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THIRD BIENNIAL UPDATE REPORT ON CLIMATE CHANGE OF THE REPUBLIC OF NORTH MACEDONIA

CLIMATE CHANGE MITIGATION

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Climate change mitigation

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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
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HPP	Hydropower Plant
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)
NCSP	National Communication Supporting Programme
OECD	Organization for Economic Co-operation and Development
RES	Renewable energy sources
SBUR	First Biennial Update Report
SDG	Sustainable Development Goals
STUGRES	Study on the Heating in the City of Skopje Analysis of Policies and Measures
TNC	Third National Communication
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*
g	gram	mass
W	watt	power
J	joule	energy
m	meter	length
Wh	watt-hour	energy
toe	ton of oil equivalent	energy
Mass Unit Conversion		
1g		
1kg	= 1 000 g	
1t	= 1 000 kg	= 1 Mg
1kt	= 1 000 t	= 1 Gg
1Mt	= 1 000 000 t	= 1 Tg

Metric Symbol	*Prefix*	*Factor*
P	peta	10^{15}
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
h	hecto	10^{2}
da	deca	10^{1}
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
µ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}

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Executive summary

The climate change mitigation analysis conducted in the Third Biennial Update Report (TBUR) builds upon and continues the analyses of previous studies: Second Biennial Update Report (SBUR), Third National Communication (TNC), First Biennial Update Report (FBUR) and the Intended Nationally Determined Contributions (INDC)1. Meanwhile, the National Strategy for Energy Development up to 2040 (Energy Strategy) was adopted in December 2019. The Energy Strategy depicts three scenarios - Reference, Moderate Transition and Green which reflect different dynamics of energy transition and enable flexibility into Macedonian response to relevant EU policies and governance for modern, competitive and climate-neutral economy by 2050. In many aspects, these developments can be considered as a strong entry point to the mitigation analyses within the TBUR. Also it should be emphasized that during the process of the Energy strategy preparation, almost all input data, as well as the results were validated in a participatory approach with the key stakeholders including the Energy Community and NGO sector. Besides, two public debates were organized with wide participation and very fruitful discussion and comments.

To assess the mitigation potential of certain measures and policies, all sectors recognized by the Intergovernmental Panel on Climate Change (IPCC) methodology (Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use and Waste) have been modelled in the TBUR. The good practices and the established detailed and robust methodology developed in SBUR have also been implemented in this BUR. Moreover in this BUR, each measure is linked with adequate SDG goals.

To evaluate the impact of each mitigation policy and measure, Scenario Without Measure is created (WOM). This scenario assumes no major changes in technology, economics, or policies so that normal circumstances can be expected to continue unchanged. This scenario has no likelihood of occurrence because it implies, for instance, that the efficiencies of devices used in households in 2040 would be the same as the efficiencies of the devices used in 2017. Nevertheless, such a scenario is of crucial importance because it allows all policies and measures to be compared to a referent option (“no action” case) and identify their performance (energy, emissions and financial savings).

The total GHG emissions from all sectors in the WOM scenario is expected to increase by 37.3% in 2040 compared to 1990, or by 64.7% compared to 2005, reaching 16,844 Gg CO_2-eq in 2040. The comparison is made relative to 1990 and 2005 because the exact base year for Macedonia is not defined yet. When analyzing the total GHG emissions without the FOLU sector, this increase is even more dramatic, i.e. +57.7% in 2040 compared to 1990. From these emissions, the largest amount is from the Energy sector, which increases its share by up to 81% in 2040. Additionally, the fastest growing sector in terms of emissions is the Waste sector, where the emissions in 2040 are 2.25 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 in 2040 compared to 1990 and 2005, but it is decreased by 13% compared to 2016.

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. Using this approach, in 2040 the GHG emissions are increased by 30.8% 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.

Taking into consideration all national strategic and planning documents, 47 mitigation measures were recognized out of which, 32 measures in the Energy sector, 11 measures in Agriculture, Forestry and Other Land Use (AFOLU) and 4 measures in the Waste sector. Each of these measures is represented with a

[1] All documents are available on this link: http://klimatskipromeni.mk/Default.aspx?LCID=213

separate table containing the all necessary information, progress of implementation (timeframe, expected results and costs, implementing entity), progress indicators as well as direct and indirect contribution to the SDG goals. In the Energy sector, some measures are defined three different paths of implementation that correspond to a different scenario.

To see which measures and policies should be prioritized, the economic effectiveness or specific cost (in €/t CO2-eq), as well as the environmental effectiveness or mitigation potential (in t CO2-eq) for each measure and policy is calculated. It can be concluded that in the WAM scenario:

- the total reduction from the proposed measures are estimated to around 5.6 Tg CO_2-eq,
- 70% can be achieved with a “win-win” policies and measures, which means that these measures are reducing the emissions by negative specific costs
- additional 20% of the reductions are realized by measures with specific costs in a range from 0-5 €/t CO_2-eq.

It is very important 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, and therefore cannot be modelled on its own.

Furthermore, additional benefits of the measures/policies are also analyzed in light of their potential for job creation (green jobs). The maximal number in the WEM scenario is in 2030 with 3,201 green jobs, from which 61% are from the energy efficiency and the remaining are from RES. In the WAM scenarios the maximal number is achieved in 2030 (7,035), while in the e-WAM scenario in 2035 (9,895). Moreover, the number of green jobs in 2035 in the e-WAM scenario is almost doubled compared to the WEM scenario. Based on the types of jobs, very basic analyses are done concerning the gender issue. It is found that at least around 27% of the maximum number of job positions in 2035 can be assigned to women

In SBUR, there were two mitigation scenarios (With Existing Measures - WEM and With Additional Measures - WAM), but the very fact that the Energy strategy now defines three scenarios necessitated TBUR defining another additional mitigation scenario (Extended Mitigation - e-WAM). Accordingly, the Reference Scenario of the Energy strategy corresponds to the WEM scenario, the Moderate Transition Scenario in TBUR is a WAM scenario, while for the Green Scenario in TBUR it is presented through the e-WAM scenario. The proposed measures in the AFOLU and Waste sector are included in each scenario. The difference in the scenarios is made by the measures from the energy sector.

When comparing the results from the different scenarios there are two approaches: one is relative to the reference scenario (WOM) and the other is relative to a base year. Since for Macedonia the base year is not yet defined, in this report 1990 and 2005 are used. On the other hand, the total GHG emissions are calculated using the IPCC methodology, but in addition, in order not to use the electricity import (MEMO item) as a mitigation measure, in this report the emissions from electricity imports are also considered. This is very important for adequately calculating the impact of each measure for Macedonia, as import dependent country. However, with the aim of comparing the result with other countries and for compatibility with the GHG Inventory, the results without the emissions from electricity import are presented.

In this regard, when comparing the results relative to the WOM scenario, the reduction of the total GHG emissions without MEMO are higher (78% in e-WAM in 2030, Figure 1,) than in the case with MEMO (67% in e-WAM in 2030, Figure 2).

FIGURE 1. COMPARISON OF TOTAL GHG EMISSIONS FROM ALL SECTORS IN WOM, WEM, WAM AND E-WAM SCENARIOS, 2030 (IN GG CO_2-EQ)

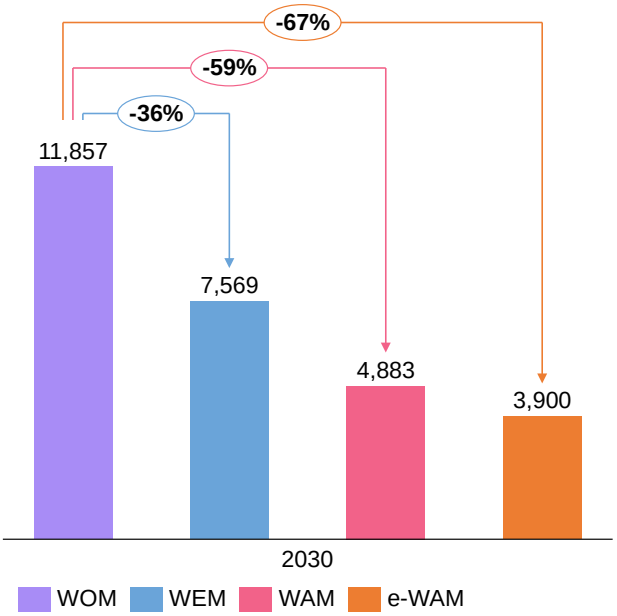
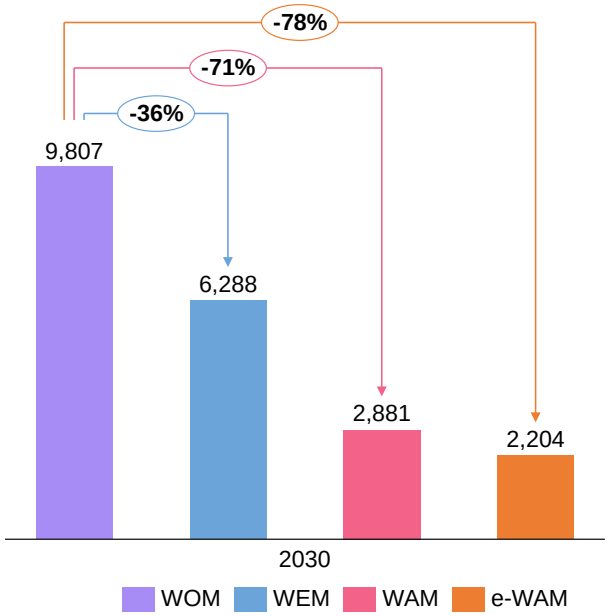


FIGURE 2. COMPARISON OF TOTAL GHG EMISSIONS FROM ALL SECTORS WITHOUT MEMO IN WOM, WEM, WAM AND E- WAM SCENARIOS, 2030 (IN GG CO_2-EQ)



Regarding the comparison of the results relative to a base year, it can be concluded that for Macedonia 1990 is a more suitable year, as there are more GHG emissions in that year compared to 2005, and therefore the reductions will be higher. The highest reduction of the GHG emissions that can be reached in 2030 is 68% (or 82% without MEMO) compared to the 1990 level and it is accomplished by implementing the e-WAM scenario (Figure 3, Figure 4).

It is projected that the emissions from the Energy sector, Agriculture and waste will be reduced by 66%, 29% and 21%, respectively compared to 1990. Besides the sinks from Forest will be increased by 95% compared to 1990. Because, there are no measures In the IPPU sector, GHG emission from this sector will increase by 45% compared to the 1990 level.

FIGURE 3. TOTAL GHG EMISSIONS FROM ALL SECTORS IN WEM, WAM AND E- WAM SCENARIOS IN 2030 COMPARED TO 1990 AND 2005 LEVEL (IN GG CO_2-EQ)

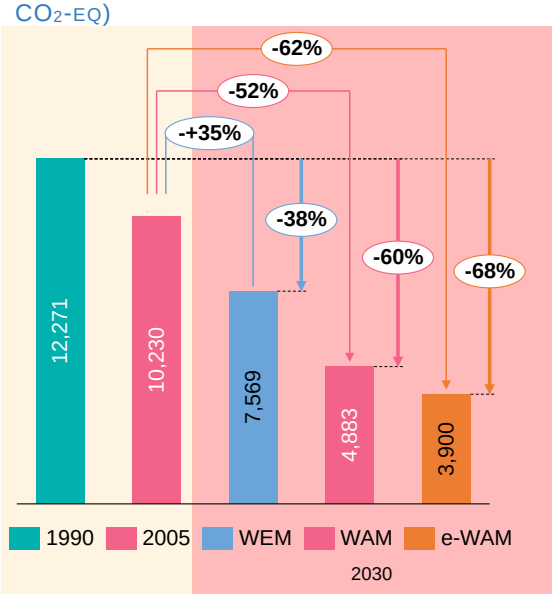
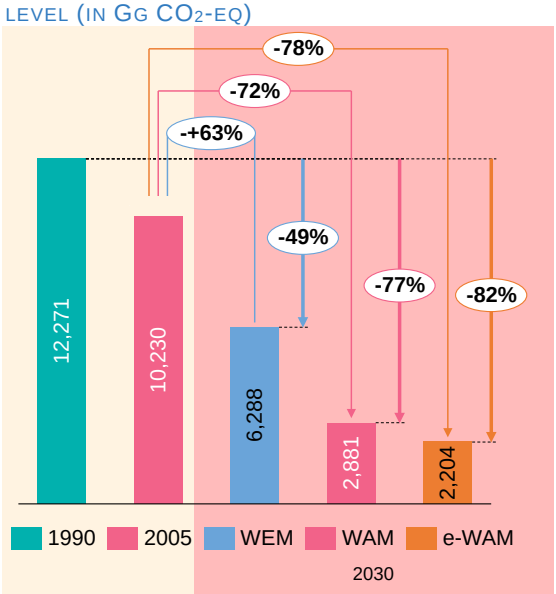


FIGURE 4. TOTAL GHG EMISSIONS FROM ALL SECTORS WITHOUT MEMO IN WEM, WAM AND E- WAM SCENARIOS IN 2030 COMPARED TO 1990 AND 2005 LEVEL (IN GG CO_2-EQ)

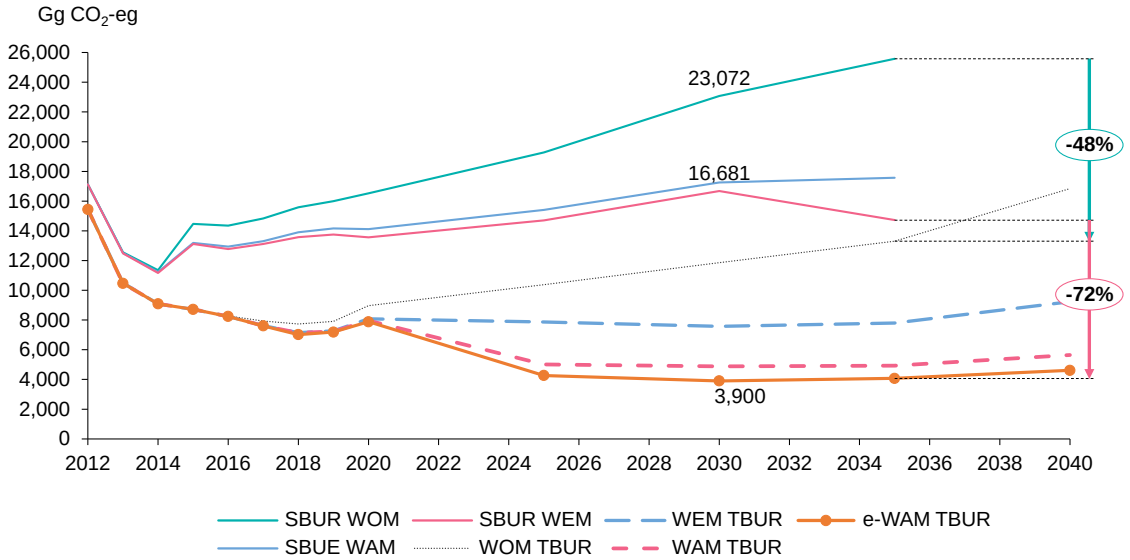


To follow the progress of the mitigation scenarios, SDG indicators and related SGD goals are identified. A comparative analysis of the obtained results with the EU average (EU-28) and the countries of Southeast Europe has been made. An important indicator regarding climate change is the greenhouse gas emissions intensity of energy consumption. It monitors the extent to which low-carbon fuels replace high-carbon fuels while meeting the energy needs and the extent to which the efficiency of technologies for production and use of energy has increased compared to the level in 2000. Although there is an increase in the energy demand, in the mitigation scenarios, as a result of energy efficiency measures, the energy consumption rate of growth is expected to be slower than that of the WOM scenario, while at the same time, with the replacement of lignite with RES and partially with this indicator is expected to reach 25% in the e-WAM scenario, which is 75% less than in 2000. In the worst case (WEM), the level of this indicator will stay almost the same as in 2014.

Another important indicator is CO_2 emissions per capita, according to which Macedonia has the lowest value compared to the analyzed countries (3.3 tCO_2/capita in 2016). In the best scenario (e-WAM), GHG emissions in 2040 will be reduced up to 75% compared to the 1990 level, which leads to 1.5 GHG emissions per capita. In the worst scenario (WOM), the GHG emissions per capita in 2040 in Macedonia will approach the EU28 2017 level (8.8 tCO_2/capita).

The more ambitious policies and measures proposed in the TBUR doubled the percentage of GHG reductions compared to the SBUR WOM scenario (Figure 5). In absolute terms, in 2030 the emissions in the SBUR WAM scenario were projected to 16,681 Gg CO_2-eq and in the TBUR e-WAM scenario to 3,900 Gg CO_2-eq. This WOM scenario is frozen to the 2017 level, which means that the measures implemented up to 2017 are included and is different compared to the WOM scenario in the SBUR (which was frozen to 2012 level). In addition, the lower GDP growth rate in TBUR (3.3% annually) also plays an important role in the projected results. Furthermore, the emissions from the waste sector in TBUR are almost six times lower compared to SBUR, because of the changes made in the calculation of the waste from the industry (waste generation rate as a percentage from GDP) as part from the GHG inventory preparation process.

FIGURE 5. COMPARISON OF THE RESULTS FROM SBUR WITH TBUR



The results obtained from the analyses in this study cannot be directly compared with the goals defined in the Intended Nationally Determined Contributions (INDC) because:

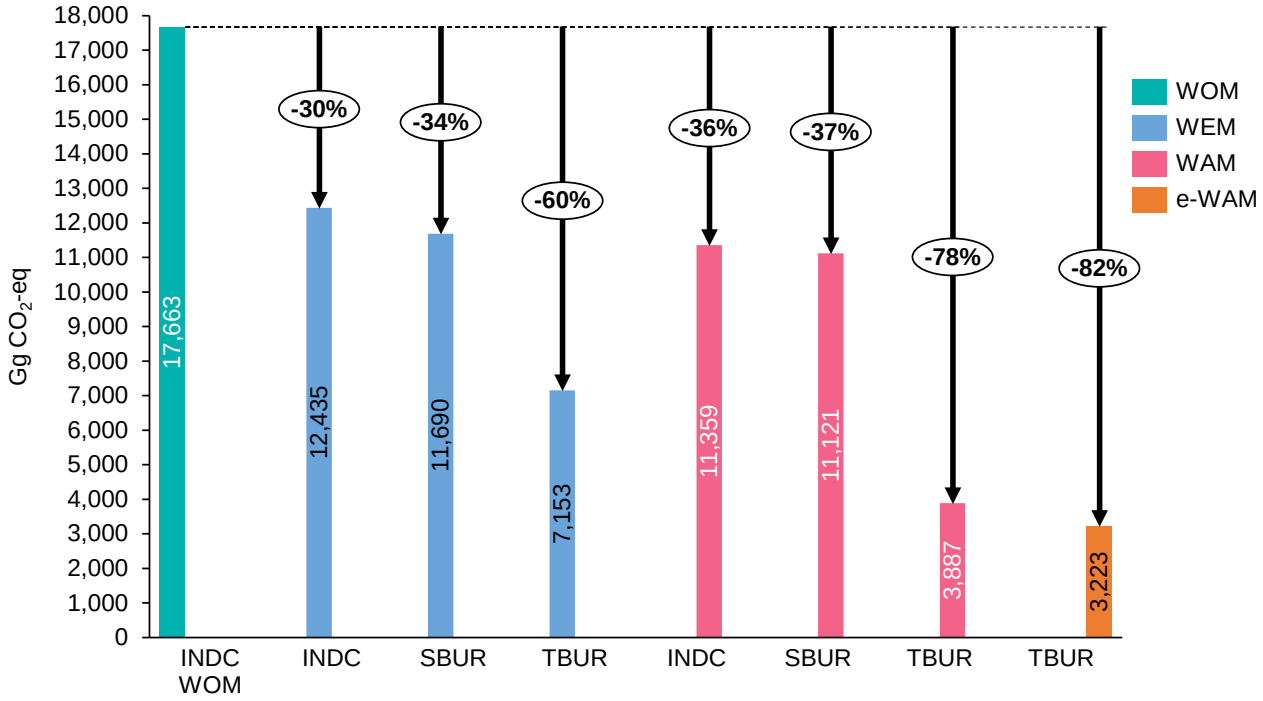
- besides CO_2 emissions this study takes into account the emissions of CH_4 and N_2O which were not included in the INDC
- an emission factor has been attributed to the import of electricity

- as a result of the changes in the modelling, the change of input parameters (prices of fuels, Gross Domestic Product (GDP) growth, population growth etc.) the Reference scenarios in the TBUR is different from the Reference scenario in the INDC.

If one was to make a realistic comparison with the INDC goals, only the CO_2 emissions should be taken into account while the emissions related to electricity import should be disregarded. Additionally, a comparison with the INDC reference scenario should be made to assess the relative decreases with respect to that scenario. The results from the comparison are displayed in Figure 6 which shows that:

- in the year 2030 in TBUR the WEM is more ambitious than the mitigation scenarios defined in the INDC, as well as in SBUR.
- in TBUR WEM in 2030 the emissions are decreased by 60% compared to the referent Business-as-usual scenario defined in INDC,
- in the TBUR WAM scenario the emissions are decreased by 78% compared to the Business-as-usual scenario in INDC.
- in the TBUR e-WAM scenario the emissions are decreased by 83% compared to the Business-as-usual scenario in INDC.

FIGURE 6. COMPARISON OF THE SBUR, INDC AND FBUR, MITIGATION AND THE HIGHER AMBITIOUS SCENARIOS FROM THE ENERGY SECTOR WITH THE INDC REFERENCE SCENARIO, 2030 (IN GG CO_2-EQ)



For the realization of WEM scenario 13.308 mil. € are needed, of which about 99% are investment in the energy sector. WAM scenario requires an additional 45%, while for the realization of e-WAM almost 85% more compared to WEM (Figure 7). The average yearly investments in WEM are approximately 4.8% of the total average annual GDP, while in the e-WAM is 8.8% (Figure 8).

Finally, in accordance with the Mitigation scenario an Action Plan for mitigation of climate change was prepared, in which the stakeholders relevant for the implementation of all 47 measures and policies were identified. Furthermore, the plan contains information on each measure's type, source of finance, indicative future emission reductions, specific costs (cost of reduced t CO_2), 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 Macedonia.

FIGURE 7. INVESTMENTS BY SCENARIOS AND BY SECTORS

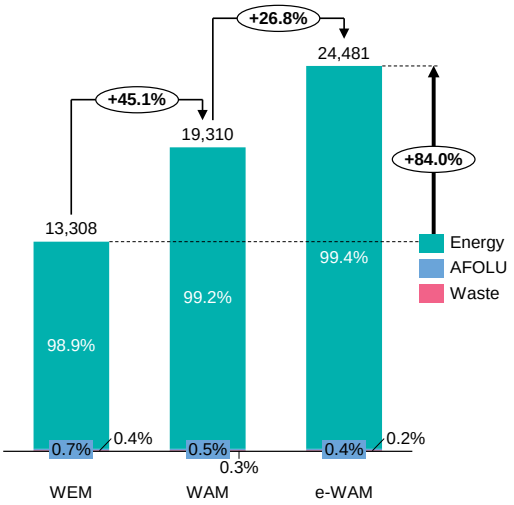
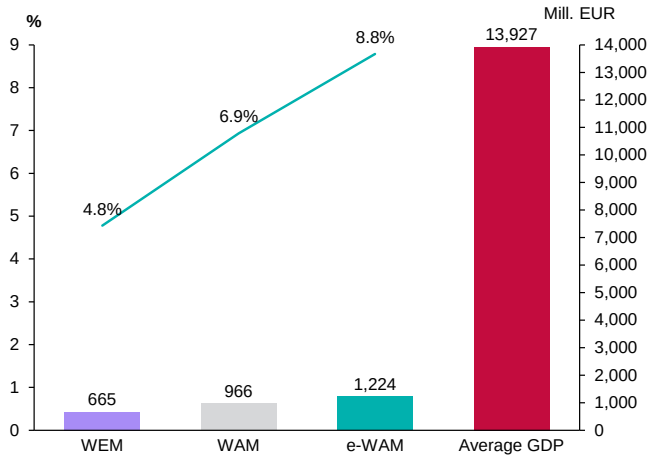


FIGURE 8. ANNUAL INVESTMENTS COMPARED TO AVERAGE GDP



1 Introduction

1.1 Context

The Republic of North Macedonia (Macedonia), a **non-Annex I party** to the United Nations Framework Convention on Climate Change (UNFCCC), ratified Paris Agreement in January 2018, 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." 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. Vulnerable sectors and climate change adaptation shall be subject to a more detailed analysis in the future NDC submissions. The country is in the process of converting to a legislative and regulatory framework that will be informed by the 2030 Climate and Energy Framework of the European Union. It will need to adopt a **Long-term Climate Action Strategy** and a **Law on Climate Action**. This initiative is being funded by a project entitled "Law and Strategy on Climate Change," which has been programmed under the EU Instrument for Pre-Accession Assistance (IPA II) funding mechanism. Work on the Long-term Climate Action Strategy started in March 2019 and the drafting of the Law on Climate Action (including transposition of EU Monitoring Mechanism Regulation 525/2013) is ongoing.

So far, **three National Communications on Climate Change (NCCC)** and **two Biennial Update Reports** (BURs), first (FBUR) and second (SBUR) have been submitted to the UNFCCC. All these documents, particularly the latest, SBUR, are based on the robust analytical work and consultations with the relevant ministries and other relevant stakeholders aimed at:

- Identification and validation of possible mitigation policies and measures in the target sectors in agreement with the sector policies and planning documents, as well as with the European Policy on Climate and Energy.
- Identification and validation of the assumptions used for the modelling of the identified policies and measures in line with the sector policies and planning documents, as well as with the European Policy on Climate and Energy.
- Prioritization of identified policies and measures and providing directions for the development of mitigation scenarios with existing and with additional measures.

Meanwhile, the **National Strategy for Energy Development up to 2040** (Energy Strategy) was adopted in December 2019. The Energy Strategy depicts three scenarios - Reference, Moderate Transition and Green which reflect different dynamics of energy transition and enable flexibility into Macedonian response to relevant EU policies and governance for modern, competitive and climate-neutral economy by 2050.

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

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, NDC, FBUR and the three NCCC timelines.

Secondly, the **SBUR scenarios** defined as WOM (without measures), WEM (with existing measures) and WAM (with additional measures) or Survival, Safeway and Climate runner correspond one to one to the Strategy's three scenarios - Reference, Moderate Transition and Green. In both cases, the scenario modelling tool is MARKAL. Also, the building principle of the scenarios is the same – reflecting different levels of ambition in mitigation action and different dynamics of the energy transition. This approach will be pursued in the TBUR mitigation analyses.

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. 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 SBUR PAMs in a tabular form, with elements prescribed in UNFCCC Guidelines for BUR preparation, is yet another element which is broadly implemented in BUR mitigation analyses, as well as in the current, and even more, in the forthcoming Energy related planning documents, such as National Energy and Climate Action Plan or Energy Efficiency Action Plan. 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 SBUR 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**, which is to be duly applied in TBUR, National Energy and Climate Plan and the forthcoming revision of the NDC.

1.2 Economics and population

Macedonia is one of the smallest countries in the Southeastern Europe region, with around 2.075 million inhabitants. Its gross domestic product (GDP) equals to 8.5 billion € and the GDP per capita is 4,086.5 € (Table 1).

TABLE 1. BASIC DEMOGRAPHIC AND ECONOMIC INFORMATION FOR THE COUNTRIES OF SOUTHEASTERN EUROPE (2018)

	Population (million)	*GDP (billion €)*	*GDP per capita (€)*	*Unemployment*
EU 28	512.38	14,521.8	28,341.9	6.3%
Bulgaria	7.05	46.0	6,524.8	5.6%
Greece	10.74	190.8	17,765.4	16.7%
Croatia	4.10	49.0	11,951.2	7.2%
Romania	19.53	169.4	8,673.8	4.0%
Montenegro	0.62	3.9	6,290.3	15.5%
Macedonia	2.08	8.5	4,086.5	17.1%
Albania	2.90	11.0	3,793.1	12.0%
Serbia	7.00	36.3	5,185.7	22.2%
Bosnia and Herzegovina	3.84	15.2	3,958.3	32.9%
Kosovo	1.80	5.8	3,222.2	25.3%

1.3 Basic characteristics of the sectors

1.3.1 Energy

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 over 80% of the total energy demand. 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 54%. There is also an increasing trend of the share of renewable energy in the gross final energy consumption, which from 17.7% in 2009 has increased to 19.6% in 2017. The efficiency of the Macedonian energy system (conversion from the total required energy into final energy) is about 71%. This value is almost at 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.

1.3.2 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.

1.3.3 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 2017) is 1.122.258 ha out of which 1.001.489 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.

1.3.4 Waste

According to the GHG inventory, the emissions in the waste sector are increased by 50% between 1990 and 2016, 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.

1.4 Scope of the TBUR mitigation analyses

The good practices and the established detailed and robust methodology developed in SBUR have also been implemented in this BUR. For the Energy sector the analyses are made with the MARKAL model, while for the AFOLU and Waste are calculated with the IPCC software. The emissions from IPPU are calculated based on the regression analyses model. Having in mind that the last year of the GHG inventory is 2016, the projections for GHG emissions are for the period 2017-2040.

Given that the Energy strategy up to 2040 was adopted in December 2019, TBUR's energy analysis is based on it as an officially adopted document. Namely, as stated at the beginning of this chapter, the strategy defines three scenarios, Reference Scenario, Scenario with moderate transition and Green scenario. In SBUR, there were two mitigation scenarios (With Existing Measures - WEM and With Additional Measures - WAM), but the fact that the Energy strategy now defines three scenarios, in TBUR one additional mitigation scenario (Extended Mitigation - e-WAM) is introduced. Accordingly, the Reference Scenario of the strategy corresponds to the WEM scenario, the Moderate transition scenario is a WAM scenario in TBUR, while the Green scenario is presented through the e-WAM scenario.

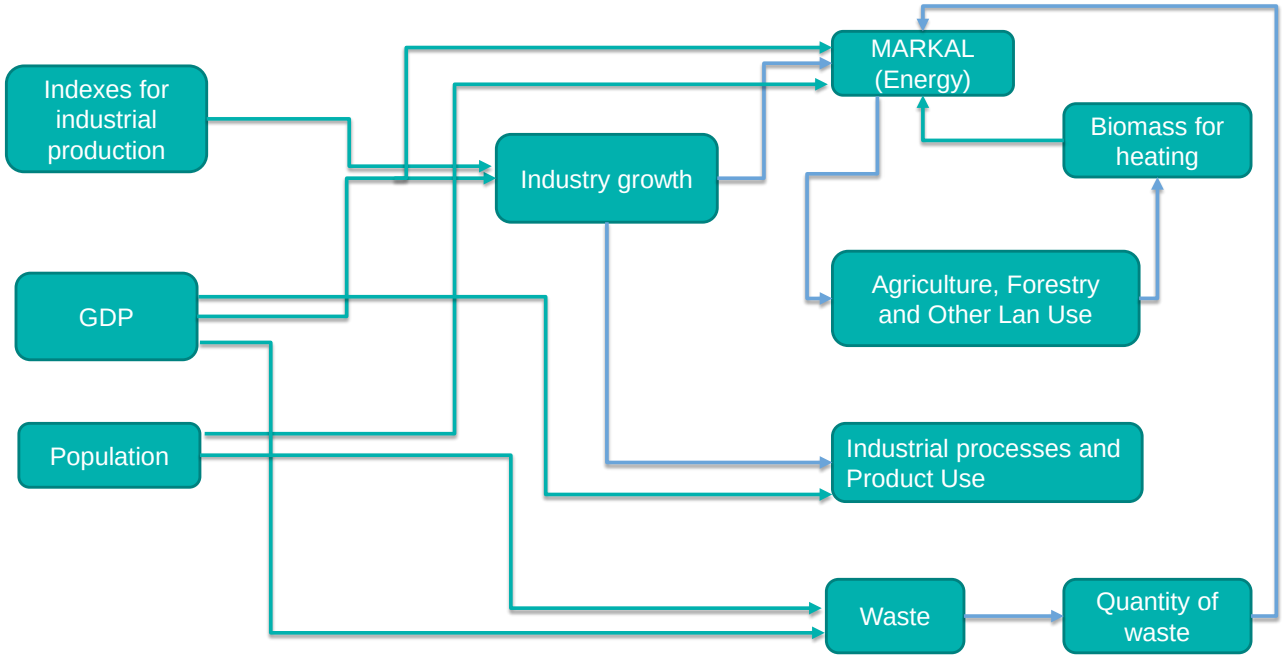
Also it should be emphasized that during the process of the Energy strategy preparation, almost all input data, as well as the results were validated in a participatory approach with the key stakeholders including Energy Community and NGO sector. Besides, two public debates were organized with wide participation and very fruitful discussion and comments.

In TBUR complete integration of the widely developed models for each of the sectors has been made, as well as their intersectoral connection through the main common drivers (Figure 9). Additionally, a few changes have been made relative to the SBUR that can be summarized as follows:

- The contribution of each measure for achieving the SDG goals is presented.
- With the help of the SDG indicators, the overall development of Macedonia in terms of GHG emission reductions in monitored, which can be compared to other countries. In this regard, for the first time in this report, an indicator from the Forestry sector was presented, with the help of which the forests area in Macedonia and its comparison with other countries was presented. Additionally, a new indicator in the Energy sector - Energy consumption in households per capita, was calculated and presented.
- For some measures in the energy sector are defined three different paths of implementation that correspond to a different scenario.
- Regarding the Energy sector, the ambitions of the proposed measures are much higher compared to those in SBUR. Several completely new measures have been introduced, the most important of which is the measure for the introduction of CO_2 tax, which significantly changes the penetration of other measures in the field of RES, energy efficiency, fuel switch, etc.
- Two completely new measures have been introduced in the AFOLU sector
- Regarding the waste sector, the changes that have been implemented in the waste sector within the GHG Inventory have been adequately incorporated into the mitigation model for the waste sector, such as the data for waste generation rate in industry and composition of waste. Additionally, for the first time in TBUR, a forecast of waste incineration emissions based on historical data has been made. Also, historical data for value added data has been linked to Total organic degradable material in the wastewater. Their connection, together with the value added projections from the MARKAL model,

has been used to calculate the projections of emissions from Industrial wastewater treatment. Furthermore, for the first time, a measure has been introduced in the category Solid Waste Disposal from Industry.

FIGURE 9. INTRA- AND INTER- SECTORAL APPROACH IN TBUR MITIGATION ANALYSES



Reference scenario

2 Reference scenario (Without measures - WOM)

WOM scenario assumes no major changes in technology, economics, or policies so that normal circumstances can be expected to continue unchanged. This scenario has no likelihood of occurrence because it implies, for instance, that the efficiencies of devices used in households in 2040 would be the same as the efficiencies of the devices used in 2017. Nevertheless, such a scenario is of crucial importance because it allows all policies and measures to be compared to a referent option ("no action" case) and identify their performance (energy, emissions and financial savings).

2.1 Energy

The Energy part of the WOM scenario is based on the Business-as-usual scenario developed in the Energy efficiency part of the Strategy for Energy Development up to 2040.

2.1.1 Key assumptions

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

- GDP, an average growth rate of 3.3% (Figure 6)
- Population, decline for 0.2% (Figure 11)
- Prices of domestic fuels for the period 2012- 2017 (Energy Regulatory Commission)
- Fuel prices – gas (Figure 12), coal, oil (World Energy Outlook (WEO) 2017)
- CO_2 emissions price (Figure 13) (WEO 2017)
- The import price of electricity for the period 2012- 2017 (HUPX)

FIGURE 10 MACEDONIA GDP PROJECTIONS

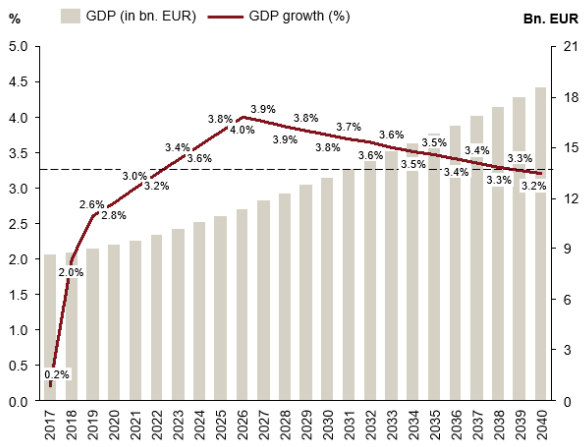


FIGURE 11 MACEDONIA POPULATION GROWTH

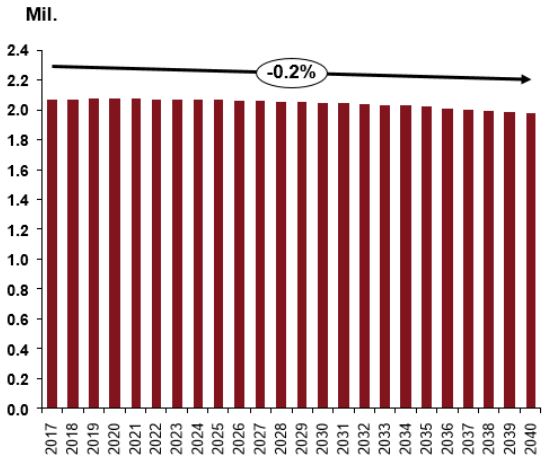


FIGURE 12. GAS PRICE PROJECTION, 2018 – 2040

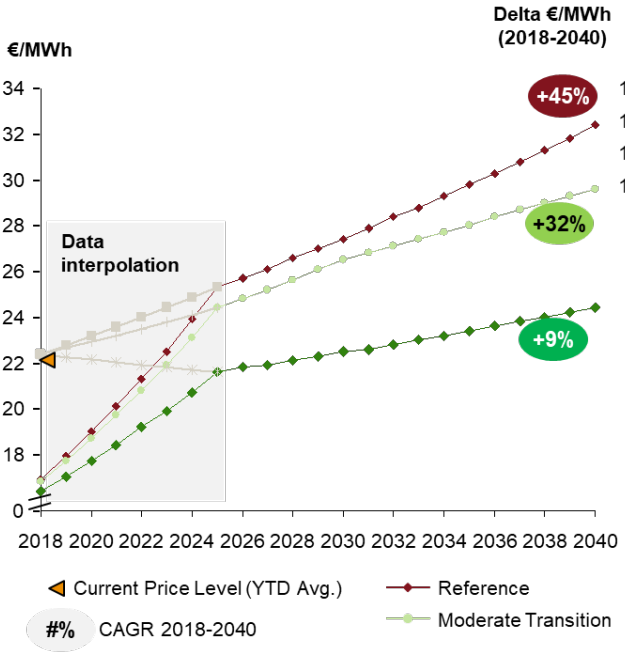
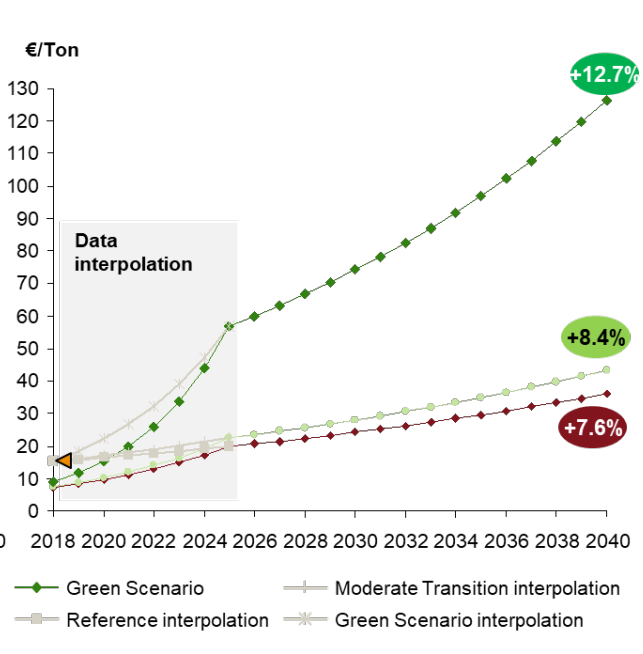


FIGURE 13. CO_2 PRICE PROJECTIONS, 2018 - 2040



Moreover, the good practices established as a part of the SBUR are implemented in this report with upgraded data for the period 2015-2017. These include the basic assumptions made in SBUR, such as:

- Dependence of value added 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 Strategy for Energy Development up to 2040.

2.1.2 Method

As support and help in forecasting the energy demand in the period until 2040, 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.

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

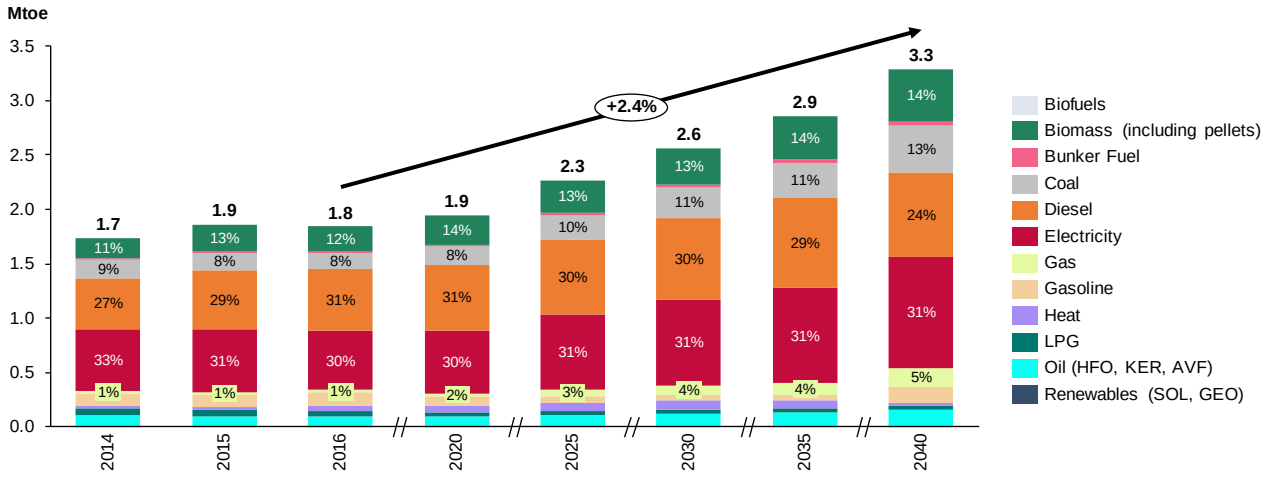
The method developed as a part of the SBUR process regarding the GHG emission from the imported electricity is also used in this report. Namely, in previous reports, under the IPCC methodology, the import of electricity, did not have an emission factor. That means that the total national GHG emissions 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.

2.1.3 Results

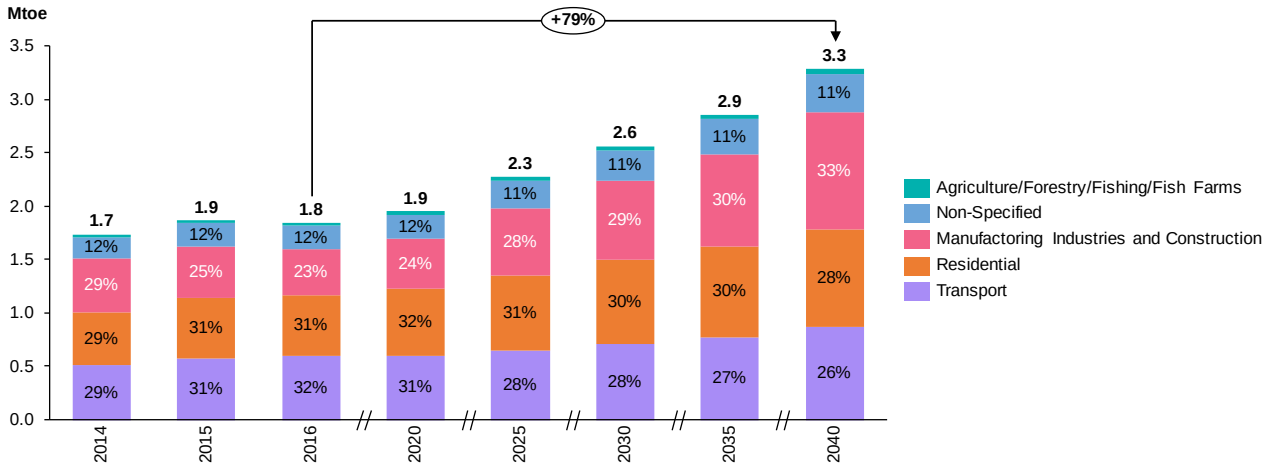
On one hand, the increase in the useful energy demand and on the other hand, not investing in energy efficiency leads to an increase in final energy consumption, which is growing at a rate of 2.4% per year in the period 2016-2040 (Figure 14). Electricity and diesel will continue to play an important 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 2040.

FIGURE 14. FINAL ENERGY CONSUMPTION BY FUELS



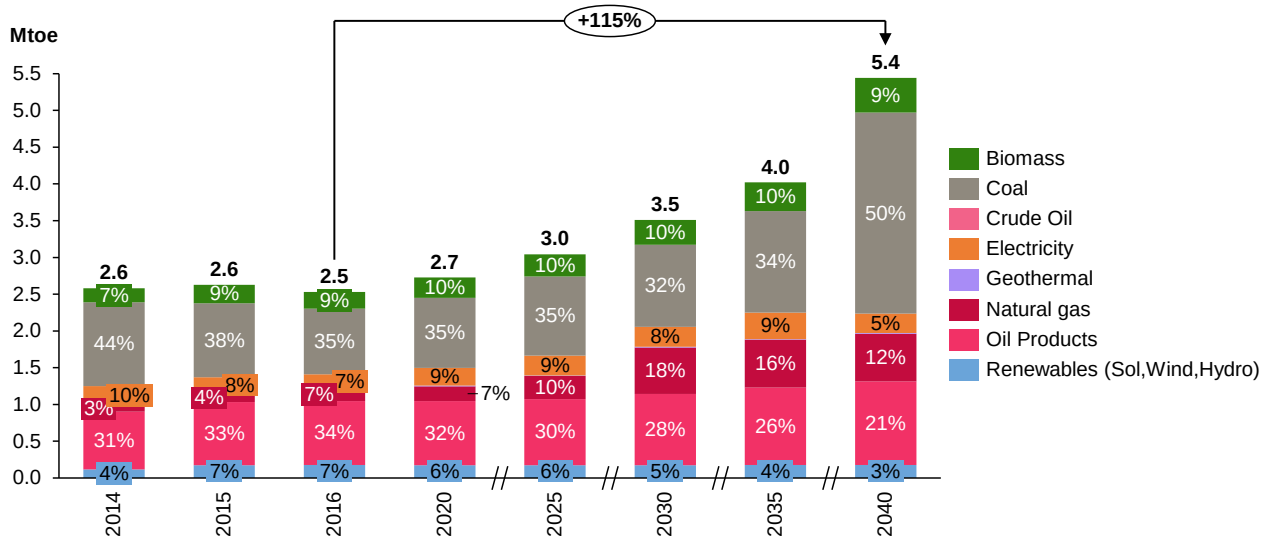
Regarding the final energy consumption by sectors, the Manufacturing Industries and Construction, Residential and the Transport sector are the most dominant ones during the whole period (Figure 15). The largest growth is in the Manufacturing Industries and Construction sector (2.5 times higher in 2040 compared to 2016).

FIGURE 15. FINAL ENERGY CONSUMPTION BY SECTORS



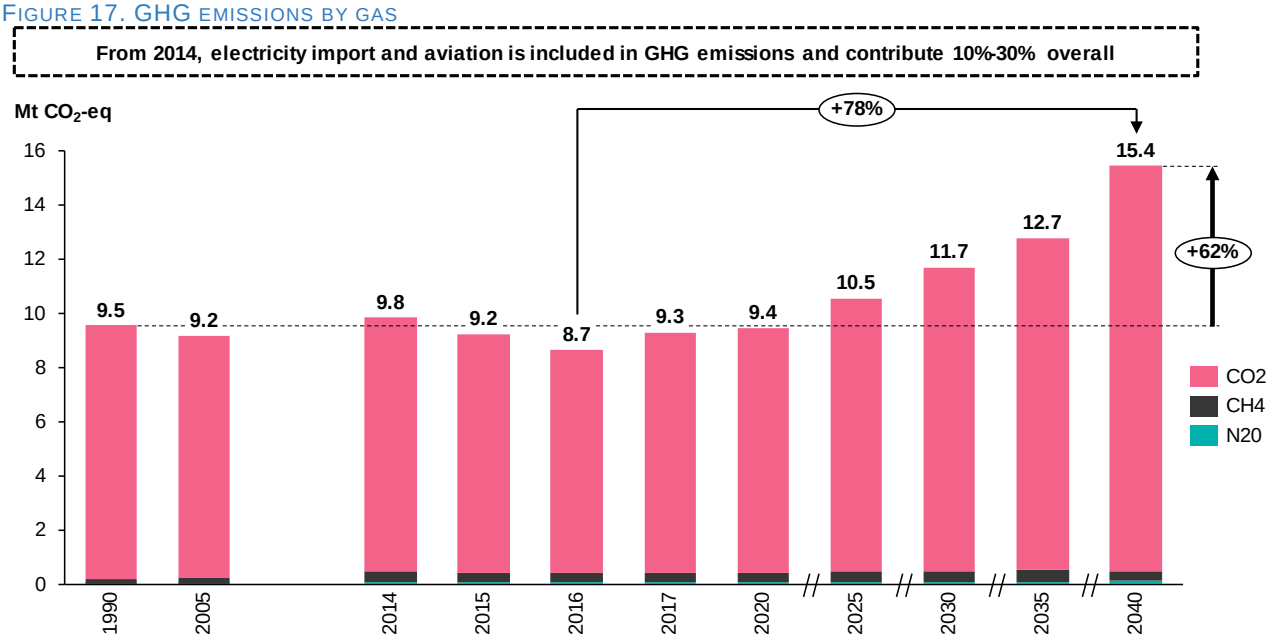
In addition to the increase of the final energy consumption, as well as not investing in RES will double the primary energy consumption in the considered period (Figure 16). Coal will still dominate, but to a much higher extent in the period 2035-2040, reaching a share of 50% in 2040. Oil products are the second largest contributors with an average share of around 30%. The fastest-growing fuel is natural gas, whose consumption is increased around 4 times in 2040 compared to 2016.

FIGURE 16. PRIMARY ENERGY CONSUMPTION BY FUELS



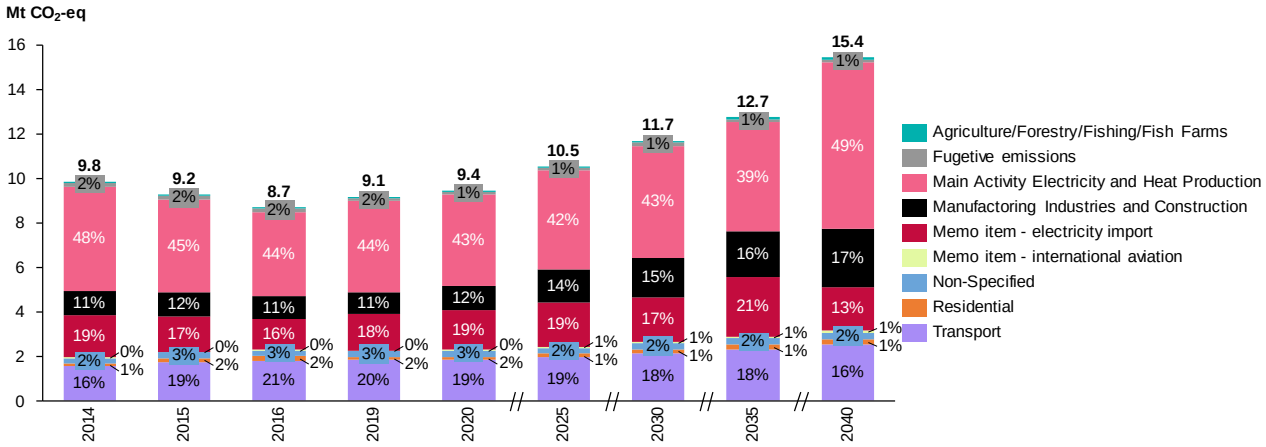
The increase of the primary energy consumption which is based on fossil fuels will increase GHG emissions in the analyzed period by 77% in 2040 relative to 2016 (Figure 17). Compared to the 1990 level, emissions will be increased by 61% in 2040. It is important to note that the emissions presented in Figure 17 for the period 2014-2040 also include the emissions from electricity import and international aviation, which are not used for reporting the national 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 17. 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 2040). As can be noted, electricity import significantly affects GHG emissions with a share of around 18% during the analyzed period (Figure 18).

FIGURE 18. GHG EMISSIONS BY SECTOR



2.2 Industrial Processes and Production Use

2.2.1 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 added value 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. The data used for the correlation in SBUR are upgraded for two more years, so the results from the correlation are more precise in TBUR. 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.

2.2.2 Method

The methodology for the calculation of the GHG emissions from IPPU that was developed in the SBUR is also applied in the TBUR. To determine the dependence of the historical emissions from the value added in the Mineral and the Metal industry, a correlation between them is calculated (Figure 19 and Figure 20). From these figures, the equation on their dependence is obtained, which is then used to estimate the emissions from these categories up to 2040. It should be emphasized that this is a basic method for calculation of GHG emission and more attention is needed in this sector during the preparation of Fourth National Communication on Climate Change. Most probably, as a result of energy efficiency measures, there is a negative trend of GHG emission in the Mineral industry. Besides, the production capacity of the entities as well as the products that are produced may contribute to GHG reduction.

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 2040 (Figure 21).

FIGURE 19. DEPENDENCE BETWEEN GHG EMISSIONS AND VALUE ADDED IN THE MINERAL INDUSTRY

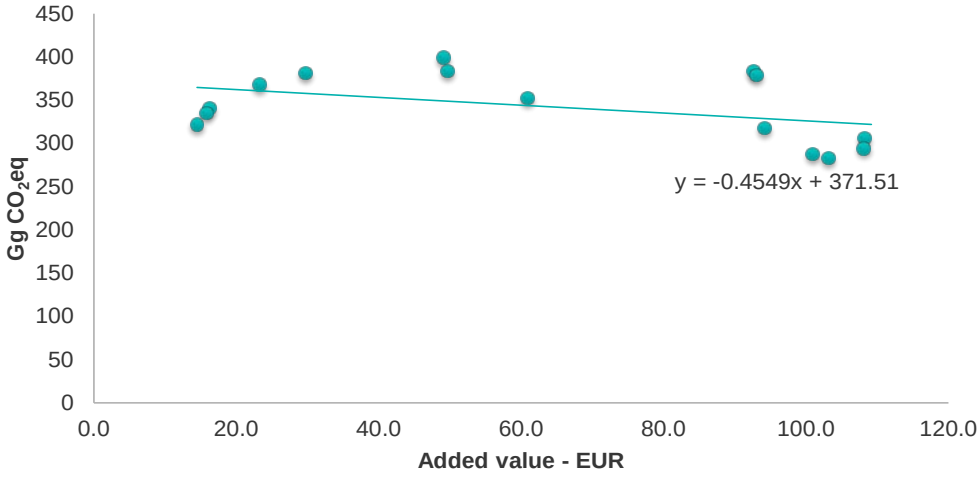


FIGURE 20. DEPENDENCE BETWEEN GHG EMISSIONS AND VALUE ADDED IN THE METAL INDUSTRY

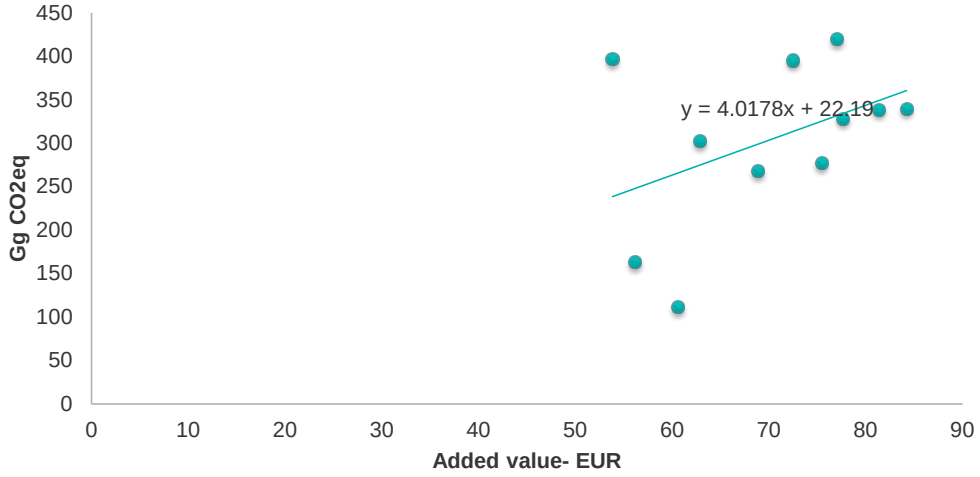
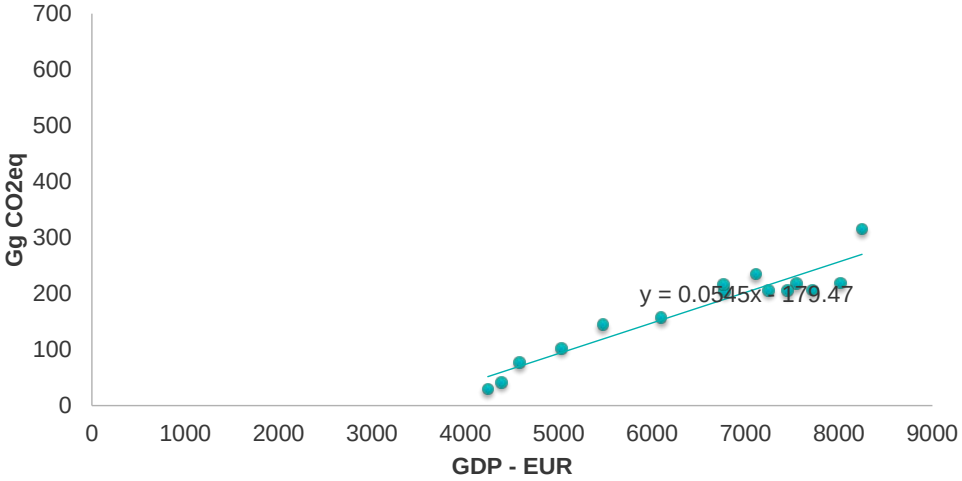


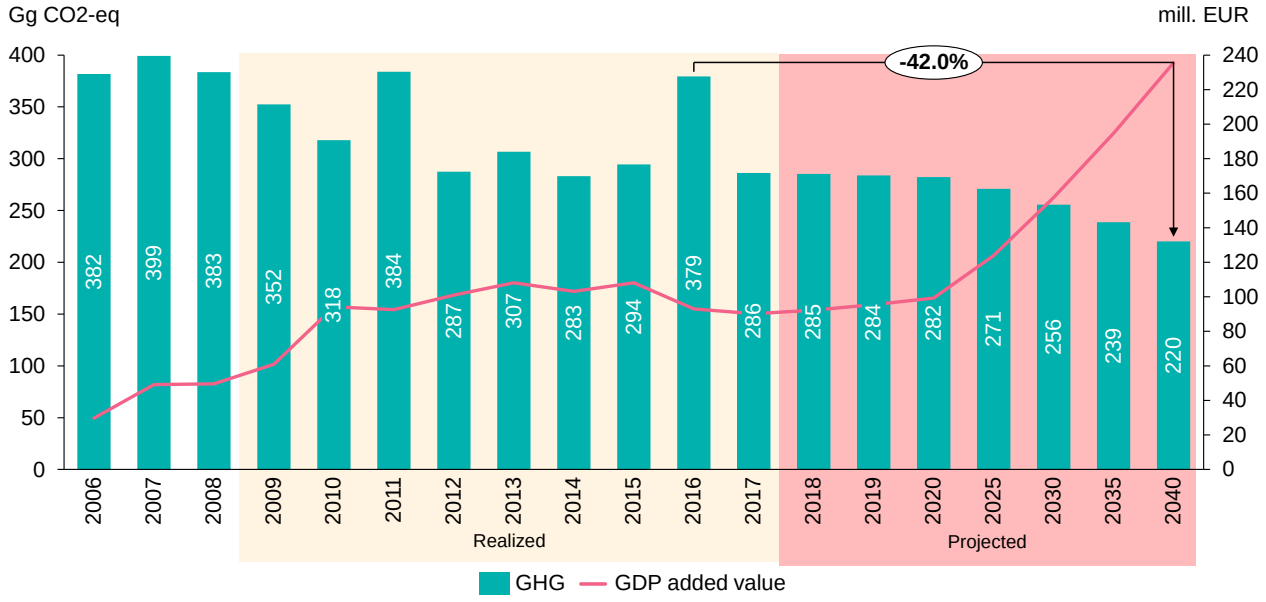
FIGURE 21. DEPENDENCE BETWEEN GHG EMISSIONS IN THE CATEGORY PRODUCT USES AS SUBSTITUTES FOR OZONE DEPLETING SUBSTANCES AND TOTAL GDP



2.2.3 Results

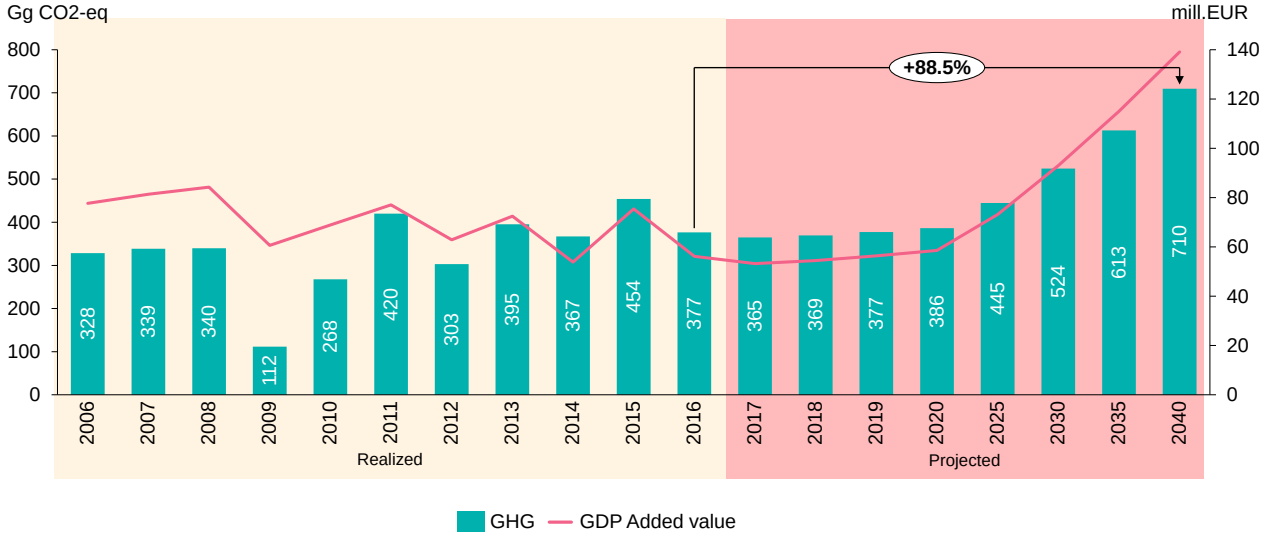
It is projected that GHG emissions from the Mineral industry, in the period up to 2040 will be reduced by 42% compared to the 2016 level (Figure 22), as the emissions in this category tend to get lower as the GDP value added increases.

FIGURE 22. HISTORIC AND PROJECTED GHG EMISSIONS AND VALUE ADDED IN THE MINERAL INDUSTRY (IN GG CO_2-EQ)



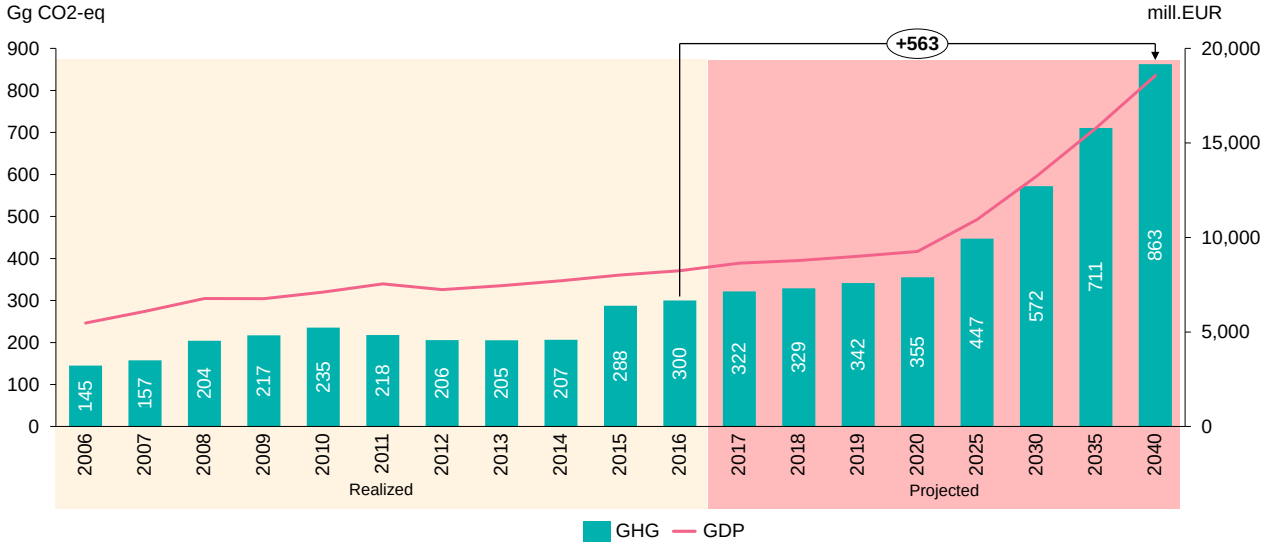
On the other hand, the emissions in the Metal industry are positively correlated to the GDP value added in this category, so the emissions in 2040 are increased by 88.5% compared to 2016 (together with the increase in the value added), reaching 710 Gg CO_2-eq in 2040(Figure 25).

FIGURE 23. HISTORIC AND PROJECTED GHG EMISSIONS AND VALUE ADDED IN THE METAL INDUSTRY (IN GG CO_2-EQ)



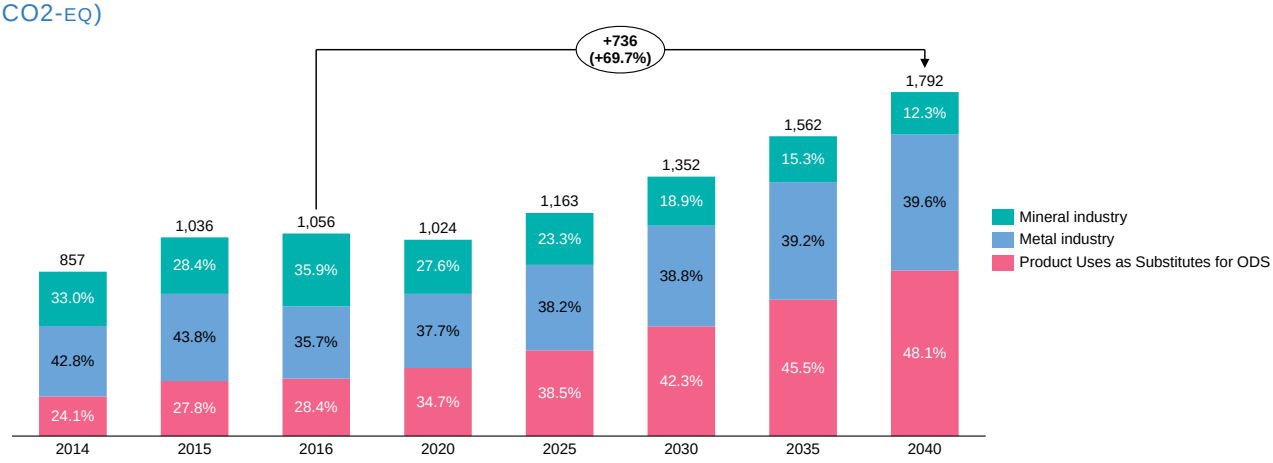
The emissions in the category Product Uses as Substitutes for ODS follow the growth of the GDP in Macedonia, and in 2040 they will achieve around 860 Gg CO2-eq or around 3 times more compared to 2016 (Figure 24).

FIGURE 24. REALISED 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 70% in 2040, compared to 2016 (Figure 25). The emissions will reach 1,792 Gg CO2-eq in 2040. Product Uses as Substitutes for ODS will be the most dominant category with an emission share of 48% in 2040 (28.4% in 2016). The share of the Metal Industry is almost the same during the planning period, while the share of the Mineral industry is reduced from 36% in 2017 to 12% in 2040.

FIGURE 25. TOTAL GHG EMISSIONS IN INDUSTRIAL PROCESSES AND PRODUCT USE SECTOR BY CATEGORIES (IN GG CO2-EQ)



2.3 Agriculture, Forestry and Other Land Use

2.3.1 Key assumptions

The major drivers of 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. Moreover, the official data show that the livestock number decreased, as well as utilized agricultural area and irrigated area. 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 and possible rapid intensification.

In defining the WOM scenario for the AFOLU sector, the hypothesis that the rate of conversion of the land for the period 2000-2016 will keep the same trend by 2040. The assessment of the values for the period 2013-2040 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.

2.3.2 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, in 2015 the official statistics for 2015 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, thus in 2040 their share is

expected to be 30% of the total number of dairy farms. 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 17% by 2040), 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 (1990-2016) continues, then it is realistic to expect a decrease in the population by an additional 28% by 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.

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 2040 the population of pigs will decrease (from 28,671 in 2016 to 20,000 in 2040), but at the same time, the number of pigs for fattening will decrease from 202,758 (2016) to 185,000 (2040).

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 2. STATISTICAL (2014, 2015 AND 2016) AND FORESEEN DATA ON THE NUMBER OF DOMESTIC ANIMALS USED IN FORECASTING GHG EMISSIONS IN LIVESTOCK

Types and categories	***2014***	***2015***	***2016***	***2020***	***2025***	***2030***	***2035***	***2040***
Dairy cows	155,432	156,699	160,603	144,814	140,534	136,381	132,350	128,438
Other cattle	86,175	96,743	94,165	93,671	92,405	91,318	90,367	87,656
Sheep	619,839	599,869	607,622	480,725	461,817	442,910	424,002	405,093
Sheep up to 1 year	113,671	123,426	116,933	120,756	116,096	112,043	108,457	104,101
Goats	81,346	88,064	101,669	44,462	36,559	28,655	20,752	12,849
Horses	19,371	18,784	19,263	19,921	19,926	19,931	19,936	19,941
Swine	23,511	20,857	28,671	22,000	21,000	20,000	20,000	20,000
Fattening pigs	141,542	174,586	202,758	165,000	168,000	170,000	180,000	185,000
Poultry	1,939,879	1,761,145	1,865,769	1,820,645	1,910,712	2,005,922	2,106,577	2,201,888
Laying hens	1,884,289	1,423,841	1,705,948	1,790,075	1,879,578	1,973,557	2,072,235	2,166,288
Broilers	4,355	51,256	15,998	6,532	7,839	9,406	11,288	12,873
Turkeys	3,690	2,910	10,070	5,535	6,642	7,971	9,565	10,908
Other poultry	19,477	17,908	36,245	18,503	16,653	14,988	13,489	11,818

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 during this activity. The use of the IPCC methodology seems like the best available option. 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). Unfortunately, both data types

are not available in the country, therefore the approach used was implementing the extrapolation method. However, there are intensive activities to derive land use changes data from historical satellite imagery and to establish datasets required for improvement of the modeling capacities in the AFOLU sector.

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 (AFOLU) 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. Due to a lack of available datasets and scenarios the IPCC methodology was combined with empirical modeling to estimate trends in Agriculture and land use changes. However, this hybrid approach is not sustainable and certain steps should be taken for the development of the datasets required.

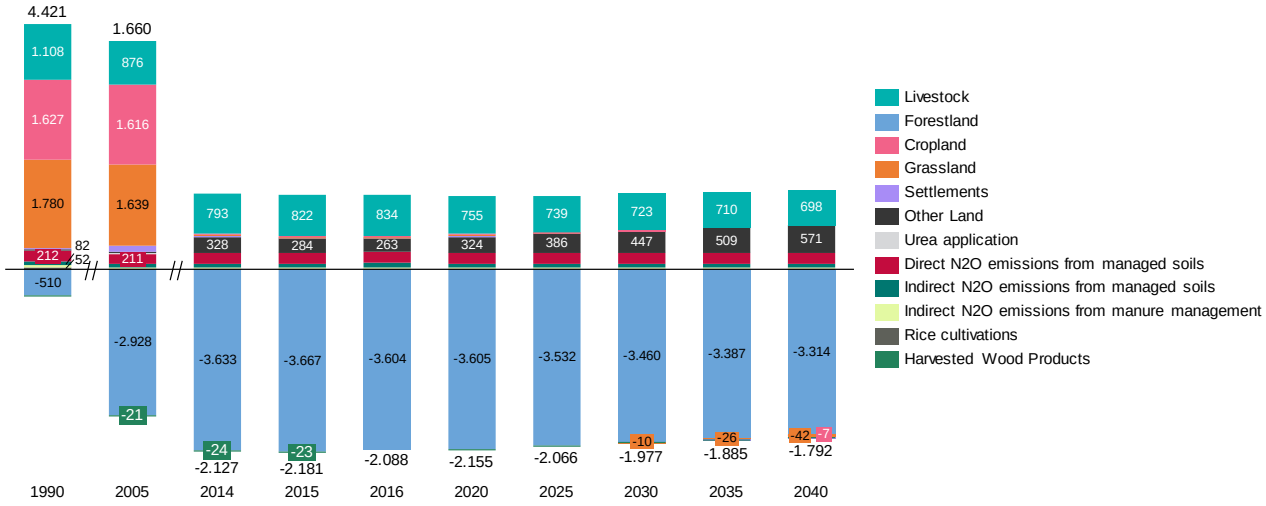
2.3.3 Results

In the period 2014 to 2040 the AFOLU sector emissions in the WOM scenario will increase by 17.5%. The main reason is decreasing of the forest carbon sink for almost 10%. However, the other land use types reduce their emission, while the other land increases. Dairy cows and other cattle are the main emitters of greenhouse gases 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. It is projected that emissions from the livestock sub-sector will reduce by 16.6% mainly due to the reduction of the number of animals.

TABLE 3. ESTIMATED TOTAL EMISSIONS FOR THE PERIOD 2014-2040 IN THE AFOLU SECTOR

	2014	2015	2016	2020	2025	2030	2035	2040
AFOLU	**-2129.9**	**-2185.7**	**-2062.1**	**-2,155.5**	**-2,066.4**	**-1,976.9**	**-1,885.4**	**-1,791.8**
Livestock	**789.8**	**816.5**	**831.2**	**754.7**	**738.8**	**723.3**	**709.8**	**698.5**
Land	**-3234.2**	**-3316.3**	**-3281.1**	**-3,226.5**	**-3,118.7**	**-3,010.9**	**-2,903.0**	**-2,795.2**
Forestland	-3632.8	-3666.6	-3603.6	-3,605.2	-3,532.4	-3,459.6	-3,386.8	-3,313.9
Cropland	34.76	28.84	31.22	28.07	19.22	10.37	1.52	-7.33
Grassland	32.25	27.94	25.80	22.21	6.09	-10.04	-26.16	-42.29
Settlements	3.64	9.36	2.92	4.59	2.79	0.99	-0.81	-2.61
Other Land	327.87	284.16	262.57	323.85	385.63	447.41	509.19	570.98
Aggregate sources and non-CO_2 emissions sources on land	**338.78**	**337.41**	**359.78**	**342.4**	**341.8**	**341.2**	**340.6**	**340.0**
Urea application	3.67	3.51	3.19	3.1	2.7	2.4	2.0	1.6
Direct N_2O emissions from managed soils	209.33	208.37	224.45	214.5	216.9	219.3	221.7	224.2
Indirect N_2O emissions from managed soils	75.46	75.26	80.71	76.0	75.8	75.6	75.4	75.2
Indirect N_2O emissions from manure management	26.27	27.10	28.01	25.9	25.0	24.1	23.2	22.4
Rice cultivations	24.05	23.17	23.42	22.9	21.3	19.8	18.2	16.6
Other	**-24.19**	**-23.27**	**28.01**	**-26.0**	**-28.3**	**-30.5**	**-32.8**	**-35.0**
Harvested Wood Products	-24.19	-23.27	23.42	-26.0	-28.3	-30.5	-32.8	-35.0

FIGURE 3. TOTAL GHG EMISSIONS IN AFOLU SECTOR BY SUBCATEGORIES (IN GG CO2-EQ



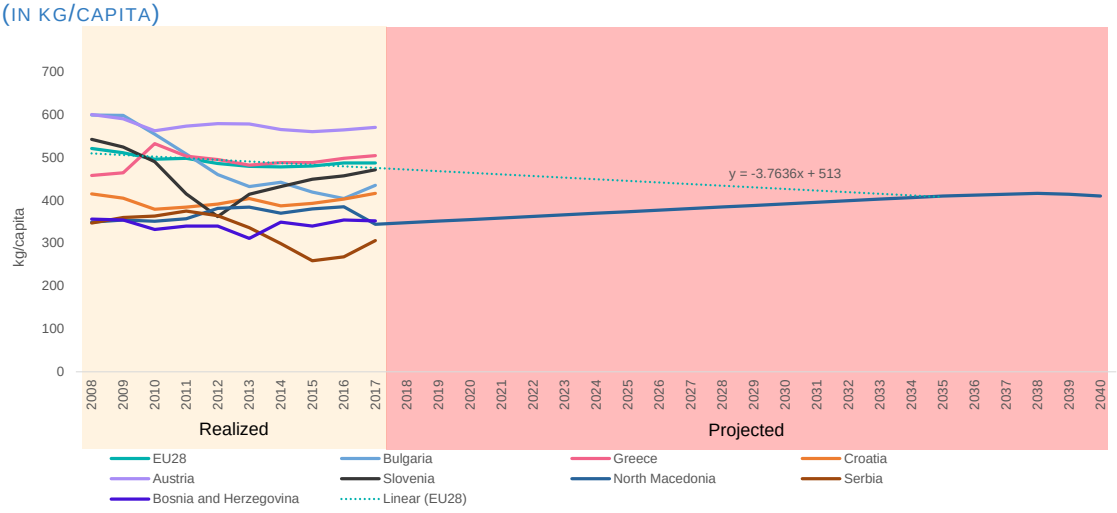
Nevertheless, only 3 subsectors will contribute to the emission and will remain a carbon positive source in 2040.

2.4 Waste

2.4.1 Key assumptions

The approach established as a part of the SBUR is also used in the TBUR. In the Waste and Energy sectors, the same key drivers are used, i.e. GDP and population (explained in the section on macroeconomic drivers). In order 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 25%. At the EU 28 level there is a downward trend, while in Macedonia, if 2017 is excluded, there is a trend of growth. In the SBUR it was assumed that these trends will continue and in 2035 Macedonia will have the same level of waste per capita as the EU28. In TBUR the same assumption is applied. Additionally, it is assumed that in the period after 2035, the amount per capita will start to decline (Figure 29).

FIGURE 26. QUANTITY OF MUNICIPAL WASTE PER CAPITA IN MACEDONIA, EU28 AND COUNTRIES IN THE SEE REGION (IN KG/CAPITA)



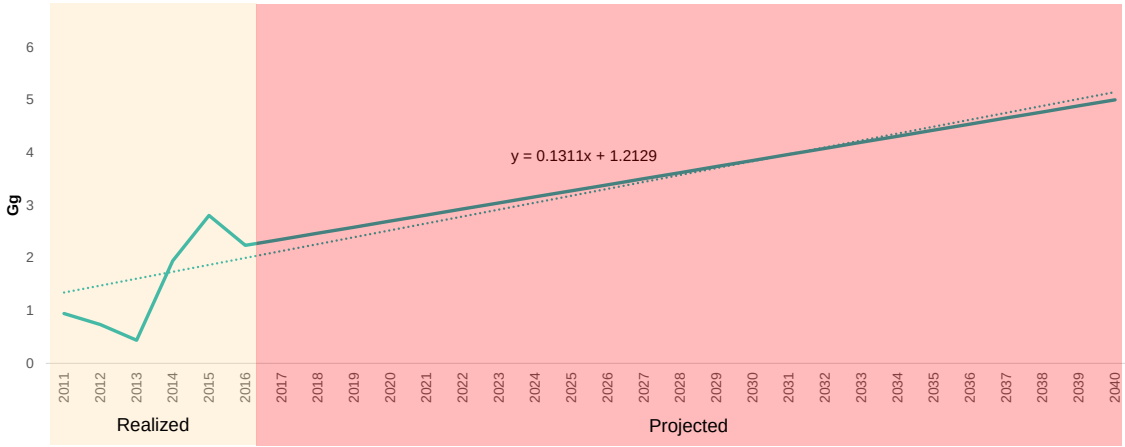
In the reference scenario it is also assumed that the composition of waste going to solid waste disposal will remain the same during the whole period as they are for 2016, i.e. food – 36.7%, garden – 10.7%, paper – 10.8%, wood – 0.4%, textile – 3.7%, nappies – 5.0% and plastic, other inert – 32.6%. Additionally, the distribution of waste by waste management treatment will be equal to the distribution in 2016, for the whole period. For calculating the industrial waste, the data for the value added for the industry from the MARKAL model are used.

2.4.2 Method

A completely new Excel model able to calculate the GHG emissions from the Waste sector was developed in the SBUR. 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 2040 are calculated.

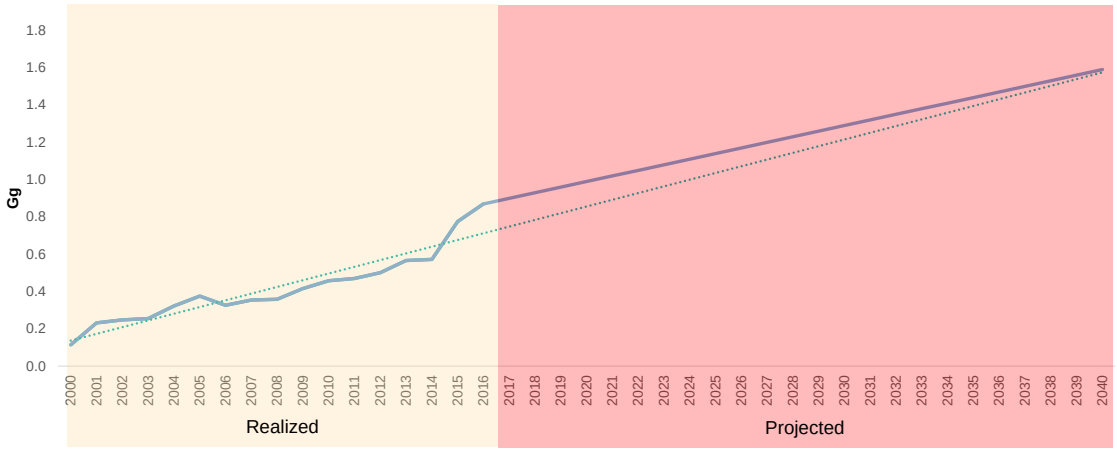
For the first time, in the reference scenario mechanical and biological treatment with composting is included (Figure 27). Based on the historical data for the period 2011-2016, an equation for the trendline of the emissions from composting is obtained. Based on this equation, the emissions for the period from 2017 to 2040 are calculated.

FIGURE 27. 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 2000-2016 (Figure 28). Using the trendline, emissions from incineration of waste up to 2040 are calculated.

FIGURE 28. 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 2008-

2016 (Figure 29). The derived equation for the correlation is used to calculate the total organic degradable material in wastewater for the period up to 2040 (Figure 30).

FIGURE 29. CORRELATION BETWEEN THE TOTAL ORGANIC DEGRADABLE MATERIAL IN WASTEWATER AND VALUE ADDED IN THE INDUSTRY FOR THE PERIOD 2008-2016

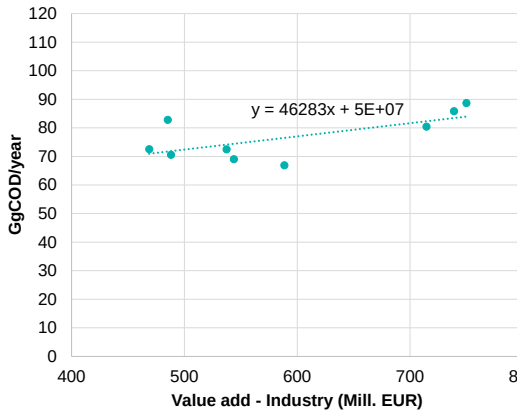
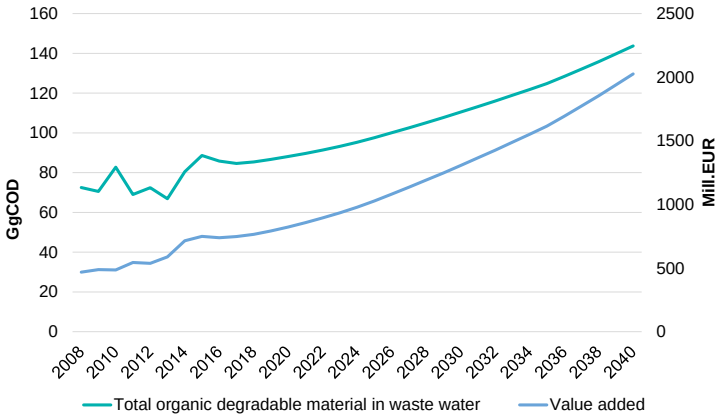


FIGURE 30. TOTAL ORGANIC DEGRADABLE MATERIAL IN WASTEWATER AND VALUE ADDED IN THE INDUSTRY FOR THE PERIOD 2008-2040



2.4.3 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 31). 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 32).

FIGURE 31. TOTAL GHG EMISSIONS IN THE WASTE SECTOR BY SUBCATEGORIES (IN GG CO_2-EQ)

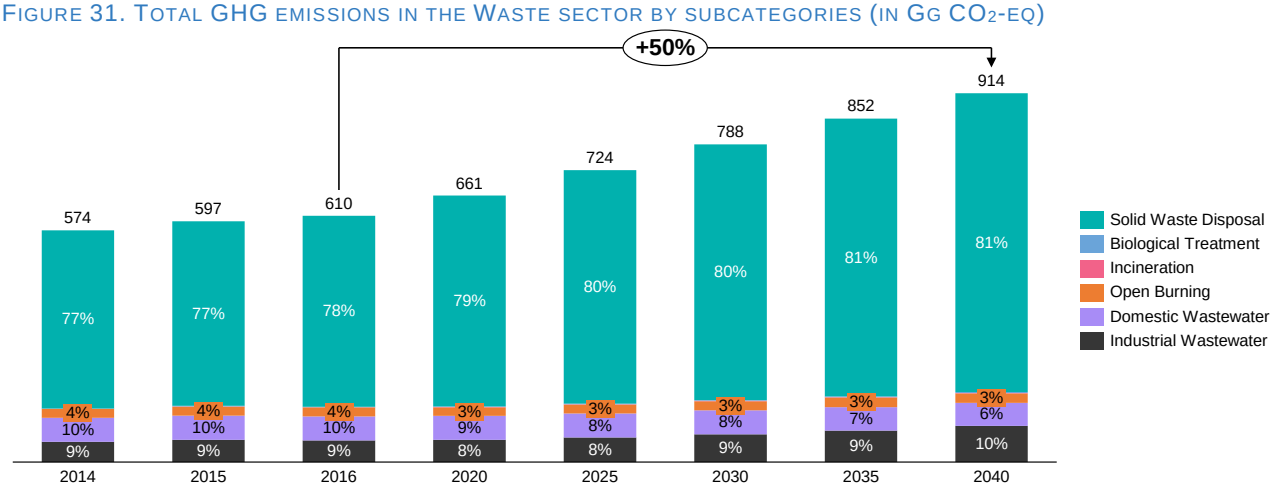
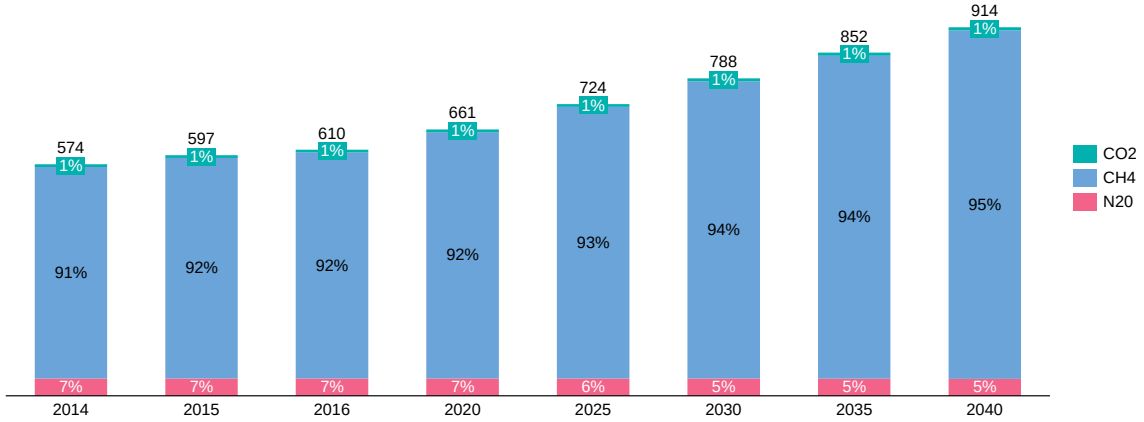


FIGURE 32. TOTAL GHG EMISSIONS IN THE WASTE SECTOR BY GASSES (IN GG CO_2-EQ)



2.5 Total emissions

The total GHG emissions from all sectors in the WOM scenario is expected to increase by 37.3% in 2040 compared to 1990, or by 64.7% compared to 2005, reaching 16,844 Gg CO_2-eq in 2040 (Figure 33). The comparison is made relative to 1990 and 2005 because the exact base year for Macedonia is not defined yet. When analyzing the total GHG emissions without the FOLU sector, this increase is even more dramatic, i.e. +57.7% in 2040 compared to 1990 (Figure 34). From these emissions, the largest amount is from the Energy sector, which increases its share by up to 81% in 2040. Additionally, the fastest growing sector in terms of emissions is the Waste sector, where the emissions in 2040 are 2.25 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 in 2040 compared to 1990 and 2005, but it is decreased by 13% compared to 2016.

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 35). Using this approach, in 2040 the GHG emissions are increased by 30.8% 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 33. TOTAL GHG EMISSIONS BY SECTORS - WOM SCENARIO (IN GG CO_2-EQ)

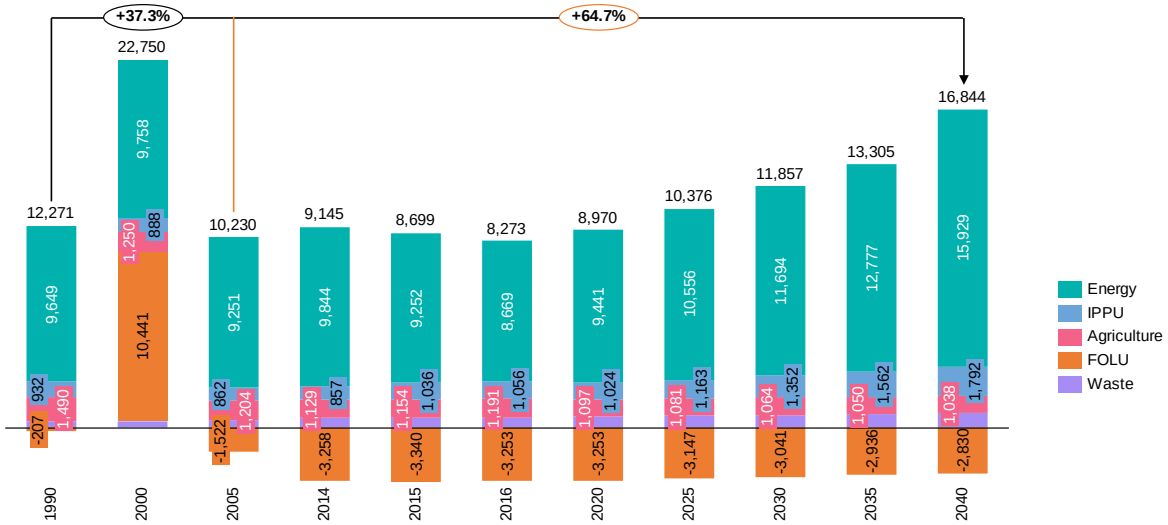


FIGURE 34. TOTAL GHG EMISSIONS BY SECTORS (WITHOUT FOLU) - WOM SCENARIO (IN GG CO_2-EQ)

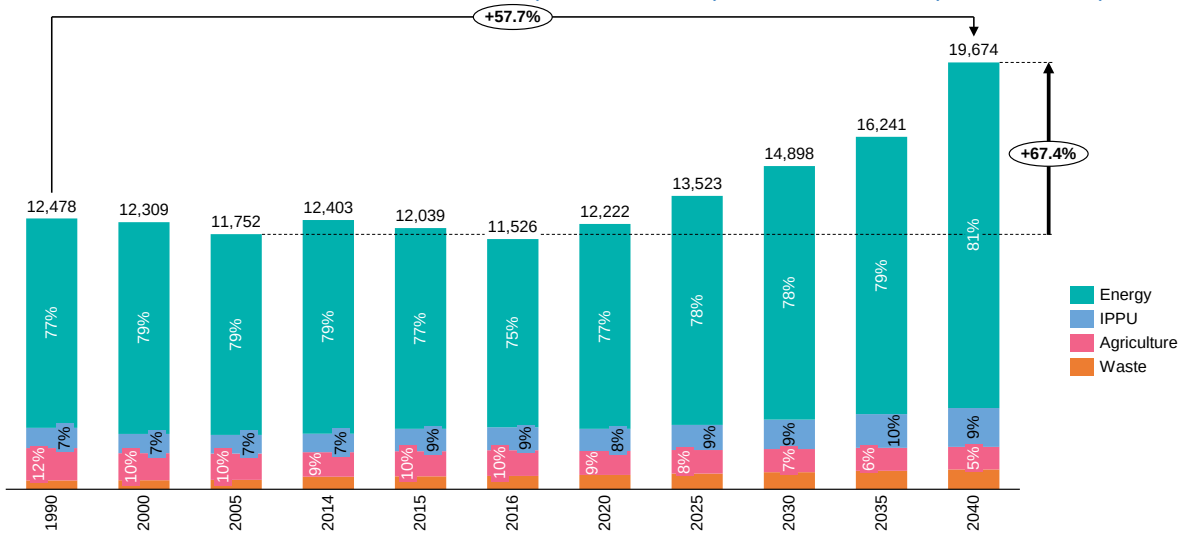
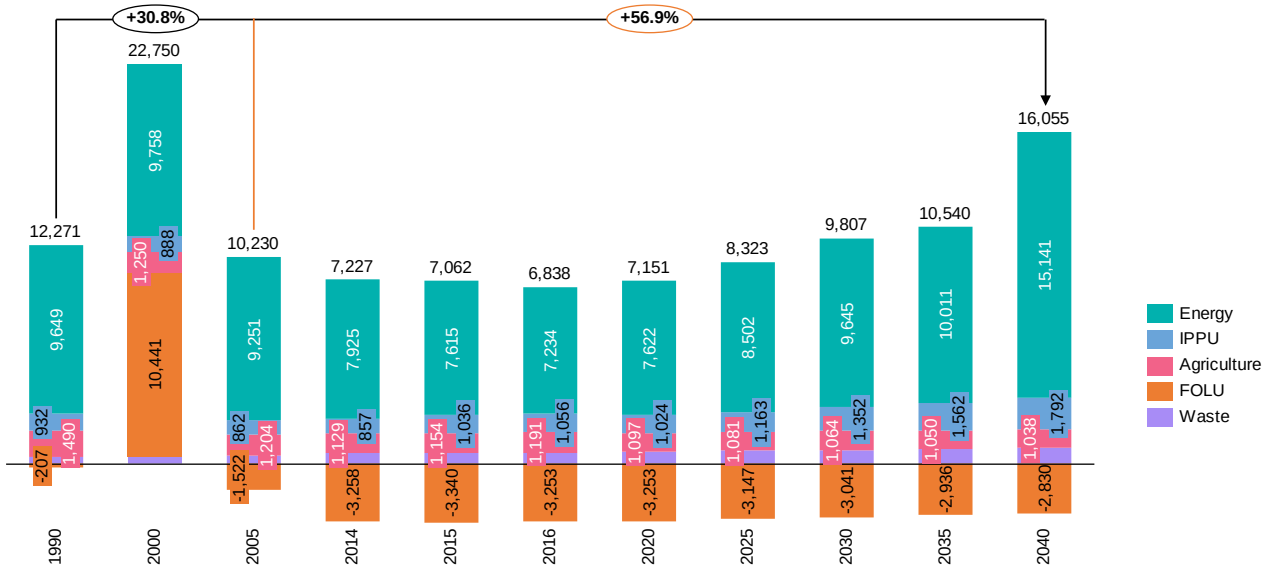


FIGURE 35. TOTAL GHG EMISSIONS BY SECTORS WITHOUT MEMO - WOM SCENARIO (IN GG CO_2-EQ)



Mitigation measures and their individual effect

3 Mitigation measures and their effect

All measures/policies (47) used in the climate change mitigation scenarios (WEM, WAM and e-WAM) are presented in this chapter and their effect is evaluated relative to the Reference scenario.

The national circumstances of decreasing tendency of emissions from the AFOLU sector, makes a difficult choice of mitigation scenarios. However, the mitigation measures can have additional effects, co-benefits and in some cases can have significant potential to be used as adaptation options as well. For example, the contour cultivation of cropland on inclined terrains, will reduce GHG emission, but also will increase the amount of water absorbed by soil and increase the yield in water limited agriculture. Also, biochar application can sink the significant amount of carbon into the soil, but also boasts a porous surface structure and chemical properties that allow it to capture and hold nutrients, moisture, and agrochemicals, as well as providing a place for micro-organisms and fungi to reside, thus increase soil fertility and result with healthier soil that will be able to provide a higher amount of water and nutrients to the crop in changing climate. Therefore, mitigation measures with such potential are favorable for North Macedonian agriculture, when AFOLU GHG emissions reduces with almost no measures applied, and the interest of the significant portion of the stakeholders for environmental measures in AFOLU sector is not high enough. These measures with a high level of co-benefits and adaptation potential can be much easier adopted by farmers due to the positive effect on crop growth and yield.

The IPCC reports that the mitigation measures can have additive positive effects, but they can also work in opposition, e.g., zero tillage can reduce the effectiveness of residue incorporation. Therefore, the choice of mitigation measures for the AFOLU sector in the country should be conducted carefully and providing the proper advisory package for the farmers. Moreover, it will be an advantage if such measures have potential to be included in the scheme of the national support for agriculture (direct payments and/or rural development programs) or to be included in IPARD program (particularly as agri-environmental measures, but not excluding all other types of measures). However, the measures that already fit in any of these programs should be considered as high priority measures, because the process of implementation will be easier, and farmers will be financially supported for implementation of such measures.

3.1 Energy

In the Energy sector, a total of 32 measures are analyzed, divided into the following categories: Energy industries, Residential, Non-specified (Commercial and Service sector), Manufacturing Industries and Construction and Transport.

3.1.1 Energy industries

In the Energy industries subcategory 8 measures in total are modelled and analyzed. The most relevant information for these measures/policies are given in Table 4- Table 12.

TABLE 4. REDUCTION OF NETWORK LOSSES

Mitigation action: ***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.***

Information	**Type**			Technical
	Sector			Electricity transmission and distribution operators
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development up to 2040 ► Development plan of EVN Macedonia, AD ► Development plan of Balkan Energy Group (BEG)
	Gases			CO_2, CH_4, N_2O
	Methodology			Technical interventions on the distribution network. 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 3%.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	► A General investment plan in the 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 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. ► Installation of modern equipment for regulation and monitoring in the heating substations for control and reduction of the consumed heat
	Energy savings	**Final energy**	**Per year**	n/a
			Cumulative	n/a
		Primary energy	**Per year**	► 11.0 ktoe in 2020 ► 28.9 ktoe in 2030 ► 263.7 ktoe in 2040 Additional benefit - decrease of net import: ► 41.8 ktoe in 2020 ► 86.6 ktoe in 2030 ► 332.3 ktoe in 2040
			Cumulative	► 32.8 ktoe in 2017-2020 ► 209.3 ktoe in 2021-2030 ► 941.0 ktoe in 2031-2040 Additional benefit decrease of net import: ► 112.6 ktoe in 2017-2020 ► 805.9 ktoe in 2021-2030 ► 1595.4 ktoe in 2031-2040
	Estimated emission reductions			► 201.8 Gg CO2-eq in 2020 ► 323.4 Gg CO2-eq in 2030 ► 701.8 Gg CO2-eq in 2040
	Timeframe			2020– 2040
	Finance			Budget: 170 M€ Source of finance: ► Distribution and transmission companies Costs (2030): ► WOM: 1,122 M€ ► WEM: 1,112 M€ Specific costs (2030): ► -31 €/t CO_2-eq
	Implementing entity			► Electricity distribution companies ► Heat distribution companies ► Energy Agency, Ministry of Economy
Progress indicators:				► Percentage of network losses (%) ► Energy savings (ktoe/GWh) ► Emissions reductions (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct***  ***indirect***  

TABLE 5. LARGE HYDROPOWER PLANTS

Mitigation action: ***Large hydropower plants***

Main objective: ***Increase of the domestic generation capacity from renewable energy sources***
Description: ***Construction of new large hydropower plants***

Information	**Type**			Technical
	Sector			Electricity producers
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Strategy for utilization of renewable energy sources in the Republic of Macedonia ► The development plan of ESM AD (JSC Macedonian Power Plants).
	Gases			CO_2, CH_4, N_2O
	Methodology			Large hydropower plants construction. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
	Assumptions			It is envisaged construction of large hydropower plants according to the following dynamics: ► Vardar valley – 2025-2030 ► Chebren – 2029 ► Tunnel Vardar – Kozjak, Veles and Gradec ► Globochica II – 2035
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	► Feasibility/pre-feasibility studies developed ► Chebren feasibility study
			Steps envisaged	► Call for investors for Chebren ► Invitation for tenders for the construction of the other hydropower plants, selection of the best bidder and commencement of the construction.
	Energy savings	**Final energy**	**Per year**	► n/a
			Cumulative	► n/a
		Primary energy	**Per year**	► 0 ktoe in 2020 ► 28.8 ktoe in 2030 ► 932.6 ktoe in 2040 Additional benefit - decrease of net import: ► 0 ktoe in 2020 ► 220.5 ktoe in 2030 ► 1156.0 ktoe in 2040
			Cumulative	► 0 ktoe in 2017-2020 ► 27.4 ktoe in 2021-2030 ► 3748.6 ktoe in 2031-2040 Additional benefit decrease of net import: ► 0 ktoe in 2017-2020 ► 340.5 ktoe in 2021-2030 ► 5926.0 ktoe in 2031-2040
	Estimated emission reductions			► 0 Gg CO2-eq in 2020 ► 740.7 Gg CO2-eq in 2030 ► 1868.2 Gg CO2-eq in 2040
	Timeframe			2020– 2040
	Finance			Budget: 1716.2 M€ Source of finance: ► Public private partnership, ELEM Costs (2030): ► WOM: 1,122 M€ ► WEM: 1,115 M€ Specific costs (2030): ► 9.5 €/t CO_2-eq
	Implementing entity			► ESM AD (JSC Macedonian Power Plants). ► Ministry of Environment and Physical Planning ► Energy Agency, Ministry of Economy
Progress indicators:				► Installed capacity (MW) ► Electricity generation (GWh) ► Emissions reductions (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** ***indirect*** 

TABLE 6. INCENTIVES FEED-IN TARIFF

Mitigation action: ***Incentives feed-in tariff***

Main objective: ***Increase of the domestic generation capacity from renewable energy sources***
Description: ***Construction of new small hydropower plants, wind and biogas with feed-in tariffs that will stimulate the construction***

Information	**Type**			Technical, regulatory
	Sector			Electricity producers
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Strategy for Utilization of Renewable Energy Sources in the Republic of Macedonia ► Renewable Energy Action Plan ► Law on Energy ► Bylaws on renewable energy
	Gases			CO_2, CH_4, N_2O
	Methodology			Small hydropower plants construction and preparation of regulation on feed-in premium tariffs. 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: ► 86 MW wind power plants ► 13 MW biogas power plants ► 92.5 MW small hydropower plants will be constructed.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	Regulation on feed-in tariffs adopted (17.04.2013)
			Steps envisaged	► 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).
	Energy savings	**Final energy**	**Per year**	► n/a
			Cumulative	► n/a
		Primary energy	**Per year**	► 1.8 ktoe in 2020 ► 24.5 ktoe in 2030 ► 169.6 ktoe in 2040 Additional benefit - decrease of net import: ► 5.7 ktoe in 2020 ► 56.4 ktoe in 2030 ► 211.4 ktoe in 2040
			Cumulative	► 3.2 ktoe in 2017-2020 ► 184.6 ktoe in 2021-2030 ► 691.6 ktoe in 2031-2040 Additional benefit decrease of net import: ► 1.8 ktoe in 2017-2020 ► 437.5 ktoe in 2021-2030 ► 1096.7 ktoe in 2031-2040
	Estimated emission reductions			► 11.75 Gg CO_2-eq in 2020 ► 149.5 Gg CO_2-eq in 2030 ► 431.6 Gg CO_2-eq in 2040
	Timeframe			2020– 2040
	Finance			Budget: 356.9 M€ Source of finance: ► Private, incentives through consumer bills Costs (2030): ► WOM: 1,122 M€ ► WEM: 1,121 M€ Specific costs (2030): ► -6.1 €/t CO_2-eq
	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
Progress indicators:				► Installed capacity (MW) ► Electricity generation (GWh) ► Emissions reductions (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** ***indirect*** 

TABLE 7. INCENTIVES FEED-IN PREMIUM

Mitigation action: ***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***

Information	**Type**			Technical, regulatory
	Sector			Electricity producers
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on Energy ► Bylaws for renewable energy
	Gases			CO_2, CH_4, N_2O
	Methodology			Solar power plants construction and preparation of regulation on feed-in premium tariffs. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
	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
Progress of implementation	**Steps taken or envisaged to achieve the action**		**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). ► Public call on awarding an agreement for right to use premium for electric power produced from photovoltaic power plant constructed on land owned by the Republic of North Macedonia (21.07.2019) ► Public call on awarding the right to use a premium for electricity generated and sold 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) ► Electronic auction for both tenders ► Public call on awarding an agreement for right to use premium for electric power produced from photovoltaic power plant constructed on land owned by the Republic of North Macedonia ► Public call on awarding the right to use a premium for electricity generated and sold 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
			Steps envisaged	► Construction of solar power plants ► New public call on awarding an agreement for right to use premium for electric power produced from photovoltaic power plant constructed on land owned by the Republic of North Macedonia ► New public call on awarding the right to use a premium for electricity generated and sold 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
	Energy savings	**Final energy**	**Per year**	n/a
			Cumulative	n/a
		Primary energy	**Per year**	► 0.0 ktoe in 2020 ► 21.5 ktoe in 2030 ► 175.7 ktoe in 2040 Additional benefit - decrease of net import: ► 0.0 ktoe in 2020 ► 53.3 ktoe in 2030 ► 209.5 ktoe in 2040
			Cumulative	► 0 ktoe in 2017-2020 ► 202.1 ktoe in 2021-2030 ► 577.8 ktoe in 2031-2040 Additional benefit decrease of net import: ► 0 ktoe in 2017-2020 ► 488.3 ktoe in 2021-2030 ► 932.4 ktoe in 2031-2040
	Estimated emission reductions			► 0 Gg CO2-eq in 2020 ► 162.6 Gg CO2-eq in 2030 ► 377.4 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: 240.6 M€ Source of finance: ► Private, incentives from the central government budget Costs (2030): ► WOM: 1,122 M€ ► WEM: 1,121 M€ Specific costs (2030): ► -3.7 €/t CO_2-eq

Implementing entity	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy ► Private investors
Progress indicators:	► Installed capacity (MW) ► Electricity generation (GWh) ► Emissions reductions (Gg CO2-eq)
Contribution for the achievement of the SDGs	***direct*** ***indirect*** 

TABLE 8. BIOMASS POWER PLANTS (CHP OPTIONAL)

Mitigation action: ***Biomass power plants (CHP optional)***

Main objective: ***Increase of the domestic generation capacity from renewable energy sources***
Description: ***Construction of biomass power plants (CHP optional) and introduction of feed-in tariffs to stimulate the construction***

Information	**Type**			Technical, regulatory
	Sector			Electricity producers
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on Energy ► Bylaws for renewable energy
	Gases			CO_2, CH_4, N_2O
	Methodology			Biomass power plants construction and preparation of regulation on feed-in premium tariffs. 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 biomass power plants with a capacity of 15 MW will be constructed.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**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).
			Steps envisaged	Modification of the Regulation on feed-in tariffs to introduce flexible feed-in premium tariffs.
	Energy savings	**Final energy**	**Per year**	► n/a
			Cumulative	► n/a
		Primary energy	**Per year**	► 0.0 ktoe in 2020 ► 3.0 ktoe in 2030 ► 18.4 ktoe in 2040
			Cumulative	► 0.0 ktoe in 2020 ► 10.5 ktoe in 2030 ► 98.1 ktoe in 2040
	Estimated emission reductions			► 0 Gg CO2-eq in 2020 ► 21 Gg CO2-eq in 2030 ► 91.1 Gg CO2-eq in 2040
	Timeframe			2020– 2040
	Finance			Budget: 24.3 M€ Source of finance: ► Private, incentives through consumer bills Costs (2030): ► WOM: 1,122 M€ ► WEM: 1,122 M€ Specific costs (2030): ► 5 €/t CO_2-eq
	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
Progress indicators:				► Installed capacity (MW) ► Electricity generation (GWh) ► Emissions reductions (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct***  ***indirect***  

TABLE 9. SOLAR ROOFTOP POWER PLANTS

Mitigation action: **Solar rooftop power plants**

Main objective: **Increase of the domestic generation capacity from renewable energy sources**
Description: **Construction of solar rooftop power plants and the introduction of "prosumer" concept**

Information

Type			Technical, regulatory		
Sector			Household and commercial sector		
Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on Energy ► Bylaws on renewable energy		
Gases			CO_2, CH_4, N_2O		
Methodology			Solar rooftop power plants construction. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.		
Assumptions			The following capacities are envisioned to be constructed by 2040:		
				Reference	Moderate Transition	Green
			Solar (MW)	250	350	400

Progress of implementation

Steps taken or envisaged to achieve the action		**Steps taken**	► Rulebook on renewable energy sources adopted. ► Distribution grid code			
		Steps envisaged	► Information campaigns			
Energy savings	**Final energy**	**Per year**	n/a			
		Cumulative	n/a			
	Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
			2020	0.0	0.0	0.0
			2030	18.9	26.3	29.9
			2040	195.0	276.2	311.1
			Additional benefit - decrease of net import:			
			2020	0.0	0.0	0.0
			2030	35.1	50.2	57.7
			2040	223.7	316.6	356.8
		Cumulative	ktoe	WEM	WAM	e-WAM
			2017-2020	0.0	0.0	0.0
			2021-2030	90.2	126.0	144.2
			2031-2040	648.8	925.6	1058.0
			Additional benefit - decrease of net import			
			2017-2020	0.0	0.0	0.0
			2021-2030	169.9	240.7	276.1
			2031-2040	924.3	1309.2	1494.9
Estimated emission reductions			Gg CO2-eq	WEM	WAM	e-WAM
			2020	1.95	2.8	3.2
			2030	100.4	142.9	164.3
			2040	392.44	552.7	627.2
Timeframe			2020 – 2040			
Finance			Budget		WEM	WAM	e-WAM
				M€	227.1	318.0	263.4
			Source of finance ► Private, donors, subsidies from national and local budget, EE fund Costs (2030): ► WOM: 1,122 M€ ► e-WAM: 1,116 M€ Specific costs (2030): ► -33 €/t CO_2-eq			
Implementing entity			► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency ► Elektrodistribucija Skopje ► Suppliers of electricity ► End-users of electricity			

Progress indicators:	► Installed capacity (MW) ► Electricity generation (GWh) ► Emissions reductions (Gg CO2-eq)	
Contribution for the achievement of the SDGs:	***direct***	***indirect***

TABLE 10. RES WITHOUT INCENTIVES

Mitigation action: ***RES without incentives***

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

Description: ***Construction of wind, solar and biogas power plants***

Information

Type	Technical, regulatory
Sector	Electricity producers
Relevant planning documents, legal and regulatory acts	► Strategy for Energy Development of North Macedonia up to 2040 ► Law on Energy ► Bylaws for renewable energy
Gases	CO_2, CH_4, N_2O
Methodology	Wind, solar and biogas power plants construction. 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:

	WEM	WAM	e-WAM
Wind (MW)	350	450	600
Solar (MW)	400	600	750
Biogas (MW)	10	10	10

Progress of implementation

Steps taken or envisaged to achieve the action	**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 10MW Oslomej PV started ► Tender for Public Private Partnership for PV Oslomej of at least 80 MW
	Steps envisaged	Modification of the Regulation on feed-in tariffs to introduce flexible feed-in premium tariffs.

Energy savings

Final energy	**Per year**	► n/a
	Cumulative	► n/a

Primary energy

Per year			
ktoe	WEM	WAM	e-WAM
2020	0	0	0
2030	17.9	27.5	29.4
2040	515.5	656.8	846.4
Additional benefit - decrease of net import:			
2020	0	0	0
2030	43.1	65.7	70.5
2040	628.1	806.1	1039.4

Cumulative			
ktoe	WEM	WAM	e-WAM
2017-2020	0	0	0
2021-2030	95.9	139.0	145.4
2031-2040	1626.4	2195.7	2685.3
Additional benefit - decrease of net import:			
2017-2020	0	0	0
2021-2030	225.5	324.7	339.8
2031-2040	2491.6	3404.0	4123.1

Estimated emission reductions			
Gg CO2-eq	WEM	WAM	e-WAM
2020	0	0	0
2030	124.4	189.2	202.8
2040	1194.1	1587.6	2040.2

Timeframe	2020 – 2040			
Finance	Budget		WEM	WAM	e-WAM
		M€	777.0	1046.0	1325.4

Source of finance:
- ► Private, ESM

Costs (2030):
- ► WOM: 1,122 M€
- ► e-WAM: 1,121 M€

Specific costs (2030):
- ► -6 €/t CO_2-eq

Implementing entity	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency ► JSC Macedonian Power Plants (ESM AD) ► Private investors
Progress indicators:	► Installed capacity (MW) ► Electricity generation (GWh) ► Emissions reductions (Gg CO2-eq)

Contribution for the achievement of the SDGs:	***direct***	***indirect***
		

TABLE 11. INTRODUCTION OF CO_2 TAX

Mitigation action: ***Introduction of CO_2 tax***

Main objective: ***Penalize the CO_2 emitters***

Description: ***Introduction of CO_2 tax in order to stimulate the investments in RES and to increase the penetration of energy efficiency measures***

Information	**Type**			Regulatory
	Sector			Energy
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on Energy ► Bylaws for renewable energy ► Law on Climate Change
	Gases			CO_2, CH_4, N_2O
	Methodology			Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
	Assumptions			Gradual introduction of CO_2 tax (2023 in WEM, 2025 in WAM and 2027 in e-WAM) based on the projected prices from WEO 2017.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	► Draft version of the Law on Climate Change ► Strategy for Energy Development of North 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
	Energy savings	**Final energy**	**Per year**	► n/a*
			Cumulative	► n/a*
		Primary energy	**Per year**	► n/a*
			Cumulative	► n/a*
	Estimated emission reductions			► n/a*
	Timeframe			2020– 2040
	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
Progress indicators:				/
Contribution for the achievement of the SDGs:			***direct***	***indirect***
				

* The exact contribution of this measure can not be calculated, as the implementation of this measure requires implementation of other measures (such as RES, energy efficiency, fuel switch etc.) which are needed to replace the CO_2 emitters.

3.1.2 Residential and Non-specified

In the Residential and Non-specified subcategories 15 measures in total are modelled and analyzed. The most relevant information for these measures/policies is given from Table 12 to Table 26

TABLE 12. ENERGY EFFICIENCY OBLIGATION SCHEMES

Mitigation action: ***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 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).***

Information	**Type**			Technical, regulatory
	Sector			All sectors (excl. transport and part of the industry according to Annex I of the Directive 2003/87/EC)
	Relevant planning documents, legal and regulatory acts			Draft version of Law on energy efficiency Directive for EE
	Gases			CO_2, CH_4, N_2O
	Methodology			Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology
	Assumptions			1. Final energy savings targets of: ► 0.5% in 2017 ► 0.7% in 2018 – 2020 ► 0.35% in 2021 – 2030 ► 0.2% in 2031 – 2040 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 by the distribution companies or suppliers.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	► Law on Energy Efficiency adopted
			Steps envisaged	► Decree for obligation schemes
	Energy savings	**Final energy**	**Per year**	► 13.2 ktoe in 2020 ► 44.4 ktoe in 2030 ► 87.6 ktoe in 2040
			Cumulative	► 46.6 ktoe in 2017- 2020 ► 291.1 ktoe in 2021- 2030 ► 672.5 ktoe in 2031- 2040
		Primary energy	**Per year**	► 10.8 ktoe in 2020 ► 67.8 ktoe in 2030 ► 306.6 ktoe in 2040
			Cumulative	► 51.3 ktoe in 2017- 2020 ► 487.0 ktoe in 2021- 2030 ► 1521.5 ktoe in 2031- 2040
	Estimated emission reductions			► 0 Gg CO2-eq in 2020 ► 162.8 Gg CO2-eq in 2030 ► 592.5 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: ► 182M€ Source of finance ► Consumers through their bills Costs (2030): ► WOM: 1,122 M€ ► WEM: 1,107 M€ Specific costs (2030): ► -88.7 €/t CO_2-eq
	Implementing entity			► Ministry of economy ► Distribution system operators ► Suppliers and traders of electricity and gas
Progress indicators:				► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** ***indirect*** 

TABLE 13. SOLAR THERMAL COLLECTORS

Mitigation action: ***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.***

Information	**Type**			Technical		
	Sector			Households and commercial sector		
	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		
	Gases			CO_2, CH_4, N_2O		
	Methodology			Installation of solar thermal collectors. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology		
	Assumptions			Share of solar thermal collector in hot water useful demand in household/commercial sector by 2040:		
					WEM	WAM	e-WAM
				Share (%)	*10% / 8%*	*25% / 16%*	*45% / 30%*
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	Program for promotion of RES for 2020 adopted		
			Steps envisaged	Continuation of the incentive measures for solar thermal collectors installation		
	Energy savings	**Final energy**	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	0.9	1.0	1.5
				2030	2.9	4.5	7.5
				2040	5.2	9.3	16.0
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	3.0	3.2	3.7
				2021-2030	18.4	27.4	45.0
				2031-2040	42.1	70.4	120.8
		Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	0.9	1.0	1.4
				2030	2.6	5.4	10.7
				2040	33.0	59.8	98.1
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	3.2	3.3	3.9
				2021-2030	17.6	34.7	68.2
				2031-2040	108.1	215.4	378.3
	Estimated emission reductions			Gg CO2-eq	WEM	WAM	e-WAM
				2020	0.2	0.4	0.7
				2030	1.3	7.2	21.5
				2040	39.5	90.8	165.4
	Timeframe			2020 – 2040			
	Finance			Budget		WEM	WAM	e-WAM
					M€	16.2	34.8	70.0
				Source of finance: ► Private, EE fund, incentives from the central government budget, donors Costs (2030): ► WOM: 1,121.9 M€ ► e-WAM: 1,121.8 M€ Specific costs (2030): ► -60 €/t CO_2-eq		
	Implementing entity			► Ministry of Economy, Energy Agency ► End-users		
Progress indicators:				► Number of installed solar collectors ► Average area per collector (m^2) ► Installed capacity (MW) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)		
Contribution for the achievement of the SDGs:				***direct*** 		***indirect*** 

TABLE 14. LABELING OF ELECTRIC APPLIANCES AND EQUIPMENT

Mitigation action: ***Labeling of electric appliances and equipment***

Main objective: ***Penetration of appliances with higher efficiency (class A++, A+, A, B)***

Description: ***Labelling of electric appliances and equipment to provide relevant information on the energy consumption of the products. The application of the labeling and eco-design of the products is necessary to ensure that the products sold in Macedonia comply with the EU regulations***

Information	**Type**			Regulatory
	Sector			Household and commercial sector
	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 ► Rulebook on labeling consumption of energy and other resources on devices using energy. ► Regulation on eco-design of products
	Gases			CO_2, CH_4, N_2O
	Methodology			Labeling of electric appliances and equipment. 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 2040 the share of energy efficient technologies will be 6%.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	New Rulebook on labeling consumption of energy and other resources on devices using energy adopted in September 2016 by the Ministry of Economy Draft version of the new Regulation on eco-design of products developed
			Steps envisaged	Adoption of the new Regulation on eco-design of products developed
	Energy savings	**Final energy**	**Per year**	► 4.6 ktoe in 2020 ► 19.0 ktoe in 2030 ► 40.0 ktoe in 2040
			Cumulative	► 17.8 ktoe in 2017-2020 ► 122.6 ktoe in 2021-2030 ► 291.1 ktoe in 2031-2040
		Primary energy	**Per year**	► 4.1 ktoe in 2020 ► 28.1 ktoe in 2030 ► 137.9 ktoe in 2040
			Cumulative	► 21.3 ktoe in 2017-2020 ► 197.6 ktoe in 2021-2030 ► 642.1 ktoe in 2031-2040
	Estimated emission reductions			► 13.1 Gg CO2-eq in 2020 ► 56.3 Gg CO2-eq in 2030 ► 236.7 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: 71 M€ Source of finance ► Private, EE fund Costs (2030): ► WOM: 1,121.9 M€ ► WEM: 1,117.1 M€ Specific costs (2030): ► -85.9 €/t CO_2-eq
	Implementing entity			► Ministry of Economy, Energy Agency ► Producers and suppliers of electrical equipment and household appliances ► End-users
Progress indicators:				► Number of devices sold (A++, A+, A, B) ► Energy savings (ktoe/GWh) ► Emissions reductions (Gg CO_2-eq)
Contribution for the achievement of the SDGs:				***direct***  ***indirect***  

TABLE 15. INCREASED USE OF HEAT PUMPS

Mitigation action: ***Increased use of heat pumps***

Main objective: ***More efficient use of electricity***

Description: ***Phasing out heating devices with resistive heaters and their replacement with heat pumps in compliance with EU Climate and Energy Policy.***

Information	**Type**			Regulatory, policy		
	Sector			Households and commercial sector		
	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 ► EU Climate and Energy Policy		
	Gases			CO_2, CH_4, N_2O		
	Methodology			Adopting a Decision that will prevent the sale of heating devices with resistive heaters. 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. The share of heat pumps in useful heat demand is:		
					WEM	WAM	e-WAM
				Share (%)	14%	40%	55%
Progress of implementation	**Steps taken or envisaged to achieve the action**	**Steps taken**		/		
		Steps envisaged		Adopting a Decision to ban the sale of heating devices with resistive heaters.		
	Energy savings	**Final energy**	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	21.4	31.9	48.0
				2030	56.1	84.7	139.3
				2040	114.4	176.3	256.1
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	69.0	100.7	146.5
				2021-2030	401.6	594.4	933.8
				2031-2040	839.3	1320.7	2007.6
		Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	20.3	34.5	46.5
				2030	98.4	137.5	186.1
				2040	395.6	413.7	519.2
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	91.0	138.3	187.6
				2021-2030	731.0	910.8	1192.2
				2031-2040	1976.6	2285.7	2873.1
	Estimated emission reductions			Gg CO2-eq	WEM	WAM	e-WAM
				2020	103.8	302.8	725.4
				2030	154.9	392.3	584.6
				2040	221.4	369.5	623.5
	Timeframe			2020 – 2040			
	Finance			Budget		WEM	WAM	e-WAM
					M€	235.0	330.6	474.4
				Source of finance: ► Private, EE fund, incentives from the central and local government budget, donors Costs (2030): ► WOM: 1,121.9 M€ ► e-WAM: 1,092.4 M€ Specific costs (2030): ► -79.9 €/t CO_2-eq		
	Implementing entity			► Ministry of Economy, Energy Agency ► End-users		
Progress indicators:				► Number of heat pump sold ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq))		
Contribution for the achievement of the SDGs:				***direct***  ***indirect*** 		

TABLE 16. PUBLIC AWARENESS CAMPAIGNS AND NETWORK OF ENERGY EFFICIENCY (EE) INFO CENTERS

Mitigation action: ***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 from buying and using appliances with higher efficiency class (A++, A+, A)***

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.***

Information

Type			Information		
Sector			Household and commercial consumers		
Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency		
Gases			CO_2, CH_4, N_2O		
Methodology			Conducting information campaigns and opening information centers for energy efficiency. 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) by 2040 to:		
				WEM	WAM	e-WAM
			Share (%)	20	30	40

Progress of implementation

Steps taken or envisaged to achieve the action		**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.			
Energy savings	**Final energy**	**Per year**	ktoe	WEM	WAM	e-WAM
			2020	15.6	17.8	24.3
			2030	48.2	53.2	67.8
			2040	90.0	96.3	110.4
		Cumulative	ktoe	WEM	WAM	e-WAM
			2017-2020	54.4	61.0	706.4
			2021-2030	332.9	371.5	758.6
			2031-2040	706.4	479.3	896.8
	Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
			2020	12.7	14.6	20.2
			2030	75.3	81.8	99.7
			2040	345.9	379.1	416.3
		Cumulative	ktoe	WEM	WAM	e-WAM
			2017-2020	60.0	67.3	88.9
			2021-2030	558.6	611.1	746.1
			2031-2040	1716.2	1890.8	2138.8
Estimated emission reductions			Gg CO2-eq	WEM	WAM	e-WAM
			2020	41.6	45.3	56.6
			2030	169.7	177.0	201.5
			2040	641.3	201.5	716.4
Timeframe			2020 – 2040			
Finance			Budget		WEM	WAM	e-WAM
				M€	2	4	8
			Cost of investment in advanced technologies		WEM	WAM	e-WAM
				M€	630	658	704
			Source of finance ► Private sector, donors, central and local governments Costs (2030):			

	► WOM: 1,121.9 M€ ► e-WAM: 1,100.3 M€ Specific costs (2030): ► -107.6 €/t CO_2-eq
Implementing entity	► Ministry of Economy, Energy Agency ► Energy suppliers ► End-users
Progress indicators:	► Number of devices sold (A++, A+, A) ► Energy savings (ktoe/GWh) ► Emissions reductions (Gg CO_2-eq)
Contribution for the achievement of the SDGs:	***direct***  ***indirect*** 

TABLE 17. RETROFITTING OF EXISTING RESIDENTIAL BUILDINGS

Mitigation action: ***Retrofitting of existing residential buildings***

Main objective: ***Retrofitting of existing residential buildings with aim 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.***

Information

Type	Technical, regulatory
Sector	Households
Relevant planning documents, legal and regulatory acts	► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
Gases	CO_2, CH_4, N_2O
Methodology	Retrofitting of existing residential buildings. 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 (90 kWh/m2). The following capacities annual renovation rates are considered:

	WEM	WAM	e-WAM
%	1	1	2

Progress of implementation

Steps taken or envisaged to achieve the action	**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
	Steps envisaged	► National Building Renovation Strategy ► Establishment of an Energy Efficiency Fund

Energy savings

Final energy – **Per year**	ktoe	WEM	WAM	e-WAM
	2020	3.7	3.7	8.1
	2030	27.9	27.9	42.0
	2040	57.9	57.9	107.2

Final energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
	2017-2020	7.5	7.5	11.8
	2021-2030	145.0	145.0	232.0
	2031-2040	437.4	437.4	750.0

Primary energy – **Per year**	ktoe	WEM	WAM	e-WAM
	2020	3.8	3.8	8.3
	2030	33.6	33.6	50.4
	2040	126.3	126.3	255.0

Primary energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
	2017-2020	8.2	8.2	12.6
	2021-2030	177.6	177.6	282.3
	2031-2040	654.2	654.2	1123.7

Estimated emission reductions	Gg CO2-eq	WEM	WAM	e-WAM
	2020	3.3	3.3	7.1
	2030	49.0	49.0	73.0
	2040	178.3	178.3	352.5

Timeframe	2020 – 2040			
Finance	Budget		WEM	WAM	e-WAM
		M€	941.8	941.8	1708.2

Finance

Source of finance:
- ► Private, donors through commercial EE loans, EE fund

Costs (2030):
- ► WOM: 1,121.9 M€
- ► e-WAM: 1,127.8 M€

Specific costs (2030):
- ► 88.6 €/t CO_2-eq

Implementing entity	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Households
Progress indicators:	► Area retrofitted (m^2) ► Energy consumption per heated/cooled area (kWh/m^2) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)

	direct	indirect
Contribution for the achievement of the SDGs:		  

TABLE 18. RETROFITTING OF EXISTING CENTRAL GOVERNMENT BUILDINGS

Mitigation action: ***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: ***Having in mind the situation with the energy performance of the public buildings at the central level and the role that they should play, it is essential to boost their renovation. Article 5 of the EE Directive 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.

Information	**Type**			Technical, regulatory		
	Sector			Central government buildings		
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency		
	Gases			CO_2, CH_4, N_2O		
	Methodology			Retrofitting of existing public buildings. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.		
	Assumptions			Annual renovation rate of the existing central government buildings:		
					WEM	WAM	e-WAM
				Rate (%)	1	2	3
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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 ► Establishment of an Energy Efficiency Fund		
	Energy savings	**Final energy**	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	0.1	0.3	0.4
				2030	1.5	3.2	4.8
				2040	3.3	6.7	10.1
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	0.1	0.2	0.3
				2021-2030	8.9	18.4	28.0
				2031-2040	24.6	50.5	76.4
		Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	0.1	0.3	0.4
				2030	2.1	4.3	6.6
				2040	9.6	20.8	32.2
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	0.1	0.3	0.4
				2021-2030	12.1	25.4	38.7
				2031-2040	53.0	104.7	157.4
	Estimated emission reductions			Gg CO2-eq	WEM	WAM	e-WAM
				2020	0.4	0.8	1.1
				2030	6.1	12.6	19.2
				2040	20.6	42.5	66.8
	Timeframe			2020 – 2040			
	Finance			Budget		WEM	WAM	e-WAM
					M€	55	155	170
				Source of finance: ► Central government budget, donors Costs (2030): ► WOM: 1,121.9 M€ ► e-WAM: 1,122.2 M€ Specific costs (2030): ► 17.5 €/t CO_2-eq			
	Implementing entity			► Ministry of Economy, Energy Agency ► Ministry of Finance ► Local self-government ► Municipal public enterprises ► Donors and financial institutions			
Progress indicators:				► Area retrofitted (m^2) ► Energy consumption per heated/cooled area (kWh/m^2) ► Energy savings (ktoe/GWh)			

	► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:	***direct***  ***indirect***  

TABLE 19. RETROFITTING OF EXISTING LOCAL SELF-GOVERNMENT BUILDINGS

Mitigation action: ***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

Information	**Type**		Technical, regulatory			
	Sector		Local self-government buildings			
	Relevant planning documents, legal and regulatory acts		► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency			
	Gases		CO_2, CH_4, N_2O			
	Methodology		Retrofitting of existing public buildings. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.			
	Assumptions		Annual renovation rate of the existing central government buildings:			
				WEM	WAM	e-WAM
			Rate (%)	0.5	1	1.5
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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 ► Establishment of an Energy Efficiency Fund			
	Energy savings	**Final energy** – **Per year**	ktoe	WEM	WAM	e-WAM
			2020	0.1	0.3	0.4
			2030	1.6	3.1	4.7
			2040	3.3	6.7	10.1
		Final energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
			2017-2020	0.1	0.3	0.4
			2021-2030	9.0	17.7	26.3
			2031-2040	25.2	50.7	76.6
		Primary energy – **Per year**	ktoe	WEM	WAM	e-WAM
			2020	0.1	0.3	0.4
			2030	2.2	4.4	6.7
			2040	14.1	27.0	39.5
		Primary energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
			2017-2020	0.1	0.3	0.4
			2021-2030	12.8	25.4	37.8
			2031-2040	67.2	124.7	181.8
	Estimated emission reductions		Gg CO2-eq	WEM	WAM	e-WAM
			2020	0.4	0.7	1.1
			2030	6.6	13.2	19.8
			2040	26.9	52.6	78.3
	Timeframe		2020– 2040			
	Finance		Budget		WEM	WAM	e-WAM
				M€	50	100	150
			Source of finance: ► Local self-government budget, donors Costs (2030): ► WOM: 1,121.9 M€ ► e-WAM: 1,122.0 M€ Specific costs (2030): ► 4.9 €/t CO_2-eq			
	Implementing entity		► Ministry of Economy, Energy Agency ► Ministry of Finance ► Local self-government ► Municipal public enterprises ► Donors and financial institutions			
Progress indicators:			► Area retrofitted (m^2) ► Energy consumption per heated/cooled area (kWh/m^2) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)			

Contribution for the achievement of the SDGs:	***direct***	***indirect***
		

TABLE 20. RETROFITTING OF EXISTING COMMERCIAL BUILDINGS

Mitigation action: ***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.***

Information	**Type**			Technical, regulatory
	Sector			Commercial sector
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
	Gases			CO_2, CH_4, N_2O
	Methodology			Retrofitting of existing commercial buildings. 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.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	► Law on Energy Efficiency adopted
			Steps envisaged	► Annual renovation rate of 1% for the existing commercial buildings
	Energy savings	**Final energy**	**Per year**	► 11.2 ktoe in 2020 ► 26.5 ktoe in 2030 ► 48.1 ktoe in 2040
			Cumulative	► 43.9 ktoe in 2017-2020 ► 183.0 ktoe in 2021-2030 ► 375.3 ktoe in 2031-2040
		Primary energy	**Per year**	► 10.8 ktoe in 2020 ► 35.7 ktoe in 2030 ► 179.4 ktoe in 2040
			Cumulative	► 41.5 ktoe in 2017-2020 ► 252.0 ktoe in 2021-2030 ► 843.0 ktoe in 2031-2040
	Estimated emission reductions			► 30.6 Gg CO2-eq in 2020 ► 98.2 Gg CO2-eq in 2030 ► 359.2 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: 530 M€ Source of finance: ► Private, donors through commercial EE loans, EE fund Costs (2030): ► WOM: 1,121.9 M€ ► WEM: 1,122.5 M€ Specific costs (2030): ► 6.3 €/t CO_2-eq
	Implementing entity			► Ministry of Economy, Energy Agency ► Ministry of Finance ► Commercial building owners
Progress indicators:				► Area retrofitted (m^2) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** / ***indirect*** 

TABLE 21. CONSTRUCTION OF NEW BUILDINGS

Mitigation action: ***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***

Information	**Type**			Technical, regulatory		
	Sector			Households		
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency		
	Gases			CO_2, CH_4, N_2O		
	Methodology			Construction of new residential buildings. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.		
	Assumptions			Construction of new residential buildings, while meeting the standard for at least C class (90 kWh/m^2)		
Progress of implementation	**Steps taken or envisaged to achieve the action**	**Steps taken**		► Financial support for construction of new buildings at municipality level ► Law on Energy Efficiency adopted		
		Steps envisaged		► National Building Renovation Strategy ► Establishment of an Energy Efficiency Fund		
	Energy savings	**Final energy**	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	2.1	2.0	2.0
				2030	15.9	12.0	12.0
				2040	30.5	15.6	15.6
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	4.3	4.2	4.2
				2021-2030	82.8	68.3	68.3
				2031-2040	252.4	149.4	149.4
		Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	2.2	2.1	2.1
				2030	19.2	14.3	14.3
				2040	65.6	26.9	26.9
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	4.7	4.6	4.6
				2021-2030	101.9	83.5	83.5
				2031-2040	364.1	186.9	186.9
	Estimated emission reductions			Gg CO2-eq	WEM	WAM	e-WAM
				2020	1.9	1.8	1.8
				2030	28.9	19.8	19.8
				2040	95.8	40.4	40.4
	Timeframe			2020 – 2040			
	Finance			Budget		WEM	WAM	e-WAM
					M€	474.1	282.7	282.7
				Source of finance: ► Private, donors through commercial EE loans, EE fund Costs (2030): ► WOM: 1,121.9 M€ ► e-WAM: 1,123.2 M€ Specific costs (2030): ► 64.6 €/t CO_2-eq			
	Implementing entity			► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Investors (households)			
Progress indicators:				► Area (m^2) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)			
Contribution for the achievement of the SDGs:				***direct***		***indirect***	
						  	

TABLE 22. CONSTRUCTION OF PASSIVE BUILDINGS

Mitigation action: ***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***

Information

Type	Technical, regulatory
Sector	Households
Relevant planning documents, legal and regulatory acts	► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
Gases	CO_2, CH_4, N_2O
Methodology	Construction of passive buildings. 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/m^2) starting from 2020 and continuously increasing their number so that in 2040, 85% of new buildings are assumed to be passive.

Progress of implementation

Steps taken or envisaged to achieve the action – **Steps taken**	► Financial support for construction of new buildings at municipality level ► Law on Energy Efficiency adopted
Steps taken or envisaged to achieve the action – **Steps envisaged**	► National Building Renovation Strategy ► Establishment of an Energy Efficiency Fund

Energy savings – Final energy – Per year

ktoe	WEM	WAM	e-WAM
2020	0.0	0.0	0.0
2030	0.0	8.5	8.5
2040	0.0	30.0	30.0

Energy savings – Final energy – Cumulative

ktoe	WEM	WAM	e-WAM
2017-2020	0.0	0.0	0.0
2021-2030	0.0	36.5	36.5
2031-2040	0.0	206.4	206.4

Energy savings – Primary energy – Per year

ktoe	WEM	WAM	e-WAM
2020	0.0	0.0	0.0
2030	0.0	10.5	10.5
2040	0.0	86.9	86.9

Energy savings – Primary energy – Cumulative

ktoe	WEM	WAM	e-WAM
2017-2020	0.0	0.0	0.0
2021-2030	0.0	46.5	46.5
2031-2040	0.0	382.9	382.9

Estimated emission reductions

Gg CO2-eq	WEM	WAM	e-WAM
2017-2020	0	0.3	0.3
2021-2030	0	17.0	17.0
2031-2040	0	123.2	123.2

Timeframe: 2020 – 2040

Budget		WEM	WAM	e-WAM
	M€	0.0	1068.0	1068.0

Finance

Source of finance:
- ► Private, donors through commercial EE loans, EE fund

Costs (2030):
- ► WOM: 1,121.9 M€
- ► e-WAM: 1,125.9 M€

Specific costs (2030):
- ► 231.2 €/t CO_2-eq

Implementing entity
- ► Ministry of Economy, Energy Agency
- ► Donors and financial institutions
- ► Investors (households)

Progress indicators:
- ► Area (m^2)
- ► Energy savings (ktoe/GWh)
- ► Emissions reduction (Gg CO2-eq)

Contribution for the achievement of the SDGs:

direct ***indirect***

TABLE 23. PHASING OUT OF INCANDESCENT LIGHTS

Mitigation action: ***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.***

Information

Type	Regulatory, policy
Sector	Households and commercial sector
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
Gases	CO_2, CH_4, N_2O
Methodology	Introducing a Regulation that will prohibit sales of incandescent light bulbs. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
Assumptions	It is assumed that a Regulation will be adopted on prohibiting sales of incandescent light bulbs, its implementation will start in 2020, and it is assumed that there will be 2-3 years of transition period.

Progress of implementation

Steps taken or envisaged to achieve the action – **Steps taken**	/
Steps envisaged	Adoption of a Regulation that will prohibit sales of incandescent light bulbs.

Energy savings – Final energy – Per year

ktoe	WEM	WAM	e-WAM
2020	5.8	20.7	20.7
2030	17.9	66.0	66.0
2040	32.6	119.4	119.4

Energy savings – Final energy – Cumulative

ktoe	WEM	WAM	e-WAM
2017-2020	23.8	66.2	66.2
2021-2030	123.0	454.1	454.1
2031-2040	255.5	959.7	959.7

Energy savings – Primary energy – Per year

ktoe	WEM	WAM	e-WAM
2020	4.6	15.9	15.9
2030	32.0	118.4	118.4
2040	186.0	667.7	667.7

Energy savings – Primary energy – Cumulative

ktoe	WEM	WAM	e-WAM
2017-2020	27.1	80.1	80.1
2021-2030	253.8	797.9	797.9
2031-2040	812.6	3053.3	3053.3

Estimated emission reductions

Gg CO2-eq	WEM	WAM	e-WAM
2020	22.7	99.9	99.9
2030	102.7	401.8	401.8
2040	390.3	1417.3	1417.3

Timeframe: 2020 – 2040

Budget		WEM	WAM	e-WAM
	M€	177.6	558.0	558.0

Finance

Source of finance:
- ► Central government budget, private

Costs (2030):
- ► WOM: 1,121.9 M€
- ► e-WAM: 1,097.2 M€

Specific costs (2030):
- ► 61.5 €/t CO_2-eq

Implementing entity
- ► Government of the Republic of North Macedonia
- ► Ministry of Economy, Energy Agency
- ► End-users

Progress indicators:
- ► Number of bulbs sold (LED, CFL)
- ► Installed capacity (W)
- ► Electricity consumption (MWh)
- ► Energy savings (ktoe/GWh)
- ► Emissions reduction (Gg CO2-eq)

Contribution for the achievement of the SDGs:

direct ***indirect***

TABLE 24. IMPROVEMENT OF THE STREET LIGHTING IN THE MUNICIPALITIES

Mitigation action: ***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).***

Information

Type	Technical
Sector	Local self-government
Relevant planning documents, legal and regulatory acts	► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
Gases	CO_2, CH_4, N_2O
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	The improvement rate of street lighting by 2040:

	WEM	WAM	e-WAM
Rate (%)	60	60	100

3Progress of implementation

Steps taken or envisaged to achieve the action – **Steps taken**	► Street lighting at some location replaced ► Promotional activities for the implementation of public-private partnership (PPP) taken
Steps taken or envisaged to achieve the action – **Steps envisaged**	► Continuing the promotional activities for the implementation of public-private partnership

Energy savings

Final energy – **Per year**	ktoe	WEM	WAM	e-WAM
	2020	2.5	2.5	3.2
	2030	6.6	6.6	7.8
	2040	9.1	9.1	9.6

Final energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
	2017-2020	12.0	12.0	14.9
	2021-2030	46.4	46.4	59.7
	2031-2040	81.3	81.3	87.1

Primary energy – **Per year**	ktoe	WEM	WAM	e-WAM
	2020	2.3	2.3	2.7
	2030	12.1	12.1	14.2
	2040	55.1	55.1	57.7

Primary energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
	2017-2020	15.0	15.0	18.0
	2021-2030	90.1	90.1	119.3
	2031-2040	259.9	259.9	276.1

Estimated emission reductions	Gg CO2-eq	WEM	WAM	e-WAM
	2020	5.8	5.8	8.9
	2030	32.5	32.5	37.9
	2040	111.9	111.9	117.1

Timeframe	2020 – 2040

Finance		WEM	WAM	e-WAM
Budget	M€	19.5	19.5	25.3

Source of finance
- ► Central and local government budget, ESCO

Costs (2030):
- ► WOM: 1,121.9 M€
- ► e-WAM: 1,119.2 M€

Specific costs (2030):
- ► -73.2 €/t CO_2-eq

Implementing entity	► Government of the Republic of North Macedonia ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Local self-government
Progress indicators:	► Number of bulbs replaced (LED, CFL) ► Installed capacity (W) ► Electricity consumption (MWh) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:	***direct***  ***indirect***  

TABLE 25. "GREEN PROCUREMENTS"

Mitigation action: ***"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.***

Information

Type	Regulatory
Sector	Public bodies
Relevant planning documents, legal and regulatory acts	► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
Gases	CO_2, CH_4, N_2O
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:

	WEM	WAM	e-WAM
Rate (%)	5	5	7

3Progress of implementation

Steps taken or envisaged to achieve the action	**Steps taken**	► Law on Energy Efficiency adopted ► Law on Public procurements
	Steps envisaged	► By laws from the Law on Energy efficiency

Energy savings

		ktoe	WEM	WAM	e-WAM
Final energy	**Per year**	2020	0.2	0.2	0.3
		2030	1.8	1.8	2.5
		2040	4.2	4.2	5.9
	Cumulative	ktoe	WEM	WAM	e-WAM
		2017-2020	0.3	0.3	0.5
		2021-2030	10.0	10.0	14.1
		2031-2040	29.9	29.9	42.4
Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
		2020	0.2	0.2	0.3
		2030	2.4	2.4	3.4
		2040	14.2	14.2	20.3
	Cumulative	ktoe	WEM	WAM	e-WAM
		2017-2020	0.4	0.4	0.5
		2021-2030	13.1	13.1	18.4
		2031-2040	64.6	64.6	91.8

Estimated emission reductions	Gg CO2-eq	WEM	WAM	e-WAM
	2020	0.5	0.5	0.8
	2030	6.6	6.6	9.4
	2040	22.4	22.4	32.7
Timeframe	2020 – 2040			

Finance		WEM	WAM	e-WAM
	Budget			
	M€	16	16	24

Source of finance
► Central and local government budget
Costs (2030):
► WOM: 1,121.9 M€
► e-WAM: 1,121.8 M€
Specific costs (2030):
► -61.2 €/t CO_2-eq

Implementing entity	► Ministry of Economy, Energy Agency ► Public Procurement Bureau ► Local self-government
Progress indicators:	► Number of devices purchase (A++, A+, A) ► Energy savings (ktoe/GWh) ► Emissions reductions (Gg CO_2-eq)
Contribution for the achievement of the SDGs:	***direct*** 7 AFFORDABLE AND CLEAN ENERGY; ***indirect*** 12 RESPONSIBLE CONSUMPTION AND PRODUCTION, 13 CLIMATE ACTION

TABLE 26. INCREASED USE OF CENTRAL HEATING SYSTEMS

Mitigation action: ***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.***

Information	**Type**			Technical, information
	Sector			Households and commercial
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency ► 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
	Gases			CO_2, CH_4, N_2O
	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.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	► Studies for analysis of the central heating system and implementation of central supply of sanitary hot water developed ► 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
	Energy savings	**Final energy**	**Per year**	► 0.4 ktoe in 2020 ► 1.3 ktoe in 2030 ► 13.3 ktoe in 2040
			Cumulative	► 0.4 ktoe in 2020 ► 10.5 ktoe in 2030 ► 51.0 ktoe in 2040
		Primary energy	**Per year**	► 0.7 ktoe in 2020 ► 2.1 ktoe in 2030 ► 26.3 ktoe in 2040
			Cumulative	► 0.7 ktoe in 2020 ► 4.1 ktoe in 2030 ► 190 ktoe in 2040
	Estimated emission reductions			► 4 Gg CO2-eq in 2020 ► 9.3 Gg CO2-eq in 2030 ► 560 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: 3.2 M€ Source of finance: ► Private, EE fund, incentives from the central and local government budget Costs (2030): ► WOM: 1,121.9 M€ ► WEM: 1,120.9 M€ Specific costs (2030): ► -105.6 €/t CO_2-eq
	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
Progress indicators:				► Increase of heat consumption (form central heating systems) (GWh) ► Increase in the number of consumers connected to the central heating system ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct***  ***indirect*** 

3.1.4 Manufacturing industries and construction

In the subcategory Manufacturing industries and construction three measures are modelled and analyzed. The most relevant information for these measures/policies is given in Table 27 to Table 29.

TABLE 27. ENERGY MANAGEMENT IN MANUFACTURING INDUSTRIES

Mitigation action: ***Energy management in manufacturing industries***

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

Description: ***This measure considers the 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.***

Information	**Type**			Regulatory, technical
	Sector			Industry
	Relevant planning documents, legal and regulatory acts			► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
	Gases			CO_2, CH_4, N_2O
	Methodology			Implementation of the ISO 50001 standard. 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%.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**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 the 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). ► Implementation of obligatory energy audits.
	Energy savings	**Final energy**	**Per year**	► 0.9 ktoe in 2020 ► 15.7 ktoe in 2030 ► 43.4 ktoe in 2040
			Cumulative	► 0.9 ktoe in 2017-2020 ► 84.1 ktoe in 2021-2030 ► 290.8 ktoe in 2031-2040
		Primary energy	**Per year**	► 0.9 ktoe in 2020 ► 18.8 ktoe in 2030 ► 103.7 ktoe in 2040
			Cumulative	► 0.9 ktoe in 2017-2020 ► 105.6 ktoe in 2021-2030 ► 474.2 ktoe in 2031-2040
	Estimated emission reductions			► 2.9 Gg CO2-eq in 2020 ► 67.8 Gg CO2-eq in 2030 ► 259.3 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: Negligible Source of finance ► Private, donors through commercial EE loans Costs (2030): ► WOM: 1,121.9 M€ ► WEM: 1,118.8 M€ Specific costs (2030): ► -45.7 €/t CO_2-eq
	Implementing entity			► Ministry of Economy, Energy Agency ► Private companies
Progress indicators:				► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** ***indirect*** 

TABLE 28. INTRODUCTION OF EFFICIENT ELECTRIC MOTORS

Mitigation action: ***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.***

Information

Type	Technical
Sector	Industry
Relevant planning documents, legal and regulatory acts	► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
Gases	CO_2, CH_4, N_2O
Methodology	Installation of efficient electric motors. 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

	WEM	WAM	e-WAM
Share (%)	40	40	60

Progress of implementation

Steps taken or envisaged to achieve the action	**Steps taken**	New efficient electric motors installed in a number of companies.	
	Steps envisaged	Replacement of the existing electric motors with more efficient	

Energy savings

Final energy – **Per year**			
ktoe	WEM	WAM	e-WAM
2020	0.1	0.1	0.3
2030	2.5	2.5	5.0
2040	7.1	7.1	7.9

Final energy – **Cumulative**			
ktoe	WEM	WAM	e-WAM
2017-2020	0.1	0.1	0.3
2021-2030	13.0	13.0	25.9
2031-2040	46.9	46.9	64.2

Primary energy – **Per year**			
ktoe	WEM	WAM	e-WAM
2020	0.2	0.2	0.3
2030	4.1	4.1	7.8
2040	35.6	35.6	39.9

Primary energy – **Cumulative**			
ktoe	WEM	WAM	e-WAM
2017-2020	0.2	0.2	0.3
2021-2030	24.8	24.8	46.2
2031-2040	134.4	134.4	168.4

Estimated emission reductions

Gg CO2-eq	WEM	WAM	e-WAM
2020	0.4	0.4	0.7
2030	14.9	14.9	28.8
2040	74.7	74.7	83.8

Timeframe: 2020 – 2040

Finance

Budget	WEM	WAM	e-WAM
M€	99.7	99.7	113.0

Source of finance
- ► Private, donors through commercial EE loans

Costs (2030):
- ► WOM: 1,121.9 M€
- ► e-WAM: 1,121.3 M€

Specific costs (2030):
- ► -21.7 €/t CO_2-eq

Implementing entity
- ► Ministry of Economy, Energy Agency
- ► Private companies

Progress indicators:
- ► Number of motors replaced
- ► Electricity consumption (GWh)
- ► Energy savings (ktoe/GWh)
- ► Emissions reduction (Gg CO2-eq)

Contribution for the achievement of the SDGs:

direct ***indirect***

TABLE 29. INTRODUCTION OF MORE ADVANCED TECHNOLOGIES

Mitigation action: ***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.***

Information

Type	Technical
Sector	Industry
Relevant planning documents, legal and regulatory acts	► Strategy for Energy Development of North Macedonia up to 2040 ► Law on energy efficiency
Gases	CO_2, CH_4, N_2O
Methodology	Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
Assumptions	The share of more advanced technologies by 2040 is:

	WEM	WAM	e-WAM
Share (%)	15	30	60

Progress of implementation

Steps taken or envisaged to achieve the action – **Steps taken**	► Construction of gas network in Macedonia
Steps envisaged	► Finishing the construction of gas network in Macedonia

Energy savings

	ktoe	WEM	WAM	e-WAM
Final energy – **Per year**	2020	1.8	4.1	6.7
	2030	13.4	38.7	59.4
	2040	32.5	89.0	119.2
Final energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
	2017-2020	6.4	13.2	21.3
	2021-2030	82.6	234.7	380.0
	2031-2040	225.3	628.8	888.0
Primary energy – **Per year**	ktoe	WEM	WAM	e-WAM
	2020	1.8	4.2	6.7
	2030	15.3	40.9	62.5
	2040	58.8	124.0	186.1
Primary energy – **Cumulative**	ktoe	WEM	WAM	e-WAM
	2017-2020	6.8	14.1	22.4
	2021-2030	98.2	252.5	401.0
	2031-2040	306.2	736.3	1075.0

Estimated emission reductions	Gg CO2-eq	WEM	WAM	e-WAM
	2020	5	12	20
	2030	49.8	128.3	206.0
	2040	148.8	317.3	474.4

Timeframe	2020 – 2040

Finance		WEM	WAM	e-WAM
	Budget	M€	141.8	344.8	438.6

Source of finance:
- ► Private, donors through commercial EE loans, EE fund

Costs (2030):
- ► WOM: 1,121.9 M€
- ► e-WAM: 1,113.3 M€

Specific costs (2030):
- ► -42.1 €/t CO_2-eq

Implementing entity	► Government of the Republic of North Macedonia ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Private investors
Progress indicators:	► Installed capacity (MW) ► Energy consumption (GWh) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:	***direct***  ***indirect*** 

3.1.5 Transport

In the Transport subcategory six measures in total are modelled and analyzed. The most relevant information for these measures/policies is given from Table 30 to Table 51

TABLE 30. INCREASED USE OF THE RAILWAY

Mitigation action: ***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***

Information	**Type**			Technical, information
	Sector			Transport
	Relevant planning documents, legal and regulatory acts			► National Transport Strategy ► Strategy for Energy Development of North Macedonia up to 2040
	Gases			CO_2, CH_4, N_2O
	Methodology			Conducting campaigns and modernization of the railway. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
	Assumptions			By 2040, 3% of the passenger kilometers of cars, 1% of passenger kilometers of busses and 6.6% of tonnes kilometers of heavy duty vehicles will be realized by railway transport.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**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 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	► Arrival and putting into use of other commissioned wagons ► Implement promotional campaigns for raising public awareness ► Continuing the campaigns for cheaper/free driving ► Enabling additional conditions for companies
	Energy savings	**Final energy**	**Per year**	► 7.9 ktoe in 2020 ► 14.8 ktoe in 2030 ► 23.2 ktoe in 2040
			Cumulative	► 23.9 ktoe in 2017-2020 ► 116.2 ktoe in 2021-2030 ► 192.6 ktoe in 2031-2040
		Primary energy	**Per year**	► 7.9 ktoe in 2020 ► 12.3 ktoe in 2030 ► 4.3 ktoe in 2040
			Cumulative	► 24.0 ktoe in 2017-2020 ► 94.8 ktoe in 2021-2030 ► 108.0 ktoe in 2031-2040
	Estimated emission reductions			► 25.7 Gg CO2-eq in 2020 ► 37.2 Gg CO2-eq in 2030 ► 24.3 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: 180.6 M€ Source of finance: ► Central government budget Costs (2030): ► WOM: 1,121.9 M€ ► WEM: 1,111.3 M€ Specific costs (2030): ► -286.2 €/t CO_2-eq
	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
Progress indicators:				► Increase of passenger km in railway transport (pkm) ► Increase of tonnes km in railway transport (tkm) ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** ***indirect*** 

TABLE 31. RENEWING OF THE NATIONAL CAR FLEET

Mitigation action: ***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 CO2 emissions (up to 90 gCO2/km by 2020 and 50 gCO2/km by 2025). The quantified effects of this measure should also be analytically modelled and mitigation costs assessed

Information

Type	Regulatory, policy, information
Sector	Transport
Relevant planning documents, legal and regulatory acts	► National Transport Strategy ► Strategy for Energy Development of North Macedonia up to 2040 ► Law on vehicles ► Law on vehicle tax
Gases	CO_2, CH_4, N_2O
Methodology	Introducing a Regulation that will prohibit the purchase of cars with a standard lower than EURO5. 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 CO2 emissions in 2020 of 95 g CO2/km, and 70 g CO2/km by 2025. In addition, advanced technologies such as diesel and gasoline HEV will be used with the following share in the total passenger km from cars by 2040:

	WEM	WAM	e-WAM
Share (%)	6	14	35

Progress of implementation

Steps taken or envisaged to achieve the action

Steps taken
► Law on vehicles adopted (August 2019)
► Law on vehicle tax bylaws to be adopted

Steps envisaged

Energy savings – Final energy – Per year

ktoe	WEM	WAM	e-WAM
2020	7.4	8.4	10.2
2030	5.0	7.5	13.9
2040	15.4	23.5	31.1

Energy savings – Final energy – Cumulative

ktoe	WEM	WAM	e-WAM
2017-2020	13.0	16.0	21.9
2021-2030	167.0	208.1	241.1
2031-2040	31.0	57.3	140.3

Energy savings – Primary energy – Per year

ktoe	WEM	WAM	e-WAM
2020	7.4	8.4	10.2
2030	5.1	7.5	13.9
2040	28.6	39.8	47.3

Energy savings – Primary energy – Cumulative

ktoe	WEM	WAM	e-WAM
2017-2020	13.1	16.0	21.9
2021-2030	166.9	208.1	241.0
2031-2040	72.7	116.7	199.7

Estimated emission reductions

Gg CO2-eq	WEM	WAM	e-WAM
2020	22.9	26.2	33.3
2030	16.0	24.0	43.1
2040	65.5	73.0	98.6

Timeframe: 2020– 2040

Budget	WEM	WAM	e-WAM
M€	1599.5	1659.5	2167.7

Finance

Source of finance:
► Private, EE fund, incentives from the central government budget
Costs (2030):
► WOM: 1,121.9 M€
► e-WAM: 1,118.5 M€
Specific costs (2030):
► -78.1 €/t CO_2-eq

Implementing entity
► Government of the Republic of North Macedonia
► Ministry of Transport and Communications
► Ministry of Economy, Energy Agency
► End-users

Progress indicators:
► Number of vehicles per type
► Energy savings (ktoe/GWh)
► Emissions reduction (Gg CO2-eq)

	direct	indirect
Contribution for the achievement of the SDGs:		  

TABLE 32. RENEWING OF OTHER NATIONAL ROAD FLEET (LIGHT DUTY AND HEAVY GOODS VEHICLES AND BUSES)

Mitigation action: ***Renewing of other national road fleet (light duty and heavy goods vehicles and buses)***

Main objective: ***Reduction of 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.***

Information	**Type**			Regulatory, policy		
	Sector			Transport		
	Relevant planning documents, legal and regulatory acts			► National Transport Strategy ► Strategy for Energy Development of North Macedonia up to 2040 ► Law on vehicles ► Law on vehicle tax		
	Gases			CO_2, CH_4, N_2O		
	Methodology			Introducing a Regulation that will prohibit the purchase of cars with a standard lower than EURO6. 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.		
Progress of implementation	**Steps taken or envisaged to achieve the action**	**Steps taken**		/		
		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		
	Energy savings	**Final energy**	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	0.2	0.2	0.2
				2030	20.3	20.3	20.8
				2040	46.5	46.5	47.9
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	0.7	0.7	0.8
				2021-2030	40.7	40.7	43.6
				2031-2040	338.9	338.9	349.8
		Primary energy	**Per year**	ktoe	WEM	WAM	e-WAM
				2020	0.2	0.2	0.2
				2030	20.3	20.3	20.8
				2040	43.4	43.4	44.9
			Cumulative	ktoe	WEM	WAM	e-WAM
				2017-2020	0.7	0.7	0.8
				2021-2030	40.6	40.6	43.5
				2031-2040	332.9	332.9	343.8
	Estimated emission reductions			Gg CO2-eq	WEM	WAM	e-WAM
				2020	1.2	1.2	1.2
				2030	64.6	64.6	66.4
				2040	142.8	142.8	147.3
	Timeframe			2020 – 2040			
	Finance			Budget: ~2300 M€ Source of finance: ► Private Costs (2030): ► WOM: 1,121.9 M€ ► e-WAM: 1,116.5 M€ Specific costs (2030): ► -80.7 €/t CO_2-eq		
	Implementing entity			► Government of the Republic of North Macedonia ► Ministry of Transport and Communications ► Ministry of Interior Affairs ► Ministry of Economy, Energy Agency ► Private companies		
Progress indicators:				► Number of vehicles per type ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)		
Contribution for the achievement of the SDGs:				***direct***  ***indirect*** 		

TABLE 33. ADVANCED MOBILITY

Mitigation action: ***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.***

Information	**Type**			Regulatory, technical, information
	Sector			Transport
	Relevant planning documents, legal and regulatory acts			► National Transport Strategy ► Strategy for Energy Development of North Macedonia up to 2040 ► Decisions made by municipalities to subsidize buying of new bicycles
	Gases			CO_2, CH_4, N_2O
	Methodology			Implementation of campaigns/subsidies, parking policies. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
	Assumptions			By 2040, 3% of short distance passenger kilometres will be replaced by walking, using bicycles or electric scooters.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**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
			Steps envisaged	► Continue the implementation of the campaigns and subsidies for buying new bicycles and renting bicycles ► Continue the construction of new bicycles tracks
	Energy savings	**Final energy**	**Per year**	► 0.7 ktoe in 2020 ► 1.2 ktoe in 2030 ► 2.0 ktoe in 2040
			Cumulative	► 2.2 ktoe in 2017-2020 ► 9.8 ktoe in 2021-2030 ► 15.8 ktoe in 2031-2040
		Primary energy	**Per year**	► 0.7 ktoe in 2020 ► 1.2 ktoe in 2030 ► 2.0 ktoe in 2040
			Cumulative	► 2.2 ktoe in 2017-2020 ► 9.8 ktoe in 2021-2030 ► 16.0 ktoe in 2031-2040
	Estimated emission reductions			► 2.1 Gg CO2-eq in 2020 ► 3.6 Gg CO2-eq in 2030 ► 6.4 Gg CO2-eq in 2040
	Timeframe			2020 – 2040
	Finance			Budget: / Source of finance: ► Private, EE fund, incentives from the central and local government budget, donors Costs (2030): ► WOM: 1,121.9 M€ ► WEM: 1,118.4 M€ Specific costs (2030): ► -983.0 €/t CO_2-eq
	Implementing entity			► Ministry of Economy, Energy Agency ► Local self-government ► End-users
Progress indicators:				► Number of bicycles/electric scooters ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** ***indirect*** 

TABLE 34. CONSTRUCTION OF THE RAILWAY TO REPUBLIC OF BULGARIA

Mitigation action: ***Construction of the railway to the Republic of Bulgaria***

Main objective: ***Connecting North Macedonia with 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 the Republic of Bulgaria***

Information	**Type**			Technical, policy
	Sector			Transport
	Relevant planning documents, legal and regulatory acts			► Work Program of the Government of the Republic of North Macedonia ► National Transport Strategy
	Gases			CO_2, CH_4, N_2O
	Methodology			Construction of the railway. 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.
Progress of implementation	**Steps taken or envisaged to achieve the action**		**Steps taken**	►
			Steps envisaged	► Finishing the construction of the railway and putting it into operation
	Energy savings	**Final energy**	**Per year**	► 5.1 ktoe in 2020 ► 10.2 ktoe in 2030 ► 14.4 ktoe in 2040
			Cumulative	► 5.1 ktoe in 2017-2020 ► 79.9 ktoe in 2021-2030 ► 127.2 ktoe in 2031-2040
		Primary energy	**Per year**	► 5.0 ktoe in 2020 ► 8.2 ktoe in 2030 ► 4.7 ktoe in 2040
			Cumulative	► 5.0 ktoe in 2017-2020 ► 62.6 ktoe in 2021-2030 ► 65.7 ktoe in 2031-2040
	Estimated emission reductions			► 16.7 Gg CO2-eq in 2020 ► 24.6 Gg CO2-eq in 2030 ► 32.3 Gg CO2-eq in 2040
	Timeframe			2023– 2040
	Finance			Budget: 720 M€ (infrastructure+trains) Source of finance: ► Central government budget Costs (2030): ► WOM: 1,121.9 M€ ► WEM: 1,128.6 M€ Specific costs (2030): ► 270.0 €/t CO_2-eq
	Implementing entity			► Government of the Republic of North Macedonia ► Ministry of Transport and Communications ► Ministry of Economy, Energy Agency
Progress indicators:				► Energy savings (ktoe/GWh) ► Increase of the tonnes km in the railway transport (tkm) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:				***direct*** ***indirect*** 

TABLE 35. ELECTRIFICATION OF THE TRANSPORT

Mitigation action: ***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:***

- ***Based the methodologies for calculation of environmental taxes as well as the excise duty on CO2***
- ***Exemption from paying excise duty for electric vehicles***
- ***Direct subsidizing of electric vehicles, 5000 EUR in the period 2020-2023***
- ***Reserve green parking in all public parking lots***
- ***Obligation to place fast chargers at all gas stations on motorways (at every 100 km by 2020)***

Information

Type	Regulatory, policy, information
Sector	Transport
Relevant planning documents, legal and regulatory acts	► National Transport Strategy ► Strategy for Energy Development of North Macedonia up to 2040 ► Law on vehicles ► Law on vehicle tax
Gases	CO_2, CH_4, N_2O
Methodology	Introducing a Regulation that will prohibit the purchase of cars with a standard lower than EURO6. Bottom-up modeling and least-cost optimization using the MARKAL model. IPCC Methodology.
Assumptions	It is envisaged that by 2040 the share of electric vehicles and "plug-in" hybrid electric vehicles in the total passenger km from cars will be:

	WEM	WAM	e-WAM
Rate (%)	10	40	45

Progress of implementation

Steps taken or envisaged to achieve the action	**Steps taken**	► Chargers installed at specific locations in the City of Skopje ► Law on vehicles adopted (August 2019) ► Law on vehicle tax and bylaws adopted
	Steps envisaged	► Development of studies for determining the best locations for installation of electric vehicles chargers from the aspect of the power grid. ► Money from the budget should be allocated for the realization of the Program for subsidizing new vehicles

Energy savings

Final energy

Per year	WEM	WAM	e-WAM
ktoe			
2020	0.6	2.5	3.4
2030	5.2	22.5	30.5
2040	12.8	53.6	61.3

Cumulative	WEM	WAM	e-WAM
ktoe			
2017-2020	0.6	3.4	3.4
2021-2030	33.0	201.8	201.8
2031-2040	87.6	465.5	464.5

Primary energy

Per year	WEM	WAM	e-WAM
ktoe			
2020	0.6	2.5	3.4
2030	3.6	14.6	20.9
2040	-10.5	-67.3	-75.1

Cumulative	WEM	WAM	e-WAM
ktoe			
2017-2020	0.6	2.5	3.3
2021-2030	21.7	92.9	131.2
2031-2040	64	10.9	-4.6

Estimated emission reductions	Gg CO2-eq	WEM	WAM	e-WAM
	2020	1.9	8.2	11.3
	2030	9.8	41.9	61.6
	2040	-10.0	-61.4	-78.8

Timeframe	2020 – 2040			
Finance	Budget		WEM	WAM	e-WAM
		M€	1201.7	5058.5	8292.3

Finance

Source of finance:
- ► Private, EE fund, incentives from the central government budget

Costs (2030):
- ► WOM: 1,121.9 M€
- ► e-WAM: 1127.6 M€

Specific costs (2030):
- ► 91.8 €/t CO_2-eq

Implementing entity	► Government of the Republic of North Macedonia ► Ministry of Transport and Communications ► Ministry of economy
Progress indicators:	► Number of electric vehicles and PHEV ► Energy savings (ktoe/GWh) ► Emissions reduction (Gg CO2-eq)

	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.

3.2 Agriculture, forestry and other land use

The mitigation measures analyzed in SBUR are still valid and should remain as such in TBUR and some activities for promotion and eventual support of these measures are recommended in order to increase the level of their implementation and effectiveness. Moreover, one new measure for Livestock subsector that address smaller size dairy farms (Manure management on dairy farms below 50 livestock units) and two new measures for Cropland subsector (Application of Biochar and Photovoltaic Irrigation) are included in TBUR. These new measures are selected according to their mitigation potential, as well as important co-benefits that will make these measures readily acceptable by the farmers. Finally, the TBUR includes total of 11 measures in this sector (4 in Livestock, 5 in Cropland and 2 in Forestland). However, each of these measures is characterized with different characteristics, mitigation potential, induced cost, influence on the production and productivity.

3.2.1 Livestock subsector

TABLE 36. LIVESTOCK – MITIGATION MEASURE – REDUCTION OF CH_4 EMISSIONS FROM ENTERIC FERMENTATION IN DAIRY COWS

Mitigation action: ***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 CH4 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.***			
Information	**Type**		Livestock, enteric fermentation in dairy cow
	Sector		AFLOU-Livestock
	Relevant planning documents, legal and regulatory acts		► Strategy for Agriculture Development ► IPARD program
	Gases		CH_4
	Methodology		Feed composition and nutrition management in up to 30% of dairy cows.
	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
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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.
	Estimated emission reductions		► 3.2 Gg CO2-eq in 2020 ► 35.0 Gg CO2-eq in 2030 ► 63.6 Gg CO2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 0.2 mil. Euro Costs (2030): ► WOM: 0 M€ ► WEM: 0.01 M€ Specific costs (2030): ► 0.2 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Number of farms (dairy cows as a percentage of the total population) used TMR modified feed and nutrition management on biannual base. ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

TABLE 37. LIVESTOCK– MITIGATION MEASURE – REDUCTION OF N_2O EMISSIONS FROM MANURE MANAGEMENT IN DAIRY COWS BY 20%

Mitigation action: ***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 NxO emissions. Therefore, on farm manure management system needs to modify. 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.***			
Information	**Type**		Livestock, manure management in dairy cow
	Sector		AFLOU-Livestock
	Relevant planning documents, legal and regulatory acts		► Law for Nature Protection ► IPARD program, ► Agro-ecology measures in national program
	Gases		N_2O; CH_4
	Methodology		Modified manure management in up to 30% of dairy cows.
	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.
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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.,
	Estimated emission reductions		► 0.2 Gg CO2-eq in 2020 ► 2.1 Gg CO2-eq in 2030 ► 3.9 Gg CO2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 1 mil. Euro Costs (2030): ► WOM: 0 M€ ► WEM: 0.1 M€ Specific costs (2030): ► 13 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Number of farms (dairy cows as a percentage of the total population) used modified manure management on 2-5 years base. ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

TABLE 38. LIVESTOCK– MITIGATION MEASURE – REDUCTION OF N_2O EMISSIONS FROM MANURE MANAGEMENT IN SWINE FARMS

Mitigation action: ***Reduction of NO_2 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.***			
Information	**Type**		Livestock, manure management in swine farms
	Sector		AFLOU-Livestock
	Relevant planning documents, legal and regulatory acts		► Law for Nature Protection ► IPARD program, ► Agro-ecology measures in national program
	Gases		N_2O; CH_4
	Methodology		Modified manure management in swine farms with more than 1000 fatteners and/or 350 sows
	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
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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
	Estimated emission reductions		► 0 Gg CO2-eq in 2020 ► 0.4 Gg CO2-eq in 2030 ► 0.7 Gg CO2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 1 mil. Euro Costs (2030): ► WOM: 0 M€ ► WEM: 0.05 M€ Specific costs (2030): ► 77.4 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Number of farms (fatteners and sows as a percentage of the total population) used modified manure management on 2-5 years base. ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

TABLE 39. LIVESTOCK– MITIGATION MEASURE – REDUCTION OF N_2O EMISSIONS FROM MANURE MANAGEMENT IN DAIRY COWS BY 20% FOR FARMS BELOW 50 LIVESTOCK UNITS

Mitigation action: ***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.***			
Information	**Type**		Livestock, manure management in dairy cow
	Sector		AFLOU-Livestock
	Relevant planning documents, legal and regulatory acts		► IPARD program, ► Agro-ecology measures in national program
	Gases		N_2O
	Methodology		Modified manure management in dairy cows.
	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.
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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.
	Estimated emission reductions		► 0.1 Gg CO_2-eq in 2020 ► 0.7 Gg CO_2-eq in 2030 ► 1.2 Gg CO_2-eq in 2040
	Timeframe		2020 - 2040
	Finance		Budget: 1 mil. Euro Costs (2030): ► WOM: 0 M€ ► WEM: 0.1 M€ Specific costs (2030): ► 44.2 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Number of farms (dairy cows as a percentage of the total population) used modified manure management in 7 years. ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

3.2.2 Land Use and Agriculture Subsector

On the base of the existing pan-Europen graphical data-set CORINE land cover, and DTM for the country, several categories of agricultural land on inclined terrain has been identified (5-15% and above 15% inclination). Areas that will be encompassed with mitigation measures were calculated on the base of the total areas under each land use category and capacities of the farmers and institutions to support the process of implementation of mitigation measures.

TABLE 40. LAND – MITIGATION MEASURE - CONVERSION OF LAND USE OF FIELD CROPS ABOVE 15% INCLINATION

Mitigation action: ***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.***			
Information	**Type**		Land management and land use change in the category of cropland
	Sector		AFLOU-Land
	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
	Gases		CO_2
	Methodology		Land use change through conversion of almost 3000 ha of arable land that has been identified on inclined terrain above 15%, to grassland.
	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,
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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, ► System for monitoring of influence of land use change on soil carbon sink
	Estimated emission reductions		► 1.0 Gg CO_2-eq in 2020 ► 3.7 Gg CO_2-eq in 2030 ► 5.3 Gg CO_2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 1.5 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 0.1 M€ Specific costs (2030): ► 21 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Area converted on yearly base, ► Percentage of soil organic matter increase and carbon sink per ha.
Contribution for the achievement of the SDGs:			***direct*** ***indirect*** 

TABLE 41. LAND – MITIGATION MEASURE - CONTOUR CULTIVATION OF CROPLAND ON INCLINED TERRAINS (5-15%)

Mitigation action: ***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 CO2 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.***			
Information	**Type**		Land management and land use change in the category of cropland
	Sector		AFLOU-Land
	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
	Gases		CO_2
	Methodology		Land cultivation system change from downslope to contour cultivation
	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
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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, ► System for monitoring of influence of land use change on soil carbon sink,
	Estimated emission reductions		► 5.0 Gg CO_2-eq in 2020 ► 28.0 Gg CO_2-eq in 2030 ► 39.7 Gg CO_2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 1.0 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 0.1 M€ Specific costs (2030): ► 2 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Area in ha with contour cultivation, ► Percentage of soil organic matter increase and carbon sink per ha ► Quantity of reduced soil sediment loss in t/ha
Contribution for the achievement of the SDGs:			***direct*** / ***indirect*** 

TABLE 42. LAND – MITIGATION MEASURE - PERENNIAL GRASS IN ORCHARD AND VINEYARDS ON INCLINED TERRAINS (5-15%)

Mitigation action: ***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 occur, 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.***			
Information	**Type**		Land management and land use change in the category of cropland
	Sector		AFLOU-Land
	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
	Gases		CO_2
	Methodology		Establishing of perennial grass between rows in vineyards and orchards for replacement of classical type of land cultivation system, on an inclined terrain (5-15%)
	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.
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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 ► System for monitoring of influence of land use change on soil carbon sink
	Estimated emission reductions		► 1.6 Gg CO_2-eq in 2020 ► 8.9 Gg CO_2-eq in 2030 ► 12.6 Gg CO_2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 1 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 0.1 M€ Specific costs (2030): ► 5.9 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Area in ha of vineyards and orchards under perennial grass, ► Percentage of soil organic matter increase and carbon sink per ha ► Quantity of reduced soil sediment loss in t/ha
Contribution for the achievement of the SDGs:			***direct*** ***indirect*** 

TABLE 43. LAND – MITIGATION MEASURE - USE OF BIOCHAR FOR CARBON SINK ON AGRICULTURAL LAND

Mitigation action: ***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 CO2 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.***			
Information	**Type**		Land management of the category of cropland
	Sector		AFLOU-Land/Agriculture
	Relevant planning documents, legal and regulatory acts		► Biochar is not present in any strategic document in the country
	Gases		CO_2
	Methodology		Research on use of biochar, development of measures, initiate national production from waste biomass that will be burnt in open fires/, introducing the measure in national system for support of the agriculture, start with active use in 2026 and achieving the annual increase by 1000 ha, reaching 15 000 ha or long term sinking 330.3 Gg-eq CO_2-eq.
	Assumptions		► Sinking the amount of 330.3 Gg-eq CO_2-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
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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 ► System for monitoring of influence of land use change on soil carbon sink,
	Estimated emission reductions		► 0 Gg CO2-eq in 2020 ► 110.0 Gg CO2-eq in 2030 ► 330.3 Gg CO2-eq in 2040
	Timeframe		2026 – 2040
	Finance		Budget: 30 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 3.4 M€ Specific costs (2030): ► 30.5 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Area in ha of agricultural arable land with applied biochar, ► Amount of carbon sink per ha and total
Contribution for the achievement of the SDGs:			***direct*** ***indirect*** 

TABLE 44. LAND – MITIGATION MEASURE – PHOTOVOLTAIC IRRIGATION ON 20 000 HA OF IRRIGATED LAND

Mitigation action: ***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".			
Information	**Type**		Agriculture – irrigation replacing fossil energy with renewables
	Sector		AFLOU-Land/Agriculture
	Relevant planning documents, legal and regulatory acts		► Law on Agriculture and Rural Development ► National strategy on Agriculture and Rural Development ► IPARD2
	Gases		CO_2
	Methodology		Installation of photovoltaic system for irrigation purposes with 2.4 kW installed capacity, capable to run 1.1 kW 3 phase pump.
	Assumptions		► About 1000 installations annually in the period of 20 years, reaching about than 20 000 hectares irrigated by photovoltaic as energy source. ► Saving annually up to 9.33 Gg-eq CO_2-eq after 20 years of measure life (if all photovoltaic installations will replace electrical energy from public network). Minimal value expected is 8.61 Gg-eq CO_2-eq (if all installations of photovoltaics will replace fossil fuel pump. The expected total saving during 20 years timeframe will be from 172.2 to 186.6 Gg-eq CO_2 eq)
Progress of implementation	**Steps taken or envisaged to achieve the action**	**Steps taken**	► There is possibility for getting support from IPARD2 funds. The measure provide 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,
	Estimated emission reductions		► 0 Gg CO2-eq in 2020 ► 93.3 Gg CO2-eq in 2030 ► 186.6 Gg CO2-eq in 2040
	Timeframe		2021 – 2040
	Finance		Budget: 47 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 3.4 M€ Specific costs (2030): ► 36.0 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Area in ha of agricultural irrigated land irrigated by electricity produced from photovoltaics, ► Amount of carbon sink per ha and total ► Share of RES in gross final energy consumption by sectors (SDG:7_40)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

3.2.3 Forest and forestry

TABLE 45. FOREST – MITIGATION MEASURE – ESTABLISHING THE INTEGRATED MANAGEMENT OF THE FOREST FIRES

Mitigation action: ***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 2016 year the average annual number of forest fires is 204 fires, average annual burned area is 8,787 ha and average annual damage is estimated on 5,2 million Euro. The total burned forest area in the same period is around 160,000 ha with the total damage of around 94 million. This measure includes the protection of the forest area by preventing the forest fires and the damages resulting from forest fires.***			
Information	**Type**		Forest fires reduction
	Sector		AFLOU-Forestry
	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"
	Gases		CO_2
	Methodology		Organization of a prompt and efficient initial attack with minimum well equipped and trained crews
	Assumptions		► Up to 3000 ha will be burned annually on average
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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) Duration: one year Vehicles procurement: 25 specialized vehicles for initial attack 25 vehicles x 40,000 € = 1,000,000 € 50 sets of hand tools and PPE for 50 crews of five fire fighters (two per vehicle) 1 set of hand tools and PPE = 4,000 € 50 sets x 5,000 € = 250,000 € ► **Phase II** - Specialized training for fire fighters (six days) 50 craws x 5 persons = 250 fire fighters 250 fire fighters x 800 € = 200,000 €
	Estimated emission reductions		► 345.0 Gg CO2-eq in 2020 ► 345.0 Gg CO2-eq in 2030 ► 345.0 Gg CO2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 1.45 M€ Costs (2030): ► WOM: 5.3 M€ ► WEM: 2.1 M€ Specific costs (2030): ► -9.3 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy, through PE "National forests"
Progress indicators:			► Forest area (ha)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

TABLE 46. FOREST – MITIGATION MEASURE – AFFORESTATION OF 5000 HA OF BARREN LAND WITH OAK (QUERCUS SPP.)

Mitigation action: ***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.***			
Information	**Type**		Afforestation of Barren Land
	Sector		AFLOU-Forestry
	Relevant planning documents, legal and regulatory acts		► Law on forests
	Gases		CO_2
	Methodology		Empirical modeling, based on scientific paper
	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 till 2040
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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 Amount 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 €
	Estimated emission reductions		► 0 Gg CO2-eq in 2020 ► 312.5 Gg CO2-eq in 2030 ► 312.5 Gg CO2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 7.8 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 0.4 M€ Specific costs (2030): ► 1.3 €/t CO_2-eq
	Implementing entity		► Ministry of Agriculture Forestry and Water Economy
Progress indicators:			► Forest area (ha)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

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3.3 Waste

In the Waste sector four measures are modelled and analyzed. The most relevant information for these measures/policies is given from Table 47 to Table 49.

TABLE 47. LANDFILL GAS FLARING

Mitigation action: ***Landfill gas flaring***
Main objective: ***Environmental protection and meeting the highest European standards***
Description: ***Rehabilitation of the existing non-compliant landfills and "wild" dumpsites with very high, high and medium risk in each of the five 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.***

Information	**Type**		Technical
	Sector		Waste – Solid waste disposal
	Relevant planning documents, legal and regulatory acts		► National Waste Management Plan ► Strategy for Waste Management in the Republic of Macedonia ► Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Vardar, Polog and Skopje region) – final and draft versions
	Gases		CO_2, CH_4
	Methodology		Covering on the existing non-compliant landfills, supplemented by gas extraction and flaring, which will convert the CH_4 emissions into CO_2 emissions. Modelling using the custom-made software tool in excel, performing calculations based on the IPCC Methodology.
	Assumptions		Closing of existing and opening of new landfills by waste management regions in the following order: ► Skopje – 2023 ► East and Northeast – 2025 ► Polog – 2026 ► Southeast – 2029 ► Pelagonia and Southeast – 2029 ► Vardar
Progress of implementation	**Steps taken or envisaged to achieve the action**	**Steps taken**	► Regional waste management plans 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
	Results achieved and estimated outcomes		Expected annual burned emissions of CH_4: ► 0 kt CH4 in 2020 ► 22.0 kt CH4 in 2030 ► 24.8 kt CH4 in 2040
	Estimated emission reductions		► 0 Gg CO2-eq in 2020 ► 489.7 Gg CO2-eq in 2030 ► 552.3 Gg CO_2-eq in 2040
	Timeframe		2020 – 2040
	Finance		Budget: 20.5 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 1.0 M€ Specific costs (2030): ► 1.42 €/t CO_2-eq
	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)
Progress indicators:			► Amount of CH_4 burned (kt) ► Emissions reduction (Gg CO_2-eq)
Contribution for the achievement of the SDGs:			***direct*** / ***indirect*** 

TABLE 48. MECHANICAL AND BIOLOGICAL TREATMENT (MBT) IN NEW LANDFILLS WITH COMPOSTING

Mitigation action: ***Mechanical and biological treatment (MBT) of waste 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.***

Information	**Type**		Technical
	Sector		Waste – Solid waste disposal
	Relevant planning documents, legal and regulatory acts		► National Waste Management Plan ► Strategy for Waste Management in the Republic of Macedonia ► Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Vardar, Polog and Skopje region) – final and draft versions
	Gases		CO_2, CH_4, N_2O
	Methodology		Opening of new regional landfills in all planning regions with installed system for mechanical and biological treatment and composting. Modelling using the custom-made software tool in excel, performing calculations based on the IPCC Methodology.
	Assumptions		Opening of the regional landfills in the following order: ► Skopje – 2023 ► East and Northeast – 2025 ► Polog – 2026 ► Southeast – 2029 ► Pelagonia and Southeast – 2029 ► Vardar
Progress of implementation	**Steps taken or envisaged to achieve the action**	**Steps taken**	► Regional waste management plans 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
	Results achieved and estimated outcomes		Amount of compost: ► 0 kt in 2020 ► 78 kt in 2030 ► 80 kt in 2040
	Estimated emission reductions		► 0 Gg CO2-eq in 2020 ► -12.2 Gg CO2-eq in 2030 (108 Gg CO2-eq in 2030**) ► 23.8 Gg CO2-eq in 2040 (109.3 Gg CO2-eq in 2030**)
	Timeframe		2020 – 2035
	Finance		Budget: 36.1 M€ Costs (2030): ► WOM: 0.1 M€ ► WEM: 2.1 M€* Specific costs: ► 12.8 €/t CO_2-eq**
	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)
Progress indicators:			► Amount of compost (kt) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

*The costs include the profit from the sale of compost

** Total reduction when including the emissions realized after 2040

TABLE 49. SELECTION OF WASTE - PAPER

Mitigation action: ***Selection of waste - paper***
Main objective: ***Environmental protection and meeting the highest European standards***
Description: ***Installation of containers for collection of selected waste, mainly paper***

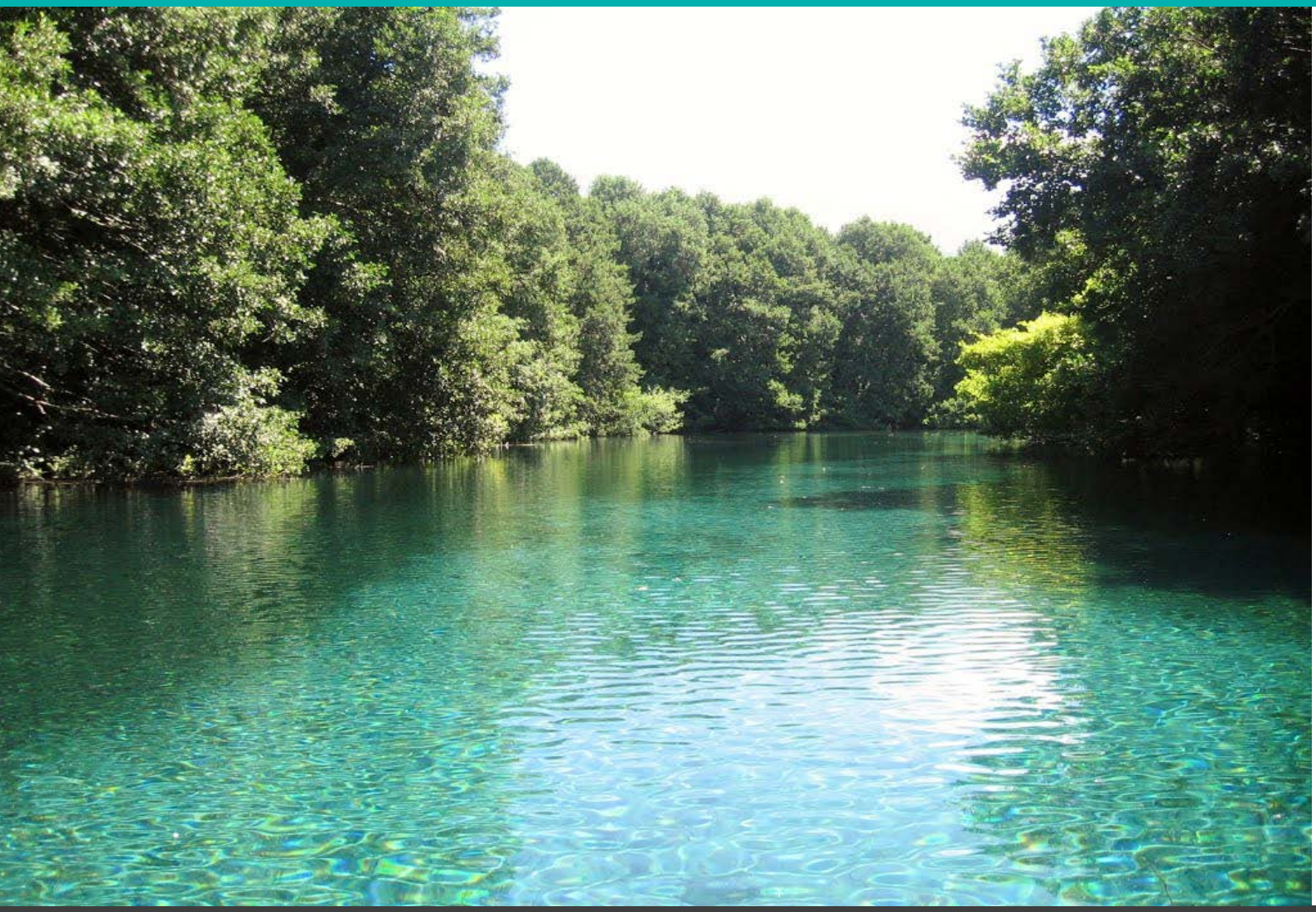
Information	**Type**		Technical
	Sector		Waste – Solid waste disposal
	Relevant planning documents, legal and regulatory acts		► National Waste Management Plan ► Strategy for Waste Management in the Republic of Macedonia ► Regional Waste Management Plans (Northeast, Southeast, Pelagonia, Polog and Skopje region) – final and draft versions
	Gases		CO_2, CH_4
	Methodology		Installation of containers for collection of selected waste. Modelling using the custom-made software tool in excel, performing caluculations based on the IPCC Methodology.
	Assumptions		Gradual increase of paper selection compared to WOM, starting from 2% upto 50% in 2040.
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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)
	Results achieved and estimated outcomes		Expected annual amount of paper waste: ► 2 kt in 2020 ► 22 kt in 2030 ► 40 kt in 2040
	Estimated emission reductions		► 0 Gg CO_2-eq in 2020 ► 10.1 Gg CO_2-eq in 2030 (62.5 Gg CO_2-eq in 2030*) ► 36.2 Gg CO_2-eq in 2040 (109.5 Gg CO_2-eq in 2030*)
	Timeframe		2020 – 2035
	Finance		Budget: 2 M€ Costs (2030): ► WOM: 0 M€ ► WEM: 0.1 M€ Specific costs: ► 2.1 €/t CO_2-eq*
	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)
Progress indicators:			► Amount of paper collected (kt) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 

* Total reduction when including the emissions realized after 2040

TABLE 50. IMPROVED WASTE AND MATERIALS MANAGEMENT AT INDUSTRIAL FACILITIES

Mitigation action: ***Improved waste and materials management at industrial facilities***
Main objective: ***Set targets for the reduction of generation, selection, reuse, recycling and treatment of waste at industrial installations***
Description: ***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).

Information	**Type**		Regulation, technical
	Sector		Waste – Solid waste disposal
	Relevant planning documents, legal and regulatory acts		► National Waste Management Plan ► Strategy for Waste Management in the Republic of Macedonia ► Law on Waste Management and bylaws ► Law on Finance and bylaws ► Regional Waste Management Plans (Northeast, East, Southeast, Southwest, Pelagonia, Vardar, Polog and Skopje region) – final and draft versions
	Gases		CO_2, CH_4
	Methodology		Amendments to the law, introduction of legal incentives
	Assumptions		Conducted substantive analysis, international experiences analyzed. The percentage of industrial waste treatment will increase from 5% in 2024 up to 30% in 2040.
Progress of implementation	**Steps taken or envisaged to achieve the action**	**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
	Results achieved and estimated outcomes		Expected annual amount of industrial waste: ► 0 kt in 2020 ► 302 kt in 2030 ► 892 kt in 2040
	Estimated emission reductions		► 0 Gg CO_2-eq in 2020 ► 3.3 Gg CO_2-eq in 2030 ► 17.5 Gg CO_2-eq in 2040
	Timeframe		► 1 year preparation, ► 2 years to implement permit changes, and ► 5 years for implementation of goals
	Finance		Budget: n/a Costs for WOM (2030): ► 0 M€ Costs for WEM (2030): ► 0 M€ Specific costs: ► 0 €/t CO_2-eq
	Implementing entity		► Ministry of Environment and Physical Planning ► Municipalities and city of Skopje ► State Environmental Inspectorate ► Inter-Municipal Waste Management Board ► Authorized Inspectors of Environment (Municipalities)
Progress indicators:			► Industrial waste collected (kt) ► Emissions reduction (Gg CO2-eq)
Contribution for the achievement of the SDGs:			***direct***  ***indirect*** 



Mitigation scenarios

4 Mitigation scenarios

4.1 Mitigation scenario (With Existing Measures - WEM)

Compared to the WOM scenario, the Mitigation Scenario includes 46 measures/policies from the list of measures given in the previous chapter (Assessment of mitigation policies and measures). 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.

Therefore, this scenario is also called "With Existing Measures" (WEM), and it can also be called baseline scenario that is likely to be achieved. 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. 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.

4.1.1 Energy

From the Energy sector, in the Mitigation scenario, 31 measures/policies are included and are represented in Table 51.

TABLE 51. 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)		
					2020	2030	2040
1	Reduction of network losses	▶ Electricity distribution companies ▶ Heat distribution companies ▶ Energy Agency, Ministry of Economy	170	Distribution and transmission companies	201.8	323.4	701.8
2	Large hydropower plants	▶ JSC ELEM ▶ Ministry of Environment and Physical Planning ▶ Ministry of Economy, Energy Agency	1716.2	JSC ELEM, Public Private Partnership	0	740.7	1868.2
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	356.9	Private sector Consumers of electricity through bills	11.7	149.5	431.6
4	Incentives feed-in premium	▶ Government of the Republic of North Macedonia ▶ Energy Regulatory Commission ▶ Ministry of Economy ▶ Private investors	240.6	Private, incentives from the central government budget	0	162.6	377.4
5	Biomass power plants (CHP optional)	▶ Government of the Republic of North Macedonia ▶ Energy Regulatory Commission	24.3	Private sector Consumers of electricity through bills	0	21	91.1

		▶ Ministry of Environment and Physical Planning ▶ Ministry of Economy, Energy Agency ▶ Private investors					
6	Solar rooftop power plants	▶ Government of the Republic of North Macedonia ▶ Energy Regulatory Commission ▶ Ministry of Economy, Energy Agency ▶ Elektrodistribucija Skopje ▶ Suppliers of electricity ▶ End-users of electricity	227.1	Private, donors, subsidies from national and local budget, EE fund	1.95	100.4	392.4
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	777	Private investors, ESM	0	124.4	1194.1
8	Introduction of CO_2 tax	▶ Government of the Republic of North Macedonia ▶ Ministry of Environment and Physical Planning ▶ Ministry of Economy, Energy Agency ▶ Ministry of Finance	n/a	n/a	n/a	n/a	n/a
9	Energy efficiency obligation schemes	▶ Ministry of economy ▶ Distribution system operators ▶ Suppliers and traders of electricity and gas	182	Consumers through their bills	0	162.8	592.5
10	Solar thermal collectors	▶ Ministry of Economy, Energy Agency ▶ End-users	16.2	Private, EE fund, incentives from the central government budget, donors	0.2	1.3	39.5
11	Labeling of electric appliances and equipment	▶ Ministry of Economy, Energy Agency ▶ Producers and suppliers of electrical equipment and household appliances ▶ End-users	71	Private, EE fund	13.1	56.3	236.7
12	Increased use of heat pumps	▶ Ministry of Economy, Energy Agency ▶ End-users	235.0	Private, EE fund, incentives from the central and local government budget, donors	103.8	154.9	221.4
13	Public awareness campaigns and network of EE info centers	▶ Ministry of Economy, Energy Agency ▶ Energy suppliers ▶ End-users	630	Private sector, donors, central and local governments	41.6	169.7	641.3
14	Retrofitting of existing residential buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Households	941.8	Private, donors through commercial EE loans, EE fund	3.3	49.0	178.3
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	55	Central government budget, donors	0.4	6.1	20.6
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	50	Local self-government budget, donors	0.4	0.7	11
17	Retrofitting of existing commercial buildings	▶ Ministry of Economy, Energy Agency ▶ Ministry of Finance ▶ Commercial buildings owners	530	Private, donors through commercial EE loans, EE fund	30.6	98.2	359.2
18	Construction of new buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Investors (households)	474.1	Private, donors through commercial EE loans, EE fund	1.9	28.9	95.8

19	Phasing out of incandescent lights	▶ Government of the Republic of North Macedonia ▶ Ministry of Economy, Energy Agency End-users	177.6	Central government budget, private	22.7	102.7	390.3
20	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	19.5	Central and local government budget, ESCO	5.8	32.5	111.9
21	Green procurements	▶ Ministry of Economy, Energy Agency ▶ Public Procurement Bureau ▶ Local self-government	16	Central and local government budget	0.5	6.6	22.4
22	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	3.2	Private, EE fund, incentives from the central and local government budget	4	9.3	560
23	Energy management in manufacturing industries	▶ Ministry of Economy, Energy Agency ▶ Private companies	/	Private, donors through commercial EE loans	2.9	67.8	259.3
24	Introduction of efficient electric motors	▶ Private companies ▶ Ministry of Economy, Energy Agency	99.7	Private, donors through commercial EE loans	0.4	14.9	74.7
25	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	141.8	Private, donors through commercial EE loans, EE fund	5	49.8	148.8
26	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	180.6	Central government budget	25.7	37.2	24.3
27	Renewing of the national car fleet	▶ Government of the RM ▶ Ministry of Transport and Communication ▶ Ministry of Economy, Energy Agency ▶ End-users	1599.5	Private, EE fund, incentives from the central government budget	22.9	16.0	65.5
28	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	2300	Private sector	1.2	64.6	142.8
29	Advanced mobility	▶ Ministry of Economy, Energy Agency ▶ Local self-government ▶ End-users		Private, EE fund, incentives from the central and local government budget, donors	2.1	3.6	6.4
30	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	16.7	24.6	32.3
31	Electrification of the transport	▶ Government of the Republic of North Macedonia	1201.7	Private, EE fund, incentives from the	1.9	9.8	-10.0

	▶ Ministry of Transport and Communications ▶ Ministry of economy		central government budget			
	Total	13,156.8		522.6	2789.3	9281.6

Greenhouse gas emissions reductions are indicative and indicates how much a given measure/policy will contribute to mitigating climate change independently. As a result of the interdependence between the measures/policies, the total reductions of greenhouse gas emissions cannot be calculated as a simple sum of the reductions of each measure/policy individually. Measures with the greatest potential for reducing greenhouse gas emissions are: Public awareness campaigns and network of EE info centers and Large hydropower plants.

The main indicators, by which the Energy sector in the Mitigation scenario can be described are shown in Table 52 and they indicate that the average annual increase by 2040 is:

- 2% of the final energy or a total increase of 56.1% in 2040 (2.8 Mtoe) compared to 2017 (1,8 Mtoe);
- 2.1 % of electricity consumption or a total increase of 61.2% in 2040 (10 TWh) compared to 2017 (7.1 TWh);
- 3.4% of the total installed capacity or an increase of 114% in 2040 (3.8 GW) compared to 2017 (1,8 GW);
- 1.8% of the gross inland consumption or a total increase of 49.2% in 2040 compared to 2017;
- 0.4% of greenhouse gas emissions or an increase of 9.2% in 2040 compared to 2017.

TABLE 52. INDICATORS FOR THE MITIGATION SCENARIO

					Annual increase rate (%)			*Total increase (%)*		
	2017	2020	2030	2040	2017/ 2020	2017/ 2030	2017/ 2040	2017/ 2020	2017/ 2030	2017/ 2040
Final energy (ktoe)	1,8	1,9	2,3	2,8	1,5%	1,9%	2,0%	4,7%	27,4%	56,1%
Electricity consumption (TWh)	6,2	6,5	8,2	10,0	1,5%	2,2%	2,1%	4,6%	32,3%	61,2%
Electricity production (GWh)	7,1	7,4	9,2	10,9	1,0%	2,0%	1,9%	3,2%	29,8%	52,4%
Installed capacity (TW)	1,8	1,8	2,7	3,8	-0,2%	3,3%	3,4%	-0,5%	53,1%	114,0%
Gross inland consumption (Mtoe)	2,6	2,7	3,0	3,5	1,3%	1,2%	1,4%	4,0%	16,2%	38,4%
GHG emissions (Tg CO_2-eq)	8,9	8,9	8,6	9,8	-0,3%	-0,3%	0,4%	-0,9%	-3,3%	9,2%

4.1.2 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 53).

TABLE 53. 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 below 50 Livestock Units	► Ministry of Agriculture, Forestry and Water Economy	1	Private sector	0.1	0.7	1.2
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**. Most of the investments are from the private sector.

4.1.3 Waste

From the Waste sector, four measures/policies are included (Table 54).

TABLE 54. 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)*		
					2020	2030	2040
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	0	489.7	552.3
2	Mechanical and biological treatment (MBT) in new landfills with composting	► Ministry of environment and physical planning ► Public utilities ► Inter-municipal board for waste management	36.1	Local self-government through Public Utilities, Public Private Partnership,	0	108.0*	109.3*

				Grants from the EU			
3	Selection of waste - paper	▶ Ministry of environment and physical planning ▶ Public utilities ▶ Inter-municipal board for waste management	2	Local self-government through Public Utilities, Public Private Partnership, Grants from the EU	0	62.5*	109.5*
4	Improved waste and materials management at industrial facilities	▶ Ministry of Environment and Physical Planning ▶ Municipalities and city of Skopje ▶ State Environmental Inspectorate ▶ Inter-Municipal Waste Management Board ▶ Authorized Inspectors of Environment (Municipalities)	0	Ministry of Environment and Physical Planning Municipalities and city of Skopje Industrial facilities	0	3.3	17.5
		Total	58.6		0	663.5	788.6

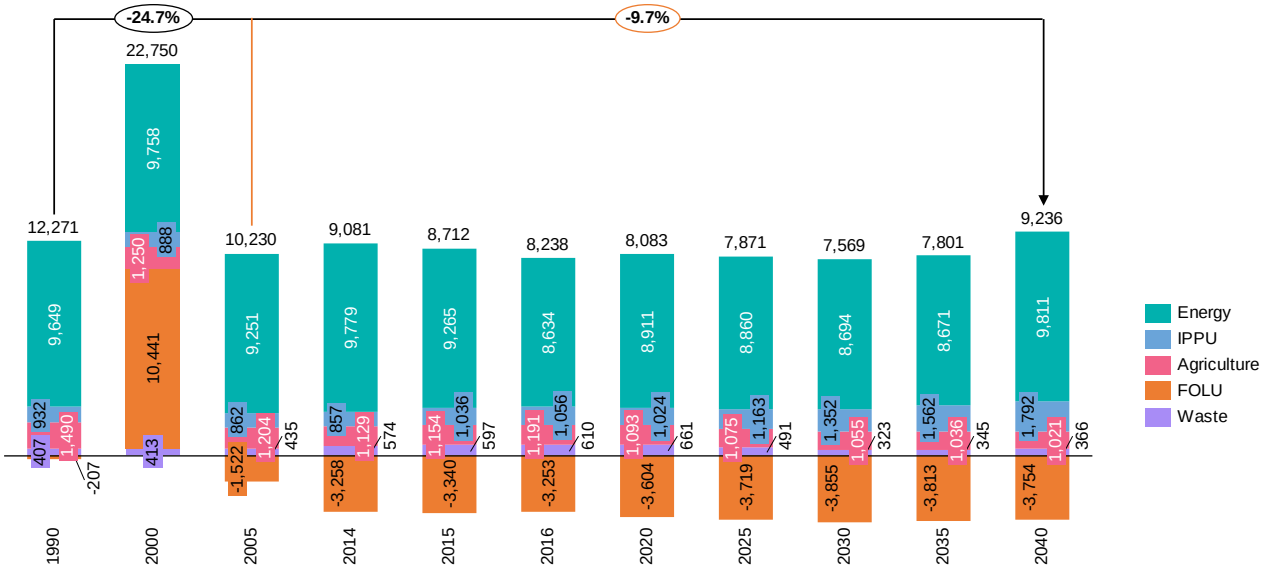
* Total reduction when including the emissions realized after 2040

For the implementation of the Mitigation scenario in the Waste sector, investments of **58.6 mil. €** are needed, for the period from **2020 to 2040**. A measure with the **most significant** potential for greenhouse gas emissions reduction is the **Landfill gas flaring**.

4.1.4 Total emissions

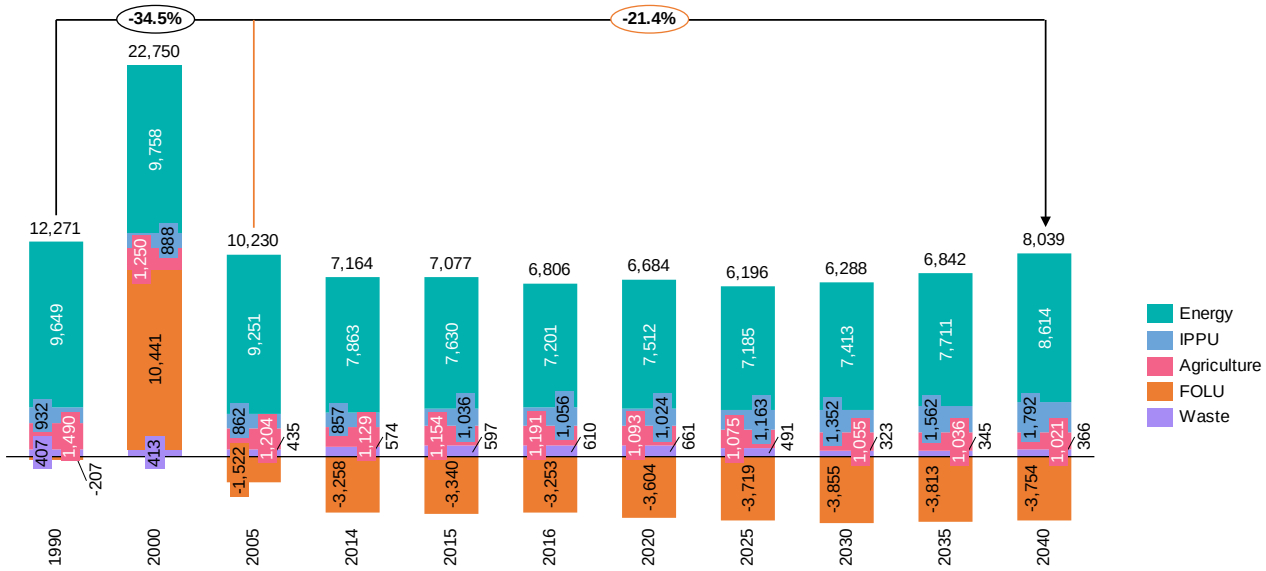
In this section, the total emissions of all sectors are calculated when implementing all of the measures that are part of the WEM scenario (described in sections 4.1.1, 4.1.2 and 4.1.3) and the results show that there is a reduction in the total GHG emissions by 10% in 2040 compared to 2005 (or by 25% compared to 1990), as shown in Figure 36. The largest amount of emissions remains in the Energy sector, with a share of 76% in 2040 (excluding the FOLU sector, where there are sinks). During the whole planning period 2017-2040, the category FOLU has an absorption of emissions, which are increased by 15% compared to 2016 (or 147% compared to 2005).

FIGURE 36. TOTAL GHG EMISSIONS BY SECTORS – WEM SCENARIO (IN GG CO_2-EQ)



Besides the total GHG emissions, results for the emissions without MEMO are also presented (Figure 37), as they are used for comparing the results with other countries and these results show even higher reduction in the total emissions by 21% in 2040 compared to 2005 (or 35% compared to 1990). This higher reduction is mainly caused by the exclusion of the emissions coming from the import of electricity.

FIGURE 37. TOTAL GHG EMISSIONS BY SECTORS WITHOUT MEMO – WEM SCENARIO (IN GG CO_2-EQ)



4.2 Higher ambition mitigation scenario (With Additional Measures - WAM)

In the higher ambition mitigation scenario, 32 measures/policies were included in the Energy sector (Table 55). Most of the measures are the same as in the WEM scenario, but with different levels of penetration which leads to a higher reduction of GHG emissions. The proposed measures in the WEM scenario from the other sectors are also implemented in this scenario.

TABLE 55. REVIEW OF THE MEASURES/POLICIES INCLUDED IN THE HIGHER AMBITION MITIGATION SCENARIO OF THE ENERGY 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 network losses	▶ Electricity distribution companies ▶ Heat distribution companies ▶ Energy Agency, Ministry of Economy	170	Distribution and transmission companies	201.8	323.4	701.8
2	Large hydropower plants	▶ JSC ELEM ▶ Ministry of Environment and Physical Planning ▶ Ministry of Economy, Energy Agency	1716.2	JSC ELEM, Public Private Partnership	0	740.7	1868.2
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	356.9	Private sector Consumers of electricity through bills	11.7	149.5	431.6
4	Incentives feed-in premium	▶ Government of the Republic of North Macedonia ▶ Energy Regulatory Commission ▶ Ministry of Economy ▶ Private investors	240.6	Private, incentives from the central government budget	0	162.6	377.4
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	Private sector Consumers of electricity through bills	0	21	91.1
6	Solar rooftop power plants	▶ Government of the Republic of North Macedonia ▶ Energy Regulatory Commission ▶ Ministry of Economy, Energy Agency ▶ Elektrodistribucija Skopje ▶ Suppliers of electricity ▶ End-users of electricity	318	Private, donors, subsidies from national and local budget, EE fund	2.8	142.9	552.7
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	1046	Private investors, ESM	0	189.2	1587.6
8	Introduction of CO_2 tax	▶ Government of the Republic of North Macedonia ▶ Ministry of Environment and Physical Planning ▶ Ministry of Economy, Energy Agency ▶ Ministry of Finance	n/a	n/a	n/a	n/a	n/a

9	Energy efficiency obligation schemes	▶ Ministry of economy ▶ Distribution system operators ▶ Suppliers and traders of electricity and gas	182	Consumers through their bills	0	162.8	592.5
10	Solar thermal collectors	▶ Ministry of Economy, Energy Agency ▶ End-users	34.8	Private, EE fund, incentives from the central government budget, donors	0.4	7.2	90.8
11	Labeling of electric appliances and equipment	▶ Ministry of Economy, Energy Agency ▶ Producers and suppliers of electrical equipment and household appliances ▶ End-users	71	Private, EE fund	13.1	56.3	236.7
12	Increased use of heat pumps	▶ Ministry of Economy, Energy Agency ▶ End-users	330.6	Private, EE fund, incentives from the central and local government budget, donors	302.8	392.3	369.5
13	Public awareness campaigns and network of EE info centers	▶ Ministry of Economy, Energy Agency ▶ Energy suppliers ▶ End-users	658	Private sector, donors, central and local governments	45.3	177	201.5
14	Retrofitting of existing residential buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Households	941.8	Private, donors through commercial EE loans, EE fund	3.3	49.0	178.3
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	155	Central government budget, donors	0.8	12.6	42.5
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	100	Local self-government budget, donors	6.6	13.2	19.8
17	Retrofitting of existing commercial buildings	▶ Ministry of Economy, Energy Agency ▶ Ministry of Finance ▶ Commercial buildings owners	530	Private, donors through commercial EE loans, EE fund	30.6	98.2	359.2
18	Construction of new buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Investors (households)	282.7	Private, donors through commercial EE loans, EE fund	1.8	19.8	40.4
19	Construction of passive buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Investors (households)	1068	Private, donors through commercial EE loans, EE fund	0.3	17	123.2
20	Phasing out of incandescent lights	▶ Government of the Republic of North Macedonia ▶ Ministry of Economy, Energy Agency End-users	558	Central government budget, private	99.9	401.8	1417.3
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	19.5	Central and local government budget, ESCO	5.8	32.5	111.9
22	Green procurements	▶ Ministry of Economy, Energy Agency ▶ Public Procurement Bureau ▶ Local self-government	16	Central and local government budget	0.5	6.6	22.4
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	3.2	Private, EE fund, incentives from the central and local government budget	4	9.3	560

24	Energy management in manufacturing industries	▶ Ministry of Economy, Energy Agency ▶ Private companies	/	Private, donors through commercial EE loans	2.9	67.8	259.3
25	Introduction of efficient electric motors	▶ Private companies ▶ Ministry of Economy, Energy Agency	99.7	Private, donors through commercial EE loans	0.4	14.9	74.7
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	344.8	Private, donors through commercial EE loans, EE fund	12	128.3	317.3
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	180.6	Central government budget	25.7	37.2	24.3
28	Renewing of the national car fleet	▶ Government of the RM ▶ Ministry of Transport and Communication ▶ Ministry of Economy, Energy Agency ▶ End-users	1659.5	Private, EE fund, incentives from the central government budget	26.2	24	73
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	2300	Private sector	1.2	64.6	142.8
30	Advanced mobility	▶ Ministry of Economy, Energy Agency ▶ Local self-government ▶ End-users		Private, EE fund, incentives from the central and local government budget, donors	2.1	3.6	6.4
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	16.7	24.6	32.3
32	Electrification of the transport	▶ Government of the Republic of North Macedonia ▶ Ministry of Transport and Communications ▶ Ministry of economy	5058.5	Private, EE fund, incentives from the central government budget	8.2	41.9	-61.4
		Total	19,185.7		826.9	3591.8	10845.1

The main indicators by which the Higher ambition mitigation scenario is described are shown in Table 56 and they indicate that the average annual increase by 2040 is:

- 1.5% of the final energy or a total increase of 42.2% in 2040 (2.8 Mtoe) compared to 2017 (1,8 Mtoe);
- 1.7% of electricity consumption or a total increase of 47.8% in 2040 (10 TWh) compared to 2017 (7.1 TWh);
- 3.7% of the total installed capacity or an increase of 128.5% in 2040 (3.8 GW) compared to 2017 (1,8 GW);
- 0.4% of the gross inland consumption or a total increase of 10.7% in 2040 compared to 2017;
- -1.6% of greenhouse gas emissions or a decrease of 30.6% in 2040 compared to 2017.

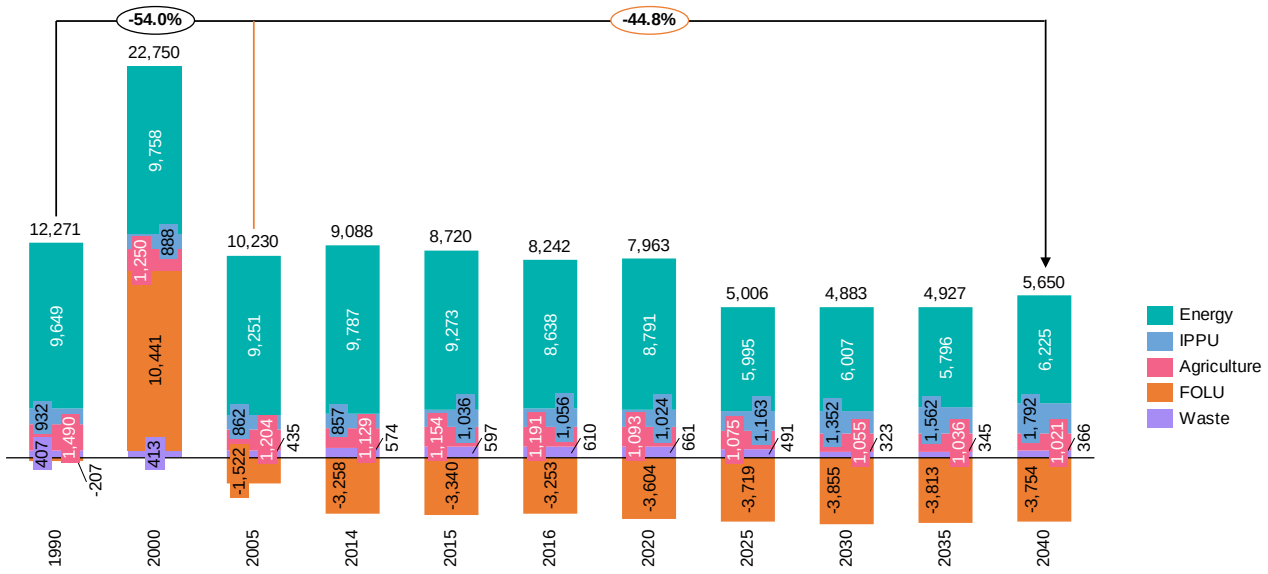
TABLE 56. INDICATORS FOR THE HIGHER AMBITION MITIGATION SCENARIO

					Annual increase rate (%)			Total increase (%)		
	2017	2020	2030	2040	2017/ 2020	2017/ 2030	2017/ 2040	2017/ 2020	2017/ 2030	2017/ 2040
Final energy (ktoe)	1,8	1,9	2,1	2,6	1,2%	1,3%	1,5%	3,6%	18,2%	42,2%
Electricity consumption (TWh)	6,2	6,4	7,9	9,2	1,1%	1,9%	1,7%	3,4%	27,6%	47,8%
Electricity production (GWh)	7,1	7,1	9,0	9,7	0,1%	1,9%	1,4%	0,2%	28,1%	38,1%
Installed capacity (TW)	1,8	1,8	2,8	4,0	-0,1%	3,7%	3,7%	-0,2%	59,7%	128,5%
Gross inland consumption (Mtoe)	2,6	2,6	2,4	2,8	1,0%	-0,5%	0,4%	3,1%	-5,7%	10,7%
GHG emissions (Tg CO_2-eq)	8,9	8,7	6,0	6,2	-0,7%	-3,1%	-1,6%	-2,2%	-33,2%	-30,6%

4.2.1 Total emissions

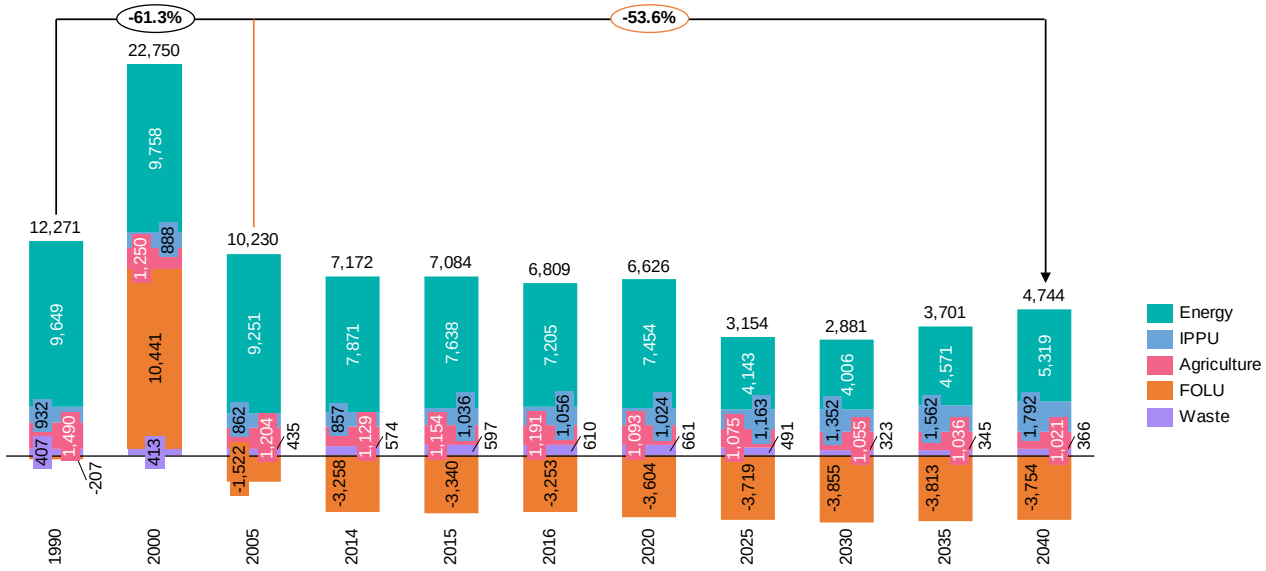
The total emissions of all sectors when adding the measures that are part of the WAM scenario show that there is a reduction in the total GHG emissions by 45% in 2040 compared to 2005 (or by 54% compared to 1990), as shown in Figure 38. The largest amount of emissions remains in the Energy sector, with a share of 66% in 2040 (excluding the FOLU sector, where there are sinks). During the whole planning period 2017-2040, the category FOLU has an absorption of emissions, which are increased by 15% compared to 2016 (or 147% compared to 2005).

FIGURE 38. TOTAL GHG EMISSIONS BY SECTORS – WAM SCENARIO (IN GG CO_2-EQ)



As in the WOM and WEM scenarios, beside the total GHG emissions, results for the emissions without MEMO are also presented (Figure 39). These results show even higher reduction in the total emissions by 54% in 2040 compared to 2005 (or 61% compared to 1990). This higher reduction is again mainly caused by the exclusion of the emissions coming from the import of electricity.

FIGURE 39. TOTAL GHG EMISSIONS BY SECTORS WITHOUT MEMO – WAM SCENARIO (IN GG CO_2-EQ)



4.3 Extended mitigation scenario (e-WAM)

In the Extended mitigation scenario, 32 measures/policies were included in the Energy sector (Table 55). As in the WEM and WAM scenarios, most of the measures are the same, but with different levels of ambitious. The proposed measures in the WEM scenario from the other sectors are also implemented in this scenario.

TABLE 57. REVIEW OF THE MEASURES/POLICIES INCLUDED IN THE EXTENDED MITIGATION SCENARIO OF THE ENERGY 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 network losses	▶ Electricity distribution companies ▶ Heat distribution companies ▶ Energy Agency, Ministry of Economy	170	Distribution and transmission companies	201.8	323.4	701.8
2	Large hydropower plants	▶ JSC ELEM ▶ Ministry of Environment and Physical Planning ▶ Ministry of Economy, Energy Agency	1716.2	JSC ELEM, Public Private Partnership	0	740.7	1868.2
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	356.9	Private sector Consumers of electricity through bills	11.7	149.5	431.6
4	Incentives feed-in premium	▶ Government of the Republic of North Macedonia ▶ Energy Regulatory Commission ▶ Ministry of Economy ▶ Private investors	240.6	Private, incentives from the central government budget	0	162.6	377.4
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	Private sector Consumers of electricity through bills	0	21	91.1
6	Solar rooftop power plants	▶ Government of the Republic of North Macedonia ▶ Energy Regulatory Commission ▶ Ministry of Economy, Energy Agency ▶ Elektrodustribucija Skopje ▶ Suppliers of electricity ▶ End-users of electricity	263.4	Private, donors, subsidies from national and local budget, EE fund	3.2	164.3	627.2
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	1325.4	Private investors, ESM	0	202.8	2040.2
8	Introduction of CO_2 tax	▶ Government of the Republic of North Macedonia ▶ Ministry of Environment and Physical Planning ▶ Ministry of Economy, Energy Agency ▶ Ministry of Finance	n/a	n/a	n/a	n/a	n/a
9	Energy efficiency obligation schemes	▶ Ministry of economy ▶ Distribution system operators ▶ Suppliers and traders of electricity and gas	182	Consumers through their bills	0	162.8	592.5

10	Solar thermal collectors	▶ Ministry of Economy, Energy Agency ▶ End-users	70	Private, EE fund, incentives from the central government budget, donors	0.7	21.5	165.4
11	Labeling of electric appliances and equipment	▶ Ministry of Economy, Energy Agency ▶ Producers and suppliers of electrical equipment and household appliances ▶ End-users	71	Private, EE fund	13.1	56.3	236.7
12	Increased use of heat pumps	▶ Ministry of Economy, Energy Agency ▶ End-users	474.4	Private, EE fund, incentives from the central and local government budget, donors	725.4	584.6	623.5
13	Public awareness campaigns and network of EE info centers	▶ Ministry of Economy, Energy Agency ▶ Energy suppliers ▶ End-users	704	Private sector, donors, central and local governments	56.6	201.5	716.4
14	Retrofitting of existing residential buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Households	1708.2	Private, donors through commercial EE loans, EE fund	7.1	73.0	352.5
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	170	Central government budget, donors	1.1	19.2	66.8
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	150	Local self-government budget, donors	26.9	52.6	78.3
17	Retrofitting of existing commercial buildings	▶ Ministry of Economy, Energy Agency ▶ Ministry of Finance ▶ Commercial buildings owners	530	Private, donors through commercial EE loans, EE fund	30.6	98.2	359.2
18	Construction of new buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Investors (households)	282.7	Private, donors through commercial EE loans, EE fund	1.8	19.8	40.4
19	Construction of passive buildings	▶ Ministry of Economy, Energy Agency ▶ Donors and financial institutions ▶ Investors (households)	1068	Private, donors through commercial EE loans, EE fund	0.3	17	123.2
20	Phasing out of incandescent lights	▶ Government of the Republic of North Macedonia ▶ Ministry of Economy, Energy Agency End-users	558	Central government budget, private	99.9	401.8	1417.3
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	25.3	Central and local government budget, ESCO	8.9	37.9	117.1
22	Green procurements	▶ Ministry of Economy, Energy Agency ▶ Public Procurement Bureau ▶ Local self-government	24	Central and local government budget	0.8	9.4	32.7
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	3.2	Private, EE fund, incentives from the central and local government budget	4	9.3	560
24	Energy management in manufacturing industries	▶ Ministry of Economy, Energy Agency ▶ Private companies	/	Private, donors through commercial EE loans	2.9	67.8	259.3

25	Introduction of efficient electric motors	▶ Private companies ▶ Ministry of Economy, Energy Agency	113	Private, donors through commercial EE loans	0.7	28.8	83.8
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	438.6	Private, donors through commercial EE loans, EE fund	20	206	474.4
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	180.6	Central government budget	25.7	37.2	24.3
28	Renewing of the national car fleet	▶ Government of the RM ▶ Ministry of Transport and Communication ▶ Ministry of Economy, Energy Agency ▶ End-users	2167.7	Private, EE fund, incentives from the central government budget	33.3	43.1	98.6
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	2300	Private sector	1.2	66.4	147.3
30	Advanced mobility	▶ Ministry of Economy, Energy Agency ▶ Local self-government ▶ End-users		Private, EE fund, incentives from the central and local government budget, donors	2.1	3.6	6.4
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	16.7	24.6	32.3
32	Electrification of the transport	▶ Government of the Republic of North Macedonia ▶ Ministry of Transport and Communications ▶ Ministry of economy	8292.3	Private, EE fund, incentives from the central government budget	11.3	61.6	-78.8
		Total	24,329.8		1307.8	4068.3	12667.1

The main indicators by which the Extended mitigation scenario is described are shown in Table 58 and they indicate that the average annual increase by 2040 is:

- 1.2% of the final energy or a total increase of 31.8% in 2040 (2.8 Mtoe) compared to 2017 (1,8 Mtoe);
- 1.6 % of electricity consumption or a total increase of 44.6% in 2040 (10 TWh) compared to 2017 (7.1 TWh);
- 3.7% of the total installed capacity or an increase of 130.4% in 2040 (3.8 GW) compared to 2017 (1,8 GW);
- 0.1% of the gross inland consumption or a total increase of 2.6% in 2040 compared to 2017;
- -2.4% of greenhouse gas emissions or a decrease of 42.2% in 2040 compared to 2017.

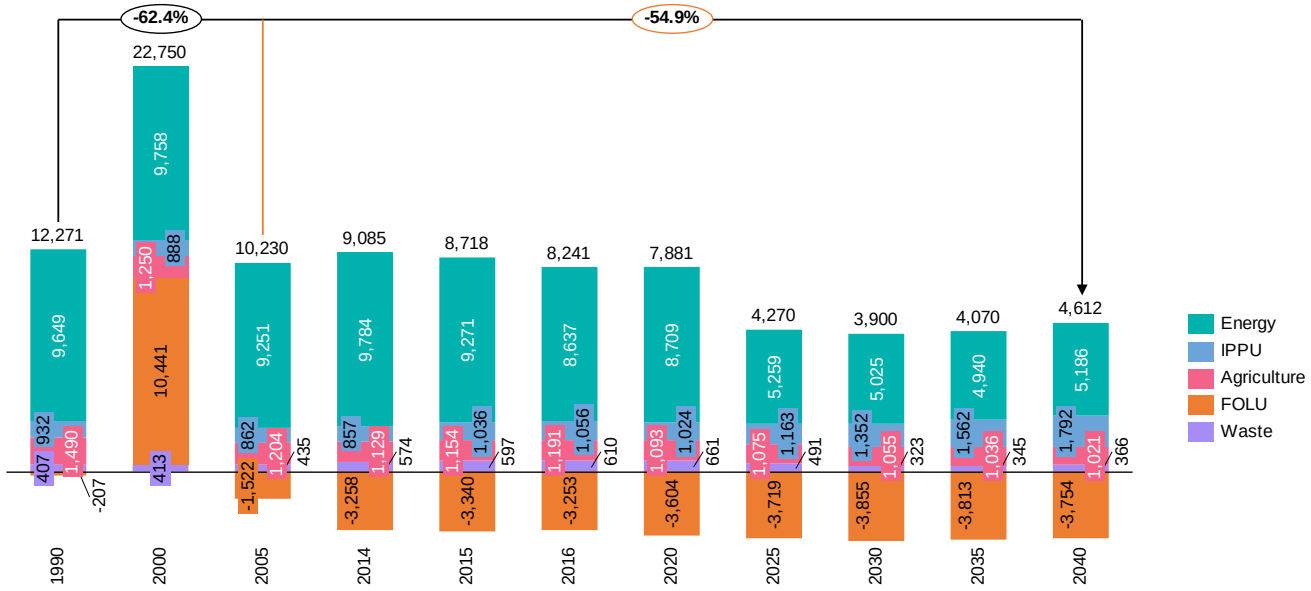
TABLE 58. INDICATORS FOR THE EXTENDED MITIGATION SCENARIO

					Annual increase rate (%)			Total increase (%)		
	2017	2020	2030	2040	2017/ 2020	2017/ 2030	2017/ 2040	2017/ 2020	2017/ 2030	2017/ 2040
Final energy (ktoe)	1.8	1.9	2.0	2.4	1.0%	0.9%	1.2%	2.9%	12.3%	31.8%
Electricity consumption (TWh)	6.2	6.4	7.7	9.0	0.8%	1.7%	1.6%	2.5%	23.9%	44.6%
Electricity production (GWh)	7.0	7.0	8.8	10.2	-0.2%	1.7%	1.6%	-0.7%	25.1%	44.4%
Installed capacity (TW)	1.8	1.8	3.1	4.1	0.0%	4.3%	3.7%	-0.1%	73.6%	130.4%
Gross inland consumption (Mtoe)	2.6	2.6	2.3	2.6	1.0%	-0.8%	0.1%	2.9%	-10.2%	2.6%
GHG emissions (Tg CO_2-eq)	8.9	8.7	5.0	5.2	-1.0%	-4.4%	-2.4%	-3.0%	-44.1%	-42.2%

4.3.1 Total emissions

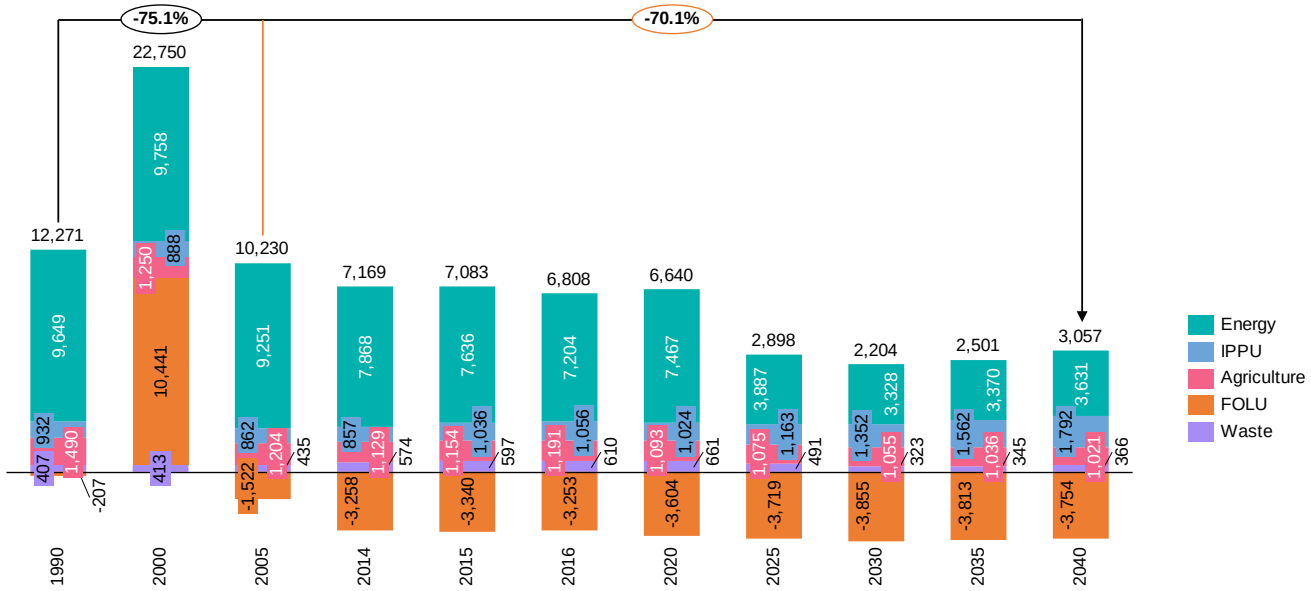
The total emissions of all sectors when adding all of the measures that are part of the e-WAM scenario show that there is a reduction in the total GHG emissions by 55% in 2040 compared to 2005 (or by 62% compared to 1990), as shown in Figure 40. The largest amount of emissions remains in the Energy sector, with a share of 62% in 2040 (excluding the FOLU sector, where there are sinks). During the whole planning period 2017-2040, the category FOLU has absorption of emissions, which are increased by 15% compared to 2016 (or 147% compared to 2005).

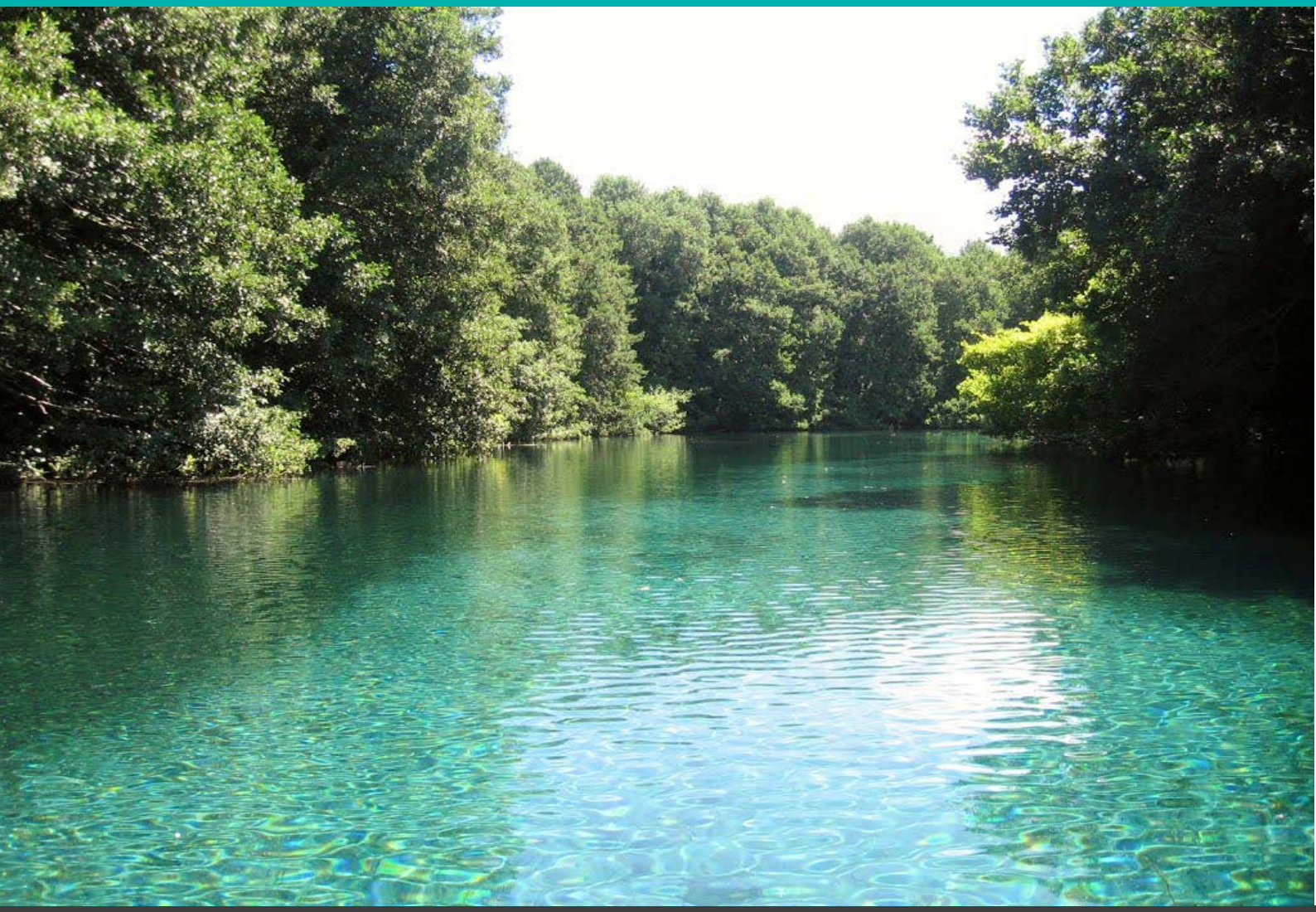
FIGURE 40. TOTAL GHG EMISSIONS BY SECTORS – E-WAM SCENARIO (IN GG CO_2-EQ)



As in all other scenarios, results for the emissions without MEMO are also presented (Figure 41) and these results show even higher reduction in the total emissions by 70% in 2040 compared to 2005 (or 75% compared to 1990). This higher reduction is again mainly caused by the exclusion of the emissions coming from the import of electricity.

FIGURE 41. TOTAL GHG EMISSIONS BY SECTORS WITHOUT MEMO – E-WAM SCENARIO (IN GG CO_2-EQ)





Assessment of mitigation policies and measures

5 Assessment of mitigation policies and measures

5.1 Economic and environmental aspects

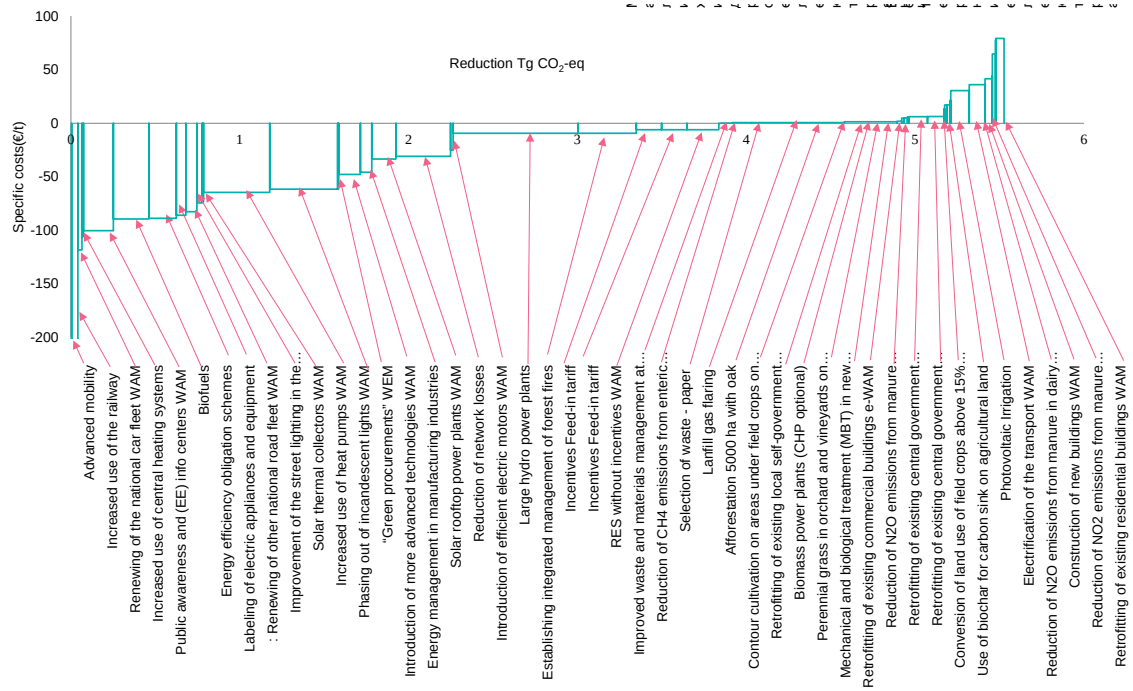
The economic and environmental aspects of the climate change mitigation policies and measures are analyzed through the following two parameters:

- 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 42, detail table is given in the Appendix (Table 63)). 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 CO_2-eq. It is very important so 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 can not 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 CO2 emitters.

FIGURE 42. 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 43). On the second place is Landfill gas flaring with a reduction of 552 Gg CO_2-eq. On the other hand, Advance mobility and Increased use of railway are measures with lower specific costs (Figure 44).

FIGURE 43. REDUCTION OF CO_2-EQ EMISSIONS IN 2030 (IN GG)

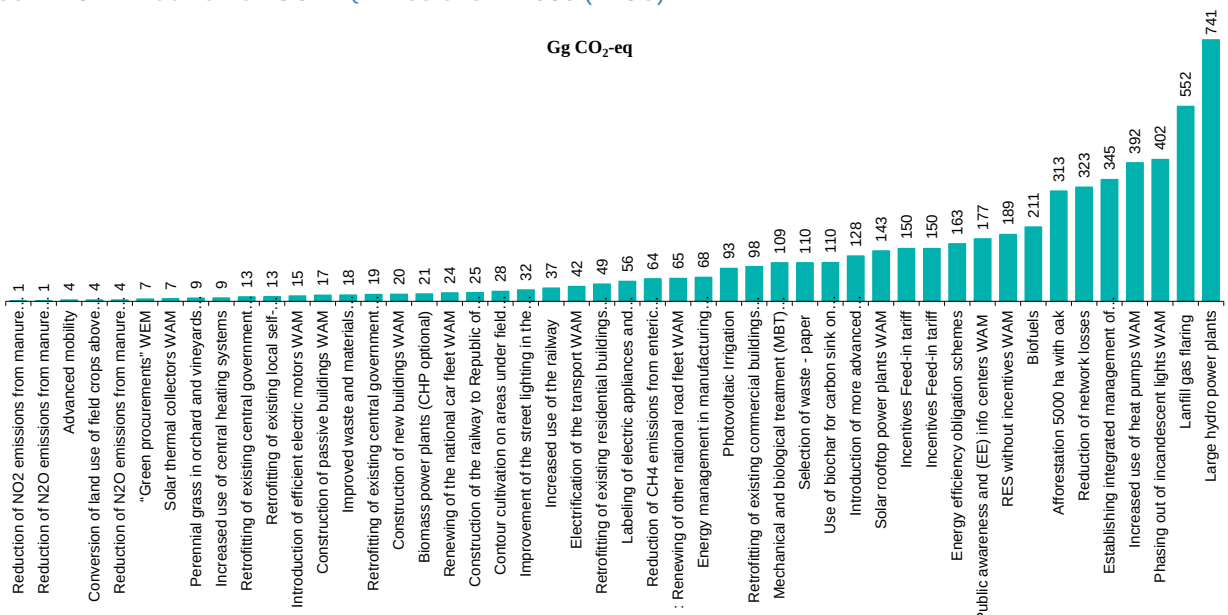
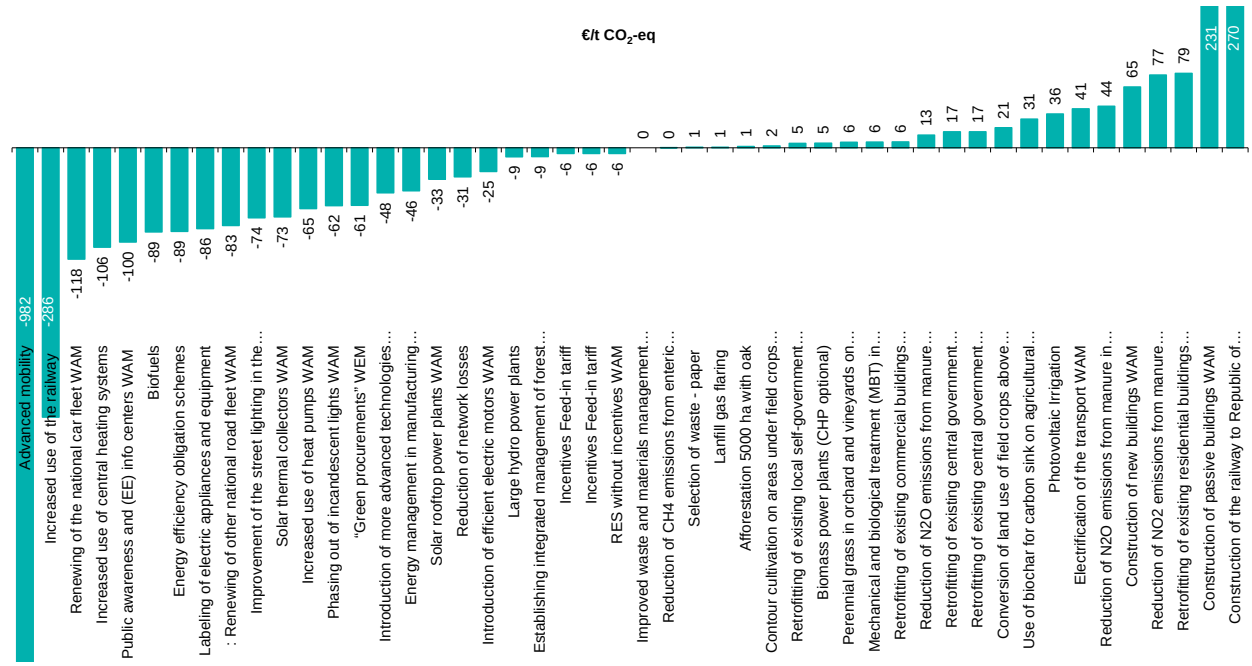


FIGURE 44. SPECIFIC COSTS FOR 2030 (IN EUR/TCO_2-EQ)



5.2 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 is implemented in TBUR too. In addition, in TBUR the number of green jobs is calculated for the policies and measures of each of the scenarios.

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 the WEM scenario higher share of green jobs is in RES, while in the e-WAM the share of Energy efficiency green jobs is almost the same as in RES (Figure 45). The maximal number in the WEM scenario is in 2030 with 3,201 green jobs, from which 61% are from the energy efficiency and the remaining are from RES. In the WAM scenarios the maximal number is achieved in 2030 (7,035), while in the e-WAM scenario in 2035 (9,895). Moreover, the number of green jobs in 2035 in the e-WAM scenario is almost doubled compared to the WEM scenario.

Furthermore, the technologies which contribute most to the creation of new domestic green jobs is Retrofiting with almost 50% in 2035 in e-WAM scenario, followed by Building of new houses, including passive houses (23%), PV (10%) and Solar thermal collectors (8%). After 2036 there is a decrease in the creation of domestic green jobs mainly because of the reduced number of PV installations, as well as retrofit of existing buildings (Figure 46).

FIGURE 45.NUMBER OF DOMESTIC GREEN JOBS FROM RES AND ENERGY EFFICIENCY, BY SCENARIO

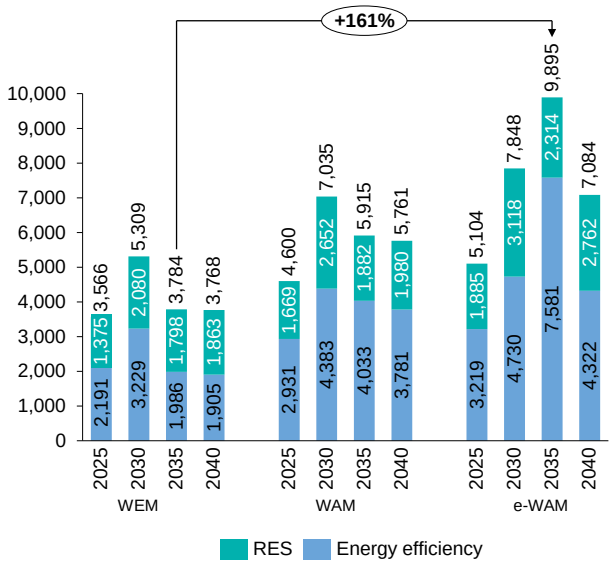
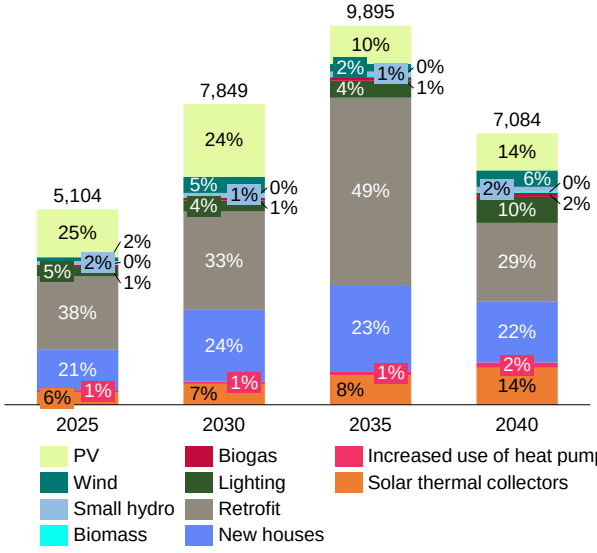
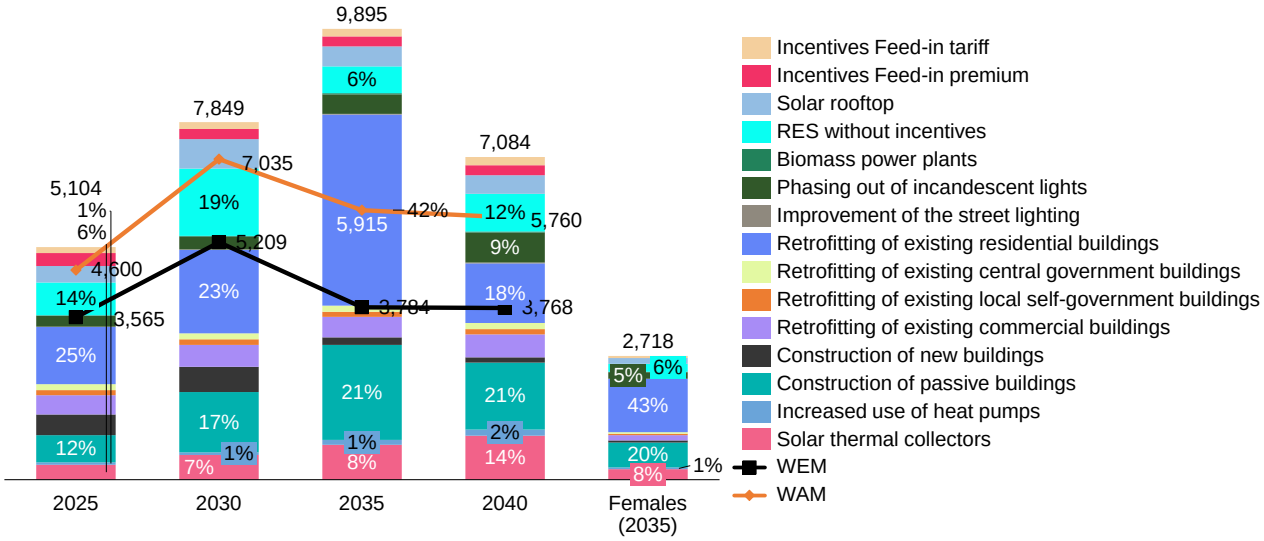


FIGURE 46. NUMBER OF DOMESTIC GREEN JOBS BY TECHNOLOGY IN E-WAM



Regarding the contribution by measures, the ones that have the highest share in the number of new domestic green jobs are: Refrofit of existing residential buildings (42%), Construction of passive houses (21%), RES without incentives (6%) and Solar thermal collectors (8%), in the e-WAM scenario in 2035 (Figure 36). Based on the types of jobs, very basic analyses are done concerning the gender issue. It is found that at least around 27% of the maximum number of job positions in 2035 can be assigned to women (Figure 36).

FIGURE 47. NUMBER OF DOMESTIC GREEN JOBS BY MEASURE IN E-WAM



5.3 Social aspects – Gender

The entire population is vulnerable to the Climate Change negative impacts and the disasters and catastrophes caused by the climate change. Still, different groups of people based on social, economic, educational, health (physical and mental), age, ethnicity, gender, place of living (geographical), environmental factors, as well as accessibility to the institutional mechanisms and sources for adaptation and mitigation are more vulnerable to the long-term effects of the climate change and the disasters and catastrophes caused by them. Gender represents a basis for discrimination, violence (in the family and the society), unequal access to goods and services, lower income, lower inclusion in the education processes, labor market and decision making processes. In general women are still exposed to gender based violation of human rights and dignity. On the other hand, gender based discrimination represents an obstacle for including full potential of women into the societal processes. Shifting the socio-cultural stereotypes remains basic and still most challenging obstacles to be resolved.

Within the TBUR, a set of activities were undertaken with a purpose of ensuring and strengthening the implementation of the Draft Action Plan for Gender Mainstreaming in Climate Change developed under the climate change projects implemented by the Ministry of Environment and Physical Planning with the support of the UNDP, in close work with the Ministry of Labor and Social Policy. The Gender issues in TBUR, mitigation part are addressed in Table 59.

TABLE 59. MAKING CLIMATE CHANGE MITIGATION PROCESS MORE GENDER RESPONSIVE

	Y/N	*More info*
Making Mitigation Assessment More Gender Responsive	Y	To certain extend. • Making Mitigation Assessment More Gender Responsive: contextual analysis of the needs, priorities, roles and experiences of women and men shall be developed. • Gender Responsive Mitigation planning ensured by following gender perspectives: gender balanced team and identification of gender based concerns/needs/priorities. • Both women and men were involved in development of baseline scenarios and mitigation-related parameters, as well as represented by various stakeholders such as NGO sector, academia, business sector. However, the institutional gender machinery has not been included at this point. • However, the Implementation phase will mean that all actors involved were aware that they will have to meet the gender requirements. The planned training on gender issues for participants from all implementing organizations will be a great opportunity to set the directions for

		achievement the gender perspective foreseen with this report, and at the same time to increase their capacity related to gender issues.
Ensure work plan highlights categories where gendered divisions of labor indicate scope for in-depth gender analysis	Y	• The number of green jobs calculated for the policies and measures of each of the scenarios has been disaggregated by gender i.e. at least around 27% of the maximum number of job positions in 2035 can be assigned to women; • The gender specialist has identified mitigation measures relevant from gender aspects.
Establish criteria for all terms of reference to include a collection of sex-disaggregated data, establishment of a small set of gender-specific indicators, and employment of gender specialist to conduct gender analysis of mitigation findings	Y	• Gender specialist engaged to conduct gender analysis of mitigation findings
Ensure women and men are involved in the development of baseline scenarios and mitigation-related parameters	Y	• The national process for the development of mitigation scenarios incorporated well balanced gender team: 44% women and 56% men. Additional efforts have been made to integrate gender responsive considerations into the GHG inventory to the extent possible, following the national Action plan on gender and climate change and the UNDP Gender Responsive National Communications Toolkit.

Although in the Republic of North Macedonia there is an institutional gender machinery at central and local level on one hand, as well as a legal framework for gender equality and gender non-discrimination on the other hand, however, climate change and its negative impacts, more precisely measures for equitable and gender responsive inclusion of both sexes in the adaptation and mitigation areas have not been introduced into the institutional, legal and strategic framework.

GENDER SENSITIVE CLIMATE DATA TRANSFORMING GOVERNMENTAL POLICIES

Older women suffer greater impact of climate change

Socio-economic inequality and cultural factors are directly correlated with people's ability to cope with and influence or mitigate climate change and its adverse effects. Socio-economics analysis of gender disaggregated data collected from Skopje citizens on their heating habits identified seven most vulnerable groups:

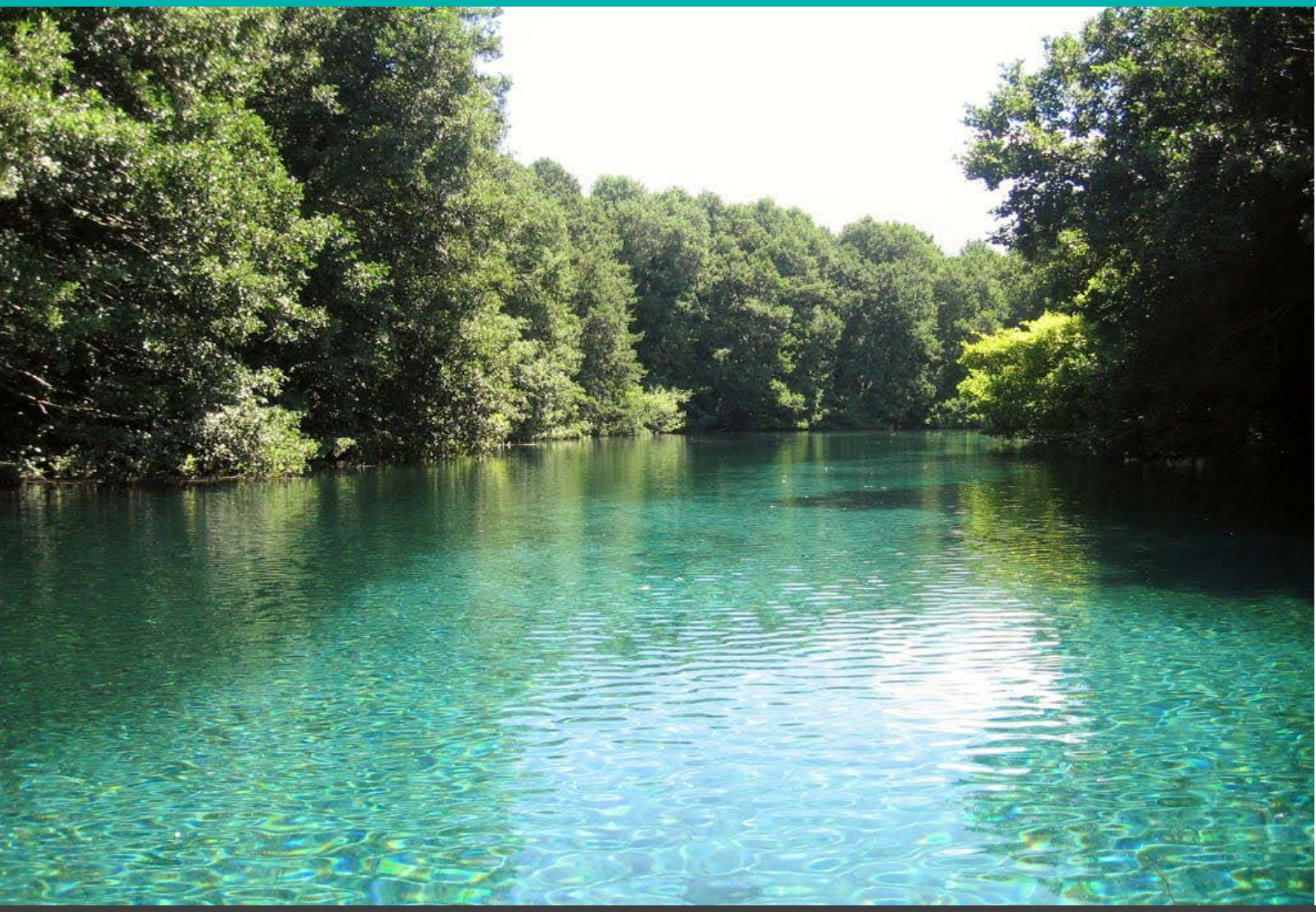
1) Single mothers living in houses with children under the age of 18, using firewood
2) Single fathers living in houses with children under the age of 18, using firewood
3) Women 65+ age, with monthly income beyond 12.000 MKD single, divorced or widower and live alone
4) Men 65+ age, with monthly income beyond 12.000 MKD, single, divorced or widower and live alone
5) Households living in a rural environment in a house with a monthly income of up to 12.000 MKD
6) Households living in an urban area in the Skopje Valley, in buildings built up to 1963 or whose last renovation was at the latest until that year, have thermal insulated roof and insulation of a facade of up to 2cm
7) Households living in houses in urban areas, are highly educated and use firewood as a way of heating their homes

The third group i.e. **65+ women who live alone and have low monthly income** has been identified from the gender aspect as critical. According to the analysis, their number is app. 1,460 in the city of Skopje. The highest percentage of these, 62% use firewood as the primary energy source for heating the household. Age and low level of physical activity make them more susceptible to negative impacts of climate change. Muscle strain in these women often leads to injuries that are particularly emphasized in winter periods, and they are also prone to viral and bacterial respiratory infections (pneumonia), chronic diseases including arthritis or osteoporosis. Often, due to poor physical activity and the fear of injuries when moving in winter when there is snow, they spend time alone at home. Loneliness increases the possibility of depression, Alzheimer's and other types of dementia. Households are heated for more than 12 hours a day, throughout the week, during working days, weekends and holidays.

The Government initially approached the household heating issue with "first come, first served" subsidy model for changing their polluting and inefficient heating appliances, which has several shortcomings:

1) it is mostly used by households that have higher income and can bear the upfront payment;
2) the subsidies are not targeted to one specific group or area thus it is impossible to measure the impact;
3) it might be easily corrupted.

However, this data-driven approach prompted timely Government response: in the 2019/2020 heating season the subsidies criteria have been redesigned in order to support 10,000 most vulnerable households in most affected cities in the country.



Comparative analyses of the scenarios and SDG indicators

6 Comparative analyses of the scenarios and SDG indicators

6.1 Comparison of the mitigation scenarios with WOM and the years 1990 and 2005

When comparing the results from the different scenarios there are two approaches: one is relative to the reference scenario (WOM) and the other is relative to a base year. Since for Macedonia the base year is not yet defined, in this report 1990 and 2005 are used. On the other hand, the total GHG emissions are calculated using the IPCC methodology, but in addition, in order not to use the electricity import (MEMO item) as a mitigation measure, in this report, the emissions from electricity imports are also considered. This is very important for adequately calculating the impact of each measure for Macedonia, as import dependent country. However, with the aim of comparing the result with other countries and for compatibility with the GHG Inventory, the results without the emissions from electricity import are presented.

In this regard, when comparing the results relative to the WOM scenario, the reduction of the total GHG emissions without MEMO are higher (78% in e-WAM in 2030, Figure 48,) than in the case with MEMO (67% in e-WAM in 2030, Figure 49).

FIGURE 48. COMPARISON OF TOTAL GHG EMISSIONS FROM ALL SECTORS IN WOM, WEM, WAM AND E-WAM SCENARIOS, 2030 (IN GG CO_2-EQ)

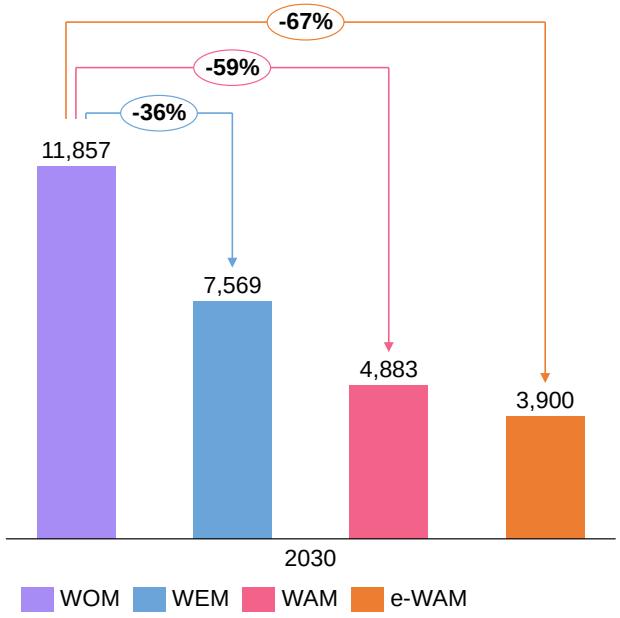
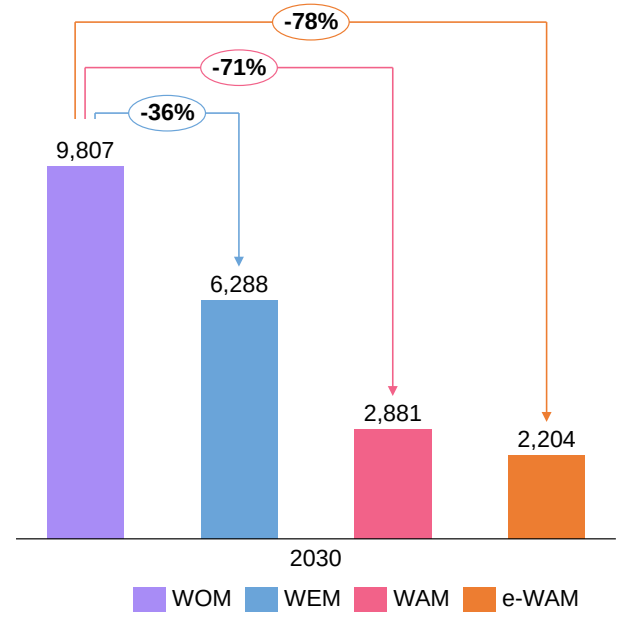


FIGURE 49. COMPARISON OF TOTAL GHG EMISSIONS FROM ALL SECTORS WITHOUT MEMO IN WOM, WEM, WAM AND E- WAM SCENARIOS, 2030 (IN GG CO_2-EQ)



Regarding the comparison of the results relative to a base year, it can be concluded that for Macedonia 1990 is a more suitable year, as there are more GHG emissions in this year compared to 2005, and therefore the reductions will be higher. The highest reduction of the GHG emissions that can be reached in 2030 is 68% (or 82% without MEMO) compared to the 1990 level and it is accomplished by implementing the e-WAM scenario (Figure 50, Figure 51).

FIGURE 50. TOTAL GHG EMISSIONS FROM ALL SECTORS IN WEM, WAM AND E- WAM SCENARIOS IN 2030 COMPARED TO 1990 AND 2005 LEVEL (IN GG CO_2-EQ)

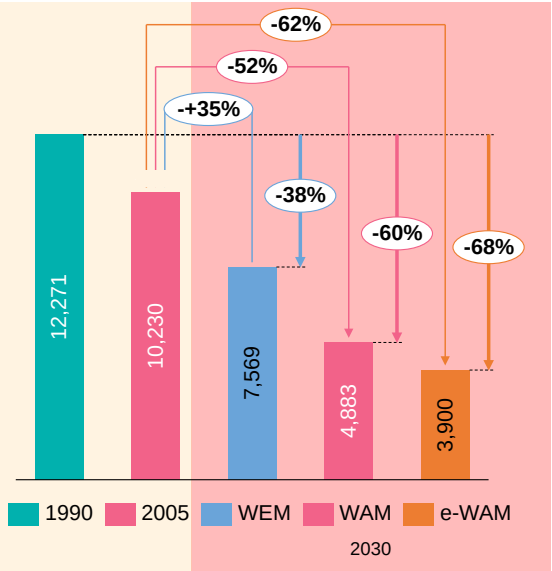
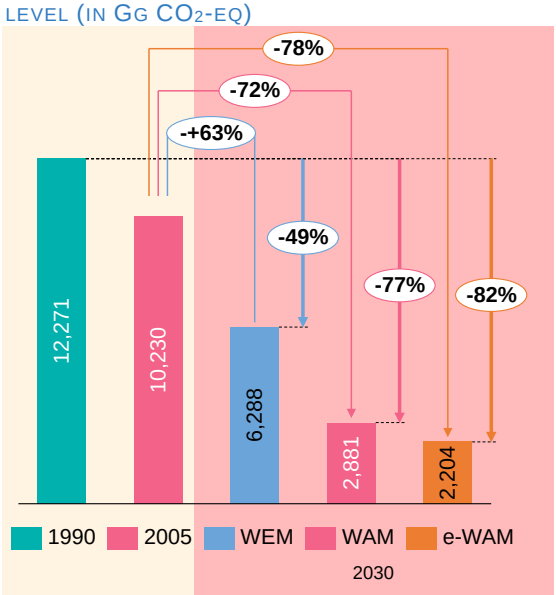


FIGURE 51. TOTAL GHG EMISSIONS FROM ALL SECTORS WITHOUT MEMO IN WEM, WAM AND E- WAM SCENARIOS IN 2030 COMPARED TO 1990 AND 2005 LEVEL (IN GG CO_2-EQ)



For the realization of WEM scenario 13.308 mil. € are needed, of which about 99% are investment in the energy sector. WAM scenario requires additional 45%, while for the realization of e-WAM almost 85% more compared to WEM (Figure 7). The average yearly investments in WEM are approximately 4.8% of the total average annual GDP, while in the e-WAM is 8.8% (Figure 8).

FIGURE 52. INVESTMENTS BY SCENARIOS AND BY SECTORS

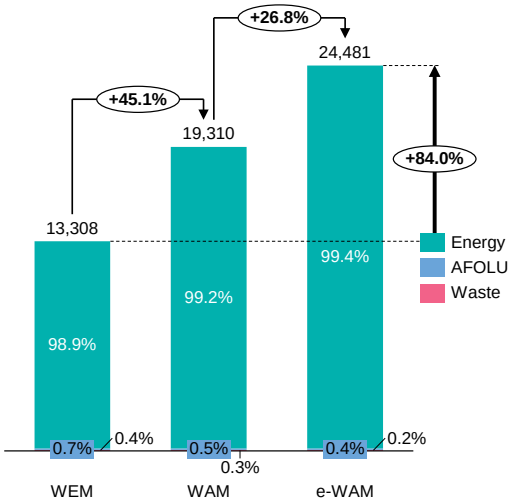
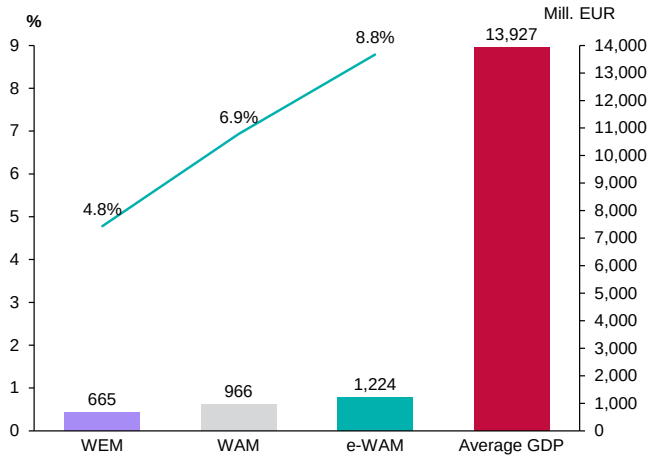


FIGURE 53. ANNUAL INVESTMENTS COMPARED TO AVERAGE GDP



6.2 Comparison of the mitigation scenarios with SBUR

The more ambitious policies and measures proposed in the TBUR doubled the percentage of GHG reductions compared to the SBUR WOM scenario. In absolute terms, in 2030 the emissions in the SBUR WAM scenario were projected to 16,681 Gg CO_2-eq and in the TBUR e-WAM scenario to 3,900 Gg CO_2-eq (Figure 54). This WOM scenario is frozen to the 2017 level, which means that the measures implemented up to 2017 are included and is different compared to the WOM scenario in the SBUR (which was frozen to 2012 level). Besides, the lower GDP growth rate in TBUR (3.3% annually) also plays an important role in the projected results. Furthermore the emissions from the waste sector in TBUR are almost six times lower compared to

SBUR (Figure 55), because of the changes made in the calculation of the waste from the industry (waste generation rate as a percentage from GDP) as part from the GHG inventory preparation process.

FIGURE 54. COMPARISON OF THE RESULTS FROM SBUR WITH TBUR

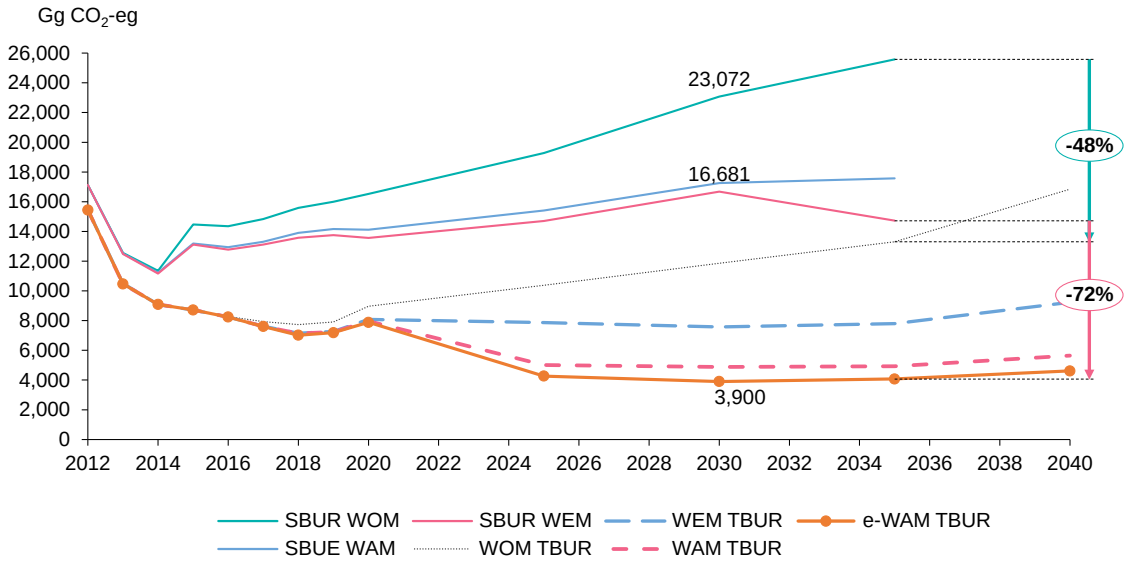
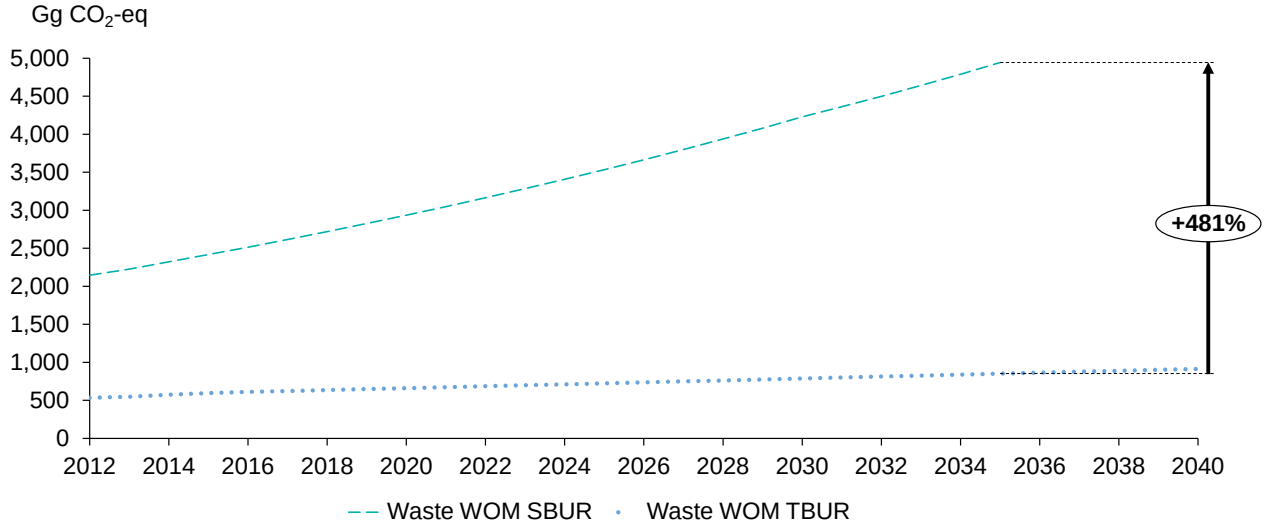


FIGURE 55. GHG EMISSIONS FROM THE WASTE SECTOR, COMPARISON BETWEEN SBUR AND TBUR WOM SCENARIO



6.3 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 are in compliance with the mapping made by EU and EUROSTAT (Table 60).

TABLE 60. 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

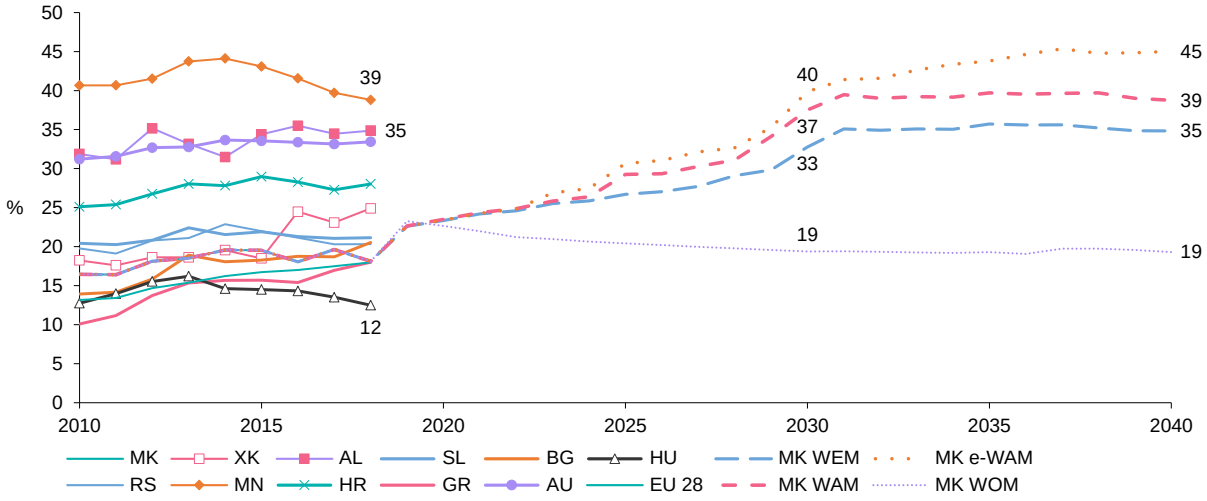
For comparing Macedonian projected progress with the countries from the West Balkan region (Serbia, Kosovo, Montenegro, Bosnia and Herzegovina and Albania), as well as, with some of the EU countries (Greece, Bulgaria, Croatia, Slovenia, Hungary, Austria and EU28) the following indicators are used:

- 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

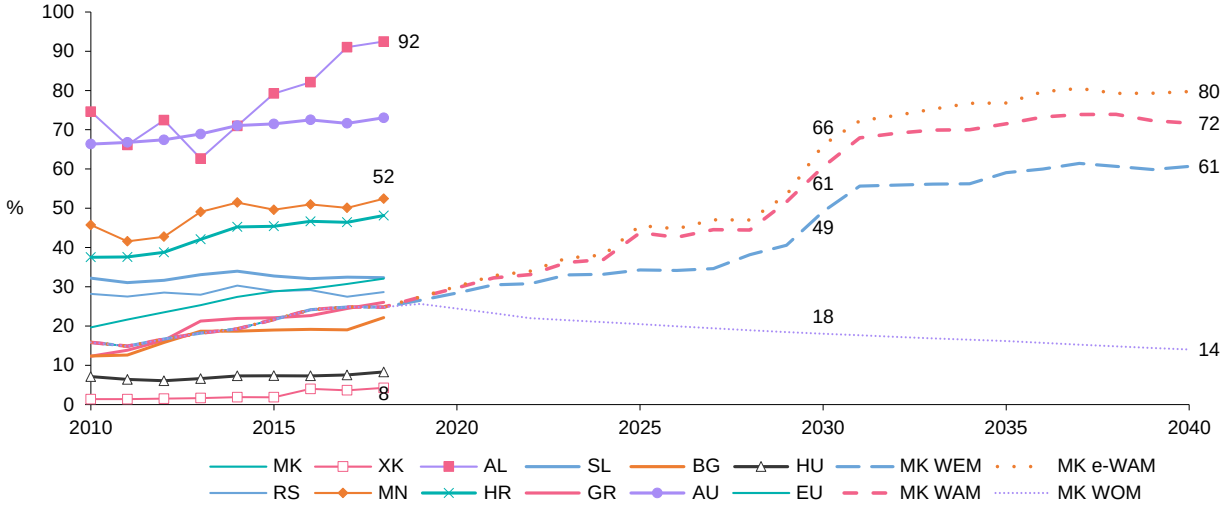
In 2018, the share of RES in the gross final energy consumption in Macedonia is around 18%, which is similar to the RES share at EU28 level (Figure 56), but it has decreased compared to 2017, mainly as a result of the increased consumption in the transport sector. However, the projected investments in RES and energy efficiency will increase the share of RES in the gross final energy consumption up to 45% in the e-WAM scenario, which is 6 percentage points higher compared to the share of Montenegro in 2018 (a country with the highest share in the considered region).

FIGURE 56. RENEWABLE ENERGY SHARE IN THE GROSS FINAL ENERGY CONSUMPTION (IN %)



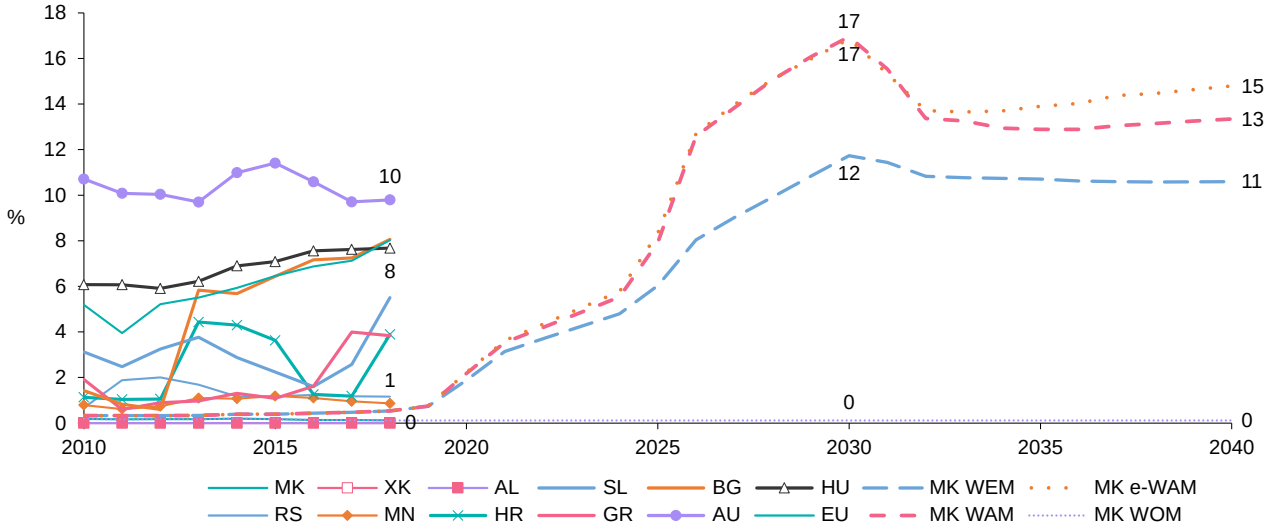
It is projected that the electricity generation in Macedonia will be driven mainly by RES power plants. The investments mainly in PV and wind supported by the hydropower plants, biogas and biomass will significantly increase the RES share in electricity generation, leading to zero carbon from electricity generation. In 2040, this share will achieve 80% in e-WAM (25% in 2018), which is higher than the share of any of the considered countries in 2018 except Albania (Figure 57).

FIGURE 57. ELECTRICITY GENERATED FROM RENEWABLE ENERGY SOURCES (IN %)



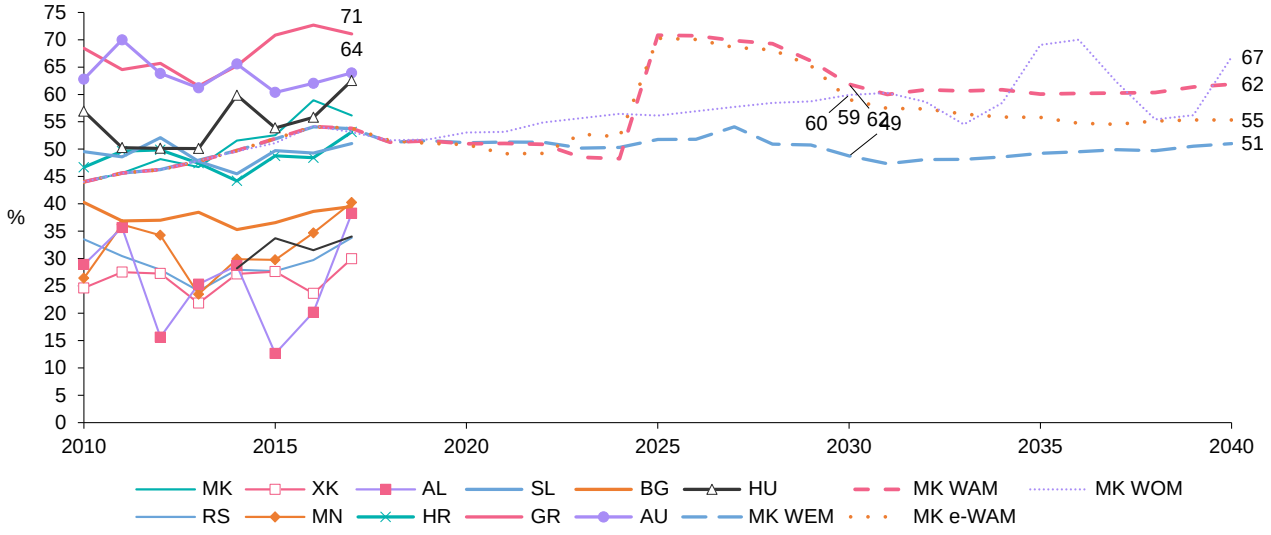
The RES share in the transport, sector, which in 2018 is almost zero, will achieve at maximum 17% in 2030, as a result of biofuels, but also electrification of the transport sector, Figure 58. It is obvious that the consumption in the transport sector is increasing and therefore it is necessary to find 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 58. SHARE OF RENEWABLE ENERGY IN FUEL CONSUMPTION OF TRANSPORT (IN %)



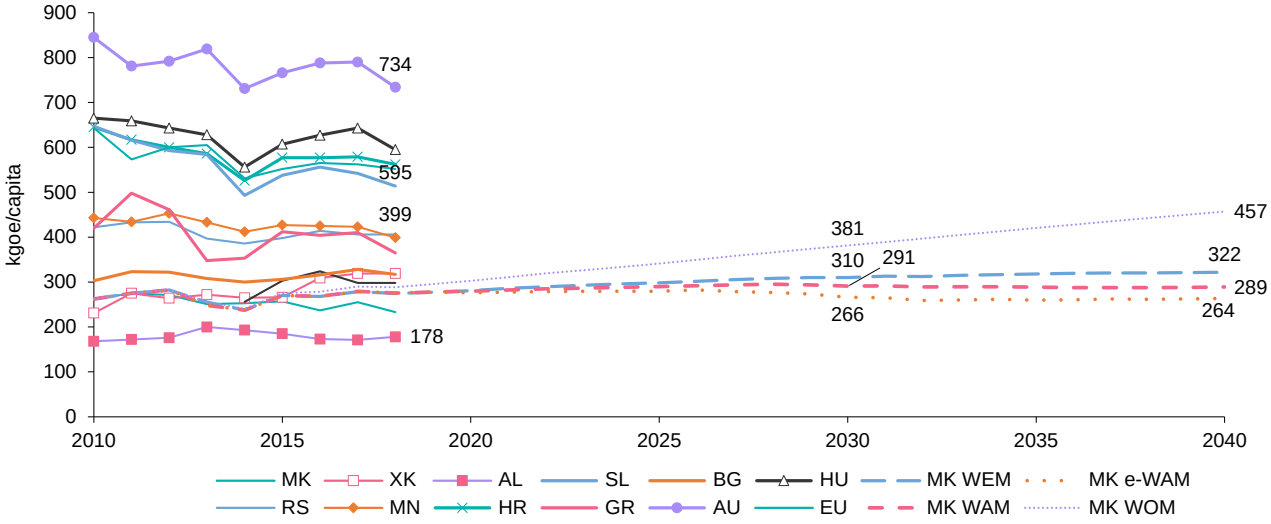
One of the indicators that is important for the security of supply is Energy dependence. The goal of the Energy development strategy up to 2040 is to maintain the energy dependence at the 2017 level (54%). The introduction of CO2 tax with a price higher than 30 €/t can significantly contribute to the 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 55% in the e-WAM scenario (Figure 59), which is similar to the level of Croatia and Slovenia in 2018. Even if part of the existing lignite power plants is replaced with gas power plants, the import dependence will increase (62% in 2040).

FIGURE 59. 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). 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 60. FINAL ENERGY CONSUMPTION IN HOUSEHOLDS PER CAPITA (KGOE/CAPITA)



Macedonia compared to EU countries has lower GHG emissions intensity of energy consumption. The results show that this indicator will be decreased to 36 % in 2040. In the worst case, the level of this indicator will stay almost the same as in 2014 (Figure 61).

When the GHG emissions are expressed relative to the 1990 level, Macedonia is again in a better position than the considered EU countries (Figure 62). However, if none of the proposed policies and measures are implemented, the GHG emissions maybe 30% higher than in 1990. In e-WAM, the GHG emissions in 2040 will be reduced up to 75% compared to the 1990 level, which leads to 1.5 GHG emissions per capita (3.3 GHG emissions per capita in 2018) (Figure 63). In the worst scenario, the GHG emissions per capita in 2040 in Macedonia will approach the EU28 2017 level.

FIGURE 61. GREENHOUSE GAS EMISSIONS INTENSITY OF ENERGY CONSUMPTION, 2000=100 (IN %)

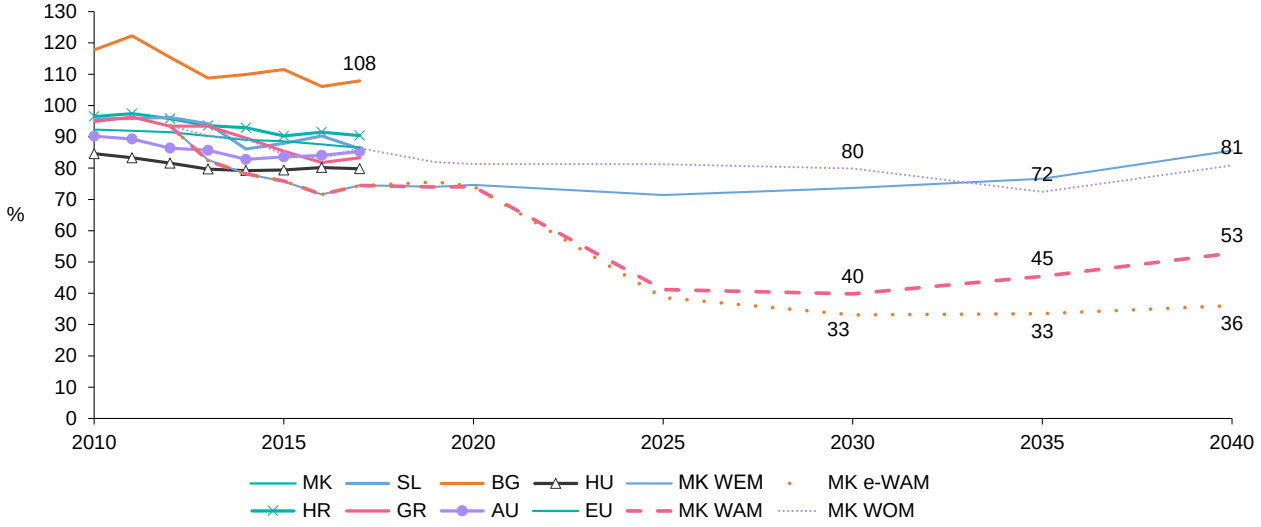
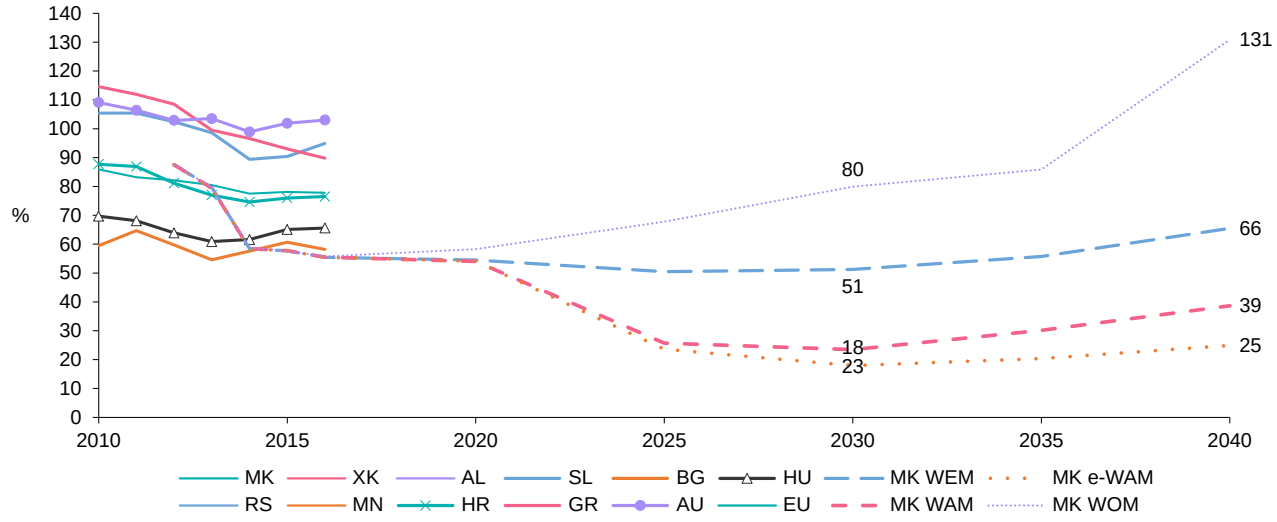
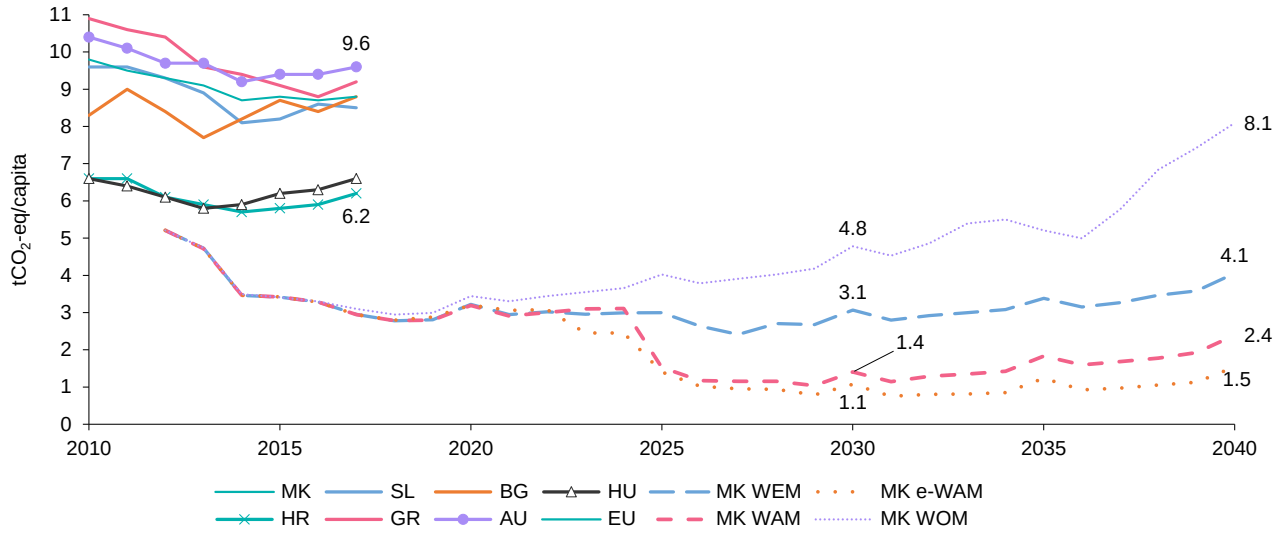


FIGURE 62. COMPARISON OF GHG EMISSIONS IN THE WOM, WEM, WAM AND E-WAM SCENARIOS, 1990=100 (IN %)



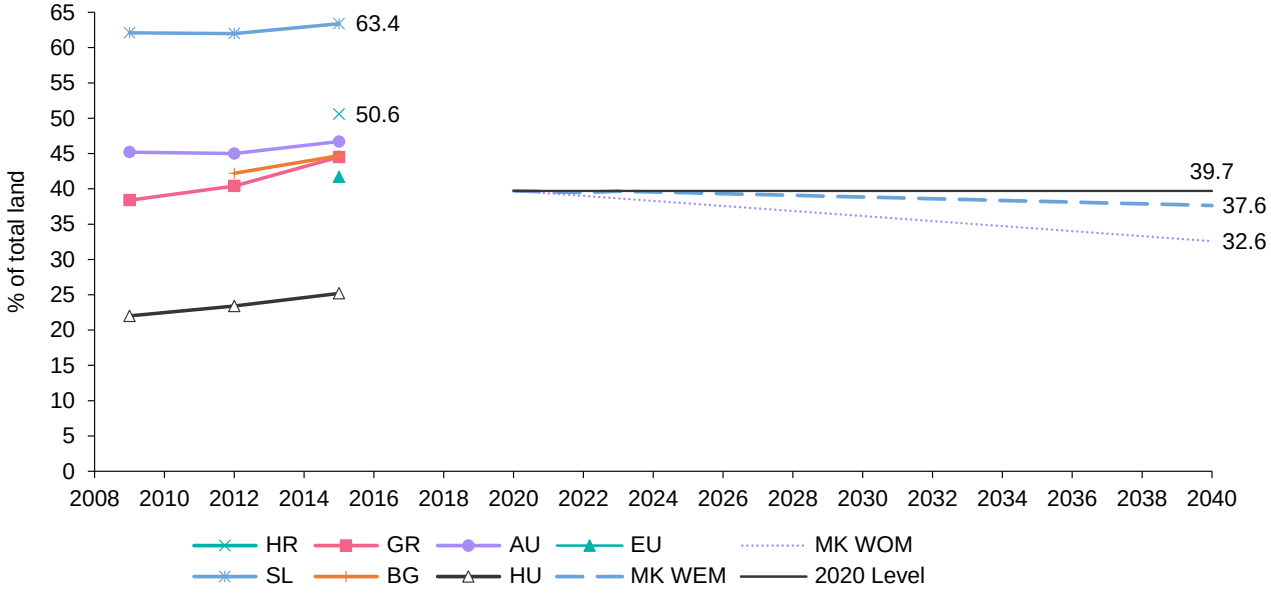
Note: The methodology used for calculating the GHG emissions is based on IPCC (excluding MEMO items)

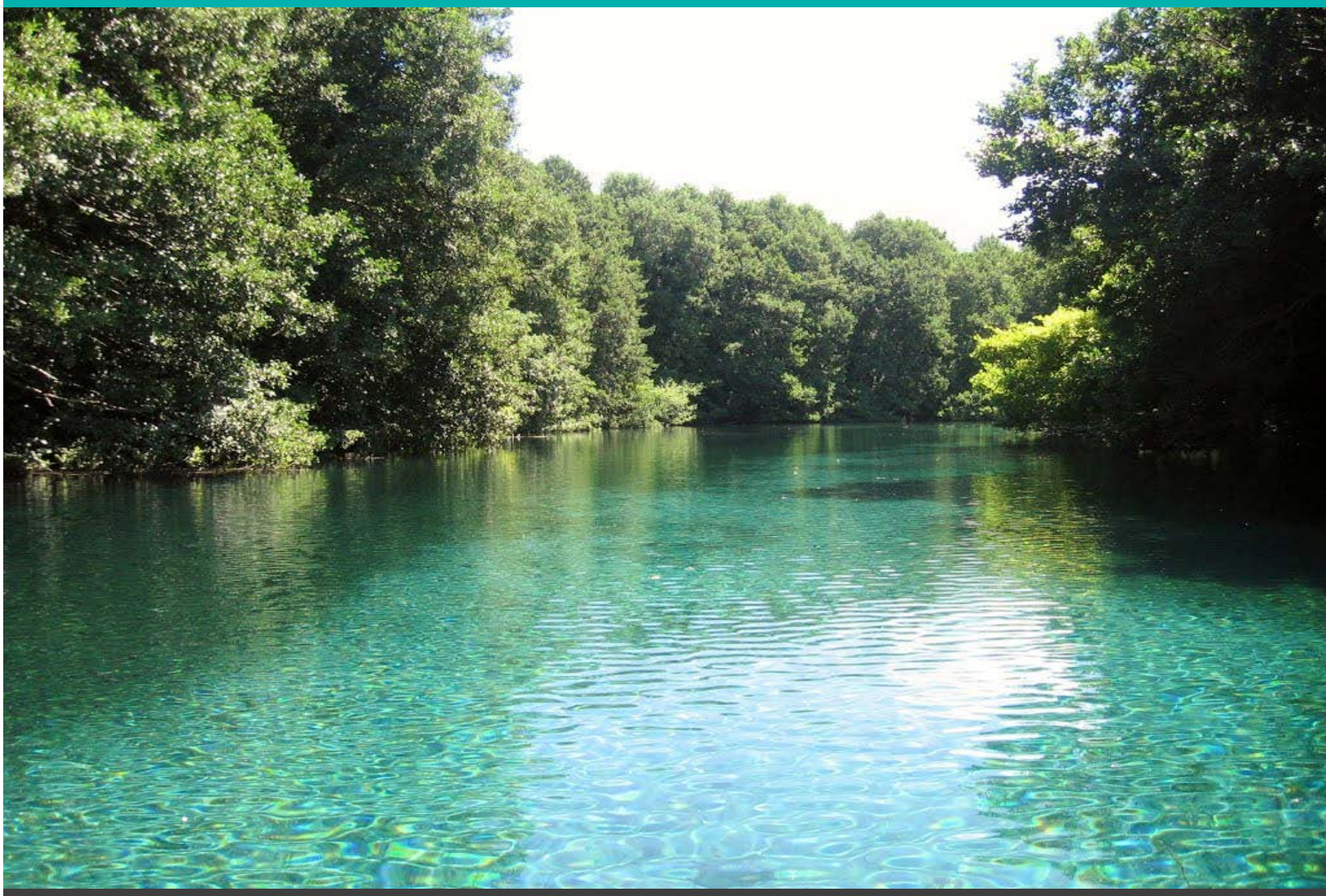
FIGURE 63. GHG EMISSIONS PER CAPITA (T CO2-EQ/CAPITA)



Forest land indicator is calculated for the first time, but it 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%. 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 64. FOREST LAND (% FROM TOTAL LAND)





Action plan

7 Action plan

TABLE 61. ACTION PLAN FOR REALIZATION OF THE SCENARIO WITH EXISTING MEASURES - WEM

Policy/ measure	*Competent entity for realization*	*Type*	*Status*	*Source of finance*	*Indicative emissions reduction (Gg CO_2-eq)*	*Specific costs: (€/t CO2-eq)*	*Budget (mil. €)*	*Green jobs*		
					2030	2030		2030	2035	2040
Reduction of network losses	► Electricity distribution companies ► Heat distribution companies ► Ministry of Economy, Energy Agency	Technical	Ongoing	Distribution and transmission companies	323.4	-31.0	170.0			
Large hydropower plants	► JSC ESM ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency	Technical	Planned	JSC ESM, Public Private Partnership	740.7	9.5	1716.2			
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	Technical, Regulatory	Ongoing	Private sector, consumers of electricity through their bills	149.5	-6.1	356.9	152.0	163.0	181.0
Incentives feed-in premium	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy ► Private investors	Technical, Regulatory	Ongoing	Private sector, incentives from the central government budget	162.6	-3.7	240.6	220.0	220.0	220.0
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	Technical, Regulatory	Ongoing	Private, incentives through consumers bills	21.0	5.0	24.3	21.0	28.0	23.0

Policy/ measure	Competent entity for realization	Type	Status	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	Specific costs: (€/t CO2-eq)	Budget (mil. €)	Green jobs		
					2030	2030		2030	2035	2040
Solar rooftop power plants	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency ► Elektrodistribucija Skopje ► Suppliers of electricity ► Electricity end-users	Technical, Regulatory	Planned	Private, donors, subsidies from national and local budget, EE fund	142.9	-33.0	318.0	443.0	209.0	167.0
RES without incentives	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Economy, Energy Agency ► JSC ESM ► Private investors	Technical, Regulatory	Ongoing	JSC ESM, Private sector	189.2	-6.0	1046.0	1377.0	693.0	669.0
Introduction of CO_2 tax	► Government of the Republic of North Macedonia ► Energy Regulatory Commission ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Ministry of Finance	Regulatory	Planned	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Energy efficiency obligation schemes	► Ministry of Economy ► Distribution system operators ► Suppliers and traders of electricity and gas	Technical, Regulatory	Planned	Consumers through their bills	162.8	-88.7	182.0			
Solar thermal collectors	► Ministry of Economy, Energy Agency ► End-users	Technical	Ongoing	Private, EE fund, incentives from the central government budget, donors	7.2	-60.0	34.8	401.0	495.0	633.0
Labeling of electric appliances and equipment	► Ministry of Economy, Energy Agency ► Producers and suppliers of electrical equipment and household appliances ► End-users	Regulatory	Ongoing	Private, EE fund	56.3	-85.9	71.0			
Increased use of heat pumps	► Ministry of Economy, Energy Agency ► End-users	Regulatory, Policy	Ongoing	Private, EE fund, incentives from the central and local government budget, donors	392.3	-79.9	330.6	38.0	73.0	88.0

Policy/ measure	Competent entity for realization	Type	Status	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	Specific costs: (€/t CO2-eq)	Budget (mil. €)	Green jobs		
					2030	2030		2030	2035	2040
Public awareness campaigns and network of EE info centers	► Ministry of Economy, Energy Agency ► Energy suppliers ► End-users	Information	Ongoing	Private sector, donors, central and local governments	177.0	-107.6	658.0			
Retrofitting of existing residential buildings	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Households	Technical, Regulatory	Ongoing	Private, donors through commercial EE loans, EE fund	49.0	88.6	941.8	1576.0	735.0	8530
Retrofitting of existing central government buildings	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Local self-government ► Municipal public enterprises ► Donors and financial institutions	Technical, Regulatory	Ongoing	Central government budget, donors	12.6	17.5	155.0	87.0	87.0	910
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	Technical, Regulatory	Ongoing	Local self-government budget, donors	13.2	4.9	100.0	77.0	75.0	770
Retrofitting of existing commercial buildings	► Ministry of Economy, Energy Agency ► Ministry of Finance ► Commercial buildings owners	Technical, Regulatory	Ongoing	Private, donors through commercial EE loans, EE fund	98.2	6.3	530.0	482.0	4470	502.0
Construction of new buildings	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Investors (households)	Technical, Regulatory	Ongoing	Private, donors through commercial EE loans, EE fund	19.8	64.6	282.7	553.0	167.0	117.0
Construction of passive buildings	► Ministry of Economy, Energy Agency ► Donors and financial institutions ► Investors (households)	Technical, Regulatory	Ongoing	Private, donors through commercial EE loans, EE fund	17.0	231.2	1068.0	1324.0	2084	1468.0
Phasing out of incandescent lights	► Government of the Republic of North Macedonia ► Ministry of Economy, Energy Agency ► End-users	Technical	Ongoing	Central government budget, private	401.8	61.5	558.0	274.0	425.0	657.0

Policy/ measure	Competent entity for realization	Type	Status	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	Specific costs: (€/t CO2-eq)	Budget (mil. €)	Green jobs		
					2030	2030		2030	2035	2040
Improvement of the street lighting in the municipalities	► Government of the Republic of North Macedonia ► Ministry of Environment and Physical Planning ► Ministry of Economy, Energy Agency ► Local self-government	Technical	Ongoing	Central and local government budget, ESCO	32.5	-73.2	19.5	9.0	12.0	15.0
Green procurements	► Ministry of Economy, Energy Agency ► Public Procurement Bureau ► Local self-government	Regulatory	Ongoing	Central and local government budget	6.6	-61.2	16.0			
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 ► Private investors	Technical, Information	Ongoing	Private, EE fund, incentives from the central and local government budget	9.3	-105.6	3.2			
Energy management in manufacturing industries	► Ministry of Economy, Energy Agency ► Private companies	Regulatory, Technical	Ongoing	Private, donors through commercial EE loans	67.8	-45.7	/			
Introduction of efficient electric motors	► Ministry of Economy, Energy Agency ► Private companies	Technical	Ongoing	Private, donors through commercial EE funds	14.9	-21.7	99.7			
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	Technical	Ongoing	Private, donors through commercial EE loans, EE funds	128.3	-42.1	344.8			
Increased use of the railway	► Government of the Republic of North Macedonia ► Ministry of Transport and Communication ► Ministry of Economy, Energy Agency ► JSC Makedonski zeleznici ► End-users ► Private companies	Technical, Information	Planned	Central government budget	37.2	-286.2	180.6			

Policy/ measure	Competent entity for realization	Type	Status	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	Specific costs: (€/t CO2-eq)	Budget (mil. €)	Green jobs		
					2030	2030		2030	2035	2040
Renewing of the national car fleet	► Government of the Republic of North Macedonia ► Ministry of Transport and Communication ► Ministry of Economy, Energy Agency ► End-users	Regulatory, Policy, Information	Ongoing	Private, EE fund, incentives from the central government budget	24.0	-78.1	1659.5			
Renewing of other national road fleet	► Government of the Republic of North Macedonia ► Ministry of Transport and Communication ► Ministry of Interior Affairs ► Ministry of Economy, Energy Agency ► Private companies	Regulatory, Policy	Ongoing	Private sector	64.6	-80.7	2300.0			
Advanced mobility	► Ministry of Economy, Energy Agency ► Local self-government ► End-users	Regulatory, Technical, Information	Ongoing	Private, EE fund, incentives from the central and local government budget, donors	3.6	-983.0	/			
Construction of the railway to the Republic of Bulgaria	► Government of the Republic of North Macedonia ► Ministry of Transport and Communication ► Ministry of Economy, Energy Agency	Technical, Policy	Ongoing	Central government budget	24.6	270.0	720.0			
Electrification of the transport	► Government of the RM ► Ministry of Transport and Communication ► Ministry of Economy	Regulatory, Policy, Information	Ongoing	Private, EE fund, incentives from the central government budget	41.9	91.8	5058.5			
Reduction of CH4 emissions from enteric fermentation in dairy cows by 3%	► Ministry of Agriculture, Forestry and Water Economy	Livestock, enteric fermentation in dairy cow	Ongoing	Private sector	35.0	0.2	0.2			

Policy/ measure	Competent entity for realization	Type	Status	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	Specific costs: (€/t CO2-eq)	Budget (mil. €)	Green jobs		
					2030	2030		2030	2035	2040
Reduction of N2O emissions from manure management in dairy cows by 20%	► Ministry of Agriculture, Forestry and Water Economy	Livestock, manure management in dairy cow	Planned	Private sector	2.1	13.0	1.0			
Reduction of NO2 emissions from manure management in swine farms by 13%	► Ministry of Agriculture, Forestry and Water Economy	Livestock, manure management in swine cow	Ongoing	Private sector	0.4	77.4	1.0			
Reduction of N2O emissions from manure in dairy cows by 20% for farms below 50 Livestock Units	► Ministry of Agriculture, Forestry and Water Economy	Livestock, manure management in dairy cow	Planned	Private sector	0.7	44.2	1.0			
Establishing integrated management of forest fires	► PE “National forests” ► Ministry of Agriculture, Forestry and Water Economy	Forest fires reduction	Ongoing	PE “National forests”, other forest enterprises	345.0	-9.3	1.5			
Afforestation	► PE “National forests” ► Ministry of Agriculture, Forestry and Water Economy	Afforestation of Barren Land	Ongoing	PE “National forests”, other forest enterprises	312.5	1.3	7.8			
Conversion of land use of field crops above 15% inclination	► Ministry of Agriculture, Forestry and Water Economy	Land management and land use change in the category of cropland	Ongoing	Private sector	3.7	21.0	1.5			

Policy/ measure	Competent entity for realization	Type	Status	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	Specific costs: (€/t CO2-eq)	Budget (mil. €)	Green jobs		
					2030	2030		2030	2035	2040
Contour cultivation on areas under field crops on inclined terrains (5-15%)	► Ministry of Agriculture, Forestry and Water Economy	Land management and land use change in the category of cropland	Ongoing	Private sector	28.0	2.0	1.0			
Perennial grass in orchard and vineyards on inclined terrains (>5%)	► Ministry of Agriculture, Forestry and Water Economy	Land management and land use change in the category of cropland	Ongoing	Private sector	8.9	5.9	1.0			
Use of biochar for carbon sink on agricultural land	► Ministry of Agriculture, Forestry and Water Economy	Land management of the category of cropland	Planned	Private sector	110.0	30.5	47.0			
Photovoltaic irrigation	► Ministry of Agriculture, Forestry and Water Economy	Agriculture – irrigation replacing fossil energy with renewables	Ongoing	Private sector	93.3	36.0	47.0			
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)	Technical	Ongoing	Local self-government through Public Utilities, Public Private Partnership, Grants from the EU	489.7	1.4	20.5			
Mechanical and biological treatment (MBT) in new landfills with composting	► Ministry of environment and physical planning ► Public utilities ► Inter-municipal board for waste management	Technical	Ongoing	Local self-government through Public Utilities, Public Private Partnership, Grants from the EU	108.0	12.8	36.1			

Policy/ measure	Competent entity for realization	Type	Status	Source of finance	Indicative emissions reduction (Gg CO_2-eq)	Specific costs: (€/t CO2-eq)	Budget (mil. €)	Green jobs		
					2030	2030		2030	2035	2040
Selection of waste - paper	► Ministry of environment and physical planning ► Public utilities ► Inter-municipal board for waste management	Technical	Ongoing	Local self-government through Public Utilities, Public Private Partnership, Grants from the EU	62.5	2.1	2.0			
Improved waste and materials management at industrial facilities	► Ministry of Environment and Physical Planning ► Municipalities and city of Skopje ► State Environmental Inspectorate ► Inter-Municipal Waste Management Board ► Authorized Inspectors of Environment (Municipalities)	Regulation, Technical	Planned	Ministry of Environment and Physical Planning Municipalities and city of Skopje Industrial facilities	3.3	0	0			

8 Recommendations

- The main recommendation is the development of an integrated tool that will encompass all sectors that will enable integrated modeling of all policies/measures.
- Develop a MARKAL model with the possibility of calculating local emissions.
- Upgrading the Industrial Processes and Product Use sector tool, developed as part of this project, with the ability to model climate change mitigation measures.
- Visualization of the results for greater awareness of the citizens and politicians.
- Visualization of the results for greater awareness of the citizens and politicians.
- Establish systematic support for research on mitigation measures in the AFOLU sector, their effect on productivity and production, the possible benefits, or adverse effects, as well as adaptation of the measures for the national circumstances.
- Establish systematic support for the research activities on establishing the national indicators, national emissions factors, and other required datasets for creating the good quality data pool for boosting the research and modelling activities
- Establishing of the experimental research station for research, modification to the national circumstances and promotion of the mitigation (and adaptation) measures targeted toward national capacity building for mitigating (and adapting to) climate change in AFOLU sector
- Development of set of indicators, monitoring and evaluation capacities as well as promotion and support of mitigation measures implementation within the agriculture and rural development policy programs in close cooperation with the Ministry of Agriculture, Forestry and Water Economy (MAFWE).Particular importance should be given for integrating mitigation measures in IPARD program as Agro-environmental measures where possible
- Development the system for training of the farmers, their awareness raising, capacity building and increasing their know-how for implementation of the mitigation measures)
- Increasing the importance of the MAFWE in the activities related to GHG mitigation in the AFOLU sector and their involvement in all stages of the measures designing, promotion and implementation.
- Improvement of the framework for and creating the enabling environment for implementation of the agro-forestry measures
- Conducting activities for proper utilization of the residual biomass in AFOLU sector, putting the emphasis on soil organic matter turnover, improving the soil health and resilience to climate change by selecting the mitigation measures that will increase the carbon stock into the soil
- Conducting activities for multisectoral approach in designing the mitigation measures in AFOLU sector, particularly interaction with energy sector (utilization of biomass for energy production, growing of bioenergy crops, rural development by electricity (energy) production in rural areas etc.)
- Joining the “4 per 1000” initiative for increasing the activities for enrichment of the soils with organic matter, therefore, increasing the utilization of the soil potential for carbon sequestration.
- Establish the monitoring net in the forest for long term monitoring of the climate change and its impact on the forest and forestry. There is no existing net of plots/units in the forest for long term monitoring of the climate change and its impact of the forest and forestry, using appropriate methodology for that purpose. This is one of the main preconditions for creating proper policies and measures for mitigation and adaptation in the forest
- Making Mitigation Assessment More Gender Responsive. It requires a contextual analysis of the needs, priorities, roles and experiences of women and men, as well as the integration of specific actions to address any gender inequalities that may have emerged from that analysis.
- Ensure Gender Responsive Mitigation Planning. Mitigation measures and policies (where applicable) have to be developed considering the gender perspective.
- Monitor. Gender sensitive indicators should be developed during the planning phase in order to secure that the progres and results will be properly monitored and evaluated during and after the implementation of the projects.

9 Appendix

TABLE 62. KEY DATA SOURCES

		Sources	
Area	**Assumption**	**Historical**	**Projections**
Demand	Macedonia GDP projections	Gov. of Macedonia, IMF, own estimation	
	Population growth	State Statistical Office	UN
	Transport and industry	State Statistical Office	*MAKRAL model calculation*
	Energy balance	State Statistical Office	*MAKRAL model calculation*
	Technology specs	State Statistical Office	IEA-ETSAP, market analysis
	Macedonia electricity demand	MEPSO	*MARKAL model calculation*
	Rest of Europe demand	ENTSO-E, Eurostat	ENTSO-E TYNDP '18 (ST scenario)
Generation	Macedonia installed capacities	ELEM, MEPSO, ERC	ELEM / working groups
	Macedonia technology specs	ELEM, MEPSO, ERC, BEG, TETO	ELEM / working groups
	Rest of Europe installed capacities	ENTSO-E, Eurostat	ENTSO-E
	Rest of Europe technology specs	Eurostat, ENTSO-E	ENTSO-E, Energy Brainpool
ETS entrance	Macedonia	Working group	
	Other non-EU countries		
Commodity prices	Commodity prices	EEX, BAFA, Nordpool, EIA, ERC, HUPX	IEA World Energy Outlook 2017
	Projections for lignite price	ELEM, Model estimation	
Fuel Supply / Availability (incl. electricity)	Lignite supply availability	ELEM	ELEM, model estimation
	Cross Border Capacities	MEPSO, GAMA, MER	ENTSO-E TYNDP 2018, GAMA, MER
	CO_2 and Local Pollutants emission rates	ELEM, team analysis	
	Current wholesale electricity & gas prices	ERC	

TABLE 63. SPECIFIC COSTS AND REDUCTION PER MEASURES

		Emission reduction	
Reduction option	**EUR/tCO$_2$**	**Per measure (Gg)**	**Added (Gg)**
Advanced mobility	-983	4	4
Increased use of the railway	-286	37	41
Renewing of the national car fleet WAM	-118	24	65
Increased use of central heating systems	-106	9	74
Public awareness and (EE) info centers WAM	-100	177	251
Biofuels	-89	211	462
Energy efficiency obligation schemes	-89	163	625
Labeling of electric appliances and equipment	-86	56	681
Renewing of other national road fleet WAM	-83	65	746
Improvement of the street lighting in the municipalities WAM	-74	32.5	778
Solar thermal collectors WAM	-73	7	785
Increased use of heat pumps WAM	-65	392	1177
Phasing out of incandescent lights WAM	-62	402	1579
"Green procurements" WEM	-61	7	1586
Introduction of more advanced technologies WAM	-48	128	1714
Energy management in manufacturing industries	-46	68	1782
Solar rooftop power plants WAM	-33	143	1925
Reduction of network losses	-31	323	2248
Introduction of efficient electric motors WAM	-25	15	2263
Large hydro power plants	-9	741	3004
Establishing integrated management of forest fires	-9	345	3349
Incentives Feed-in tariff	-6	150	3499
Incentives Feed-in tariff	-6	149.5	3648
RES without incentives WAM	-6	189	3837
Improved waste and materials management at industrial facilities	0	18	3855
Reduction of CH4 emissions from enteric fermentation in dairy cows by 3%	0	64	3918
Selection of waste - paper	1	110	4028
Lanfill gas flaring	1	552	4580
Afforestation 5000 ha with oak	1	313	4893
Contour cultivation on areas under field crops on inclined terrains (5-15%)	2	28	4921
Retrofitting of existing local self-government buildings WAM	5	13	4934
Biomass power plants (CHP optional)	5	21	4955
Perennial grass in orchard and vineyards on inclined terrains (>5%)	6	9	4964
Mechanical and biological treatment (MBT) in new landfills with composting	6	109	5073
Retrofitting of existing commercial buildings e-WAM	6	98	5171
Reduction of N2O emissions from manure management in dairy cows by 20%	13	4	5175
Retrofitting of existing central government buildings WAM	17	13	5188
Retrofitting of existing central government buildings e-WAM	17	19	5207
Conversion of land use of field crops above 15% inclination	21	4	5211
Use of biochar for carbon sink on agricultural land	31	110	5321
Photovoltaic Irrigation	36	93	5414
Electrification of the transport WAM	41	42	5456
Reduction of N2O emissions from manure in dairy cows by 20% for farms below 50 Livestock Units	44	1	5457
Construction of new buildings WAM	65	20	5477
Reduction of NO2 emissions from manure management in swine farms by 13%	77	1	5478
Retrofitting of existing residential buildings WAM	79	49	5527
Construction of passive buildings WAM	231	17.0	5544
Construction of the railway to Republic of Bulgaria	270	25	5568