Develop and implement projects for railway network reconstruction and expansion, as well as for renewal of train (cars and locomotives) fleet

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2016-2018	2020	2025	2030
Progress	Increase of passenger km in railway transport (pkm)				
	Increase of tonnes km in railway transport (tkm)				
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		91.7	98.0		102.9
Other	Final energy savings (ktoe)	37.2	39.7		41.7
	Primary energy savings (ktoe)	29.8	31.8		33.4

Finance	Budget	434 M€
	Source of finance	Central government budget
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Transport and Communications • Ministry of Economy, Energy Agency • JSC Macedonian Railway Transport • End-users • Private companies
Monitoring entity		Ministry of Economy, Energy Agency
		direct indirect

Contribution for the achievement of the SDGs	 

PAM 28 Renewing of the national car fleet

Main objective: Use of more advanced technologies in order to slow down the growing energy consumption in the transport sector, which is complex and with limited capabilities of energy use reduction.

Description: The measures recommended in the Study on the transport sector analysis of policies and measures should be implemented: Reduction of VAT from 18% to 5% for hybrid and electric vehicles; Direct subsidizing of hybrid vehicles, Excise duties of diesel fuel and petrol need to be gradually equaled.

Obligations of public institutions to purchase vehicles with low CO_2 emissions (up to 90 gCO_2/km by 2020 and 50 gCO_2/km by 2025).

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, policy, information	Transport	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• National Transport Strategy • Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on vehicles • Law on vehicle tax
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	It is assumed that only new vehicles and vehicles not older than eight years will be sold, i.e. vehicles that meet EU standards such as CO_2 emissions in 2020 of 95 g CO_2/km, and 70 g CO_2/km by 2025. In addition, advanced technologies such as diesel and gasoline HEV will be used with a share of 35% in the total passenger km from cars by 2040.
Status of implementation	Under implementation
Steps taken	• Law on vehicles adopted (August 2019) • Law on vehicle tax adopted • Bylaws stemming from the Law on vehicle tax adopted
Steps envisaged	• Implementation of the program for subsidizing for purchasing vehicles stipulated in the Law on vehicles, • Revision of the Law on excise duty to be prepared (excise duties of diesel fuel and petrol need to be gradually equalized). • Amend the VAT Law in order to reduce the VAT rate from 18% to 5% for hybrid and electric vehicles • Starting from 2022, obligations of public institutions to purchase vehicles with low CO_2, which in the first phase could be done by the Government obligating the public institutions under its jurisdiction to foresee in their annual procurement plans purchase of certain percentage of such vehicles, while in the second phase the obligation could be put in the EE Law and / or the Law on Biofuels, thus making it mandatory for all public institutions • Increase the EURO standard for import of cars

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2016-2018	2020	2025	2030
Progress Number of vehicles per type				
Emissions reduction (Gg CO_2-eq)	2030	2040	2050	
	28.3	30.3	33.5	
Other – Final energy savings (ktoe)	23.0	24.7	27.3	
Other – Primary energy savings (ktoe)	23.0	24.7	27.3	

Finance	Budget	1172 M€
	Source of finance	Private, EE fund, incentives from the central government budget
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Transport and Communications • Ministry of Finance • Ministry of Economy, Energy Agency

	• End-users
Monitoring entity	• Ministry of Economy, Energy Agency • Ministry of interior
Contribution for the achievement of the SDGs	direct:  indirect: 

PAM 29 Renewing of other national road fleet

Main objective: Reduction of the local air pollution.

Description: This measure anticipates introduction of a regulation that will enable renewal of the vehicle fleet of light duty and heavy goods vehicles and buses.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, policy	Transport	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• National Transport Strategy • Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on vehicles • Law on vehicle tax
Methodology [for estimating the emissions]	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	It is assumed that only new advanced vehicles such as HEVs that meet EU standards for exhaust fumes will be sold.
Status of implementation [idea, planning phase, under implementation]	Under implementation
Steps taken	• Law on vehicles adopted (August 2019) • Bylaws stemming from the Law on vehicle tax adopted
Steps envisaged	• Successive implementation of EURO standards (EU new standard is a EURO 6, while in Macedonia is EURO 4) for import of new EE vehicles • Raise the minimum standard for the passenger transport vehicles from eco category 3 to eco category 2 • Implementation of Bus Rapid Transport (BRT) system for Skopje.

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2016-2018	2020	2025	2030
Progress	Number of vehicles per type				
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		351.4	400.8		447.3
Other	Final energy savings (ktoe)	110.8	126.3		141.0
	Primary energy savings (ktoe)	110.8	126.3		141.0

Finance	Budget	5381 M€
	Source of finance	Private
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Transport and Communications • Ministry of Economy, Energy Agency • Association of road transport carriers • Private companies
Monitoring entity		• Ministry of Transport and Communications • Ministry of Economy, Energy Agency

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 30 Advanced mobility

Main objective: Reduction of the local air pollution.

Description: The measure includes conducting campaigns/providing subsidies and systems for use of new or rented bicycles, electric scooters, promoting walking, and introduction of parking policies that would reduce the use of cars in the city area. People, especially in smaller towns where a lot of them use cars for short distances, would increase the use of bicycles/electric scooters or walking.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, technical, information	Transport	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• National Transport Strategy • Strategy for Energy Development of the Republic of Macedonia up to 2040 • Decisions made by municipalities to subsidize buying of new bicycles
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	By 2050, 5% of short distance passenger kilometres will be replaced by walking, using bicycles or electric scooters
Status of implementation	Under implementation
Steps taken	• Subsidies and campaigns for buying new bicycles/electric scooters implemented • Systems for bicycles renting implemented • Bicycles tracks constructed • Zonal parking implemented • New multi-level car parks constructed • In the period 2016-2019 around 17,500 bicycles and around 300 electric scooters were subsidized. The subsides at the yearly level are around 230000 €.
Steps envisaged	• Continue the implementation of the campaigns and subsidies for buying new bicycles and renting bicycles • Continue the construction of new bicycles tracks

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2016-2018	2020	2025	2030
Progress	Number of bicycles/electric scooters	12660*			

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	3.0	6.4	12.5

Other		2030	2040	2050
	Final energy savings (ktoe)	1	2.5	4.8
	Primary energy savings (ktoe)	1	2.5	4.8

Finance – Budget	12
Finance – Source of finance	Private, EE fund, incentives from the central and local government budget, donors
Implementing entity	• Ministry of Economy, Energy Agency • Local self-government • End-users
Monitoring entity	• Ministry of Economy, Energy Agency • Local self-government
Contribution for the achievement of the SDGs	direct: 7 AFFORDABLE AND CLEAN ENERGY indirect: 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

*Only those that applied for subsidies

PAM 31 Construction of the railway to Republic of Bulgaria

Main objective: Connecting the Republic of Macedonia with the Republic of Bulgaria and extending the export to external markets, not just in the neighboring countries but in the Southeast Europe and Turkey region, using the railway transport.
Description: Construction of the railway to Republic of Bulgaria.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, policy	Transport	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Work Program of the Government of the Republic of North Macedonia • National Transport Strategy
Methodology [for estimating the emissions]	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	By 2040 up to 5% of the tonne kilometers (to the Republic of Bulgaria) of the heavy goods vehicles will be replaced by the railroad transport.
Status of implementation [idea, planning phase, under implementation]	Under implementation
Steps taken	• In 2017, EU awarded 70 mil. EUR grant to the Government for construction of this railway line • First phase (Kumanovo - Beljakovce) is under construction, 67% constructed by the end of 2019 • Since the construction of the first phase was cancelled, new tender was published for both the first and the second phase in February 2021 (North Macedonia: Rail Corridor VIII, First And Second Section Re-Tender Eastern Part Of Railway Corridor VIII, First Section Kumanovo-Baljakovce And Second Section, Beljakovce – Kriva Palanka).
Steps envisaged	• Finish the construction of the first and the second phase by the end of 2024 • Tender for the third phase (Kriva Palanka – Deve Bair) to be announced.

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2016-2018	2020	2025	2030
Progress	Increase of the tonnes km in the railway transport (tkm)				
Emissions reduction (Gg CO_2-eq)		2030	2040		2050
		24.6	37.5		50.3
Other	Final energy savings (ktoe)	10.2	15.3		20.5
	Primary energy savings (ktoe)	8.2	12.2		16.2

Finance – Budget	720 M€ (infrastructure+trains)
Finance – Source of finance	Central government budget
Implementing entity	• Government of the Republic of North Macedonia • Ministry of Transport and Communications
Monitoring entity	• Ministry of Transport and Communications

Contribution for the achievement of the SDGs	direct	indirect
	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	7 AFFORDABLE AND CLEAN ENERGY; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 32 Electrification of the transport

Main objective: Transition from society based on fossil fuels to low carbon society, where the renewable energy and electrification of the transport will play the most important role.

Description: At least the following measures recommended in the "Study on the transport sector, analysis of policies and measures" should be implemented:

- Direct subsidizing of electric vehicles, 5000 EUR
- Obligation to place fast chargers at all gas stations on motorways (at every 100 km by 2020)

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, policy, information	Transport	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• National Transport Strategy • Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on vehicles • Law on vehicle tax
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	It is envisaged that by 2050 the share of electric vehicles and "plug-in" hybrid electric vehicles in the total passenger km from cars will be 55%.
Status of implementation	Under implementation
Steps taken	• Chargers installed at specific locations in the City of Skopje, as well as other cities • Law on vehicles substantially amended in August 2019 • Law on vehicle tax and bylaws adopted in 2019 • Exemption from paying excise duty for electric vehicles • Reservation of Greenparking in all public parking lots • Base the methodology for calculation of vehicle tax on import on CO2
Steps envisaged	• Amend the VAT Law in order to reduce the VAT rate from 18% to 5% for hybrid and electric vehicles • Development of studies for determining the best locations for installation of electric vehicles chargers from the aspect of the power grid. • Funds in the budget should be allocated for the realization of the Program for subsidizing new vehicles • Development of strategy for electrification of the transport sector • Development of strategy for introduction of hydrogen

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2018	2020	2025	2030
Progress	Increase of the tonnes km in the railway transport (tkm)				
Emissions reduction (Gg CO_2-eq)		2030	2040	2050	
		120.3	259.7	272.2	
Other	Final energy savings (ktoe)	60.7	125.6	131.7	
	Primary energy savings (ktoe)	40.8	83.8	87.8	

Finance	Budget	7579 M€
	Source of finance	Private, EE fund, incentives from the central government budget
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Transport and Communications • Ministry of Economy, Energy Agency
Monitoring entity		• Ministry of Economy, Energy Agency • Ministry of interior
		direct indirect

Contribution for the achievement of the SDGs	

*Although these vehicles are more efficient than fossil fuel vehicles, the emissions from this measure may increase, considering that the electricity in the power system is mainly produced from fossil fuels, therefore this measure should be implemented in parallel with the measures for electricity generation from RES.

5.2 IPPU

PAM 33 Implementation of Kigali amendment on HFC phase-down

Main objective: Phase-down of greenhouse gases hydrofluorocarbons (HFCs)

Description: The Kigali Amendment is an amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer. The Amendment adds powerful greenhouse gases hydrofluorocarbons (HFCs) to the list of substances controlled under the Protocol and which are to be phased down. The Republic of North Macedonia has become the 94th country to ratify the Kigali Amendment to phase down HFC refrigerants. North Macedonia is following the schedule of the Kigali Amendment to the Montreal Protocol, for Annex 5 countries, starting with a freeze in 2024 of the HFCs and ending with a permanent 80% reduction in 2045.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical, regulatory	IPPU	HFC	National

Relevant planning documents, legal and regulatory acts	• Order for banning the import and export of products containing chlorofluorocarbons (HCFCs) ("Official Gazette of the Republic of Macedonia" No. 92/10) • Order to limit the import of substances that deplete the ozone layer ("Official Gazette of the Republic of Macedonia" no. 92/10, 150/12): • Order for banning the sale of 1,1-dichloro-1-fluoroethane (HCFC 141b) and mixtures containing 1,1-dichloro-1-fluoroethane (HCFC 141b) ("Official Gazette of the Republic of North Macedonia" no. 111/21) • RATIFICATION ACT OF THE AMENDMENT TO THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER
Methodology	IPPU model developed in Excel

Assumptions	• Phase-down schedule for N. Macedonia of HFC according to Kigali Amendment:
	  • Baseline formula – average consumption for 2020-2022 + 65% of hydrochlorofluorocarbon (HCFC) baseline
	  ○ 2024 - freeze
	  ○ 2029 - -10%
	  ○ 2035 - -30%
	  ○ 2040 - -50%
	  ○ 2045 - -80%
	• Since the data for the consumption in 2020-2022 of HFC is still not reported, in this measure the average consumption in the period 2017-2019 is assumed for the baseline.
	• The addition of 65% of HCFC in the baseline is optional, and is not advisable to be considered if the consumption of HCFC is reduced to zero. Having the legal acts which are in place in North Macedonia, the consumption (i.e. import) of HCFH is minimal, and equal to 0 in 2017, and therefore this addition is not considered in this measure.

Status of implementation	Under implementation
Steps taken	• Ratification of the Amendment to the Montreal protocol on substances that deplete the ozone layer • Ongoing UNIDO project for implementation of the Kigali Amendment to the Montreal Protocol, considering the situation in the country with regard to the current HFC consumption. Legal documents, stakeholder engagement, and awareness raising events are in progress, which led to the ratification of the Kigali Amendment in February 2020 (https://open.unido.org/projects/MK/projects/200289)
Steps envisaged	• Implementation of the schedule for HFC phase-down, with the help of projects supported by Montreal Protocol fund

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2019	2030	2040	2050

Progress	HFC [tonnes]	120	139	80	0
Emissions reduction (Gg CO_2-eq)		2030	2040	2050	
		225.6	471.6	861.6	
Finance	Budget	N/A			
	Source of finance	Montreal Protocol fund, private sector			
Implementing entity		• Minister of Environment and Physical Planning			
Monitoring entity		Minister of Environment and Physical Planning			
Contribution for the achievement of the SDGs		direct	indirect		
					

5.3 AFOLU

5.3.1 Livestock

PAM 34 Reduction of CH_4 emissions from enteric fermentation in dairy cows by 3%

Main objective: Decrease level of CH_4 emission from enteric fermentation in highly productive dairy cows

Description: By modification of the feed composition and nutrition practice in dairy cows, the emission of CH_4 due to enteric fermentation can be reduced by 20%. It is foreseen that the number of dairy cows under intensive farming system will be increased form present 1% to 30% in 2040. Because of highly productive cows involved the CH_4 emission will also increase. But, with modification of feed content (adding carbohydrates, high quality forages and tannins) into TMR, the CH_4 emission will be decreased by 20%. The mitigation measure can be easily applied on dairy farms, by nutrition management. It is also cost effective; do not require additional subsidies or incentives. Practical training and demonstration for farmers will be sufficient.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Technical	AFLOU-Livestock	CH_4	National

Relevant planning documents, legal and regulatory acts	• Strategy for Agriculture Development • IPARD program
Methodology	Regression model, IPCC methodology
Assumptions	• Increased number of highly productive dairy cows under intensive farming, • Introduced modified TMR and nutrition management. • Expected to be on organized in farms with more than 50 heads
Status of implementation	Under implementation
- Steps taken	• TMR with partly modified feed composition in already used on two intensive farms that account about 1% of the dairy cow population
- Steps envisaged	• Development advisory package for TMR modified feed and nutrition management for the intensive dairy farms with more than 50 cows, • Incentives for dissemination of the advisory package to target farmers, • Monitoring of the effect of TMR modified feed and nutrition management, and further improvements.

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Number of farms (dairy cows as a percentage of the total population) used TMR modified feed and nutrition management on biannual base	1%			

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance	Budget	0.2 mil. EUR
	Source of finance	Private sector, IPARD programme
Implementing entity		Ministry of Agriculture Forestry and Water Economy
Monitoring entity		Ministry of Agriculture Forestry and Water Economy
Contribution for the achievement of the SDGs		direct: 2 ZERO HUNGER; indirect: 13 CLIMATE ACTION

PAM 35 Reduction of N_2O emissions from manure management in dairy cows by 20%

Main objective: Decrease level of N_2O emission from manure management in highly productive dairy cows

Description: By modification of the manure management in dairy cows, the emission of N_2O can be reduced up to 20%. It is foreseen that the number of dairy cows under intensive farming system with more than 50 heads will be increased form present 1% to 30% in 2040. All those farms will need to apply improved manure management in order to reduce N loss, and N_xO emissions. Therefore, on farm manure management system needs to modify. The mitigation measure considers on farm adaption on existing farms and moderate investments on newly established farms. It will require subsidies for adapting and incentives in farm design and construction.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Technical	AFLOU-Livestock	N_2O	National

Relevant planning documents, legal and regulatory acts	• Law for Nature Protection • IPARD program, • Agro-ecology measures in national program
Methodology	Regression model, IPCC methodology
Assumptions	• Target group are the farms with more than 50 heads. The manure management practice is expected to be change from solid fraction (N loss factor 40), to below animal (N loss factor 28). It can be applied to 10% of the population and shift toward practice is expected to be done in 15% of the farms by 2025. The proportion of the high productive dairy cows is expected to reach 25% in 2040. In such action the reduction of the N_2O emissions in manure management on dairy cows will be up to 25% by 2040. • Increased number of highly productive dairy cows under intensive farming, • On farm modified manure management.
Status of implementation	Planning phase
- Steps taken	• None
- Steps envisaged	• Adaption in manure management on intensive dairy farms with more than 50 cows, • Design and construction of intensive dairy farms with more than 50 cows, • Monitoring of the effect modified manure management in the intensive dairy farms with more than 50 cows.

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Number of farms (dairy cows as a percentage of the total population) used modified manure management on 2-5 years base.	0%			

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance	Budget	1 mil. EUR
	Source of finance	Private sector, IPARD programme
Implementing entity		Ministry of Agriculture Forestry and Water Economy

Monitoring entity	Ministry of Agriculture Forestry and Water Economy
Contribution for the achievement of the SDGs	direct:  indirect: 

PAM 36 Reduction of N_2O emissions from manure management in swine farms by 13%

Main objective: Decrease level of NO_2 emission from manure management in highly productive swine farms

Description: By modification of the manure management in swine farms, the emission of N_2O can be reduced up to 50%. It is foreseen that number of fatteners and number of fatteners per sow will increase, while the total number of sows will remain stable over period. Number of swine farms with more than 1000 fatteners and/or 350 sows will also increase, and they need to adapt improved manure management system, in order to reduce N loss. In 2040 is expected that 90% of fatteners will be produced on those farms, accounting for 75% of sow in the country. The mitigation measure consider on farm adaption on existing farms and moderate investments on newly established farms. It will require subsidies for adapting and incentives in farm design and construction.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Technical	AFLOU-Livestock	N_2O	National

Relevant planning documents, legal and regulatory acts	• Law for Nature Protection • IPARD program, • Agro-ecology measures in national program
Methodology	Regression model, IPCC methodology
Assumptions	• Swine production system is expected to shift towards intensification that will bring modification of the swine farms. The management practice is supposed to shift form solid manure towards below animal (practice that already exists on large swine farms). Then the fraction of N loss will be reduced by 50%. The implementation of shift will be slightly over years in category sows and finishing pigs (e.g. sows from 55% in 2020 to 75% in 2040; finishing pigs from 70% in 2020 to 92% in 2040 • Increased number of highly productive swine farms with more than 1000 fatteners and/or 350 sows, • On farm modified manure management.
Status of implementation	Under implementation
- Steps taken	• Existing swine farms with more than 1000 fatteners and/or 350 sows are working on modification in manure management system
- Steps envisaged	• Adaption in manure management on intensive swine farms with more than 1000 fatteners and/or 350 sows, • Design and construction of intensive swine farms with more than 1000 fatteners and/or 350 sows, • Monitoring of the effect modified manure management in the intensive swine farms with more than 1000 fatteners and/or 350 sows

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Number of farms (fatteners and sows as a percentage of the total population) used modified manure management on 2-5 years base.	0%			

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance: Budget	1 mil. EUR
Finance: Source of finance	Private sector, IPARD programme
Implementing entity	Ministry of Agriculture Forestry and Water Economy
Monitoring entity	Ministry of Agriculture Forestry and Water Economy

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 37 Reduction of N_2O emissions from manure in dairy cows by 20% for farms below 50 Livestock Units

Main objective: Decrease level of N_2O emission from manure management in dairy cows on farm farms below 50 Livestock Units

Description: By modification of the manure management in dairy cows, the emission of N_2O can be reduced up to 30%. In discussion with farmers, the most common system is dry manure management, where manure together with bedding (mostly wheat or barley straw) are taken out of the barn daily or within week. The manure than is composting on pile near the farm. Farmers do not use any cover of manure nor tanks for collecting liquid drainage of the pile. Fermentation is usually mixed where in bottom parts is anaerobic, but on the surface, due to aeration it is aerobic. Manure is used as fertilizer mostly within 2-3 months (depending on storage capacity on the farm and field availability). Depending on manure fermentation the loss of N can be up to 60%. The N loss and reduction of the N_2O emissions can be reached by prolonging fermentation period up to 6 months and covering the pile. Hence the measure is to support farmers with less than 50 cows to provide proper manure storage places for longer period.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Technical	AFLOU-Livestock	N_2O	National

Relevant planning documents, legal and regulatory acts	• IPARD program, • Agro-ecology measures in national program
Methodology	Regression model, IPCC methodology
Assumptions	• Replaced low productive with high productive dairy cows, • On farm modified manure management for farms with 10 to 50 cows. • Dairy cow produce manure about 7% of the life weight per day. Milking cows are weighted between 500 and 650 kg, depending on breed and conditions. Heifers 1-2 year, calves 3-12 months and young calves 0-3 months are transformed into adult cow by coefficient 2, 4 and 10, respectively. For simplicity, animal units (AU) should be used as a base (1 AU = 500 kg). Based on usual feed consumption, bedding material (annual average use of 8% wheat/barley straw) it can be expected about 0.04 m^3 manure per AU/day. • The manure has about 40% moisture and during the storage reduce volume for 40%. For the period of 6 months total volume of 5 m^3 per AU should be expected. For pile composting, a trench with clay or concreate floor with inclination of 4% is required. The pile needs to be protected from rainfall (either by roof or covered by plastic foil. Aeration is occurring when fresh manure is adding, taking care that old and already fermented one should be always on top. By prolonging manure storage and covering period the reduction of N_2O emission will be for 30% is expected.
Status of implementation	Planning phase
- Steps taken	• None
- Steps envisaged	• Provide incentives to build on farm manure storage place, • Train farmers for BAT in manure management, • Monitoring of the effect modified manure management

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Number of farms (dairy cows as a percentage of the total population) used modified manure management in 7 years.	0%			

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance	Budget	1 mil. EUR
	Source of finance	Private sector, IPARD programme
Implementing entity		Ministry of Agriculture Forestry and Water Economy

Monitoring entity	Ministry of Agriculture Forestry and Water Economy
Contribution for the achievement of the SDGs	direct: 2 ZERO HUNGER; indirect: 13 CLIMATE ACTION

5.3.2 Forestry

PAM 38 Establishing integrated management of forest fires

Main objective: Reducing the average annual burned area for 6000 ha

Description: Forest fires are already detected as a very significant problem of forest loss and source of GHG emissions. In the period from 1999 to 2019 year the average annual number of forest fires is 229 fires, average annual burned area is 10,985 ha and average annual damage is estimated on 6,9 million Euro. The total burned forest area in the same period is around 219,163 ha with the total damage of around 138 million. This measure includes the protection of the forest area by preventing the forest fires and the damages resulting from forest fires.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	AFLOU-Forestry	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Law on forest, • Special rule book for forest fire protection, • Strategy for development of the forest fire protection, diseases and insects with action plan for realization of the projects and procurements for the needs of PE "Makedonski sumi"
Methodology	Regression model, IPCC methodology
Assumptions	• Up to 3000 ha will be burned annually on average
Status of implementation	Under implementation
- Steps taken	• The location for building and establishment of a forest fire training center in the frame of the PE "National forests" is already chosen, the plan prepared and 8 vehicles are purchased.
- Steps envisaged	• **Phase I** - Procurement of vehicles for initial attack, had tools and personal protective equipment (PPE) o Duration: one year o Vehicles procurement: 25 specialized vehicles for initial attack o 25 vehicles x 40,000 € = 1,000,000 € o 50 sets of hand tools and PPE for 50 crews of five fire fighters (two per vehicle) o 1 set of hand tools and PPE = 4,000 € o 50 sets x 5,000 € = 250,000 € • **Phase II** - Specialized training for fire fighters (six days) o 50 craws x 5 persons = 250 fire fighters o 250 fire fighters x 800 € = 200,000 €

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Forest area (ha)				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance: Budget	1.45 mil. EUR
Finance: Source of finance	PE “National forests”, other forest enterprises
Implementing entity	Ministry of Agriculture Forestry and Water Economy, through PE "National forests"
Monitoring entity	Ministry of Agriculture Forestry and Water Economy, through PE "National forests"
	direct: indirect:

Contribution for the achievement of the SDGs	 

PAM 39 Afforestation

Main objective: Afforestation of 5000 ha of barren land with Oak (Quercus spp.)

Description: Afforestation and reforestation may change landscapes and may have an impact on the provision of landscape-related goods and services. The supply with goods and services benefiting people and societies and the conservation of traditional cultural landscapes, as well as landscape ecology, need to be taken into account. According to the many strategic documents there are about 1,500,000 ha barren land aimed for afforestation or reforestation.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	AFLOU-Forestry	CO_2,	National

Relevant planning documents, legal and regulatory acts	• Law on forest
Methodology	Regression model, IPCC methodology
Assumptions	• The oak is species resistant on high air temperature and small amount of precipitations-dry conditions (conditions that are expected in agreement with the official national scenarios on climate change for Macedonia) and lees sensitive to forest fires, as well. Besides, the economic and technical value of the timber mass is high. The afforestation could be done on one location (all 5,000 ha) or distributed but not to more than five location. • Minimum 80 % of the seedlings have to be alive after third year of the afforestation and with good health and morphological condition should be maintained
Status of implementation	Under implementation
- Steps taken	• There are already existed nurseries for production of more than 8.000.000 seedlings annually

- Steps envisaged	• Area for afforestation should be chosen, around 7.5 million Oak seedlings should be produced, afforestation to be done with proper care in the next 5 years
	• **Phase I** – seedling production
	  • Duration: 3 years
	  • Number of seedlings: 2,500 seedlings/ha x 5,000 ha = 12,500,000 seedlings
	  • Costs for seedling production: 12,500,000 seedlings x 20 den. = 250,000,000=4,100,000 €
	• **Phase II** – soil preparation and afforestation
	  • Sub phase - soil preparation
	  • Duration: four months
	  • Costs: 5,000 ha x 15,000 den = 75,000,000 den = 1,250.000 €
	  • Sub phase - afforestation
	  • Duration: six months
	  • Costs: 5,000 ha x 20,000 den = 100,000,000 den = 1,650,000 €
	• **Phase III** – maintenance and protection
	  • Duration: five years
	  • Costs: 5.000 ha x 10.000 den = 50.000.000 den = 800.000 €

Indicators		Indicator value in the last reporting year	Indicative trajectory		Indicator target value
		2018	2020	2025	2030
Progress	Forest area (ha)				
	Forest planted/covered with new seedlings (ha)				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance	
Budget	7.8 mil. EUR
Source of finance	PE “National forests”, other forest enterprises
Implementing entity	Ministry of Agriculture Forestry and Water Economy

Monitoring entity	Ministry of Agriculture Forestry and Water Economy
Contribution for the achievement of the SDGs	direct:  indirect: 

5.3.3 Land use change

PAM 40 Conversion of land use of field crops above 15% inclination

Main objective: To reduce the intensity of soil erosion and loss of soil organic matter

Description: Cultivation of land on inclined terrain causes intensive processes of soil erosion and mineralization of sol organic matter. These processes lead to intensive decomposition of soil organic matter and emission of soil carbon into atmosphere. Conversion of such areas into perennial grassland (pastures, meadows) will significantly decrease intensity of soil organic matter depletion and emission of soil carbon, and will lead to carbon sink. Areas above 15% inclination by law should not be cultivated and are not considered as agricultural land. This conversion supposes land use change and change of the production system, which might influence the net annual income of primary producers. Due to this, its implementation should be supported with incentives, especially in the first years of conversion, in order to bridge possible loss of incomes in farm holds.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Technical	AFLOU-Land	CO_2,	National

Relevant planning documents, legal and regulatory acts	• Law on agricultural land • Rulebook on GAP • Rulebook on cross compliance for minimum requirements of GAP and environmental protection
Methodology	Regression model, IPCC methodology
Assumptions	• The total area of almost 3000ha is intensively cultivated which leads to decreasing of SOM as a result of its intensive decomposition and intensive soil erosion processes. If conversion to grass land is implemented, the estimated SOM increase is for more than 2% which for the total converted area of 2975 ha. The conversion of land use, should: • Stop the intensive process of erosion of the top soil layer which leads to loss of soil organic matter and its intensive ex-city mineralization, • Stop on site mineralization of soil organic matter due to intensive processes of cultivation, • Intensify carbon sink through accumulation of soil organic matter
Status of implementation	Under implementation
- Steps taken	• The effects of conversion of crop land to grass land has been monitored on two experimental fields in the past four years, • Land Parcel Identification System has been established and will serve as a tool for control of the process of conversion
- Steps envisaged	• Establishment of system for systematic control of land use and land use change on national level, • Institutional support to primary producers with subsiding the process of conversion of crop fields into grassland

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Area converted on yearly base (ha/year)				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance: Budget	1.5 mil. EUR
Finance: Source of finance	Private sector, IPARD programme
Implementing entity	Ministry of Agriculture Forestry and Water Economy
Monitoring entity	Ministry of Agriculture Forestry and Water Economy

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 41 Contour cultivation on areas under field crops on inclined terrains (5-15%)

Main objective: To reduce erosion of top soil and conservation of soil organic mater

Description: Regular cultivation in crop production means a massive disturbance of top soil layer, which cause intensive mineralization of soil organic matter (SOM) and CO_2 emissions. Downslope cultivation of cropland usually causes intensive processes of soil erosion. Field experiments showed that the quantity of eroded sediment is multiply higher if compared to contour cultivation. This eroded sediment is reach with SOM which in such circumstances is rapidly mineralized, due to what significant quantity of soil carbon is released into atmosphere.

Contour cultivation means that all agro-technical operations should be across the slope. This measure is easy to be implemented, since it does not require a special technical capacities and know-how. In practice, farmers usually are not aware of its importance and influence of the overall soil fertility. With a systematic campaign for increasing the awareness of the farmers this measure can be widely adopted.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Technical	AFLOU-Land	CO_2,	National

Relevant planning documents, legal and regulatory acts	• Law on agricultural land • Law on water • Rulebook on Good Agricultural Practices • Rulebook on cross compliance for minimum requirements of GAP and environmental protection
Methodology [for estimating the emissions]	Regression model, IPCC methodology
Assumptions	• 14,000 ha (30%) of the total 47,090 ha of no-irrigated land on inclined terrines (above 5%) are planned for this measure • Decreasing of soil erosion processes of the top soil layer and SOM loss with contour ploughing of inclined cropland, • Increasing of soil carbon with preservation of SOM in the top soil layer
Status of implementation [idea, planning phase, under implementation]	Under implementation
- Steps taken	• Contour cultivation tested in practice of two experimental sites, • Contour cultivation promoted among farmers within several national and international Projects
- Steps envisaged	• Incorporation of contour cultivation as an agro-ecological measure into strategic documents, • Promotion of contour cultivation among farmers, • Institutional support to primary producers with subsiding the process of adoption of the system of contour cultivation

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Area in ha with contour cultivation				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance	Budget	1.0 mil. EUR
	Source of finance	Private sector, IPARD programme
Implementing entity		Ministry of Agriculture Forestry and Water Economy
Monitoring entity		Ministry of Agriculture Forestry and Water Economy

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 42 Perennial grass in orchard and vineyards on inclined terrains (>5%)

Main objective: Reducing of soil erosion and increasing of SOM in vineyards and orchards on inclined terrains (5-15% slope)

Description: In vineyards and orchard on locations where rows are oriented downslope, as a result of intensive classical system of cultivation, an intensive processes of soil erosion and depletion of SOM occurs, which lead to intensive emissions of soil carbon. Simple change of cultivation system with establishment of perennial grass can significantly mitigate the process of SOM loss and emissions of soil carbon. The measure is easy to be implemented with low initial cost.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Technical	AFLOU-Land	CO_2,	National

Relevant planning documents, legal and regulatory acts	• Law on agricultural land • Law on water • Rulebook on GAP • Rulebook on cross compliance for minimum requirements of GAP and environmental protection
Methodology [for estimating the emissions]	Regression model, IPCC methodology
Assumptions	• Decreasing of soil erosion processes of the top soil layer and SOM loss when classical type of cultivation system with deep plowing is replaced with perennial grass and no-tillage system • Increasing of soil carbon with accumulation of SOM in the top soil layer due to mulching of moved biomass and accumulation of biomaterial in the root zone of the perennial grass.
Status of implementation [idea, planning phase, under implementation]	Under implementation
- Steps taken	• Perennial grass in vineyards and orchards as a cover crop tested in practice in two regions, • Perennial grass in vineyards and orchards as an agro-ecological measure promoted among farmers within several national and international Projects
- Steps envisaged	• To foresee cover crops in perennial plantations (vineyards and orchards) as an agro-ecological measure into strategic documents, • To promote the effects of cover crops among vine and fruit growers, • Institutional support to primary producers with subsiding the process of implementing the measure

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Area of vineyards and orchards under perennial grass (ha)				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance – Budget	1 mil. EUR
Finance – Source of finance	Private sector, IPARD programme
Implementing entity	Ministry of Agriculture Forestry and Water Economy
Monitoring entity	Ministry of Agriculture Forestry and Water Economy
Contribution for the achievement of the SDGs	direct: 13 CLIMATE ACTION; indirect

PAM 43 Use of biochar for carbon sink on agricultural land

Main objective: Carbon sink by negative emission technology

Description: The agricultural soils in the country are characterized as soils with relatively low carbon content and with average to low fertility. The application of biochar can improve soil water holding capacity, nutrients storage into the soil, and increase yield. Biochar can capture even 3 times more CO_2 compared to its weight, because of its high carbon concentration. Biochar was included for the first time as a promising negative emission technology in the new IPCC special report "An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty" published in 2018. The process of application of biochar should go through several steps: i) research, ii) development the suitable technology for various soil/crop combination iii) experimental/demonstrative sites iv) development the measure for support from national programs for support of agriculture v) promotion of measure. This is new measure, need some research, therefore, in period 2017 – 2040 we predict only 15 years of active use of the measure.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Research, Education, Technical	AFLOU-Land/Agriculture	CO_2,	National

Relevant planning documents, legal and regulatory acts	• Biochar is not present in any strategic document in the country
Methodology	Regression model, IPCC methodology
Assumptions	• Sinking the amount of 330.3 Gg-eq CO2-eq and removing that amount from the atmosphere • Increasing of soil carbon content with adding of biochar as persistent carbon source. Most of the biochar will remain in the in the top soil layer due to available application technology incorporation biochar by plow on the plowing depth. • The positive effects on the soil fertility and soil health • Local production of the biochar by using residual biomass that is usually burnt in open fires.
Status of implementation	Idea
- Steps taken	• None
- Steps envisaged	• To conduct experimental research and to determine optimal biochar application rates for different soil/crop combinations • To foresee application of biochar on arable land as an agro-ecological measure into strategic documents, • To promote the effects of biochar on soil health, yield and environment, • Institutional support to primary producers with subsiding the process of implementing the measure

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Area of vineyards and orchards under perennial grass (ha)				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance: Budget	30 mil. EUR
Finance: Source of finance	Private sector, IPARD programme
Implementing entity	Ministry of Agriculture Forestry and Water Economy
Monitoring entity	Ministry of Agriculture Forestry and Water Economy
Contribution for the achievement of the SDGs	direct: 13 CLIMATE ACTION; indirect

PAM 44 Photovoltaic Irrigation

Main objective: Mitigation by replacing the non-renewable energy sources for water pumping with renewable, thus reducing the CO_2 emission

Description: Installation of photovoltaic system for irrigation purposes with 2.4 kW installed capacity, capable to run 1.1 kW 3 phase pump. The two cases are considered as mitigation practice, replacing the petrol pump with consumption of 0,3l petrol per hour (one of the most popular pumps in the country) with 3 phase AC pump and adding photovoltaic and replacing 1.1 kW electricity pump with 3 phase AC pump and adding the photovoltaic. The measure is suitable for already established on farm irrigation systems, but also for new establishing of the irrigation systems with on-farm water source. The measure is compatible with IPARD 2 measure "Production of energy from renewable resources for self-consumption, through processing of plant and animal products from primary and secondary biomass (except biomass from fishery products) for production of biogas and/or biofuels, use of solar energy, windmills, geo-thermal energy etc".

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Research, Education, Technical	AFLOU-Land/Agriculture	CO_2,	National

Relevant planning documents, legal and regulatory acts	• Law on Agriculture and Rural Development • National strategy on Agriculture and Rural Development • IPARD2
Methodology [for estimating the emissions]	Regression model, IPCC methodology
Assumptions	• About 1000 installations annually in the period of 20 years, reaching about than 20 000 hectares irrigated by photovoltaic as energy source.
Status of implementation [idea, planning phase, under implementation]	Planning phase
- Steps taken	• There is possibility for getting support from IPARD2 funds. The measure provides up to 65% of co-financing and promoting of photovoltaic irrigation if the frame of this measure is feasible
- Steps envisaged	• To promote the photovoltaic irrigation as mitigation measure • To include the measure in agri-environmental scheme • To investigate possibilities for diversification of farm incomes trough distributing the excess of electricity produced into the network,

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress: Increase in installed capacity (MW)				

Emissions reduction (Gg CO_2-eq)	2030	2040	2050

Finance: Budget	47 mil. EUR
Finance: Source of finance	Private sector, IPARD programme
Implementing entity	Ministry of Agriculture Forestry and Water Economy
Monitoring entity	Ministry of Economy, Energy Agency

Contribution for the achievement of the SDGs	direct	indirect
		

5.4 Waste

PAM 45 Landfill gas flaring

Main objective: Environmental protection and meeting the highest European standards

Description: Rehabilitation of the existing landfills and illegal ("wild") dumpsites with very high, high and medium risk in each of the eight waste management regions, as well as opening of regional landfills. The rehabilitation includes covering on the existing non-compliant landfills, supplemented by gas extraction and flaring.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Waste – Solid waste disposal	CO_2, CH_4	Regional

Relevant planning documents, legal and regulatory acts	• National Waste Management Plan 2021-2031 • Strategy for Waste Management in the Republic of Macedonia • Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Polog, Vardar and Skopje region)
Methodology	Regression model, IPCC methodology
Assumptions	Closing of existing and opening of new landfills by waste management regions in the following order: • Skopje – 2025 • East and Northeast – 2026 • Polog – 2027 • Southeast – 2030 • Pelagonia and Southeast – 2030 • Vardar 2030
Status of implementation	Planning phase
- Steps taken	• Regional waste management plans developed and adopted, • EU funds provided for construction of a regional landfill for the East and Northeast planning region provided, construction of six transfer stations and closing of all non-compliant landfills. • Discussions started with EBRD for involvement in financing regional waste management projects.
- Steps envisaged	• Obtaining funds for the other regions • Starting the construction of the new regional landfill for the East and Northeast planning region • Covering on the existing non-compliant landfills and installation of gas flaring systems where it is feasible

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2030	2040	2050
Progress – Amount of CH_4 burned (kt)	0	24.8	29.1	18.7

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	561.3	655.0	823.5

Finance – Budget	10.5 mil. EUR
Finance – Source of finance	Local self-government through Public Utilities, Public Private Partnership, EU funds, IFIs
Implementing entity	• Ministry of Environment and Physical Planning • Municipalities (Public municipal enterprises for waste management) • Regional waste management companies / Inter-Municipal Waste Management Board
Monitoring entity	Ministry of Environment and Physical Planning State Environmental Inspectorate Authorized Inspectors of Environment (Municipalities)
Contribution for the achievement of the SDGs	direct: 13 CLIMATE ACTION indirect

PAM 46 Mechanical and biological treatment (MBT) in new landfills with composting

Main objective: Environmental protection and meeting the highest European standards

Description: Opening of new regional landfills in all waste management regions with installed system for mechanical and biological treatment and composting. This includes treatment of the garden and food municipal waste. This measure will help achieve the goals for recycling of municipal solid waste of 25% in 2025, 45% in 2035 and 65% in 2045, as defined in the National Waste Management Plan 2021-2031.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Waste – Solid waste disposal	CO_2, CH_4, N_2O	Regional

Relevant planning documents, legal and regulatory acts	• National Waste Management Plan 2021-2031 • Strategy for Waste Management in the Republic of Macedonia • Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Polog, Vardar and Skopje region) – final and draft versions
Methodology [for estimating the emissions]	Regression model, IPCC methodology
Assumptions	Opening of the regional landfills in the following order: • Skopje – 2025 • East and Northeast – 2026 • Polog – 2027 • Southeast – 2030 • Pelagonia and Southeast – 2030 • Vardar 2030 Reduction of the amount of not treated biodegradable components of municipal waste on an annual level, expressed as a reduction of the percentage of biodegradable components in municipal waste generated, is assumed with a rate as defined in Table 8 of the National Waste Management Plan 2021-2031.
Status of implementation [idea, planning phase, under implementation]	Planning phase
- Steps taken	• Regional waste management plans developed and developed • EU funds provided for construction of a regional landfill for the East and Northeast planning region provided, construction of six transfer stations and closing of all non-compliant landfills.
- Steps envisaged	• Obtaining funds for the other regions • Starting the construction of the new regional landfill for the East and Northeast planning region

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2030	2040	2050
Progress – Amount of compost (kt)	0	68	93	86

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	35.2	145.2	216.1

Finance	Budget	36.1 mil. EUR
	Source of finance	Local self-government through Public Utilities, Public Private Partnership, EU funds
Implementing entity		• Ministry of Environment and Physical Planning • Municipalities / Public municipal enterprises for waste management • Regional waste mgmt companies / Inter-Municipal Waste Management Board
Monitoring entity		Ministry of Environment and Physical Planning State Environmental Inspectorate Authorized Inspectors of Environment (Municipalities)
Contribution for the achievement of the SDGs		direct: 11 SUSTAINABLE CITIES AND COMMUNITIES; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION indirect: 13 CLIMATE ACTION

* Total reduction when including the emissions realized after 2040

PAM 47 Selection of waste

Main objective: Environmental protection and meeting the highest European standards

Description: Installation of containers for collection of selected waste, mainly paper, but also wood, textile, nappies, plastic and other inert waste. This measure will help achieve the goals for recycling of municipal solid waste of 25% in 2025, 45% in 2035 and 65% in 2045, as defined in the National Waste Management Plan 2021-2031.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Technical	Waste – Solid waste disposal	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• National Waste Management Plan 2021-2031 • Strategy for Waste Management in the Republic of Macedonia • Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Polog, Vardar and Skopje region)
Methodology [for estimating the emissions]	Regression model, IPCC methodology
Assumptions	• Gradual increase, compared to WOM of ○ paper selection reaching 82% in 2050 ○ wood selection reaching 36% in 2050 ○ textile selection reaching 32% in 2050 ○ nappies selection reaching 50% in 2050 ○ plastic and other inert waste reaching 69% in 2050
Status of implementation [idea, planning phase, under implementation]	Planning phase
- Steps taken	• Regional waste management plans developed • Containers for waste selection installed in several cities in Macedonia, mostly in Skopje. • Private companies – digitalization of information (bills) realized
- Steps envisaged	• Installation of containers for waste selection in all cities in Macedonia. • Promoting the reduction of paper consumption and dematerialization of the information using ICT (Information and Communication Technologies)

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2030	2040	2050
Progress – Amount of municipal waste selected (kt)		121	231	319

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	30.2	75.1	129.6

Finance – Budget	2 mil. EUR
Finance – Source of finance	Local self-government through Public Utilities, Public Private Partnership, EU funds
Implementing entity	• Ministry of Environment and Physical Planning • Public municipal enterprises for waste management • State Environmental Inspectorate • Inter-Municipal Waste Management Board • Authorized Inspectors of Environment (Municipalities)
Monitoring entity	Ministry of Environment and Physical Planning
Contribution for the achievement of the SDGs	direct: 11 SUSTAINABLE CITIES AND COMMUNITIES; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION indirect: 13 CLIMATE ACTION

PAM 48 Improved waste and materials management at industrial facilities

Main objective: Set targets for reduction of generation, selection, reuse, recycling and treatment of waste at industrial installations

Description: This measure takes into account the Extended Producer Responsibility schemes, including the goals defined in the Law on Management of Packaging and Packaging Waste, which enables and contributes to achieving the goals of the circular economy. In addition, the measures that are part from the Circular economy and climate change report of UNDP for Nort Macedonia shows that the import dependance of row materials of the country can be reduced if circular economy is applied.

On an individual assessment, each IPPC installation operator shall submit proposals for 1) waste generation, 2) waste selection, 3) waste reuse, 4) waste recycling, 5) waste treatment. Goals are set in integrated environmental permits.

Goals are set for a 5 year framework (progressive goals for each year) that will be updated as appropriate after the deadline.

Two levels of goals: mandatory and higher incentives (through tax or financial incentives).

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulation, Technical	Waste – Solid waste disposal	CO_2, CH_4	National

Relevant planning documents, legal and regulatory acts	• National Waste Management Plan 2021-2031 • Strategy for Waste Management in the Republic of Macedonia • Law on Waste Management and bylaws • Law on Management of Packaging and Packaging Waste • Law on Extended Producer Responsibility for Waste Management • Law on Finance and bylaws • Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Polog, Vardar and Skopje region)
Methodology [for estimating the emissions]	Regression model, IPCC methodology
Assumptions	• Conducted substantive analysis, international experiences analyzed. The percentage of industrial waste treatment will increase according to the goals defined in the Law on Management of Packaging and Packaging Waste, for each type of industrial waste.
Status of implementation [idea, planning phase, under implementation]	Planning phase
- Steps taken	/
- Steps envisaged	• Analysis of possible tax and financial options to encourage the achievement of higher goals • Analysis done; opportunities/mechanisms identified • Modified and issued environmental permits • Regular annual implementation oversight • Regular annual reporting by IPPC operators

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2030	2040	2050
Progress – Industrial waste collected (kt)	/	1256	2101	3186
Emissions reduction (Gg CO_2-eq)	2030	2040	2050	
	16.4	51.5	95.8	

Finance – Budget	n/a
Finance – Source of finance	Ministry of Environment and Physical Planning, Municipalities and city of Skopje, Industrial facilities, EU funds
Implementing entity	• Ministry of Environment and Physical Planning • Public municipal enterprises for waste management • State Environmental Inspectorate • Inter-Municipal Waste Management Board • Authorized Inspectors of Environment (Municipalities)
Monitoring entity	Ministry of Environment and Physical Planning

Contribution for the achievement of the SDGs	direct	indirect
	11 SUSTAINABLE CITIES AND COMMUNITIES; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION

PAM 49 Improved industrial wastewater treatment

Main objective: Increase the rate of industrial wastewater treatment, by reducing the sludge

Description: This measure assumes industrial sludge treatment processes which includes mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re-use. This measure, i.e. treatment of the industrial wastewater is also part of the integrated environmental permits of the industrial facilities.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulation, Technical	Waste – Industrial wastewater	CH_4	National

Relevant planning documents, legal and regulatory acts	• National Waste Management Plan 2021-2031 • Strategy for Waste Management in the Republic of Macedonia • Law on Waste Management and bylaws • Law on Management of Packaging and Packaging Waste • Law on Extended Producer Responsibility for Waste Management • Law on Finance and bylaws • Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Polog, Vardar and Skopje region)
Methodology [for estimating the emissions]	Regression model, IPCC methodology
Assumptions	• The emissions from industrial wastewater will be reduced by 50% in 2050 when compared to the emissions from this category in 2050 in the WOM scenario.
Status of implementation [idea, planning phase, under implementation]	Planning phase
- Steps taken	/
- Steps envisaged	• Modified and issued environmental permits • Regular annual implementation oversight • Regular annual reporting by IPPC operators

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2030	2040	2050
Progress: Sludge removed in each industry sector (kg COD/yr)	0	51,531,106	141,338,206	385,499,107

Emissions reduction (Gg CO_2-eq)	2030	2040	2050
	62.4	163.5	370.5

Finance	
Budget	n/a
Source of finance	Ministry of Environment and Physical Planning, Industrial facilities, EU funds

Implementing entity	• Ministry of Environment and Physical Planning • Public municipal enterprises for waste management • State Environmental Inspectorate • Inter-Municipal Waste Management Board • Authorized Inspectors of Environment (Municipalities)
Monitoring entity	Ministry of Environment and Physical Planning

	direct	indirect

Contribution for the achievement of the SDGs

5.5 Additional PAMs (enablers of mitigation action)

PAM 50 Introduction of CO_2 tax

Main objective: Incentivize lowering CO2 emissions
Description: Introduction of CO_2 tax in order to stimulate the investments in RES and to increase the penetration of energy efficiency measures

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on Energy • Bylaws for renewable energy • Law on Climate Change
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
Assumptions	• Gradual introduction of CO_2 tax (2023 in WAM) based on the projected prices from WEO 2017.
Status of implementation	Under implementation
- Steps taken	• Draft version of the Law on Climate Change • Strategy for Energy Development of the Republic of Macedonia up to 2040
- Steps envisaged	• Adoption of the Law on Climate Change • Adoption of the Strategy on Climate Action • Adoption of the National Energy and Climate Plan

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress kt CO_2 emissions paid under carbon tax	2030	2040		2050

Finance – Budget	n/a
Finance – Source of finance	n/a
Implementing entity	• Government of the Republic of North Macedonia • Ministry of Environment and Physical Planning • Ministry of Economy, Energy Agency • Ministry of Finance
Monitoring entity	Ministry of environment and physical planning

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 51 Program for just transition

Main objective: Developing programs for socially responsible and just transition

Description: Depending on selected level of transition from conventional energy, it is important to develop programs for socially responsible and just transition to mitigate negative effects of associated job losses. Such programs should provide an answer how to redeploy employees to other jobs and stimulate new job opportunities by investing in low carbon technologies and services.

Timeframe	Type	Sector	Gases	Scope
2020 – 2030	Regulatory	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on Energy • Documents from project which are working in this area
Methodology	TBC
Assumptions	• Oslomej is decommissioned in 2021 • Bitola is decommissioned in the period 2025-2027
Status of implementation	Under implementation
Steps taken	• EBRD project of just transition in Oslomej region • NGO project of just transition in Oslomej region • 100 MW PV power plant in Oslomej • 20 MW PV power plant in Oslomej • 20 MW PV power plant in Bitola
Steps envisaged	•

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress indicator				

Progress	Program adopted	2030	2040	2050

Finance	Budget	n/a
	Source of finance	JSC ESM, state budget, donors
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Economy • JSC Macedonian Power Plants (ESM AD) • Ministry of labor and social policy
Monitoring entity		Ministry of Economy

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION

PAM 52 Identification of the proper location for solar and wind power plants

Main objective: Development of methodology for selection of the most appropriate location foe solar and wind power plants

Description: Avoid excessive damage to nature, Government, energy companies and NGOs can prioritize land areas that have already been disturbed by industrial activity such as mines or quarries. In territories that have been historically dependent on coal production, depleted coal and other mines can be used for this purpose. In addition, for the wind warms it is important to find appropriate locations, not environmentally sensitive (e.g habitats of birds and bats).

Timeframe	Type	Sector	Gases	Scope
2020 – 2023	Technical	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on Energy • Law on environmental protection • Documents from project which are working in this area
Methodology	TBC
Assumptions	• Oslomej is decommissioned in 2021 • Bitola is decommissioned in the period 2025-2027
Status of implementation	Planning
- Steps taken	• 100 MW PV power plant in Oslomej • 20 MW PV power plant in Oslomej • 20 MW PV power plant in Bitola
- Steps envisaged	•

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress Methodology developed	2030	2040		2050

Finance – Budget	n/a
Finance – Source of finance	State budget, donors
Implementing entity	• Government of the Republic of North Macedonia • Ministry of Economy • JSC Macedonian Power Plants (ESM AD) • Ministry of labor and social policy • Donors
Monitoring entity	• Ministry of Economy

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 53 Smart communities

Main objective: Develop pilots for smart communities

Description: Smart academic campuses could have an exemplary role where all advanced concepts and principles from smart energy systems can be tested with the goal for roll-out on larger scale.

Timeframe	Type	Sector	Gases	Scope
2020 – 2030	Education, Technical	Education, Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	/
Methodology	TBC
Assumptions	/
Status of implementation	Planning
- Steps taken	• PV power plants are installed at the Faculty of Electrical Engineering and Information Technologies
- Steps envisaged	•

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress: Number of smart communities	2030	2040		2050

Finance: Budget	Depends on the type of smart community
Finance: Source of finance	• Donors • Horizon 2020 and other research programs
Implementing entity	• Universities (or high schools)
Monitoring entity	• Ministry of Education and Science • Ministry of Economy

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 54 Construction of 400 kV electricity transmission interconnection Macedonia-Albania (Bitola-Elbasan)

Main objective: Improve the interconnectivity level

Description: this project is the last segment of the Corridor 8 for transmission of electricity between Bulgaria, Macedonia, Albania and Italy. The project is included in the List of Projects of Energy Community Interest (PECI).

Timeframe	Type	Sector	Gases	Scope
2020 – 2023	Technical	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• PECI list • Plan for development of the transmission system, 2020-2029, MEPSO • Infrastructure Capacity Project, Technical Assistance Window (IPA) Western Balkans
Methodology	Calculation of interconnectivity level, using MARKAL results from the Strategy for energy development up to 2040 and ENTSO-E Winter outlook
Assumptions	Interconnectivity level will be increased for at least 7%
Status of implementation	Under implementation
- Steps taken	• an agreement for construction signed
- Steps envisaged	•

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress Interconnectivity level	2030	2040		2050

Finance – Budget	34 Mil. €
Finance – Source of finance	EBRD (17.2 Mil. €), Grand from Western Balkan Investment Fund (16.9 Mil. €)
Implementing entity	• MEPSO
Monitoring entity	• Ministry of economy

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 55 Develop natural gas cross-border infrastructure to diversify supply routes and increase market competitiveness

Main objective: Develop natural gas cross-border infrastructure to diversify supply routes and increase market competitiveness

Description: On 10 July 2015 the Republic of North Macedonia became a signatory to the Memorandum of understanding on a common approach to address the natural gas diversification and the challenges of security of supply within the Central and Southeastern Europe Gas Connectivity Initiative (CESEC).

NER JSC Skopje has started implementing the obligations under this Initiative aimed at promoting the diversification of natural gas supply and ensuring security in the supply of the region, which should take place by improving the regional infrastructure and integration of markets through the joint engagement of all EU Member States and Contracting Parties of the Energy Community. This initiative should provide the supply of the necessary quantities of natural gas to all consumers in the region of Central and South-Eastern Europe (CESEC), including the Republic of North Macedonia.

In addition, there are two other initiatives - pipelines to Kosovo* and Serbia. The pipeline to Serbia could provide additional alternative source and transit opportunity to the Macedonian system, while the connection with Kosovo* could provide transit opportunity. Both can increase the utilization rate of the system, thus have the potential to decrease tariffs and help the gasification efforts in Macedonia. The projects for gas pipelines to Kosovo* and Serbia are on the preliminary PECI 2020 list that should be adopted by the Ministerial council at the end on 2020, while the gas project to Greece is already included on the PMI list, verified on 14 October 2016 by the Ministerial council of the Energy Community.

Furthermore, Macedonia and Albania have signed a Memorandum of understanding and a working group is established and it is expected that by the end of 2020 more concrete activities will start.

Timeframe	Type	Sector	Gases	Scope
2020 – 2025	Technical, Regulatory	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• List of Projects of Mutual Interest • List of Project of Energy Community Interest
Methodology	/
Assumptions	/
Status of implementation	Under implementation
- Steps taken	Macedonia – Greece pipeline • Project application after the fourth open call for co-financing of infrastructure projects within the IPA instrument Investment Framework of the Western Balkans, November 2018 and update of the same in April 2019. The investment grant application has a positive screening status and the final decision was made in December 2019; • A letter was submitted with a request for expression of interest for financing the Project submitted to the European Investment Bank (EIB), October 2018. The EIB submitted a positive response to this request in November 2018. Intensive negotiations have started for the financing procedure. • Mutual Feasibility Study is prepared by DESFA and NER in January 2019 and it is submitted and accepted by EIB • A request for technical assistance (100% grant) has been submitted for the preparation of an Environmental Impact Assessment Study and a general design project to Connect (Technical Assistance for Connectivity in the Western Balkans). The application was approved in January 2019. The study and the general design project are being prepared by Konnekta. According to the plans, the Study (EIA) has already been prepared and submitted to the EIB for comments, while the project documentation should be completed by the middle of 2020. • A request for technical assistance (100% grant) for preparation of tender documentation for construction and construction supervision has been submitted. The same has been approved, but due to the coronavirus situation it is postponed. Macedonia – Kosovo* pipeline • Memorandum of Understanding is signed, February 2019 • A letter with a request for expression of interest for financing the Project was submitted to the EBRD. At the beginning of 2019, the EBRD submitted a positive response to this request and the bank supported the implementation of this project; • A project application was submitted after the 21st open call for technical assistance for preparation of a Feasibility Study and Environmental Impact Assessment Study within the IPA Instrument Investment Framework of the Western Balkans, November 2018 and update of the same in April 2019. The technical assistance application was approved in July 2019; The TOR (Terms of Reference) has been developed. A

		Feasibility Study and an Environmental Impact Assessment Study are expected to be completed by the middle of 2020. Macedonia – Serbia pipeline: • Activities for signing a Memorandum of Understanding.			
	- Steps envisaged	• Start with the construction of Macedonia-Greece pipeline			
	Indicators	Value in the last reporting year	Indicative trajectory		Target value
		2018	2020	2025	2030
	Progress – Natural gas interconnection capacity (Mill. Nm^3)	2030	2040		2050
Finance	Budget	n/a			
	Source of finance	Grant – 10 Mil. €, Central government budget			
Implementing entity		• National Energy Resources of Macedonia			
Monitoring entity		Ministry of Economy			
Contribution for the achievement of the SDGs		direct	indirect		
					

PAM 56 Develop gas transmission network

Main objective: Increase the access to the transmission network

Description: Macedonia has an ambitious gasification plan and a detailed list of planned infrastructure project of the gas network in Macedonia with timeline is given in Chapter 4, Energy transmission infrastructure. The increased level of transmission network access is especially aimed at the industrial consumers (which are most affected by the green scenario), as natural gas is one of the fuels that will significantly contribute to the energy transition in the industry sector. In addition, with the implementation of this measure the air quality will be significantly improved.

Timeframe	Type	Sector	Gases	Scope
2020 – 2025	Technical	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Gasification plan of Macedonia
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model.
Assumptions	/
Status of implementation	Under implementation
- Steps taken	• Klechovce-Valve station 5(Stip), with length of 61 km and diameter of 500mm, finished in 2016 (light blue line in Figure 78), and • Valve station 5(Stip)-Negotino, with length of 38 km and diameter of 500mm, finished in 2019 (purple line in Figure 78).
- Steps envisaged	• Negotino (Kavadarci)-Bitola, with length of 92 km and diameter of 500mm, 90% realized up to June 2020 (green line in Figure 78) • Skopje-Tetovo-Gostivar, with length of 76 km and diameter of 500mm, and additional branch to Tetovo with length of 10 km and diameter of 150 mm, 53.1% realized at the beginning of November 2019 (yellow line in Figure 78). It is expected that in the near future the construction of three additional gas pipelines will be started: • Gostivar-Kicevo, with length of 34 km, in a process of obtaining building permit (to be finished by 2022) • Sveti Nikole – Veles, with length of 32 km, in a process of preparing project documentation (to be finished by 2023) • Kicevo-Ohrid (to be finished by 2025) • Bitola – Ohrid (to be finished by 2025) • Valve station 5 (Stip)-Radovis-Strumica, with length of 60 km

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress: Final energy consumption of natural gas in Industry (ktoe)	2030	2040		2050

Finance – Budget	~200 Mil. €
Finance – Source of finance	State budget
Implementing entity	• National Energy Resources of Macedonia
Monitoring entity	Ministry of Economy

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 57 Develop a gas distribution network

Main objective: Diversification of the energy resources

Description: Macedonia has an ambitious gasification plan and natural gas is one of the fuels that will significantly contribute to the energy transition up to 2040. In addition, with the implementation of this measure the air quality will be significantly improved.

Timeframe	Type	Sector	Gases	Scope
2020 – 2025	Technical	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Gasification plan of Macedonia • Feasibility study about gasification (revised version in 2020)
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model.
Assumptions	Development of a cost benefit analyses for each city
Status of implementation	Under implementation
- Steps taken	• Tender announced • EBRD support for procurement and installation of household equipment (50 mill. EUR) • Tender for technical and legal support for preparation and implementation of a tender procedure is announced in June 2020 by EBRD
- Steps envisaged	

Indicators	Value in the last reporting year	Indicative trajectory		Target value
	2018	2020	2025	2030
Progress: Final energy consumption of natural gas except Industry (ktoe)	2030	2040		2050

Finance: Budget	/
Finance: Source of finance	Grant, Central governmental budget, Local self-government budgets
Implementing entity	• Ministry of economy, • National Energy Resources of Macedonia, • Local self-government
Monitoring entity	Ministry of Economy

Contribution for the achievement of the SDGs	direct	indirect
	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

PAM 58 Pursue regional electricity market integration

Main objective: Increase the electricity price competitiveness and affordability.

Description: It is anticipated that day ahead market coupling, and development of power exchange is playing an important role in the future for North Macedonia and EnC market integration initiatives (WB6). Future potential domestic capacities for electricity generation are considered in the context of integrated regional and European market. In addition, a well-integrated regional market will serve as a control indicator for price competitiveness and steer future capital investment decisions.

In order to have competitive natural gas market in Macedonia, the interconnection agreement between Macedonian and Bulgarian TSOs is of crucial importance.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory,	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Energy Law and bylaws
Methodology	/
Assumptions	/
Status of implementation	Under implementation
Steps taken	• The decree for the operation of the organized electricity market and the necessary technical, staff and financial conditions that should be fulfilled, is adopted by the Government
Steps envisaged	•

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030

Progress	Coupled with Bulgaria Macedonian and Bulgarian gas TSOs agreement signed	2030	2040	2050

Finance	Budget	/
	Source of finance	National electricity market operator (MEMO), GAMA
Implementing entity		• National electricity market operator (MEMO), • GAMA
Monitoring entity		• Energy Regulatory Commission

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 59 Develop further distribution system network to integrate more RES, including prosumers and more electric vehicles (EVs), as well as continuously improve network reliability

Main objective: Develop further distribution system network to integrate more RES, as well as continuously improve network reliability..

Description: The RES policies and measures envisage a huge number of solar PVs up to 1,400 MW, out of which 250 – 400 MW being rooftop PVs. Such trend indicates an important role of the distribution network system to service growing decentralised systems. In addition, European practice shows that regulators are imposing additional pressure and incentive to improve the operational performance and results of distribution system operators. The key changes that should be considered in the future are related in introducing new quality indicators in the tariff methodology (voltage quality, quality of supply, customer relationship quality etc.), as well as additional revisions on investment decisions (CAPEX and regulated asset base), operating efficiency and expected returns for distribution system operators. These changes in the regulatory framework will indirectly contribute to improvements in asset management, workforce management, automation and roll out of "behind the meter" services in the future.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory, technical	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Energy Law and bylaws • Plan for development of the distribution network
Methodology	/
Assumptions	The potential for distributed RES, prosumers and electric vehicles will be increased
Status of implementation	Under implementation
Steps taken	• Chargers for Electric vehicles are being installed • Old meters are being replaced with smart meters
Steps envisaged	•

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030

Progress	2030	2040	2050
Number of prosumers Capacity of distributed PV Number of electric vehicles			

Finance – Budget	/
Finance – Source of finance	EVN, consumers through their electricity bills
Implementing entity	• EVN • Energy Regulatory Commission
Monitoring entity	• Energy Regulatory Commission

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 60 Price signal demand response

Main objective: Introduce price signals to consumers in order to implement demand response.

Description: Demand response is one of the main methods that are used in order to reduce the maximum electricity consumption in the system, and thus reduce its peak load and integrate higher level of RES in the system. Price signalling provided by the electricity suppliers can significantly contribute towards achieving these goals. By implementing the new Energy Law, and by the liberalized market it is envisioned that the role of the universal supplier will be reduced, and that the concurrency of the suppliers will be increased. Therefore, each of them may introduce different pricing signals for different type of consumers.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Energy Law and bylaws • Study on automated demand response, MEPSO
Methodology	/
Assumptions	Price signal demand response will reduce the peak load and enable higher integration of RES
Status of implementation	Under implementation
Steps taken	/
Steps envisaged	•

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress – Number of suppliers on the market with price signals	2030	2040	2050	

Finance – Budget	/
Finance – Source of finance	Electricity suppliers/traders, Consumers
Implementing entity	• Electricity suppliers/traders • Consumers
Monitoring entity	• Energy Regulatory Commission

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 61 Adoption of annual program for vulnerable consumers

Main objective: Protect vulnerable customers .

Description: The Implementation of the GHG and RES targets will increase the price of electricity as it is described in Chapter 4 Internal energy market. Having this in mind a program for vulnerable costumers is needed that will protect them from the price shocks.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Regulatory	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Energy law • Separate rules for electricity, gas and heat supply • Program for vulnerable consumers for 2020
Methodology	/
Assumptions	This early program should define the categories of vulnerable costumers and associated measures, including financial supports and responsible institutions for realization of the program.
Status of implementation	The first program is adopted by the Government
Steps taken	/
Steps envisaged	•

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030

Progress	Program adopted	2030	2040	2050

Finance		
	Budget	Different for each year
	Source of finance	Budget and potential donors

Implementing entity	• Ministry of economy • Suppliers of electricity, gas and heat
Monitoring entity	• Energy Regulatory Commission

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 62 Participation in development of energy transition technologies and measures

Main objective: Streamline energy transition technologies and measures into national R&I priorities

Description: The development of sectoral strategies and plans for science and R&I should be realized in cooperation between Ministry of Education and Science and relevant energy stakeholders, in order to prioritize energy transition technologies and measures. Same is needed for the programmes in the Fund for Innovation and Technology Development.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Research	Energy, Research, Economy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Innovation Strategy, 2012-2020 • Law on Innovation Activity • Annual programs of the Fund for Innovation and Technology Development
Methodology	/
Assumptions	/
Status of implementation	The Fund for Innovation and Technology Development has already announced two public calls for research in climate change and local pollution
Steps taken	/
Steps envisaged	/

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030

Progress		2030	2040	2050
	Number of research projects development of energy transition technologies and measures			

Finance	
Budget	/
Source of finance	• Fund for Innovation and Technology Development • Horizon 2020 • Donors

Implementing entity	• Ministry of Education and Science • Fund for Innovation and Technology Development • Chamber of Commerce
Monitoring entity	• Ministry of Education and Science

Contribution for the achievement of the SDGs	direct	indirect
		

PAM 63 Increased level of education of sustainable energy needs

Main objective: Adjust energy related curricula at all educational levels to make them responsive to energy transition trends

Description: The development of consciousness for sustainable energy needs to be addressed from the earliest education levels and incorporated in the curricula of all primary, secondary and tertiary educational levels. Moreover, stimulating science and education in energy transition will help mobilization of the existing and building of new research capacities, as well as better integration into European Research Area (ERA) in energy themes.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Regulatory	Education	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Law on primary education • Law on secondary education • Law on higher education
Methodology	/
Assumptions	/
Status of implementation	/
Steps taken	/
Steps envisaged	/

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress – Number of curricula for sustainable energy needs	2030	2040		2050

Finance – Budget	/
Finance – Source of finance	/
Implementing entity	• Universities, High and Primary schools
Monitoring entity	• Ministry of Education and Science

Contribution for the achievement of the SDGs	direct	indirect
	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	7 AFFORDABLE AND CLEAN ENERGY; 13 CLIMATE ACTION

PAM 64 Inter-sectoral and geographical mobility of researchers

Main objective: Encourage inter-sectoral and geographical mobility of researchers

Description: Knowledge and experience transfer among researchers from industry and academia, as well as incoming and outgoing mobility is needed to build internal capacities. For example, at highest educational level, industrial doctorates can be promoted as a tool to support industry driven science..

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Education, Regulatory	Education, Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	• Law on primary education • Law on secondary education • Law on higher education
Methodology	/
Assumptions	/
Status of implementation	Faculty of Electrical Engineering and Information Technologies has established INNOFEIT, which is a place where the faculty staff, students and company representatives can interact, network and transfer technologies and innovations. The goal of INNOFEIT is to improve, strengthen and stimulate the transfer of knowledge.
Steps taken	/
Steps envisaged	/

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress – Number of industrial doctorates	2030	2040	2050	

Finance – Budget	/
Finance – Source of finance	• Industry companies • Donors
Implementing entity	• Universities • Industry companies
Monitoring entity	• Ministry of Education and Science • Ministry of Economy

Contribution for the achievement of the SDGs	direct	indirect
	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	7 AFFORDABLE AND CLEAN ENERGY, 13 CLIMATE ACTION

PAM 65 Increase the role of SME sector in energy transition

Main objective: Encourage SME sector to diversify their portfolio of services and products in RES and EE

Description: To support greater involvement of local SME in energy transition, it is necessary to promote further expansion of RES projects and EE measures overall, especially via financial mechanisms, as well as green public procurement for innovative products. Private investments in RES and EE will be encouraged by structuring financing instruments with grant components to lower the risk of private investments in untested but promising clean energy technologies or business models. In addition, provision of technical assistance for SMEs in order to facilitate the access of enterprises to external services is needed. This covers the areas of external research and development, testing, design, instruction and training, market research, business consulting, etc.

Timeframe	Type	Sector	Gases	Scope
2030 – 2050	Research, Technical, Voluntary	Energy	CO_2, CH_4, N_2O	National

Relevant planning documents, legal and regulatory acts	/
Methodology	/
Assumptions	/
Status of implementation	/
Steps taken	/
Steps envisaged	/

Indicators	Indicator value in the last reporting year	Indicative trajectory		Indicator target value
	2018	2020	2025	2030
Progress – Number of innovations/patents in the field of clean energy	2030	2040		2050

Finance – Budget	/
Finance – Source of finance	• Grants • Private investments
Implementing entity	• SMEs
Monitoring entity	• Ministry of Economy

direct	indirect
Contribution for the achievement of the SDGs	

5.6 Regional approach

After the adoption of the Strategy for energy development until 2040 in December 2019 and the preparation of the draft version of Mitigation report on climate change as a part of TBUR, the Ministry of Local Self-Government started with the preparation of the Strategy for regional development for the period 2019-2029. The Strategy was prepared in the second half of 2020 and in December 2020 is submitted to the Assembly of the Republic of North Macedonia for adoption.

The Strategy for regional development analyzes the disparity of the eight planning regions in North Macedonia in different areas, including the energy sector. For the needs of this strategy, a special document was prepared with a detailed analysis of the energy sector in relation to the eight planning regions. In addition, five measures have been elaborated in detail, which are based on the measures defined in the Energy strategy, TBUR and NECP, but a regional context is given. The following are the most important observations that are presented in the Strategy for regional development:

1. Energy consumption in households per capita,
2. Energy consumption in industry per added value,
3. Participation of the regions in RES for heating and cooling,
4. Participation of the RES regions in electricity production.

For each of the four parameters, a ranking of the regions from 1 to 8. was made. Each of the parameters is assigned the same weight factor and it turns out that in terms of these four parameters the best is the Southwest planning region, followed by the Polog and Skopje planning region (*Table 6*). The lowest ranked regions are the Pelagonija and Vardar planning region. The GHG emissions are not considered because there is no information by region, but given that TPP Bitola is in the Pelagonija region, this region is convincingly the worst of all other regions. Additionally, the analysis of the impact of the energy system on climate change shows that the most affected regions, i.e. the largest reductions of the GHG emissions will be in the Pelagonija and Southwest planning region where TPP Bitola and TPP Oslomej are located.

Table 6: Ranking of regions

Planning region	Energy consumption in households per capita (kWh/жител)	Energy consumption in industry at added value (kWh/EUR)	Participation of the regions in RES for heating and cooling	Participation of the RES regions in electricity production	Ranking
Vardar	2737	7.3	7.7%	8.6%	**8**
East	2855	0.8	14.3%	1.8%	**6**
Southwest	2585	0.6	12.8%	35.0%	**1**
Southeast	2509	2.3	13.7%	5.5%	**4**
Pelagonija	2840	1.4	12.7%	3.3%	**7**
Polog	2615	1.1	14.5%	31.1%	**2**
Northeast	2400	0.6	7.0%	0.0%	**5**
	2841	1.8	17.2%	14.7%	**3**

Source: Strategy for regional development for the period 2019-2029

It is obvious that there is disparity between the regions and in order to reduce it, i.e. to have improvement of those planning regions that are lagging behind, but at the same time to ensure those planning regions that are developed to continue their development, five priority measures are proposed.

1. ***Just transition***: In the Pelagonija and Southwest planning region the decommissioning of the TPP on coal is more that obvious since large investments are needed to meet the obligations of the Large Combustion Plants Directive and the Industrial Emissions Directive which are mandatory from 2025 and 2028, respectively. Second reason for their potential decommission is the introduction of a CO_2 tax, which would make the production price of these plants uncompetitive to the market. The third factor is the challenge related to coal supply, i.e. depletion of current facilities and the possibility of opening new ones. As a possible solution, it is proposed to create conditions for investment in new facilities for electricity production, primarily from RES that would be built on mines or coal landfills. This already started on the coal landfill in Oslomej where it is planned to build 120 MW solar power plants. This approach should be applied to Bitola as well, because in the Pelagonija planning region, except for TPP Bitola, there are almost no other production facilities. It is also necessary to develop transition programs that will include mechanisms in which employees can be exploited. It is planned to build about 320 MW of photovoltaic power plants in these two regions. The investment is projected to about 200 mill EUR.

   Connection with the PAMs from NDC: PAM 4, PAM 7, PAM 48, PAM 49.

2. ***Increasing the participation of the Southeast, East and Northeast planning region in the electricity production form RES***: There is almost no production of electricity from RES in the Northeast Planning Region. At the same time, solar radiation data show that these regions are among the most favorable for

the installation of photovoltaic power plants. One of the ways to solve this problem is to use the existing mechanisms for support of electricity from RES (feed-in tariffs or premiums). It is recommended the mayors in these regions to find land that would be suitable for the construction of photovoltaic power plants and together with the competent bodies of the state administration to announce tenders for the construction of photovoltaic power plants on state land. Additionally, the possibility of announcing a tender for construction of photovoltaic power plants on private land, which would apply only to these regions, could be considered. On the other hand these regions are rich in biomass, but its consumption in the households will be reduced, as a result of local pollution, so small cogeneration biomass power plants can be built. This measure envisages construction of at least 100 MW photovoltaic power plants, 20 MW photovoltaic power plants on the roof, 5 MW small hydro power plants and 5 MW TPP on biomass (with the possibility for heat production). A total of 90 mill. EUR are projected for the implementation of this measure.
Connection with the PAMs from NDC: PAM 3, PAM 4, PAM 5, PAM 6, PAM 7, PAM 57, PAM 50

3. ***Increasing energy efficiency in the industry***: The main problem with the industry is the use of coal and oil derivatives, especially in the Skopje, Polog and Vardar planning regions. The solution to this problem is the construction of a gas network that will significantly contribute to the use of more efficient technologies. At the same time the gas network can be used by the other planning regions to attract investors. The fuel switch (from coal to natural gas) will improve the air quality, too. The realization of this measure would cost around 100 mill. EUR.
Connection with the PAMs from NDC: PAM 24, PAM 45, PAM 26, PAM 54, PAM 55, PAM 63.

4. ***Energy efficiency in households***: The East, Pelagonija, Vardar and Skopje are the planning regions that have the highest energy consumption in households per capita. This is mostly due to the use of firewood in inefficient stoves, but if the consumption of firewood is reduced, the share of renewable sources in the gross final energy consumption will be reduced, too. To prevent this, it is necessary to increase energy efficiency by insulating homes, which will reduce the energy needs for heating and cooling and the introduction of more efficient technologies for household heating such as heat pumps (under the Renewable Energy Directive they are considered as RES).
Connection with the PAMs from NDC: PAM 9, PAM 10, PAM 11, PAM 12, PAM 13, PAM 14, PAM 18, PAM 19, PAM 20, PAM 23, PAM 55, PAM 59.

5. ***Mitigation of climate change through landfill gas burning.*** The GHG emission in the waste sector increasing continualsy. This is due to the increasing amount of waste that is deposited. In addition, its inadequate treatment at non-standard landfills contributes to air pollution. Regarding the waste sector, except for the Skopje planning region, almost all other planning regions are identical and lag behind European practices. For that purpose, during the construction of regional landfills, where mechanical and biological treatment of waste by composting will be performed, landfill gas combustion systems should be introduced. The investment for the realization of this measure is around 36 mill. EUR.
Connection with the PAMs from NDC: PAM 44, PAM 45.

In addition to these measures, in the Strategy for regional development it is recommended to improve the statistics at the regional level in order to be able to make analyzes in a simpler way, but also to monitor the implementation of the proposed measures. Additionally, the following four considerations are common for all measures:

- mobilization of financial resources and quality human resources;
- establishing solid forms of organization and efficient coordination;
- preparation of the public and
- implementation of an inclusive process of amendments to the normative framework in order to introduce fiscal instruments that will increase the source revenues of the municipalities for environmental protection and sustainable management and development of the related infrastructure

6 Assessment of mitigation policies and measures

6.1 Economic and environmental aspects

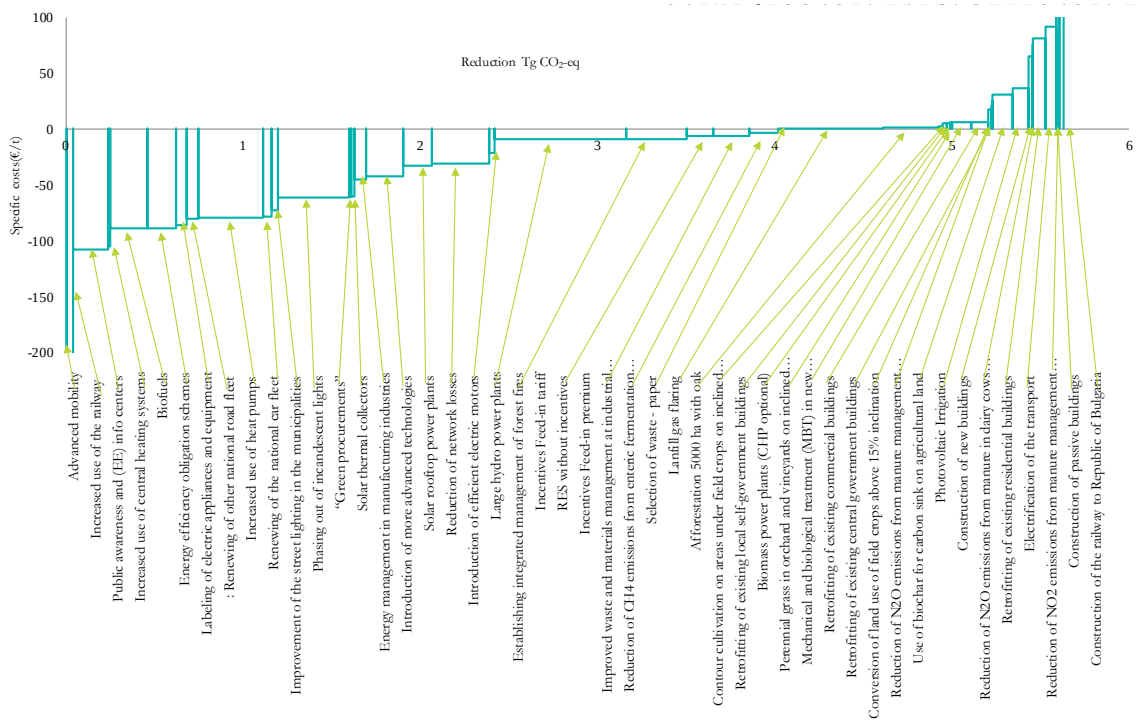
The economic and environmental aspects of the climate change mitigation policies and measures are analyzed through the following two parameters:

- Economic effectiveness or specific cost - shows the number of investments required in order to reduce 1 t CO_2-eq by applying the specific policy/measure and it is expressed in €/t CO_2-eq.
- Environmental effectiveness or mitigation potential - indicates the extent to which emission reductions are achieved by applying the specific policy/measure and it is expressed in t CO_2-eq.

The combined presentation of these two parameters results in the so-called Marginal Abatement Cost Curve (MAC curve) which serves as a tool for determining priorities in the implementation of mitigation policies and measures.

The MAC curve is created for the WAM scenario for 2030 (as target year) and it shows that the total reduction from the proposed measures is estimated to around 5.6 Tg CO_2-eq (*Figure 47*) 70% of the reduction can be achieved with a "win-win" policies and measures, which means that these measures are reducing the emissions by a negative specific costs (total cost of the proposed measure are lower compared to the costs of the WOM scenario). Furthermore, additional 20% of the reduction is realized by measures with specific costs in range from 0-5 €/t CO2-eq. It is crucial to underline that this is not the total amount of GHG emission reduction, because there is one more measure which is very important, but its independent contribution cannot the estimated. This measure is the Introduction of CO_2 tax, which depends to a high extent on the other measures (such as the measures for RES, energy efficiency, fuel switch etc.) which are needed to replace the CO_2 emitters.

Figure 47. The marginal abatement cost curve for 2030



From a reduction point of view the best measure is the construction of Large hydropower plants (including all hydropower plants that are part from the measure), which in 2030 can reduce the emissions for 741 Gg CO_2-eq (Figure 48). On the second place is Landfill gas flaring with a reduction of 490 Gg CO_2-eq. On the other hand, Advance mobility and Increased use of railway are measures with lower specific costs (*Figure 48*).

Figure 48. Reduction of CO_2-eq emissions in 2030 (in Gg)

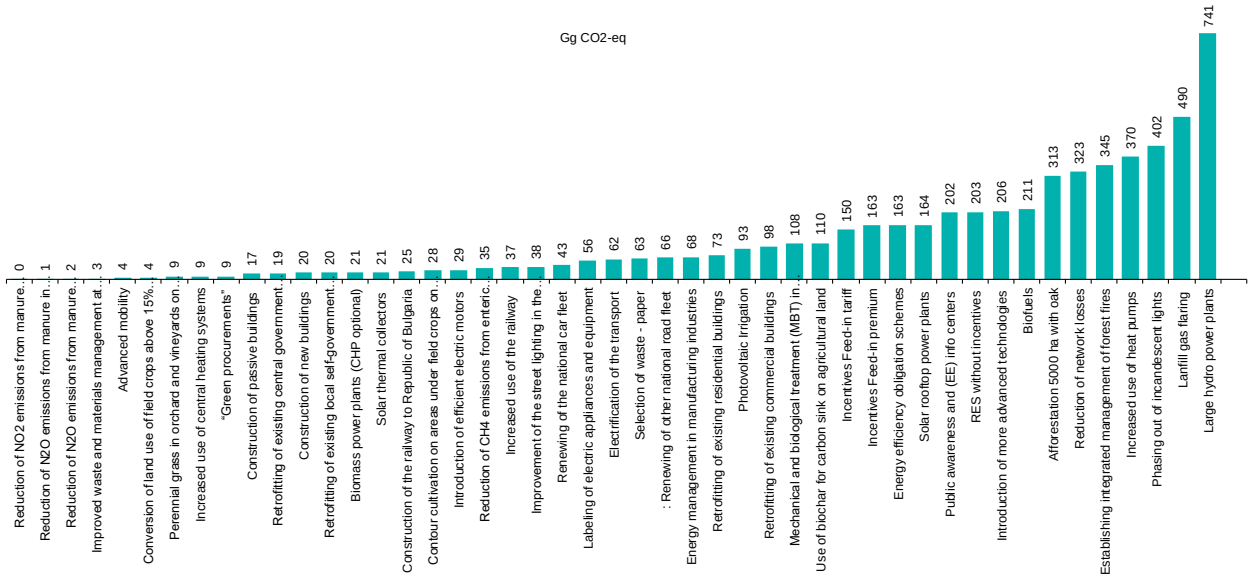
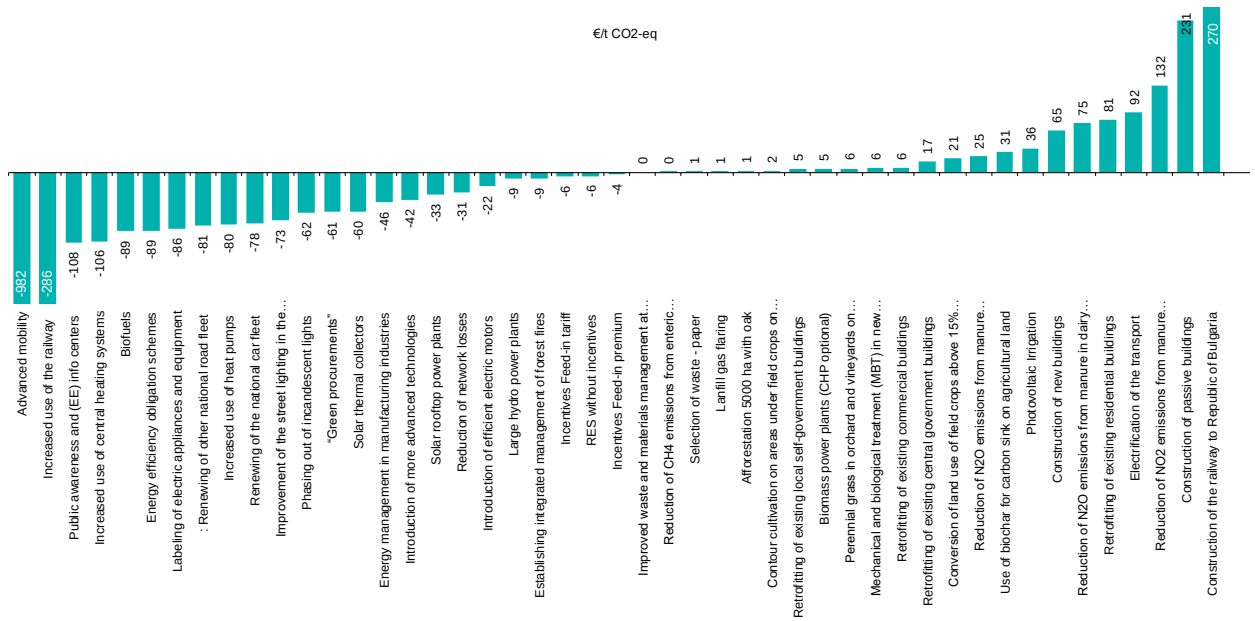


Figure 49. Specific costs for 2030 (in EUR/tCO_2-eq)



6.2 Social aspects - Jobs

In addition to the economic and environmental effectiveness of the proposed policies and measures, their social aspect is also very important and should be considered for the overall process of sustainable development. In this study the social aspect is analyzed through the number of newly created green jobs. The methodology that was developed for the Intended Nationally Determined Contributions and also used in the FBUR and SBUR, TBUR is implemented in 4NC too. The number of green jobs in each year depends on the time (year) of implementation of the policies and measures in each scenario. In general, in all scenarios the

share of green jobs the field of Energy efficiency green jobs is higher compared to RES green jobs (Figure 50). The maximal number in the WAM scenario is in 2040 with 10877 green jobs, from which 64% are from the energy efficiency and the remaining are from RES.

Furthermore, the technologies which contribute most to the creation of new domestic green jobs is Retrofitting with around 40% in 2040 in WAM scenario, followed by installation of PV (20%), Building of new houses, including passive houses (17%), and Solar thermal collectors (10%). After 2040 there is a decrease in the creation of domestic green jobs mainly because of the reduced number of building retrofit (Figure 51).

Figure 50.Number of domestic green jobs from RES and energy efficiency, by scenario

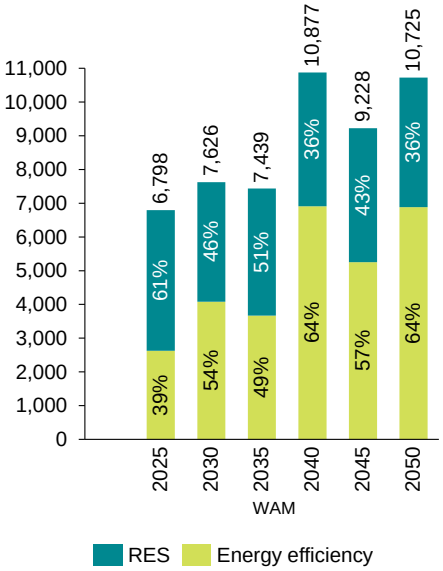
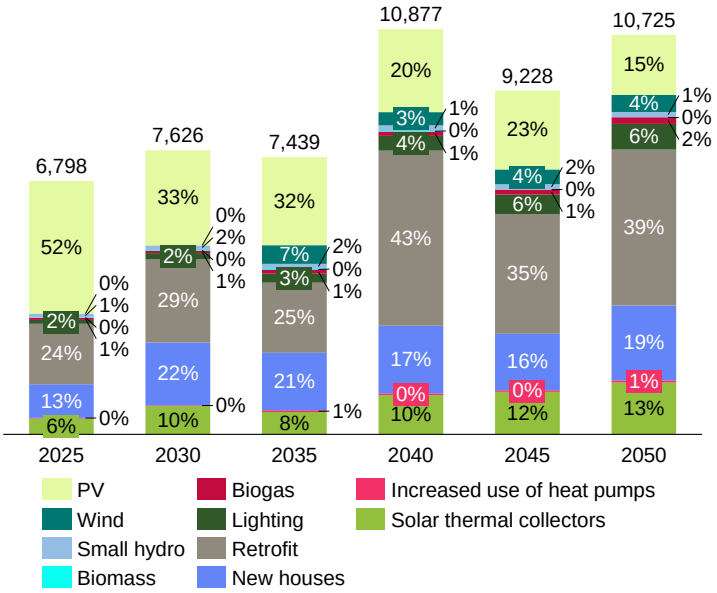
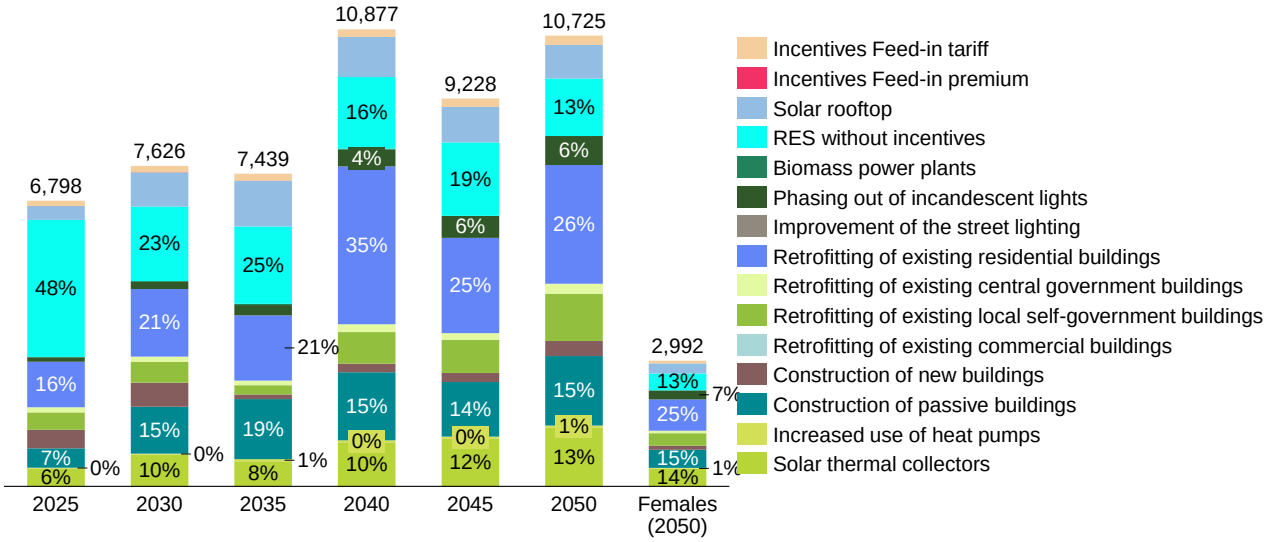


Figure 51. Number of domestic green jobs by technologies in WAM



Regarding the contribution by measures, the ones that have the highest share in the number of new domestic green jobs are: Retrofit of existing residential buildings (35%), RES without incentives (16%), Construction of passive houses (15%), and Solar thermal collectors (10%), in the WAM scenario in 2040 (*Figure 52*). Based on the types of jobs, very basic analyses are done concerning the gender issue. It is found that at least around 28% of the maximum number of job positions in 2040 can be assigned to women (*Figure 52*).

Figure 52. Number of domestic green jobs by measure in WAM



6.3 The role of the private sector

The role of the private sector in the mitigation action is particularly analyzed in the Study on Industry Analysis of Policies and Measures (STUIND). In this study more disaggregated and additional PAMs in the Industry sector that contribute to (i) increasing energy efficiency, (ii) increasing renewable sources utilization for electricity production and (iii) improving waste management are considered. With this study it was shown that the mitigation potential in the Industry is even higher compared to the results from TBUR. The final energy consumption can be reduced by additional 4% compared to the reduction in TBUR (24%). The main goal of this study was to improving the productivity of the companies and reducing their emissions. The results show that the total GHG emissions can be reduced by 10.6%, while the local emissions (SOx) by 98%.

The main conclusion from the study is that first, within each of the companies, the ISO 50001 standard should be introduced, or regular energy audit should be implemented, especially in large companies. Based on this, goals should be set for each company individually and a series of measures should be taken to achieve them. When implementing the measures, it is recommended to start with the measures that have the least investment and the least risk, such as the Soft measures. These measures can often be ignored, as their individual effect may be small, but if implemented together, their potential is shown to reach up to 8% of the total reductions in GHG emissions from the proposed measures in the Industry. On the other hand, the biggest potential for reducing energy consumption, and thus GHG and local emissions, is the measure Process change and the introduction of CO_2 tax. As a result of these measures the consumption of coal in the Industry is completely replaced by natural gas and renewable energy sources (biomass). However, the implementation of this measure is accompanied by large investments, and thus carries the greatest risk

Regarding investments, the private sector has a dominate role as it participates with 85% in total investments needed for realization of the PAMs. So far, supported by feed-in tariff mechanism, 110 private companies have invested in 140 MW RES capacities (dominantly solar and small hydro). According to the official data from the State Statistical Office, the number of companies in the sector “Electricity, gas, steam and air conditioning supply” in 2018 is doubled compared to 2017 (224 vs. 107) which is mainly a result of the companies which invested in renewables. Having in mind that more than 2,000 MW (solar, wind, small hydro, biomass and biogas) are projected by 2040, it is expected that this prominent role of the private sector will be sustained and even enhanced.

The role of the private sector is very important in meeting the objectives set out in this document. However, the measures presented in this document are minimum that should be achieved. Any additional investment by the private sector, but also by state-owned companies, which contributes to additional reductions in GHG emissions, is more than welcome. On the other hand, it should be borne in mind that additional investments

in any type of fossil fuels will contribute to increasing GHG emissions, and thus will drive the country away from meeting the set goals.

6.4 Health benefit

The Carbon Reduction Benefits on Health (CaRBonH) calculation tool[3] was used to examine the health and economic co-benefits that can be achieved through reductions in domestic carbon emissions with the proposed mitigation policies and measures (PaMs) analyzed in the Fourth National Communication.

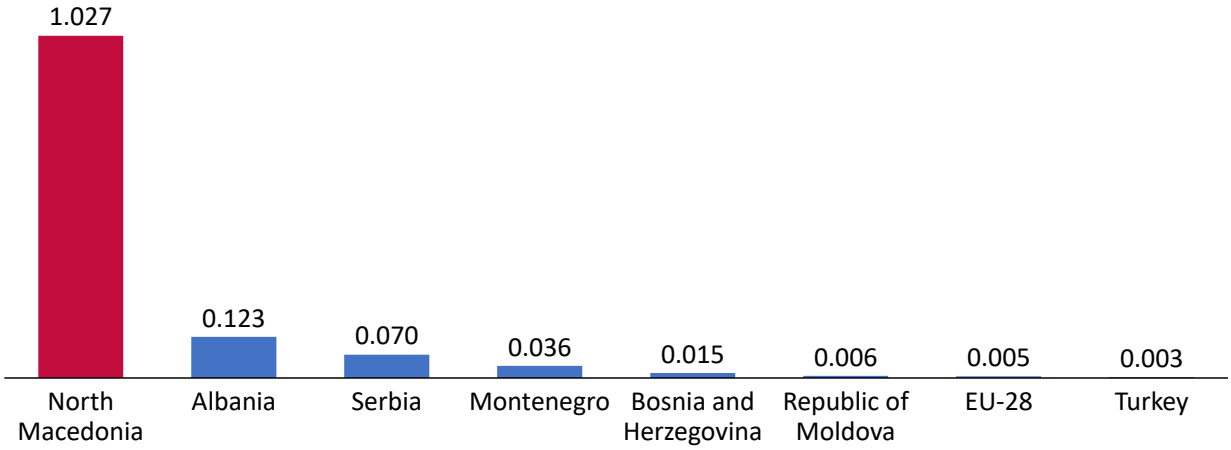
The CaRBonH tool was developed by the WHO Regional Office for Europe to quantify the health and related economic gains from implementing climate mitigation policies and measures reported in the NDCs submitted to UNFCCC [1]. It covers 53 Member States of the WHO European Region. The tool is Excel-based, and as input data it requires the emission reductions of GHGs and air pollutants ($PM_{2.5}$, SO_2, NO_x, and NH_3) in kilotons per year.

The tool provides the following outputs: **reduced population-weighted exposure** and **health and economic co-benefits** of reducing air pollutant emissions due to carbon mitigation interventions. The output results are summarized in the sections below.

6.4.1 Change in population-weighted $PM_{2.5}$ concentration

The outputs of the CaRBonH tool show that the reduction of GHG emissions and air pollutants achieved in 2050 with the energy-related carbon mitigation interventions, analyzed in the Fourth National Communication of North Macedonia, would translate into a reduction of the population exposure to $PM_{2.5}$ concentrations for 1.027 μg/m^3. The decreased emissions from North Macedonia will affect the transboundary pollution at a regional level and contribute to the ambient $PM_{2.5}$ concentration changes in the neighboring countries, such as Albania, Serbia (including Kosovo) and Montenegro (Figure 53).

Figure 53. $PM_{2.5}$ concentration changes (reduced exposure) in 2050, in μg/m^3



6.4.2 Health co-benefits of reduced $PM_{2.5}$ concentration

Another relevant output of the tool are the health co-benefits that North Macedonia may achieve with mitigation PaMs in the energy sector, through improvements in air quality due to reductions in air pollutant emissions. The results also show the health benefits of these reductions to the other neighboring countries covered in the CaRBonH tool. Hence, the implementation of PaMs in North Macedonia (in 2050) will result in 404 premature deaths avoided or 4,045 life-years gained in total (considering all countries included in CaRBonH tool). Besides the prevented mortality, the results show a reduction in total cases of illnesses (morbidity).

[3] For this report CaRBonH tool -version: 1.0R (from 10 November 2018) was used, available at: https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications/2018/achieving-health-benefits-from-carbon-reductions-manual-for-carbonh-calculation-tool-2018

The preventable mortality from air pollutant emissions in 2050 in North Macedonia is 133 deaths, representing 33% of the total avoidable deaths (Figure 54). The EU -28 region has the highest share of the prevented deaths because it represents the population exposure of the 28 countries, some of which are more affected by the North Macedonia emissions reductions due to their proximity (e.g., Greece, Bulgaria, Romania, Croatia, and Slovenia). The number of averted deaths in the country represents approximately 3.9% of the 3,400 premature deaths in 2019, attributed to exposure to average annual $PM_{2.5}$ concentrations at a level of 20.9 $\mu g/m^3$, estimated by the European Environment Agency (EEA) [2]. The benefit of reduced air pollution in terms of years of life lost will result in 1,468 years gained in 2050 at national level, or 36% of the total life-years gained in the region. This figure represents approximately 4.3% of the years of life-lost (YLL) attributable to $PM_{2.5}$ exposure in the country in 2019, estimated to be around 33,900 YLL [2].

Additionally, the improved air quality results in fewer cases of illnesses (morbidity) in the country, such as 589 prevented cases of bronchitis in children and 2,611 fewer asthma symptom days in children, 92 fewer cases of chronic bronchitis in adults, and 6,528 averted work lost days (WLD or absenteeism) in adult employed population, 170,692 restricted activity days (RAD) avoided plus 105 fewer cases of hospital admissions (HA) (Figure 55).

Figure 54. Avoided premature deaths in 2050 due to the emissions reductions achieved with PaMs

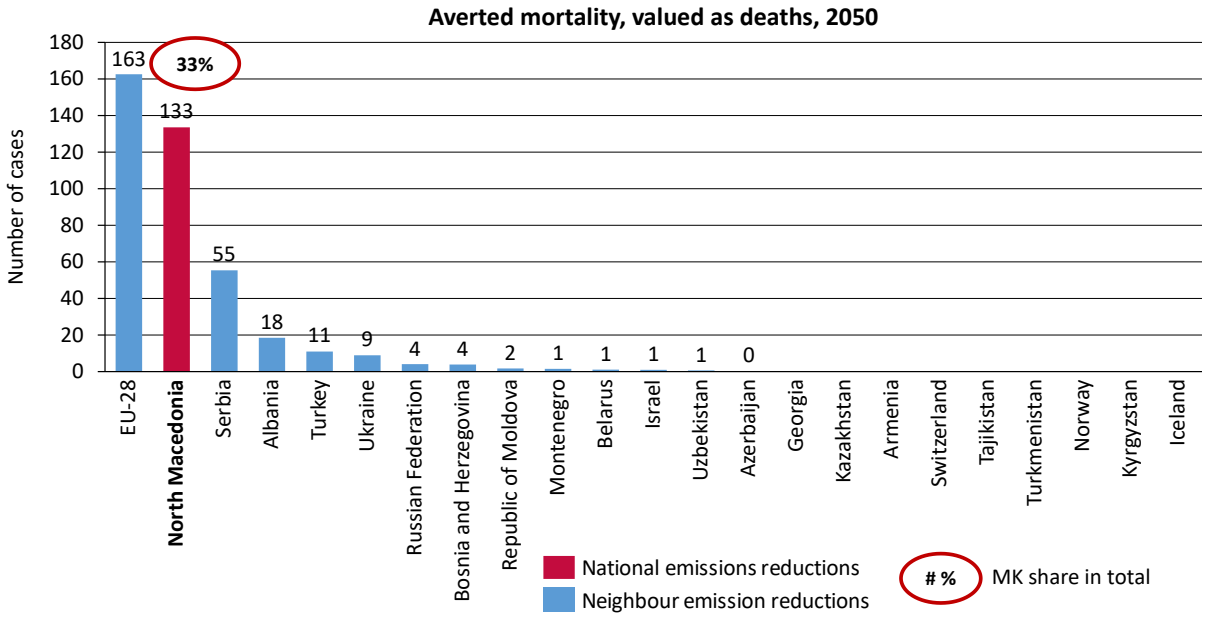
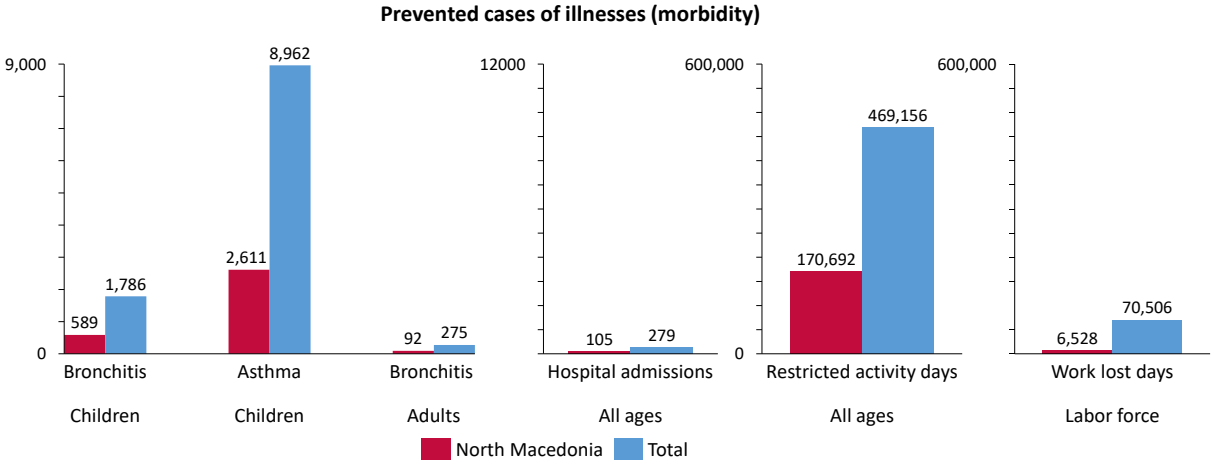


Figure 55. Prevented cases of illnesses due to reductions in $PM_{2.5}$ ambient air concentrations

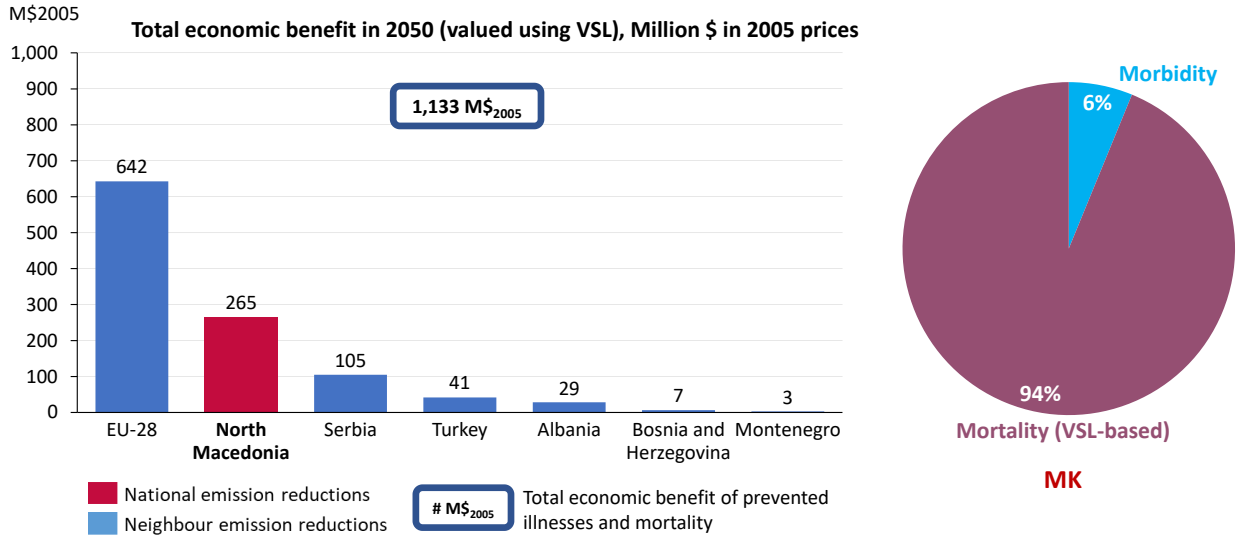


6.4.3 Economic benefits of reduced PM2.5 concentration

The economic value of the health benefits is estimated considering the market costs of the health care expenditures and the prevented productivity losses, and the social costs associated with premature deaths avoided or life-years gained.

The results show that the overall economic benefit of the prevented illnesses and mortality in 2050 (in all countries covered with CaRBonH tool) due the mitigation PaMs in North Macedonia. is 1,133 million US$ (expressed in 2005 prices), evaluated using the value of the statistical life (VSL) (i.e., the value of the prevented premature death) (Figure 56), or 485 million US$2005 if the value of a life year (VOLY) is used. In the case of North Macedonia, the estimated economic benefit from avoided premature deaths vary between 120 million US$2005 (VOLY metric) and 265 million US$2005 (VSL metric). These costs represent 1.2% and 2.8%, respectively, of the country's GDP in 2019 (in 2005 prices). The welfare improvements, attributed to the averted premature deaths, account for 249 million US$2005, or 94% of the total economic benefits (valued using VSL metric) for the country.

Figure 56. Total economic benefit (valued using VSL) of emission reductions in 2050, in million US$ in 2005 prices

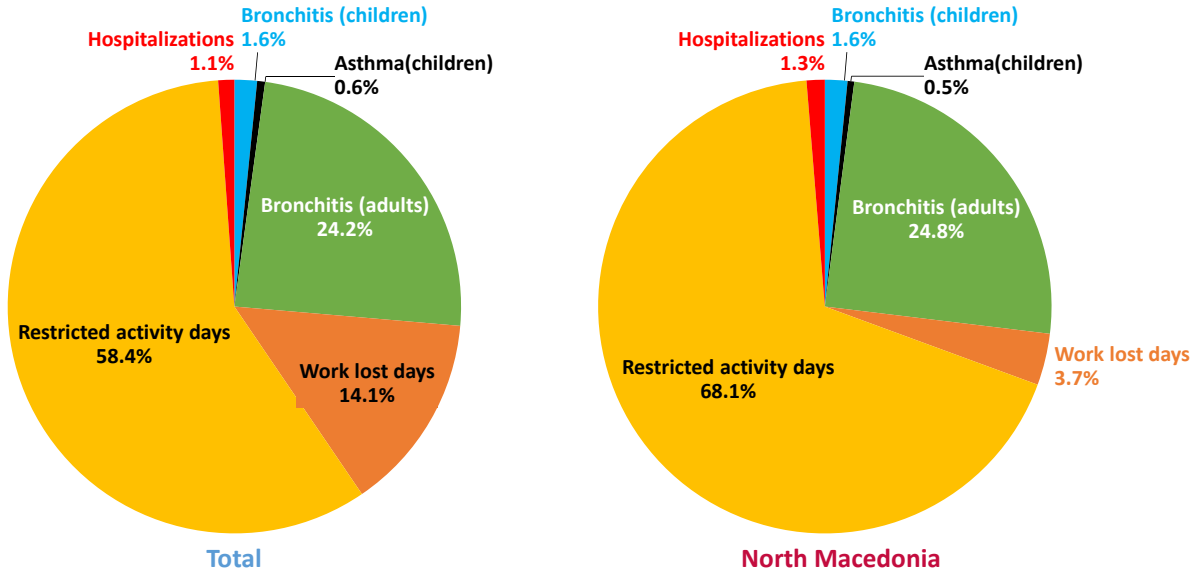


** Economic benefits from emissions reductions only in North Macedonia*

Note: VSL= Value of Statistical Life;

The economic benefit of the total avoided morbidity cases (in all countries) in 2050 amounts to around 77 million US$2005, and in the case of North Macedonia is 16 million US$2005. The breakdown of these morbidity benefits by the outcomes is presented in Figure 57. The chart on the left represents total benefits for all countries in the CaRBonH tool, while the chart on the right represents the benefits only for North Macedonia. When all countries are considered, most of the costs savings result from reducing the restricted activity days – 58%, around 24% are from avoided bronchitis in adults, and about 14% are from prevented work lost days. Similarly, in the case of North Macedonia, around 68% of morbidity benefits are because of the avoided restricted activity days, nearly 25% from prevented bronchitis in adults, and 4% from work lost days. In both cases, the reduced hospital admissions and avoided cases of bronchitis and asthma in children contribute to the remaining 3% of the benefits.

Figure 57. Breakdown of morbidity benefits by outcome in 2030



7 Mitigation scenario

Compared to the WOM scenario, the Mitigation Scenario includes 63 measures/policies from the measures given in the previous chapter. Measures included in this scenario are called existing measures because they are highly likely to be realized, i.e. they fall into one of the following groups:

- Already started/planned to start in the near future;
- Priority projects/policies in sectoral strategic and planning documents;
- They arise from already adopted laws or laws that will be adopted in the near future.

Within this chapter, for each sector individually (Energy, Agriculture, Forestry and Other land use and Waste), and for each measure/policy that is part of this scenario, tabular representation including the following information is given: the competent entities for their realization, the necessary investments, the source of funding and indicative emissions reduction (Gg CO_2-eq). The results of the mitigation scenario are first shown separately for each sector (due to the specificity of each of the sectors), and eventually, the aggregate results are obtained.

7.1 Energy

In the Energy sector, 32 measures/policies are proposed as presented in Table 7.

Table 7. Review of the measures/policies included in the Mitigation scenario of the energy sector

#	Policy/measure	Competent entity for realization	Budget (mil. €)	Source of finance	Indicative emissions reduction (Gg CO_2-eq)		
					2030	2040	2050
1	Reduction of network losses	► Electricity distribution companies ► Heat distribution companies ► Energy Agency, Ministry of Economy	170	Distribution and transmission companies	104.4	168.5	168.5
2	Large hydropower plants	► JSC ESM ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency	1556	JSC ESM, Public Private Partnership, Independent power producers	617.7	757.8	1556.7
3	Incentives Feed-in tariff	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Private investors	557	Independent power producers Consumers of electricity through bills	123.3	147.0	178.9
4	Incentives feed-in premium	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy ► Private investors	160	Independent power producers, incentives from the central government budget	108.0	108.0	108.0
5	Biomass power plants (CHP optional)	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Private investors	24.3	Independent power producers Consumers of electricity through bills	21.0	21.0	21.0
6	Solar rooftop power plants	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency	699	Independent power producers, donors, subsidies from national and local budget, EE fund	84.6	214.6	234.9

		► Elektrodistribucija Skopje ► Suppliers of electricity ► End-users of electricity					
7	RES without incentives	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency ► JSC Macedonian Power Plants (ESM AD) ► Private investors	2194	Public private partnership, Independent power producers, ESM	74.0	219.8	286.6
8	Development of the biofuels market	► Government of the Republic of North Macedonia ► Ministry of economy ► Companies that sell oil products	n/a	Central government budget, consumers	96.0	96.0	96.0
9	Energy efficiency obligation schemes	► Ministry of economy ► Distribution system operators ► Suppliers and traders of electricity and gas	124	Consumers through their bills	10.3	24.4	58.4
10	Solar thermal collectors	► Ministry of Economy, Energy Agency ► End-users	60	Private, EE fund, incentives from the central government budget, donors	14.8	19.9	23.3
11	Labeling of electric appliances and equipment	► Ministry of Economy, Energy Agency ► Producers and suppliers of electrical equipment and household appliances ► End-users	48	Private, EE fund	42.4	100.5	240.9
12	Increased use of heat pumps	► Ministry of Economy, Energy Agency ► End-users	240	Private, EE fund, incentives from the central and local government budget, donors	281.7	430.3	555.9
13	Public awareness campaigns and network of EE info centers	► Ministry of Economy, Energy Agency ► Energy suppliers ► End-users	598	Private sector, donors, central and local governments	117.9	279.1	669.0
14	Retrofitting of existing residential buildings	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Households	3187	Private, donors through commercial EE loans, EE fund	20.5	56.6	90.3
15	Retrofitting of existing central government buildings	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Local self-government ► Municipal public enterprises ► Donors and financial institutions	290	Central government budget, donors	20.9	38.6	58.9
16	Retrofitting of existing local self-government buildings	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Local self-government ► Municipal public enterprises ► Donors and financial institutions	280	Local self-government budget, donors	20.9	38.6	58.9
17	Retrofitting of existing commercial buildings	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Commercial buildings owners	880	Private, donors through commercial EE loans, EE fund	48.6	86.7	150.7
18	Construction of new buildings	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Investors (households)	370	Private, donors through commercial EE loans, EE fund	21.3	32.6	46.3

19	Construction of passive buildings	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Investors (households)	1520	Private, donors through commercial EE loans, EE fund	16.6	58.2	94.0
20	Phasing out of incandescent lights	► Government of the Republic of North Macedonia ► Ministry of Economy, Energy Agency End-users	1027	Central government budget, private	114.0	131.9	139.5
21	Improvement of the street lighting in the municipalities	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Local self-government	40	Central and local government budget, ESCO	37.9	37.9	37.9
22	Green procurements	► Ministry of Economy, Energy Agency ► Public Procurement Bureau ► Local self-government	34	Central and local government budget	2.9	6.9	16.5
23	Increased use of central heating systems	► Ministry of Economy, Energy Agency ► Balkan energy Dooel Skopje ► JSC Skopje Sever ► "Energetika" –Skopje, subsidiary to JSC Macedonian Power Plants (ESM AD) ► Private investors	20	Private, EE fund, incentives from the central and local government budget	4.1	16.8	24.8
24	Energy management in manufacturing industries	Ministry of Economy, Energy Agency Private companies	n/a	Private, donors through commercial EE loans	28.4	35.6	50.8
25	Introduction of efficient electric motors	Private companies Ministry of Economy, Energy Agency	172	Private, donors through commercial EE loans	33.0	50.9	102.7
26	Introduction of more advanced technologies	Government of the Republic of North Macedonia Ministry of Environment and Physical Planning Ministry of Economy, Energy Agency Private investors	1414	Private, donors through commercial EE loans, EE fund	237.2	747.9	1304.5
27	Increased use of the railway	Government of the RM Ministry of Transport and Communication Ministry of Economy, Energy Agency JSC Makedonski zeleznici End-users Private companies	434	Central government budget	91.7	98.0	102.9
28	Renewing of the national car fleet	Government of the RM Ministry of Transport and Communication Ministry of Economy, Energy Agency End-users	1172	Private, EE fund, incentives from the central government budget	28.3	30.3	33.5
29	Renewing of other national road fleet	Government of the Republic of North Macedonia Ministry of Transport and Communications Ministry of Interior Affairs Ministry of Economy, Energy Agency Private companies	5381	Private sector	351.4	400.8	447.3
30	Advanced mobility	Ministry of Economy, Energy Agency Local self-government	12	Private, EE fund, incentives from the central and local government budget, donors	3.0	6.4	12.5

		End-users					
31	*Construction of the railway to the Republic of Bulgaria*	*Government of the Republic of North Macedonia* *Ministry of Transport and Communications* *Ministry of Economy, Energy Agency*	*720*	*Central government budget*	*24.6*	*37.5*	*50.3*
32	Electrification of the transport	Government of the Republic of North Macedonia Ministry of Transport and Communications Ministry of economy	7579	Private, EE fund, incentives from the central government budget	120.3	259.7	272.2
		Total	30,962		2,921	4,758	7,292

For the implementation of the Mitigation measures in the Energy sector, investments of 30,962 mil. € are needed, for the period from 2020 to 2050.

It is important to emphasize that the investments in the WAM scenario contribute to reducing the total system costs (€ 35,958 million discounted in 2012) compared to the reference scenario costs (€ 39,786 million), which is a reduction of 9.6%. If all of the measures are implemented in parallel and the "Energy efficiency first" principal is applied, then the total investment can be reduced by about 25%. Measures with the most significant potential for greenhouse gas emissions reduction are the RES without incentives, Large hydro power plants and Phasing out of incandescent lights.

The main indicators by which the WEM scenario is described are shown in (Table 8) and they indicate that the average annual increase by 2050 is:

- 1.1% of the final energy or a total increase of 42.6% in 2050 (2.6 Mtoe) compared to 2017 (1.8 Mtoe);
- 1.6 % of electricity consumption or a total increase of 71.4% in 2050 (10.9 TWh) compared to 2017 (6.3 TWh);
- 3.7% of the total installed capacity or an increase of 236% in 2050 (5.9 GW) compared to 2017 (1,8 GW);
- 0% of the gross inland consumption or a decrease of 0.6% in 2050 compared to 2017;
- -2.3% of greenhouse gas emissions or an increase of 54.2% in 2050 compared to 2017 (9.2 kt CO_2-eq).

Table 8. Indicators for the WAM scenario

					Annual increase rate (%)			*Total increase (%)*		
	2017	2030	2040	2050	2017/ 2030	2017/ 2040	2017/ 2050	2017/ 2030	2017/ 2040	2017/ 2050
Final energy (ktoe)	1.8	2.3	2.4	2.6	1.7%	2.3%	1.1%	24.9%	33.6%	42.6%
Electricity consumption (TWh)	6.3	8.1	9.2	10.9	1.9%	2.9%	1.6%	27.5%	45.1%	71.4%
Electricity production (TWh)	7.3	8.6	9.7	11.5	1.2%	2.2%	1.4%	17.4%	31.9%	57.6%
Installed capacity (TW)	1.8	3.4	4.7	5.9	5.1%	7.9%	3.7%	91.5%	167.3%	236.4%
Gross inland consumption (Mtoe)	2.6	2.5	2.6	2.6	-0.3%	0.0%	0.0%	-3.3%	0.2%	-0.6%
GHG emissions (Tg CO_2-eq)	9.2	6.0	4.9	4.2	-3.3%	-4.8%	-2.3%	-35.0%	-47.1%	-54.2%

Compare to WAM, the main indicators by which the WEM scenario is described are shown in (Table 9) and they indicate that the average annual increase by 2050 is:

- 2% of the final energy or a total increase of 94% in 2050 (3.6 Mtoe) compared to 2017 (1.8 Mtoe);
- 2.1 % of electricity consumption or a total increase of 98% in 2050 (12.6 TWh) compared to 2017 (6.3 TWh);
- 3.5% of the total installed capacity or an increase of 207.9% in 2050 (5.4 GW) compared to 2017 (1,8 GW);
- 1.3 of the gross inland consumption or a total increase of 54.1% in 2050 compared to 2017;

- 0.5% of greenhouse gas emissions or an increase of 18.3% in 2050 compared to 2017 (9.2 kt CO_2-eq)

Table 9. Indicators for the WEM scenario

					Annual increase rate (%)			Total increase (%)		
	2017	2030	2040	2050	2017/ 2030	2017/ 2040	2017/ 2050	2017/ 2030	2017/ 2040	2017/ 2050
Final energy (ktoe)	1.8	2.6	3.0	3.6	2.7%	4.0%	2.0%	41.3%	66.0%	94.0%
Electricity consumption (TWh)	6.3	8.8	10.5	12.6	2.5%	3.9%	2.1%	38.1%	64.9%	98.2%
Electricity production (TWh)	7.3	9.9	10.9	15.6	2.4%	3.1%	2.3%	35.5%	48.7%	113.3%
Installed capacity (TW)	1.8	3.2	4.9	5.4	4.6%	8.1%	3.5%	80.1%	175.7%	207.9%
Gross inland consumption (Mtoe)	2.6	3.0	3.5	4.0	1.1%	2.2%	1.3%	14.9%	33.2%	54.1%
GHG emissions (Tg CO_2-eq)	9.2	8.5	8.9	10.9	-0.7%	-0.3%	0.5%	-8.2%	-3.7%	18.3%

7.2 IPPU

In the Mitigation scenario, there is one measure that is envisioned in the IPPU sector, i.e. the Product Uses as Substitutes for ODS category, as shown in Table 10.

Table 10. Review of the measures/policies included in the Mitigation scenario of the IPPU sector

#	Policy/ measure	Competent entity for realization	Budget (mil. €)	Source of finance	Indicative emissions reduction (Gg CO_2-eq)		
					2030	2040	2050
1	Implementation of Kigali amendment on HFC phase-down	▶ Ministry of Environment and Physical Planning	N/A	Private sector	225.6	471.6	861.6
		Total	N/A		225.6	471.6	861.6

7.3 Agriculture, Forestry and Other Land Use

In the Mitigation scenario, 11 measures/policies are included from the Agriculture, Forestry and Other land use sector, from which four are from Livestock, two from Forestry, and five form Agriculture and Other land use (Table 11).

Table 11. Review of the measures/policies included in the Mitigation scenario of the Agriculture, Forestry and Other land use sector

#	Policy/ measure	Competent entity for realization	Budget (mil. €)	Source of finance	Indicative emissions reduction (Gg CO_2-eq)		
					2020	2030	2040
1	Reduction of CH4 emissions from enteric fermentation in dairy cows by 3%	▶ Ministry of Agriculture, Forestry and Water Economy	0.2	Private sector	3.2	35.0	63.6
2	Reduction of N2O emissions from manure management in dairy cows by 20%	▶ Ministry of Agriculture, Forestry and Water Economy	1	Private sector	0.2	2.1	3.9
3	Reduction of NO2 emissions from manure management in swine farms by 13%	▶ Ministry of Agriculture, Forestry and Water Economy	1	Private sector	0	0.4	0.7
4	Reduction of N2O emissions from manure in dairy cows by 20% for farms	▶ Ministry of Agriculture, Forestry and Water Economy	1	Private sector	0.1	0.7	1.2

	below 50 Livestock Units						
5	Establishing integrated management of forest fires	▶ PE "National forests" Ministry of Agriculture, Forestry and Water Economy	1.5	PE "National forests", other forest enterprices	345	345	345
6	Afforestation	▶ PE "National forests" Ministry of Agriculture, Forestry and Water Economy	7.8	PE "National forests", other forest enterprices	0	312.5	312.5
7	Conversion of land use of field crops above 15% inclination	▶ Ministry of Agriculture, Forestry and Water Economy	1.5	Private sector	1.0	3.7	5.3
8	Contour cultivation on areas under field crops on inclined terrains (5-15%)	▶ Ministry of Agriculture, Forestry and Water Economy	1	Private sector	5.0	28.0	39.7
9	Perennial grass in orchard and vineyards on inclined terrains (>5%)	▶ Ministry of Agriculture, Forestry and Water Economy	1	Private sector	1.6	8.9	12.6
10	Use of biochar for carbon sink on agricultural land	▶ Ministry of Agriculture, Forestry and Water Economy	30	Private sector	0	110.0	330.3
11	Photovoltaic irrigation	▶ Ministry of Agriculture, Forestry and Water Economy	47	Private sector	0	93.3	186.6
		Total	93		356.1	939.6	1,301.4

Using the proposed measures in the Agriculture, Forestry and Other land use sector in 2040, a greenhouse gas emissions reduction of 1,301Gg CO_2-eq can be achieved. The measures from the Forestry category contribute the most to the reduction of greenhouse gas emissions, i.e. they account for 50.5% of the total emission reduction from the Agriculture, Forestry and Other Land use sector in 2040. In order to obtain this reduction, it is necessary to invest 93 € mil. for the period from 2020-2040. 90% of the investments are from the private sector. Measures with the most significant potential for greenhouse gas emissions reduction are the Use of biochar for carbon sink on agricultural land and Afforestation.

7.4 Waste

From the Waste sector, four measures/policies are included (Table 12).

Table 12. Review of the measures/policies included in the Mitigation scenario of the Waste sector

#	Policy/ measure	Competent entity for realization	Budget (mil. €)	Source of finance	Indicative emissions reduction (Gg CO_2-eq)		
					2030	2040	2050
1	Landfill gas flaring	▶ Ministry of Environment and Physical Planning ▶ Public municipal enterprises for waste management ▶ State Environmental Inspectorate ▶ Inter-Municipal Waste Management Board ▶ Authorized Inspectors of Environment (Municipalities)	20.5	Local self-government through Public Utilities, Public Private Partnership, Grants from the EU	561.3	655.0	823.5
2	Mechanical and biological treatment (MBT)	▶ Ministry of environment and physical planning ▶ Public utilities for waste management	36.1	Local self-government through Public Utilities,	35.2	145.2	216.1

	in new landfills with composting	▶ State Environmental Inspectorate ▶ Inter-municipal board for waste management ▶ Authorized Inspectors of Environment (Municipalities)		Public Private Partnership, Grants from the EU			
3	Selection of waste - paper	▶ Ministry of environment and physical planning ▶ Public utilities for waste management ▶ State Environmental Inspectorate ▶ Inter-municipal board for waste management ▶ Authorized Inspectors of Environment (Municipalities)	2	Local self-government through Public Utilities, Public Private Partnership, Grants from the EU	30.2	75.1	129.6
4	Improved waste and materials management at industrial facilities	▶ Ministry of Environment and Physical Planning ▶ Public utilities for waste management ▶ State Environmental Inspectorate ▶ Inter-Municipal Waste Management Board ▶ Authorized Inspectors of Environment (Municipalities)	/	Ministry of Environment and Physical Planning Municipalities and city of Skopje Industrial facilities	16.4	51.5	95.8
5	Improved industrial wastewater treatment	▶ Ministry of Environment and Physical Planning ▶ Public utilities for waste management ▶ State Environmental Inspectorate ▶ Inter-Municipal Waste Management Board ▶ Authorized Inspectors of Environment (Municipalities)	/	Ministry of Environment and Physical Planning, Industrial facilities, EU funds	62.4	163.5	370.5
		Total	58.6		705.5	1,090.3	1,635.5

* Total reduction when including the emissions realized after 2050

For the implementation of the Mitigation scenario in the Waste sector, investments of 58.6 mil. € are needed, for the period from 2020 to 2050. All investments are covered by the central budget of Macedonia, the local self-governments and the City of Skopje and the private sector. A measure with the most significant potential for greenhouse gas emissions reduction is the Landfill gas flaring.

7.5 Additional PAMs (enablers of mitigation action)

In addition, 16 measures are considered, that help in achieving the goals for reducing GHG emissions (Table 13).

Table 13. Review of the additional measures/policies included in the Mitigation scenario

#	Policy/ measure	Competent entity for realization	Budget (mil. €)	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	#	Policy/ measure
1	Introduction of CO_2 tax	▶ Government of the Republic of North Macedonia	n/a	n/a	n/a	n/a	n/a

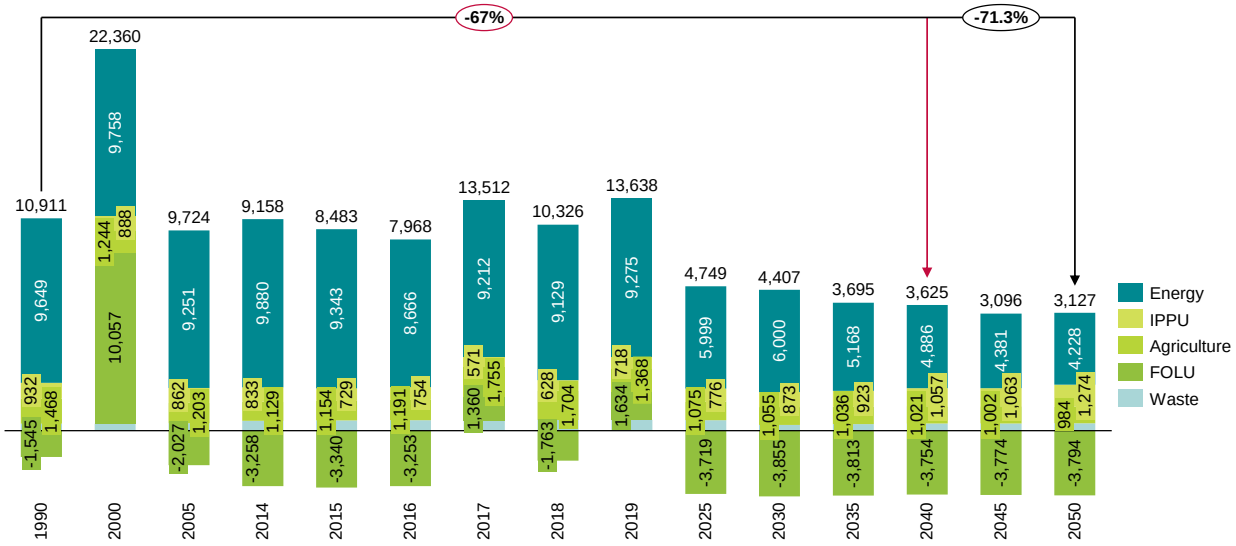
		► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency Ministry of Finance					
2	Program for just transition	Government of the Republic of North Macedonia Ministry of Economy JSC Macedonian Power Plants (ESM AD) Ministry of labor and social policy	n/a	JSC ESM, state budget, donors	n/a	n/a	n/a
3	Identification of the proper location for solar and wind power plants	Government of the Republic of North Macedonia Ministry of Economy JSC Macedonian Power Plants (ESM AD) Ministry of labor and social policy Donors	n/a	State budget, donors	n/a	n/a	n/a
4	Smart communities	Universities (or high schools)	n/a	Donors Horizon 2020 and other research programs	n/a	n/a	n/a
5	Construction of 400 kV electricity transmission interconnection Macedonia-Albania (Bitola-Elbasan)	MEPSO	34	EBRD (17.2 Mil. €), Grand from Western Balkan Investment Fund (16.9 Mil. €)	n/a	n/a	n/a
6	Develop natural gas cross-border infrastructure to diversify supply routes and increase market competitiveness	National Energy Resources of Macedonia	n/a	Grant – 10 Mil. €, Central government budget	n/a	n/a	n/a
7	Develop gas transmission network	National Energy Resources of Macedonia	200	State budget			
8	Develop a gas distribution network	Ministry of economy, National Energy Resources of Macedonia, Local self-government	n/a	Grant, Central governmental budget, Local self-government budgets	n/a	n/a	n/a
9	Pursue regional electricity market integration	National electricity market operator (MEMO), GAMA	n/a	National electricity market operator (MEMO), GAMA	n/a	n/a	n/a
10	Develop further distribution system network to integrate more RES, including prosumers and more electric vehicles (EVs), as well as continuously improve network reliability	EVN Energy Regulatory Commission	n/a	EVN, consumers through their electricity bills	n/a	n/a	n/a
11	Price signal demand response	Electricity suppliers/traders Consumers	n/a	Electricity suppliers/traders Consumers	n/a	n/a	n/a
12	Adoption of annual program for vulnerable consumers	Ministry of economy Suppliers of electricity, gas and heat	n/a	Budget and potential donors	n/a	n/a	n/a
13	Participation in development of energy transition technologies and measures	Ministry of Education and Science Fund for Innovation and Technology Development Chamber of Commerce	n/a	Fund for Innovation and Technology Development Horizon 2020 Donors	n/a	n/a	n/a
14	*Increased level of education of sustainable energy needs*	*Universities, High and Primary schools*	n/a		n/a	n/a	n/a
15	Inter-sectoral and geographical mobility of researchers	Universities Industry companies	n/a	Industry companies Donors	n/a	n/a	n/a

16	Increase the role of SME sector in energy transition	SMEs	n/a	Grants Private investments	n/a	n/a	n/a

7.6 Total emissions

The overall emissions of all sectors, when adding all of the measures that are part of the WAM scenario, show that there is a reduction in the total net GHG emissions by 67% in 2040 and 71% in 2050 compared to 1990 (Figure 58). The largest amount of emissions remains in the Energy sector, with a share of 54% in 2050 (excluding the FOLU sector, where sinks occur). During the whole planning period up to 2050, the FOLU category has an absorption of emissions, which is increasing by 16% compared to 2016 (or around 2 times compared to 1990).

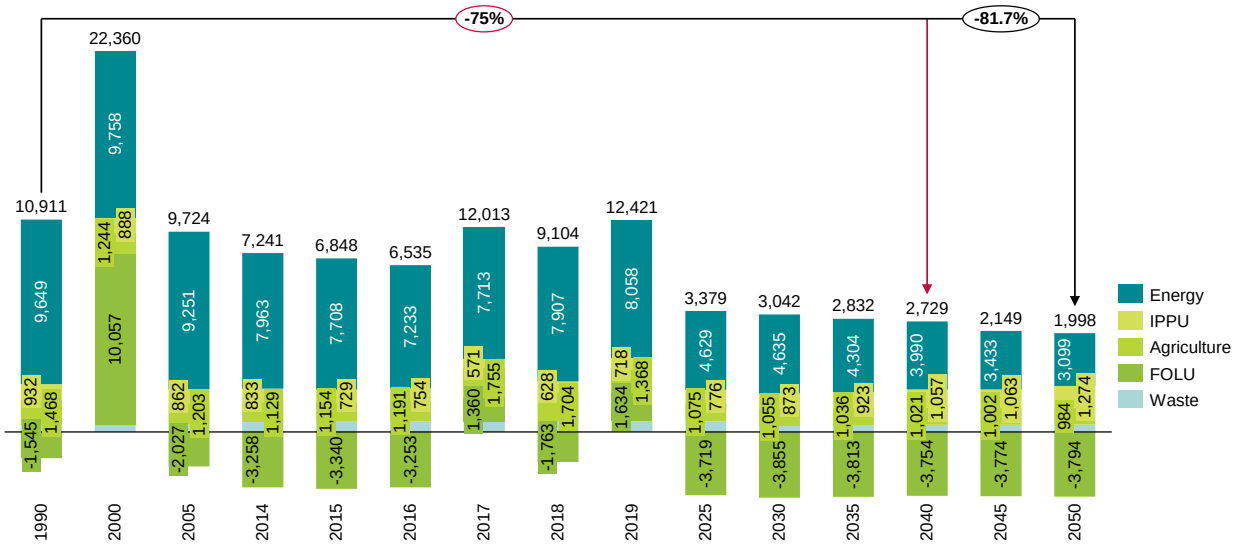
Figure 58. Total GHG emissions by sectors – WAM scenario (in Gg CO_2-eq)



Note: Due to the large area affected by fires in 2000, FOLU instead of sinks, contributed to the increase of the GHG emissions.

The results for the emissions without MEMO are also presented (Figure 59) and they show even higher reduction in the total net emissions by 75 in 2040 and 82 in 2050 compared to 1990. This higher reduction is again mainly caused by the exclusion of the emissions coming from the import of electricity.

Figure 59. Total GHG emissions by sectors without MEMO – WAM scenario (in Gg CO_2-eq)



Note: Due to the large area affected by fires in 2000, FOLU instead of sinks, contributed to the increase of the GHG emissions

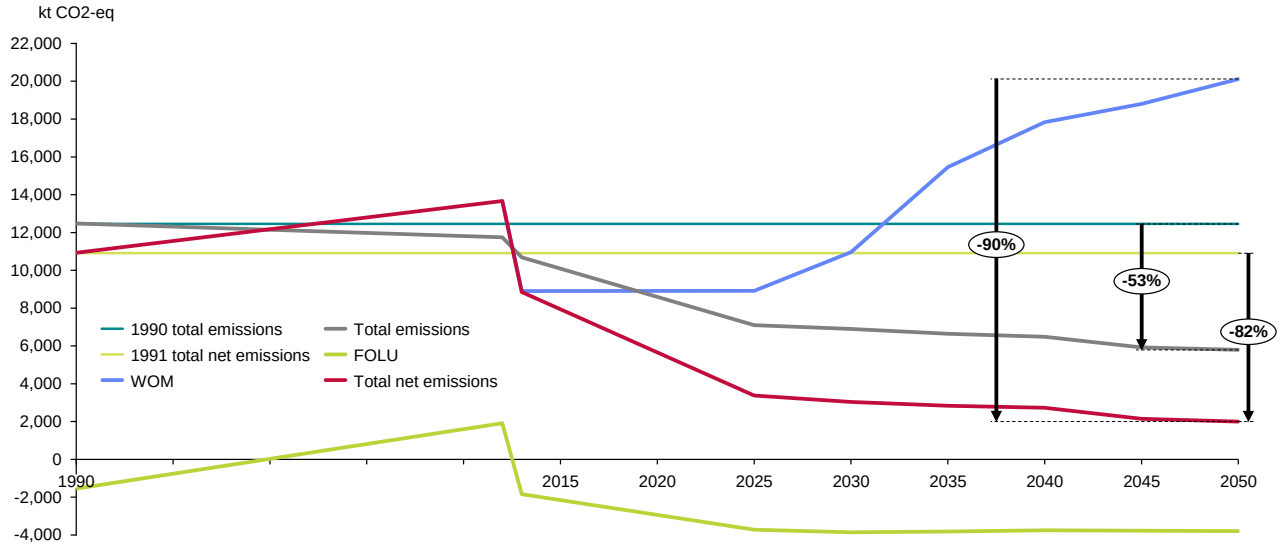
8 Overall and sectoral targets

The target for climate change mitigation in Macedonia is expressed as a reduction of greenhouse gas emissions and a reduction of net greenhouse gas emissions. The difference is that the FOLU sector is included in the GHG net emissions. The targets are expressed in relation to 1990, as a base year and are:

- 53% GHG emissions reduction
- 82% net GHG emissions reduction

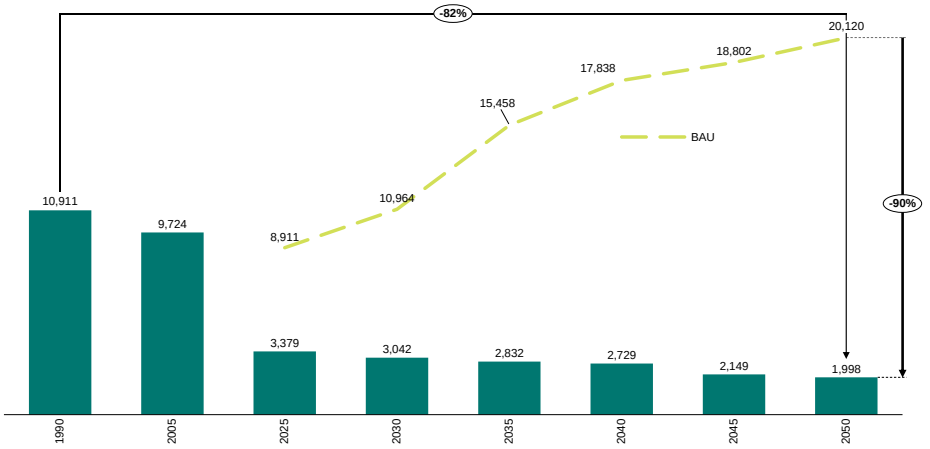
Additionally, compared to the WOM scenario the economy-wide GHG emission reduction target for Macedonia is 90% in 2050 (Figure 60). The indicative trajectory shows that by 2025, Macedonia will reach 70% of the total GHG reduction target in 2030and 31% of the target in 2050 (Figure 61). After 2030, there is an increase in the GHG emissions in WOM scenario, that are mainly result of the transport sector (increase in the transport of goods).

Figure 60. Trajectory of GHG emissions (in Gg CO_2-eq) and indicative reduction targets (in %)



Note: 2000 is removed from the figure for better presentation of the results

Figure 61. Trajectory of net GHG emissions (in Gg CO2-eq) and indicative reduction targets (in %)

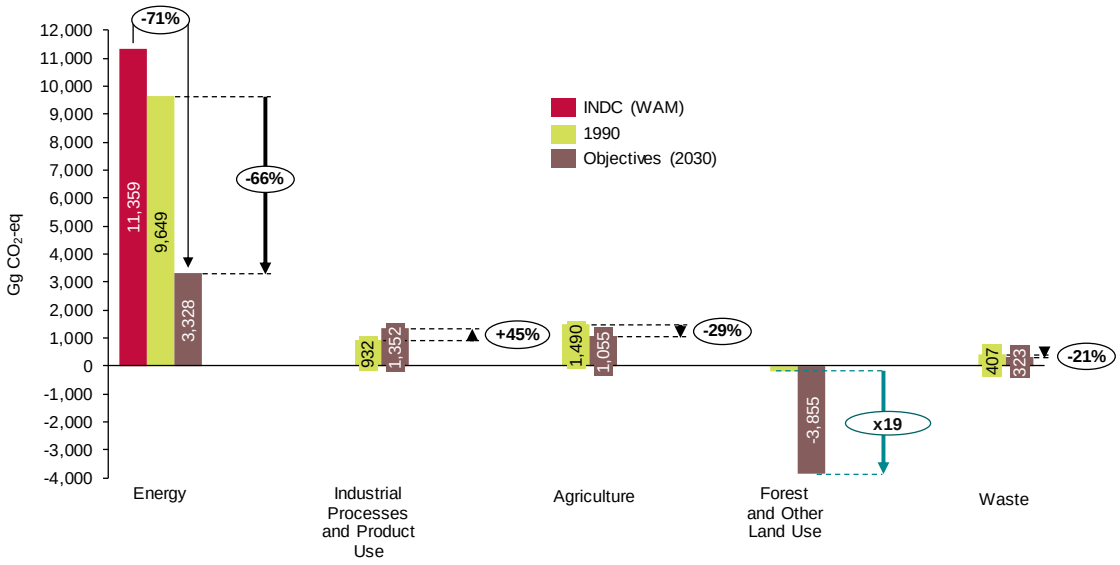


Source: Results from the Strategy for energy development up to 2040 and TBUR, project team analyses

The GHG goal for 2030 calculated as a part of the NDC and TBUR was based on 1990 figures. In order to achieve the target for GHG emissions reduction in 2030 defined in these two documents, sectoral **objectives** were set for each sector (Figure 4):

- Energy sector – 66% (6,321 Gg CO_2-eq) GHG emissions reduction (mainly through decommissioning of coal-fired TPP Oslomej in 2021 and TPP Bitola up to 2027)
- Industrial Processes and Product Use – 45% (420 Gg CO_2-eq) GHG emissions increase
- Agriculture – 29% (435 Gg CO_2-eq) GHG emissions reduction
- Forest and Other Land Use – 18 times (2,647 Gg CO_2-eq) GHG removals increase
- Waste – 21% (84 Gg CO_2-eq) GHG emissions reduction

Figure 62. Sectoral objectives for 2030 relative to 1990 level, and comparison with INDC target



Source: Results from the Strategy for energy development up to 2040 and TBUR, project team analyses

In the latest National inventory on climate change, 1990 was revised and it was found that the value for the Forestry sector should be more than seven times higher compared to the previous value (sink of 200 kt CO_2-eq was replaced with 1540 kt CO_2-eq). This has a big impact on the net GHG emission reduction for 2030. This report takes into account the new figure for Forestry sector in 1990. The changes in the other sector are minor.

At the same time, the emissions from the energy sector in 2018 decreased by 23% compared to 1990, as a result of the reduced electricity production from coal, almost complete removal of the use of heavy fuel oil for electricity generation and the introduction of natural gas.

Because there are significant changes in greenhouse gas emissions during the years 1990-2018, and in order to be clearer to the general public, the emissions and net emissions targets in 2030, in addition to 1990 are expressed in relation to other years. In this document, the emission reduction are expressed relative to 2005, 2014 and 2016..

The results of the comparison show that emissions in 2050 will decrease by:

- 51% in relation to 2005
- 45% in relation to 2014
- 42% in relation to 2016

The results of the comparison show that net emissions in 2050 will decrease by:

- 79% in relation to 2005
- 73% in relation to 2014
- 77% in relation to 2016

Figure 63. 2050 GHG emission target compared to 1990, 2005, 2014 and 2016

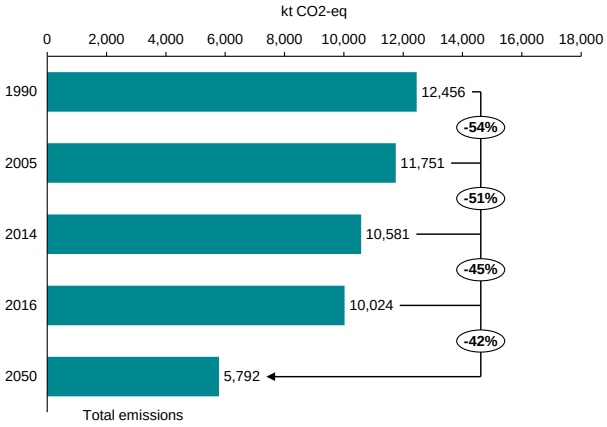
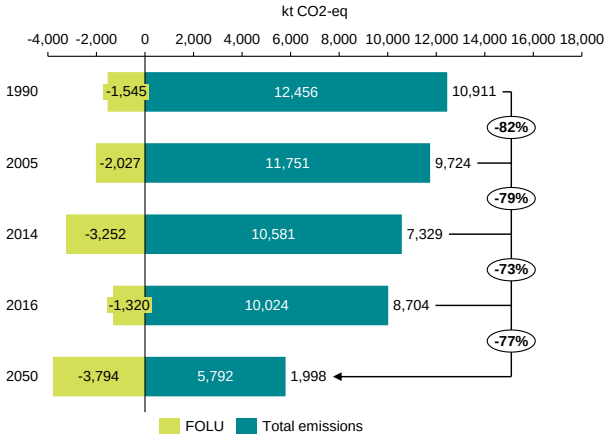


Figure 64. 2050 net GHG emission target compared to 1990, 2005, 2014 and 2016



If comparisons are made with 1990 in terms of net emissions, it should be noted that in 2014 about 60% of the target for 2030 has already been achieved. The comparison in terms of only emissions shows that in 2014 about 72% of the goal was achieved.

Figure 65. Achievement in 2014 compared to 2050 target – net GHG emissions

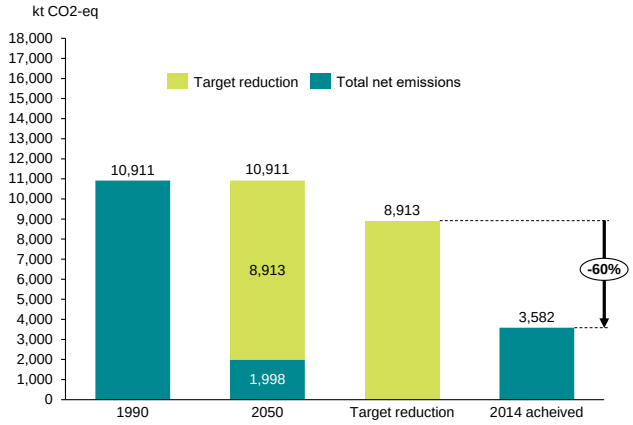
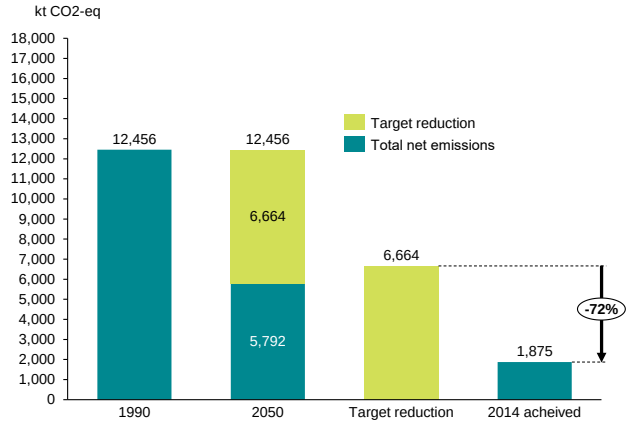


Figure 66. Achievement in 2014 compared to 2050 target – emissions



Regardless of the year in which the comparisons of emissions and net emissions are made, what is important is that a **green agenda** is planned that will contribute to the continuation of the downward trend of emissions that has already begun and additionally intensify it, especially in the period after 2025. Particular attention needs to be paid to sectors where emissions are expected to increase, such as the Transport sector.

8.1 Comparison with other countries by using SDG indicators

The contribution of Macedonia in global efforts for achieving sustainable development, in this report, is measured through the global indicator framework for Sustainable Development Goals (SDG). On one hand, SDG indicators are used to track the progress of implementation of each of the policies and measures proposed. On the other hand, in this chapter some of the indicators are used for comparing the Macedonian overall planned progress with the countries in the regions, as well as with some of the EU countries. With the proposed policies and measures six Sustainable Development Goals are covered. The relevant indicators that contribute towards achieving each of the goals comply with the mapping made by EU and EUROSTAT (Table 14).

Table 14. SDG indicators used in TBUR

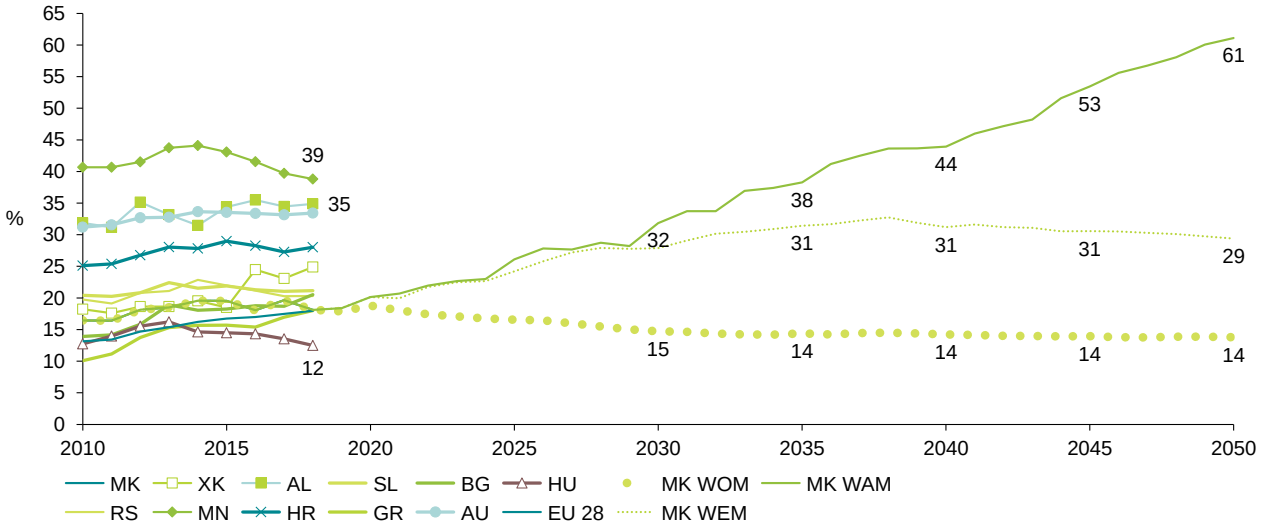
Goal	Code	Indicator
	sdg_07_60	Population unable to keep home adequately warm by poverty status
	sdg_01_60	Population living in a dwelling with a leaking roof, damp walls, floors or foundation or rot in window frames of floor by poverty status
	sdg_02_60	Ammonia emissions from agriculture
	sdg_07_10	Primary energy consumption
	sdg_07_11	Final energy consumption
	sdg_07_20	Final energy consumption in households per capita
	sdg_07_30	Energy productivity
	sdg_07_40	Share of renewable energy in gross final energy consumption by sector
	sdg_07_50	Energy import dependency by products
	sdg_07_60	Population unable to keep home adequately warm by poverty status*
	sdg_13_20	Greenhouse gas emissions intensity of energy consumption
	sdg_09_50	Share of buses and trains in total passenger transport
	sdg_09_60	Share of rail and inland waterways in total freight transport
	sdg_12_30	Average CO2 emissions per km from new passenger cars
	sdg_11_60	Recycling rate of municipal waste
	sdg_09_50	Share of buses and trains in total passenger transport
	sdg_12_30	Average CO2 emissions per km from new passenger cars
	sdg_12_50	Generation of waste excluding major mineral waste by hazardousness
	sdg_07_10	Primary energy consumption
	sdg_07_11	Final energy consumption
	sdg_07_30	Energy productivity
	sdg_07_40	Share of renewable energy in gross final energy consumption by sector
	sdg_13_10	GHG emissions
	sdg_13_20	Greenhouse gas emissions intensity of energy consumption
	sdg_07_10	Primary energy consumption
	sdg_07_11	Final energy consumption
	sdg_07_40	Share of renewable energy in gross final energy consumption by sector
	sdg_15_10	Share of forest area

For comparing Macedonian projected progress with the countries from the West Balkan region (Serbia, Kosovo, Montenegro, Bosnia and Herzegovina and Albania), as well as, with some of the EU countries (Greece, Bulgaria, Croatia, Slovenia, Hungary, Austria and EU28) the following indicators are used:

- renewable energy share in the gross final energy consumption
- electricity generated from renewable energy sources
- energy dependence
- share of renewable energy in fuel consumption in transport
- final energy consumption in households per capita
- greenhouse gas emissions intensity of energy consumption
- greenhouse gas emissions per capita

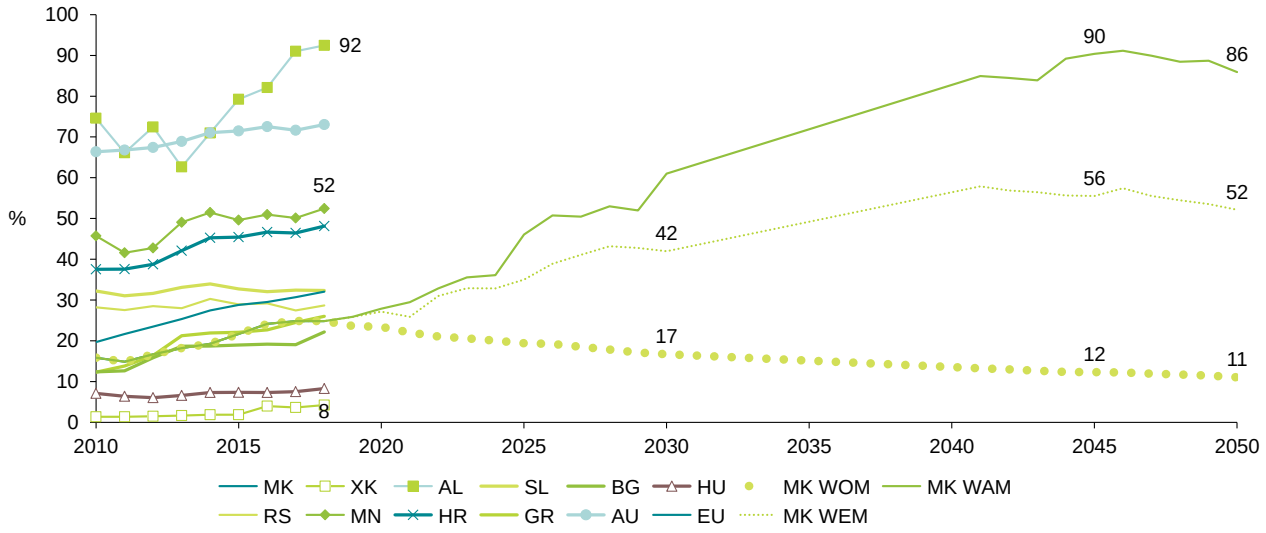
In 2018, the share of RES in the gross final energy consumption in Macedonia is around 18%, which is similar to the RES share at EU28 level (Figure 67), but it has decreased compared to 2017, mainly as a result of the increased consumption in the transport sector. However, the projected investments in RES and energy efficiency will increase the share of RES in the gross final energy consumption up to 61% in the WAM scenario in 2050.

Figure 67. Renewable energy share in the gross final energy consumption (in %)



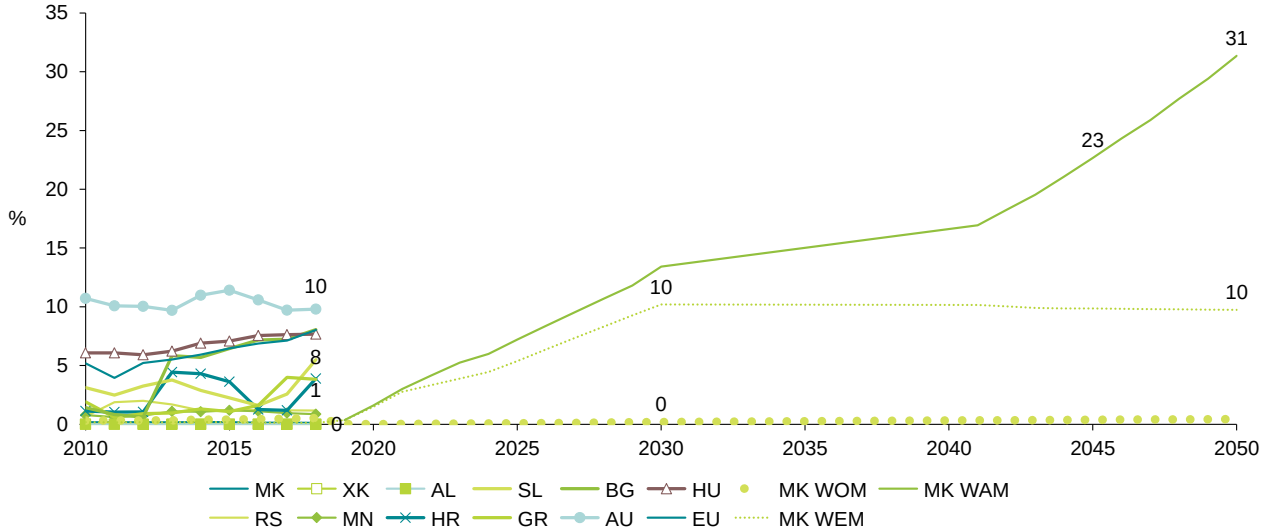
It is projected that the electricity generation in Macedonia will be driven mainly by RES power plants. The investments mainly in PV and wind supported by the hydropower plants, biogas and biomass will significantly increase the RES share in electricity generation, leading to zero carbon from electricity generation. In 2050, this share will achieve 86% in WAM (25% in 2018), which is higher than the share of any of the considered countries in 2018 except Albania (Figure 68).

Figure 68. Electricity generated from renewable energy sources (in %)



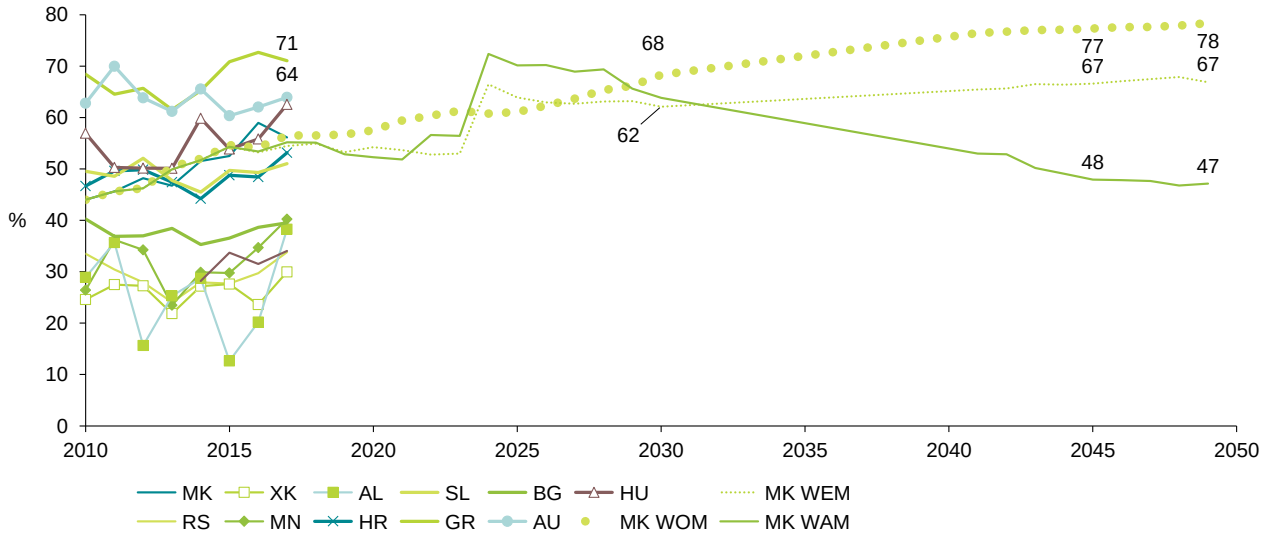
The RES share in the transport, sector, which in 2018 is almost zero, will achieve at maximum 31% in 2050, as a result of biofuels, but also electrification of the transport sector, *Figure 69*. It is obvious that the consumption in the transport sector is increasing and therefore it is necessary to find appropriate mechanisms to implements these measures, because otherwise the transport sector will be the main problem in reaching the overall RES share in gross final energy consumption. At the moment, the best country in EU is Austria with 10% share of RES in fuel consumption in transport.

Figure 69. Share of renewable energy in fuel consumption of transport (in %)



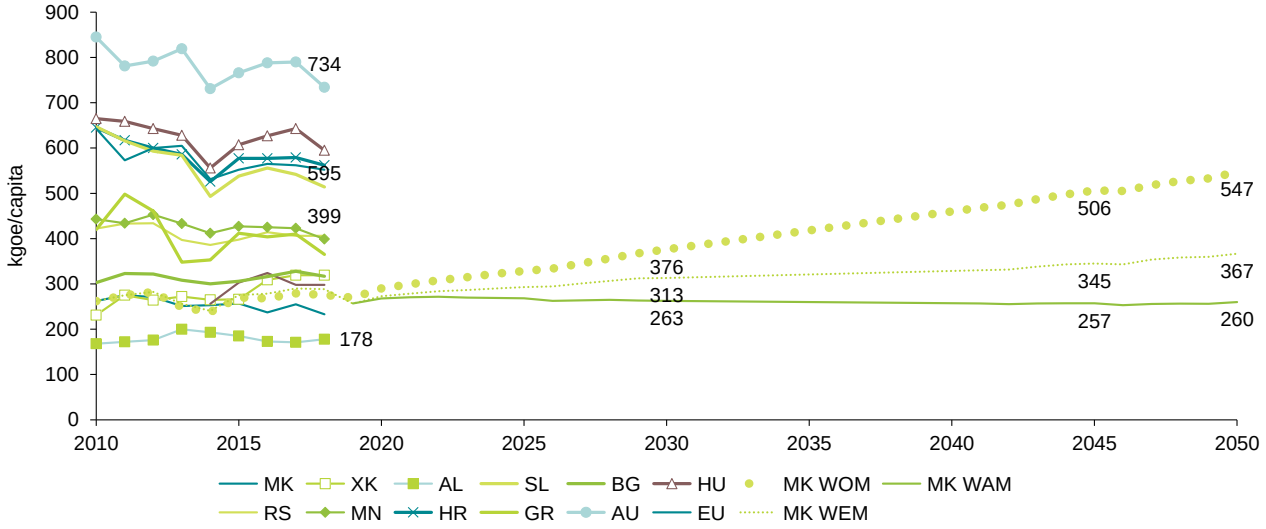
One of the indicators that is important for the security of supply is Energy dependence. The goal of the Energy development strategy up to 2040 is to maintain the energy dependence at the 2017 level (54%). The introduction of CO2 tax with a price higher than 30 €/t can significantly contribute to the decommissioning of the lignite power plants in Macedonia. That will increase the import dependence if the investments in RES are not realized. The realization of RES investment will decrease the import dependence to 47% in the WAM scenario (*Figure 70*), which is similar to the level of Slovenia in 2018.

Figure 70. Energy dependence (in %)



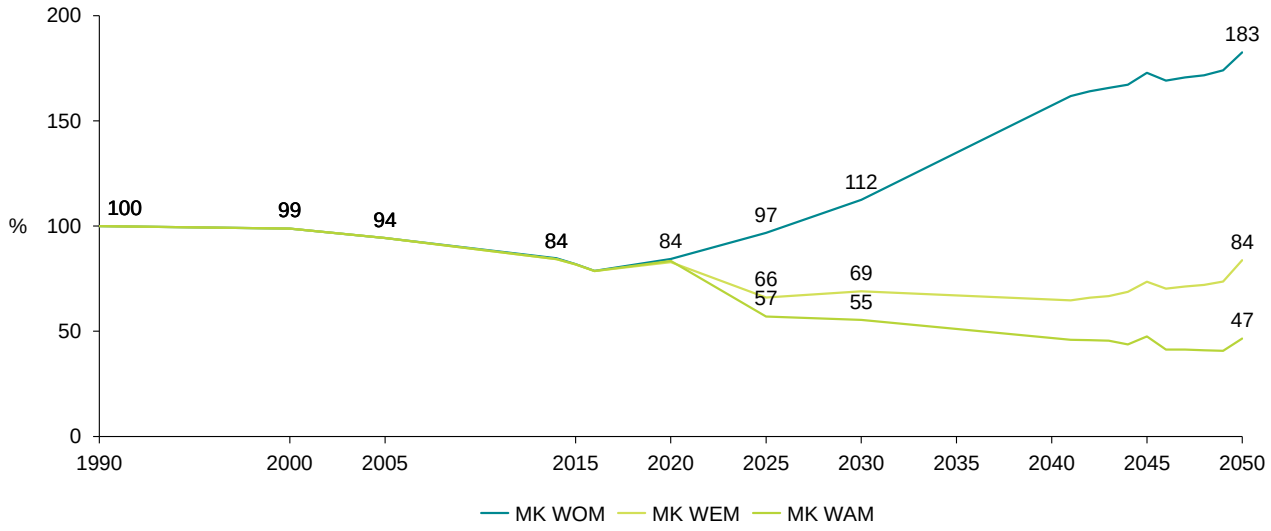
Another important indicator, which helps in following the implementation of the energy efficiency measures in the residential sector is the Final energy consumption in households per capita. Macedonia in 2018 has two times lower final energy consumption in households per capita compared to the EU28 level (552 kgoe/capita) (*Figure 71*). On the other hand, the implementation of the energy efficiency measures in the residential sector in the EU28 level contributes to decreasing the values of this indicator. Although, the projected useful energy is increasing, the level of this indicator during the overall planning period is predicted to maintain the same level as in 2018.

Figure 71. Final energy consumption in households per capita (kgoe/capita)



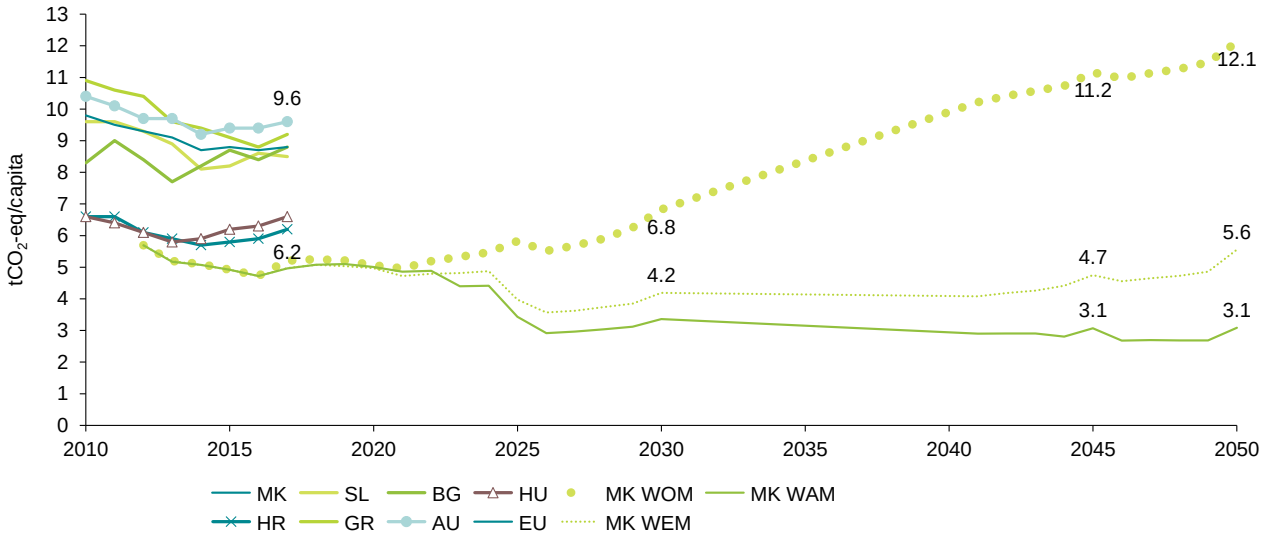
When the GHG emissions are expressed relative to the 1990 level, Macedonia is again in a better position than the considered EU countries (*Figure 72*). However, if none of the proposed policies and measures are implemented, the GHG emissions are 83 percentage points higher than in 1990. In WAM, the GHG emissions in 2050 will be reduced up to 47 percentage points compared to the 1990 level, which leads to 3.1 tCO_2-eq/capita (6.2 tCO_2-eq/capita in 2018) (*Figure 73*).

Figure 72. Comparison of GHG emissions in the WOM, WEM, WAM and WAM scenarios, 1990=100 (in %)



Note: The methodology used for calculating the GHG emissions is based on IPCC (excluding MEMO items), emissions and sinks from FOLU are excluded

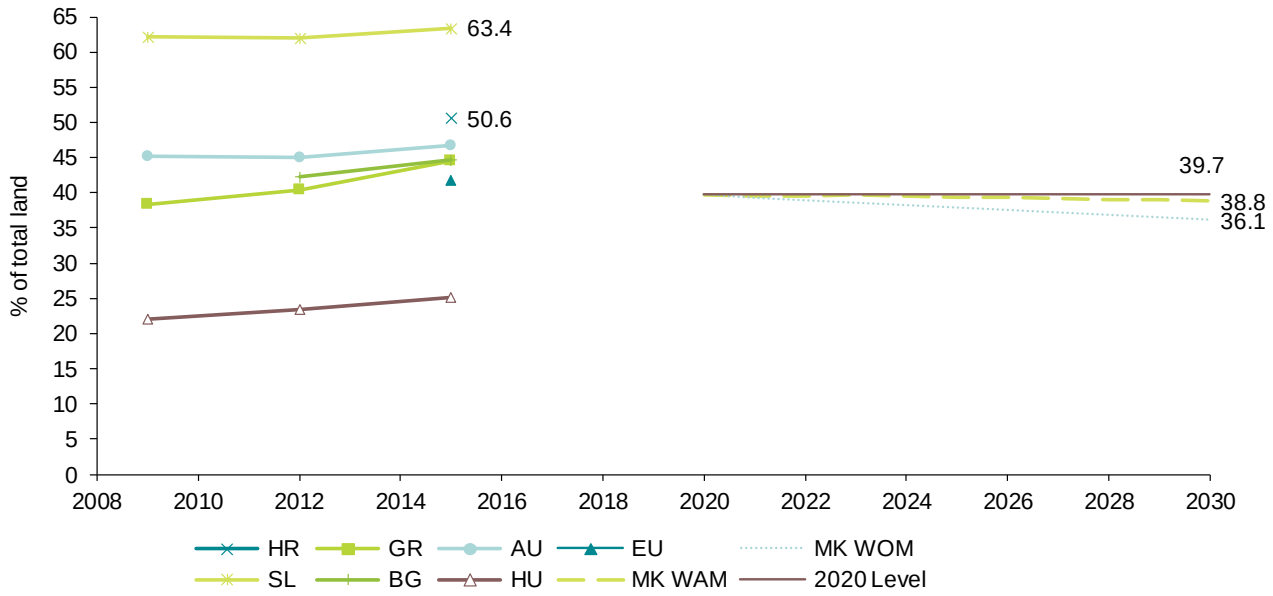
Figure 73. GHG emissions per capita (t CO2-eq/capita)



Note: The methodology used for calculating the GHG emissions is based on IPCC (excluding MEMO items), emissions and sinks from FOLU are excluded

Forest land indicator is very important as the forest land influences to a high extend the overall GHG emissions mitigation potential. As a starting point for comparison, the percentage of forest land to total land in 2020 is used (around 40%). Compared to the selected EU countries, Macedonia is almost at the same level as EU 28. The country with the highest forest land share is Slovenia with 63.4% followed by Croatia with 50.6% (*Figure 74*). If the proposed measures in the Forest sector are not implemented the share of the forest land will decline for around 7 percentage points. On the other hand, the proposed measures will contribute to maintain almost the same level as in 2020.

Figure 74. Forest land (% from total land)



Additional runs

Additional scenarios were created in order to reflect the latest energy prices and what if these prices remain at this high level in the future. The results show that investments in renewable energy sources as well as energy efficiency measures yield even greater results.

The Ukraine crise led to a further increase in energy prices. For the next 5-10 years many energy price scenarios are developing, although it is very difficult to determine the prices under the current circumstances. In order to depict the developments in the next 5-10 years as realistically as possible, several scenarios were made with different energy prices, the period when the prices would return to some normal limits, and what the price of CO2 would be. The price of electricity is expected to reach 400-600 EUR/MWh in some scenarios, and the price of gas 500-2500 EUR/1000nm3. The differences in the price of CO_2 in the period until 2035 are also considered. In one scenario the CO_2 price is predicted to start at 8 EUR/t and gradually increase to 100 EUR/t by 2035, in another scenario it starts at 8 EUR/t but increases to 35 EUR/t in 2034, and in 2035 it will be 100 EUR/t and the third scenario the CO_2 price start at 35 EUR/t and gradually increase to 100 EUR/t by 2035.

The results in these scenarios show that the investment in renewable energy sources and energy efficiency are the most cost effective. What is of particular importance for the electricity system, in order to ensure security of supply and electricity at affordable prices, is that REK Bitola continues to operate until 2029. In some scenarios, it operates until 2034 but with reduced intensity, around 1000 GWh. The changes in these scenarios compared to the WAM scenario are result of high gas prices and a significant reduction in the production from TETO of natural gas, which is reduced to about 500-600 GWh. These scenarios show that in 2030 there may be a deviation from the greenhouse gas emissions goal if insufficient investment is made in renewable energy sources and the price of gas remains at a high level for a longer period.

Carbon neutrality of North Macedonia in 2050 is possible, but a big problem arises in the last three years of the time period, i.e. in 2048, 2049 and 2050, when in order to achieve a 90% reduction in emissions in the energy sector, an increase in consumption of of biomass is required primarily in the industry sector, where it is more difficult to introduce hydrogen as a technology.

Appendix 2 Action Plan

#	Policy/measure	Sector affected	GHG affected	Competent entity for realization	Type of measure	Status of implementation	Budget (mil. €)	Source of finance	Indicative emissions reduction (Gg CO_2-eq)		
									2030	2040	2050
1	Reduction of network losses	Energy supply	CO_2, CH_4, N_2O	► Electricity distribution companies ► Heat distribution companies ► Energy Agency, Ministry of Economy	Technical	Under imlementation	170	Distribution and transmission companies	104.4	168.5	168.5
2	Large hydropower plants	Energy supply	CO_2, CH_4, N_2O	► JSC ESM ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency	Technical	Under implementation	1556	JSC ESM, Public Private Partnership, Independent power producers	617.7	757.8	1556.7
3	Incentives Feed-in tariff	Energy supply	CO2, CH4, N2O	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Private investors	Technical, Regulatory	Under imlementation	557	Independent power producers Consumers of electricity through bills	123.3	147.0	178.9
4	Incentives feed-in premium	Energy supply	CO2, CH4, N2O	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy ► Private investors	Technical, Regulatory	Under imlementation	160	Independent power producers, incentives from the central government budget	108.0	108.0	108.0
5	Biomass power plants (CHP optional)	Energy supply	CO2, CH4, N2O	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Private investors	Technical, Regulatory	Under imlementation	24.3	Independent power producers Consumers of electricity through bills	21.0	21.0	21.0
6	Solar rooftop power plants	Energy supply	CO2, CH4, N2O	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency ► Elektrodustribucija Skopje	Technical, Regulatory	Under imlementation	699	Independent power producers, donors, subsidies from national and local budget, EE fund	84.6	214.6	234.9

				► Suppliers of electricity ► End-users of electricity							
7	RES without incentives	Energy supply	CO2, CH4, N2O	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency ► JSC Macedonian Power Plants (ESM AD) ► Private investors	Technical, Regulatory	Under imlementation	2194	Public private partnership, Independent power producers, ESM	74.0	219.8	286.6
8	Development of the biofuels market	Energy supply	CO_2, CH_4, N_2O	► Government of the Republic of North Macedonia ► Ministry of economy ► Companies that sell oil products	Regulatory, Policy	Under implementation	n/a	Central government budget, consumers	96.0	96.0	96.0
9	Energy efficiency obligation schemes	Energy demand excluding transport	CO_2, CH_4, N_2O	► Ministry of economy ► Distribution system operators ► Suppliers and traders of electricity and gas	Technical, Regulatory	Under implementation	124	Consumers through their bills	10.3	24.4	58.4
10	Solar thermal collectors	Households and Commercial	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► End-users	Technical	Under implementation	60	Private, EE fund, incentives from the central government budget, donors	14.8	19.9	23.3
11	Labeling of electric appliances and equipment	Households and Commercial	CO_2, CH_4, N_2O	► Ministry of Economy, Energy Agency ► Producers and suppliers of electrical equipment and household appliances ► End-users	Regulatory	Under implementation	48	Private, EE fund	42.4	100.5	240.9
12	Increased use of heat pumps	Households and Commercial	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► End-users	Regulatory, Policy	Under implementation	240	Private, EE fund, incentives from the central and local government budget, donors	281.7	430.3	555.9
13	Public awareness campaigns and network of EE info centers	Households and Commercial	CO_2, CH_4, N_2O	► Ministry of Economy, Energy Agency ► Energy suppliers ► End-users	Information	Under implementation	598	Private sector, donors, central and local governments	117.9	279.1	669.0
14	Retrofitting of existing residential buildings	Households	CO_2, CH_4, N_2O	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Households	Technical, Regulatory	Under implementation	3187	Private, donors through commercial EE loans, EE fund	20.5	56.6	90.3
15	Retrofitting of existing central government buildings	Central government	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Local self-government ► Municipal public enterprises	Technical, Regulatory	Under implementation	290	Central government budget, donors	20.9	38.6	58.9

				► Donors and financial institutions							
16	Retrofitting of existing local self-government buildings	Local self-government	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Local self-government ► Municipal public enterprises ► Donors and financial institutions	Technical, Regulatory	Under implementation	280	Local self-government budget, donors	20.9	38.6	58.9
17	Retrofitting of existing commercial buildings	Commercial	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Commercial buildings owners	Technical, Regulatory	Under implementation	880	Private, donors through commercial EE loans, EE fund	48.6	86.7	150.7
18	Construction of new buildings	Households	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Investors (households)	Technical, Regulatory	Under implementation	370	Private, donors through commercial EE loans, EE fund	21.3	32.6	46.3
19	Construction of passive buildings	Households	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Investors (households)	Technical, Regulatory	Under implementation	1520	Private, donors through commercial EE loans, EE fund	16.6	58.2	94.0
20	Phasing out of incandescent lights	Housegolds and Commercial	CO2, CH4, N2O	► Government of the Republic of North Macedonia ► Ministry of Economy, Energy Agency End-users	Regulatory, Policy	Under implementation	1027	Central government budget, private	114.0	131.9	139.5
21	Improvement of the street lighting in the municipalities	Local self-government	CO2, CH4, N2O	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Local self-government	Technical	Under implementation	40	Central and local government budget, ESCO	37.9	37.9	37.9
22	Green procurements	Public bodies	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► Public Procurement Bureau ► Local self-government	Regulatory	Under im	34	Central and local government budget	2.9	6.9	16.5
23	Increased use of central heating systems	Households and Commercial	CO2, CH4, N2O	► Ministry of Economy, Energy Agency ► Balkan energy Dooel Skopje ► JSC Skopje Sever ► "Energetika" –Skopje, subsidiary to JSC Macedonian Power Plants (ESM AD) ► Private investors	Technical, information	Under implementation	20	Private, EE fund, incentives from the central and local government budget	4.1	16.8	24.8

24	Energy management in manufacturing industries	Industry	CO2, CH4, N2O	Ministry of Economy, Energy Agency Private companies	Regulatory, technical	Under implementation	n/a	Private, donors through commercial EE loans	28.4	35.6	50.8
25	Introduction of efficient electric motors	Industry	CO2, CH4, N2O	Private companies Ministry of Economy, Energy Agency	Technical	Under implementation	172	Private, donors through commercial EE loans	33.0	50.9	102.7
26	Introduction of more advanced technologies	Industry	CO2, CH4, N2O	Government of the Republic of North Macedonia Ministry of Environment and Physical Planning Ministry of Economy, Energy Agency Private investors	Technical	Under implementation	1414	Private, donors through commercial EE loans, EE fund	237.2	747.9	1304.5
27	Increased use of the railway	Transport	CO2, CH4, N2O	Government of the RM Ministry of Transport and Communication Ministry of Economy, Energy Agency JSC Makedonski zeleznici End-users Private companies	Technical, information	Under implementation	434	Central government budget	91.7	98.0	102.9
28	Renewing of the national car fleet	Transport	CO2, CH4, N2O	Government of the RM Ministry of Transport and Communication Ministry of Economy, Energy Agency End-users	Regulatory, pollicy, information	Under implementation	1172	Private, EE fund, incentives from the central government budget	28.3	30.3	33.5
29	Renewing of other national road fleet	Transport	CO2, CH4, N2O	Government of the Republic of North Macedonia Ministry of Transport and Communications Ministry of Interior Affairs Ministry of Economy, Energy Agency Private companies	regulatory, policy	Under implementation	5381	Private sector	351.4	400.8	447.3
30	Advanced mobility	Transport	CO2, CH4, N2O	Ministry of Economy, Energy Agency Local self-government End-users	Regulatory, technical, information	Under implementation	12	Private, EE fund, incentives from the central and local government budget, donors	3.0	6.4	12.5
31	*Construction of the railway to the Republic of Bulgaria*	*Transport*	*CO2, CH4, N2O*	*Government of the Republic of North Macedonia* *Ministry of Transport and Communications* *Ministry of Economy, Energy Agency*	*Technical, policy*	*Under implementation*	*720*	*Central government budget*	*24.6*	*37.5*	*50.3*
32		Transport		Government of the Republic of North Macedonia			7579		120.3	259.7	272.2

	Electrification of the transport		CO2, CH4, N2O	Ministry of Transport and Communications Ministry of economy	Regulatory, policy, information	Under implementation		Private, EE fund, incentives from the central government budget			
33	*Reduction of CH4 emissions from enteric fermentation in dairy cows by 3%*	AFLOU-Livestock	CH4	► Ministry of Agriculture, Forestry and Water Economy	Education, Technical	Under implementation	0.2	Private sector	3.2	35	63.6
34	*Reduction of N2O emissions from manure management in dairy cows by 20%*	AFLOU-Livestock	N2O	► Ministry of Agriculture, Forestry and Water Economy	Education, Technical	Planned	1	Private sector	0.2	2.1	3.9
35	*Reduction of NO2 emissions from manure management in swine farms by 13%*	AFLOU-Livestock	N2O	► Ministry of Agriculture, Forestry and Water Economy	Education, Technical	Under implementation	1	Private sector	0	0.4	0.7
36	*Reduction of N2O emissions from manure in dairy cows by 20% for farms below 50 Livestock Units*	AFLOU-Livestock	N2O	► Ministry of Agriculture, Forestry and Water Economy	Education, Technical	Planned	1	Private sector	0.1	0.7	1.2

37	*Establishing integrated management of forest fires*	AFLOU-Forestry	CO2, CH4, N2O	► PE "National forests" ► Ministry of Agriculture, Forestry and Water Economy	Technical	Under implementation	1.5	PE "National forests", other forest enterprices	345	345	345
38	*Afforestation*	AFLOU-Forestry	CO2, CH4, N2O	► PE "National forests" ► Ministry of Agriculture, Forestry and Water Economy	Technical	Under implementation	7.8	PE "National forests", other forest enterprices	0	312.5	312.5
39	*Conversion of land use of field crops above 15% inclination*	AFLOU-Land use	CO2	► Ministry of Agriculture, Forestry and Water Economy	Education, Technical	Under implementation	1.5	Private sector	1	3.7	5.3
40	*Contour cultivation on areas under field crops on inclined terrains (5-15%)*	AFLOU-Land use	CO2	► Ministry of Agriculture, Forestry and Water Economy	Education, Technical	Under implementation	1	Private sector	5	28	39.7
41	*Perennial grass in orchard and vineyards on inclined terrains (>5%)*	AFLOU-Land use	CO2	► Ministry of Agriculture, Forestry and Water Economy	Education, Technical	Under implementation	1	Private sector	1.6	8.9	12.6
42	*Use of biochar for carbon sink on agricultural land*	AFLOU-Land use	CO2	► Ministry of Agriculture, Forestry and Water Economy	Research, Education, Technical	Planned	30	Private sector	0	110	330.3

43	*Photovoltaic irrigation*	AFLOU-Land use	CO2	► Ministry of Agriculture, Forestry and Water Economy	Research, Education, Technical	Under implementation	47	Private sector	0	93.3	186.6
44	*Landfill gas flaring*	Waste – Solid waste disposal	CO_2, CH_4	► Ministry of Environment and Physical Planning	Technical	Under implementation	20.5	Local self-government through Public Utilities,	561.3	655	823.5
				► Public municipal enterprises for waste management				Public Private Partnership,			
				► State Environmental Inspectorate				Grants from the EU			
				► Inter-Municipal Waste Management Board							
				► Authorized Inspectors of Environment (Municipalities)							
45	*Mechanical and biological treatment (MBT) in new landfills with composting*	Waste – Solid waste disposal	CO2, CH4, N2O	► Ministry of environment and physical planning	Technical	Under implementation	36.1	Local self-government through Public Utilities,	35.2	145.2	216.1
				► Public utilities				Public Private Partnership,			
				► Inter-municipal board for waste management				Grants from the EU			
46	*Selection of waste - paper*	Waste – Solid waste disposal	CO2, CH4, N2O	► Ministry of environment and physical planning	Technical	Under implementation	30.2	Local self-government through Public Utilities,	30.2	75.1	129.6
				► Public utilities				Public Private Partnership,			
				► Inter-municipal board for waste management				Grants from the EU			
47	*Improved waste and materials management at industrial facilities*	Regulation, Technical	CO_2, CH_4	► Ministry of Environment and Physical Planning	Regulation, Technical	Planned	/	Ministry of Environment and Physical Planning	16.4	51.5	95.8
				► Municipalities and city of Skopje				Municipalities and city of Skopje			
				► State Environmental Inspectorate				Industrial facilities			

				► Inter-Municipal Waste Management Board						
				► Authorized Inspectors of Environment (Municipalities)						
48	Improved industrial wastewater treatment	Regulation, Technical	CO2, CH4	► Ministry of Environment and Physical Planning	Under implementation	/	Ministry of Environment and Physical Planning,	62.4	163.5	370.5
				► Public utilities for waste management			Industrial facilities, EU funds			
				► State Environmental Inspectorate						
				► Inter-Municipal Waste Management Board						
				► Authorized Inspectors of Environment (Municipalities)						
49	Implementation of Kigali amendment on HFC phase-down	Regulatory, technical	HFC	► Ministry of Environment and Physical Planning		N/A	Private sector	225.6	471.6	861.6