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List of Experts

Project personnel for coordination of the process:
Ms Maja Azievska (M.Sc.), Project Manager
Ms Pavlina Zdraveva, Project Assistant

National climate change focal point:
Ms Teodora Obradovic Grncarovska (M.Sc.)

National GHG Inventory

Coordination
Acad. Jordan Pop-Jordanov
Acad. Tome Bosevski
Dr. Natasa Markovska

Energy
Acad. Tome Bosevski
Dr. Mirko Todorovski
Dr. Risto Filkoski

Industry
Dr. Bosko Nikov
Dr. Trajce Stafilov

Agriculture
Dr. Vladimir Dzabirski
Dr. Dusko Mukaetov

LUCF
Dr. Ljupco Nestorovski
Dr. Nikola Nikolov

Waste
Dr. Trajce Stafilov
Dr. Bosko Nikov

Climate Change Mitigation

Coordination
Acad. Tome Bosevski
Acad. Jordan Pop-Jordanov
Dr. Natasa Markovska

Electric Power
Acad. Tome Bosevski
Dr. Anton Causevski
Dr. Mirko Todorovski

Industry and Heating
Dr. Risto Filkoski
Dr. Anton Causevski
Dr. Ilija Petrovski

Transport
Dr. Risto Filkoski
Dr. Anton Causevski
Dr. Ilija Petrovski

Waste
Dr. Josif Tanevski
Dr. Nataša Markovska
Ms Verica Taseska (Dip. Eng.)

Agriculture
Dr. Ordan Cukaliev
Dr. Nataša Markovska
MsVerica Taseska (Dip. Eng.)

Vulnerability and Adaptation to Climate Change

Climate and Climate Scenarios
Dr. Klemen Bergant
Mr. Pece Ristevski (M.Sc.)
Ms Nina Aleksovska (M.Sc.)
Ms Suzana Alcinova Monevska (M.Sc.)

Agriculture
Dr. Ordan Cukaliev
Dr. Dusko Mukaetov
Dr. Sreten Andonov
Mr.Pece Ristevski (M.Sc.)
Mr. Ivan Micev (Dip. Eng.)

Biodiversity
Dr. Vlado Matevski

Forestry
Dr. Nikola Nikolov

Health
Dr. Vladimir Kendrovski

Water Resources
Dr. Katerina Donevska

Compilation of the SNC
Dr. Natasa Markovska

Technical Support
Ms Verica Taseska (Dip. Eng.)

ABBREVIATIONS

ADA	Austrian Development Agency
AWMS	Animal Waste Management System
CARDS	Community Assistance for Reconstruction, Development, and Stabilization
CC	Combined Cycle
CCFAP	Climate Change Framework Action Plan
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
CIS	Commonwealth of Independent States
CNG	Compressed Natural Gas
COP	Conference of the Parties
CORINAIR	Methodology for preparation of national inventories of atmospheric emissions
CVD	Cardiovascular Diseases
DNA	Designated National Authority
DOC	Degradable Organic Component
EATD	Emission Allowance Trading Directive
EE	Energy Efficiency
EIA	Environmental Impact Assessment
ERC	Energy Regulatory Commission
EU CAP	EU Common Agriculture Policy
FAO	Food and Agriculture Organization
FNC	First National Communication to UNFCCC
GACMO	GHG Costing Model
GCM	Global Circulation Model
GEF	Global Environmental Facility
GHG	Greenhouse Gases
HIF	Health Insurance Fund
HMS	Hydro-Meteorological Service
HPP	Hydropower Plant
IMF	International Monetary Fund
IAEA	International Atomic Energy Agency
IPARD	Instruments for Pre-Accession Assistance for Rural Development
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
LEAP	Long-range Energy Alternatives Planning System
LFG	Landfill Gas
LPG	Liquefied Petroleum Gas
LPIS	Land Parcel Identification System
LUCF	Land Use Change and Forestry
MED-HYCOS	Mediterranean Hydrological Cycle Observing System
MIKE SHE	Integrated Hydrological Modelling System
MOAFWE	Ministry of Agriculture, Forestry, and Water Economy
MOE	Ministry of Economy
MOEPP	Ministry of Environment and Physical Planning
MOES	Ministry of Education and Science
MOF	Ministry of Finance
MOH	Ministry of Health
MOI	Ministry of Interior
MOTC	Ministry of Transport and Communications
MSW	Municipal Solid Waste
NCCC	National Climate Change Committee

NCSU	National Communications Support Unit
NEAP	National Environmental Action Plan
NEHAP	National Environmental Health Action Plan
NGO	Non-Governmental Organization
NIR	National Inventory Report
NSSD	National Strategy for Sustainable Development
OPTIM	Optimization programme
O&M	Operation and Maintenance
POP	Persistent Organic Pollutants
QA/QC	Quality Assurance/Quality Control
REC	Regional Environmental Centre
RES/REN	Renewable Energy Sources/Renewables
RIHP	Republic Institute for Health Protection
RIMSYS	River Monitoring System in Macedonia
R&D	Research and Development
SAA	Stabilization and Association Agreement
SSO	State Statistical Office
SOM	Soil Organic Matter
STRiM	System for Transnational Environmental Risk Management
SWDS	Solid Waste Disposal Site
TPP	Thermal Power Plant
ULSG	Units of Local Self-Government
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
WASP	Wien Automatic System Planning
WEC	World Energy Council
WMO	World Meteorological Organization

Chemical Symbols

CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
CH_4	Methane
HFCs	Hydrofluorocarbons
N_2O	Nitrous oxide
NO_x	Nitrous oxides
NMVOCs	Non-methane volatile organic compounds
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride
SO_x	Sulphur oxides

Contents

EXECUTIVE SUMMARY

1.

1. EXECUTIVE SUMMARY

1.1. National Circumstances

Country Profile

Location	Southern Europe, central part of the Balkan Peninsula, 41° 50'N, 22° 00'E; 25,713 km^2.
Landforms	Macedonia is an elevated plateau of large, rolling hills and deep valleys, completely bisected and surrounded by mountains. The Dinaric Alps extend down into Macedonia, the highest point being in the Korab Mountain range, at 2,764 m. Major lakes include Ohrid (deepest lake in the Balkans), Prespa, and Dojran. The River Vardar divides the country; other rivers of note include the Bregalnica and the Crna.
Climate	Different climatic types and subtypes are a combination of three major climate drivers: Mediterranean, Continental, and Alpine.
Population	2,037,000 (2005) – Macedonian 64%, Albanian 25%, Turkish 4%, Roma 3%, Serb 2%, Bosniaks 0.5%, Vlachs 0.5%, Others 1% (Census 2002). **Languages**: Macedonian, Albanian, Turkish, Serbian. **Religion**: Orthodox 67%, Muslim 30%.
Politics	Parliamentary democracy; distribution of powers into the legislative (Parliament), the executive (the President of the Republic, the Government), and the judicial.
Economy	GDP: USD 4.5 billion (2005). GDP per head: USD 2,226.00 (2005). Annual growth: GDP growth of 3.8% (2005). Inflation: 0.5% (2005). 'Doing Business', 2008 report (World Bank and International Finance Corporation) ranked Macedonia as fourth in the list of the top reformists in the field of economy; Transparency International in 2007 ranked Macedonia 84th according to the corruption perceptions index.

Climate Change-related Institutional and Policy Framework

UNFCCC Focal Point & DNA for CDM	Ministry of Environment and Physical Planning – MOEPP (MOEPP is also Designated National Authority – DNA for the Clean Development Mechanism).
Other Stakeholders	National Climate Change Committee, Climate Change Project Office, UNDP, GEF, academic sector, NGOs, independent experts, international experts/Institutions, private sector, media.
International Agreements	UNFCCC (ratified December 1997) and Kyoto Protocol (July 2004); Macedonia is a non-Annex I Party (i.e., party not included in Annex I) to the Convention.
National Strategic Documents	The First National Communication on Climate Change (March 2003); National Strategy for the First Commitment Period 2008-2012 according to the Kyoto Protocol (February 2007); National Strategy on Environmental Investments (to be adopted by the end of 2008).

Development Priorities and Objectives

National	National Strategy for Sustainable Development; Second National Environmental Action Plan.
International (EU integration)	Transposition and harmonization of EU legislation and implementation of the Stabilization and Association Agreement.

1.2. National Greenhouse Gas Inventory

The national greenhouse gas (GHG) inventory has been prepared for the years 1999-2002 (with 2000 as the base year), and covers the following **sectors**: energy, industrial processes, agriculture, land-use change and forestry, waste, and, for the first time, solvents and other product use. Six **GHGs covered** by the UNFCCC are considered: CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. Besides these, information on indirect GHGs - CO, NO_x, SO_x, and NMVOCs – is provided.

The **total CO_2-eq emissions** in Macedonia for the period 1990-2002 range from 11.9 to 14.4 Mt CO_2-eq. Emissions for the base year 2000 amount to 14,318 kt CO_2-eq, i.e. **7.16 t CO_2-eq per capita**. The **main contributor** to the total CO_2-eq emissions is the energy sector with about 70% of the total emissions. The second biggest contribution comes from the agricultural sector with about 10-15%, while all other sectors are contributing

with less than 10% each. The only exception is in the year 2000, when due to enormous forest fires, the emissions from the LUCF sector were about 14% of the total national emissions. About 75-80% of the equivalent emissions are direct CO_2 emissions from burning, 12-14% are CH_4 emissions, 5-9% are N_2O emissions, and about 2% are CO emissions. Figure 1 shows the contribution of the individual sectors and GHGs to the total CO_2-eq emissions for the base year (2000).

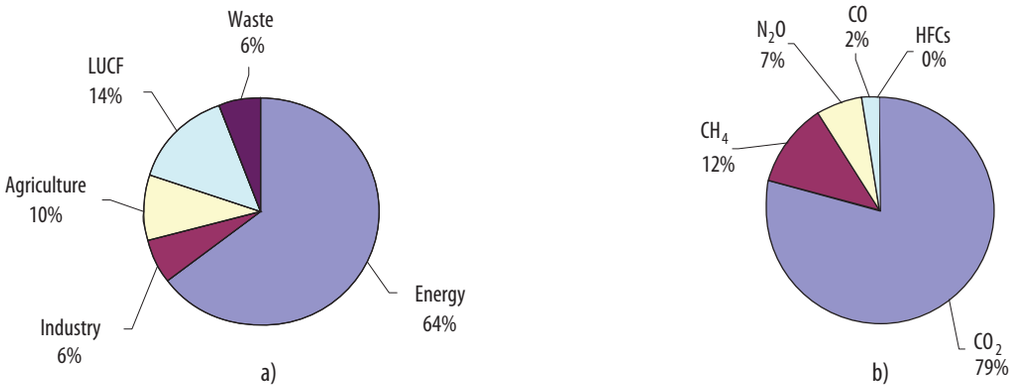


Figure 1. Sectoral contribution
(a) and GHGs' contribution (b) to overall emissions for the year 2000

It is shown that the most important key source in Macedonia is the energy industry (51.3%), which accounts for the GHG emissions from the lignite-fired power plants. The other key sources, which considerably lag behind, are: road transport (7.4%), solid waste disposal on land (6%), enteric fermentation (4.4%), agricultural soils (2.9%), cement production (2.9%), and manufacturing industries and construction (2.9%).

The **uncertainty** relating to GHG emissions from the energy sector is estimated at 8.45%, while specifically for the major key source – the energy industry – it amounts to 10.75% (having in mind the uncertainty of the input data, the estimated percentages are acceptable).

In general, **considerable progress** has been achieved in both, the i**nventory process itself** (strengthening the technical capacity of the inventory team, improving communication with data sources and other stakeholders, promotion of QA/QC procedures, documenting and archiving, regional cooperation), as well as the **results obtained** from the GHG inventorying conducted for the SNC (reliable data series for GHG emissions). However, there is still much room for improvements in order to enable application of higher-Tier methods in the subsequent inventories. The **methodological and technical recommendations** involve:

- Developing country-specific lignite-conversion and CO_2-emission factor and CO-emission factor for lignite thermal power plants and lignite mines in Macedonia, as well as CH_4-emission factors for the fugitive emissions;
- Categorizing the combustion technologies in the non-energy industries (manufacturing industries and construction – industrial boiler plants and energy systems, district heating plants, etc., transport, commercial institutional and residential, etc.) and determination of category-specific emission factors;
- Incorporating the GHG emissions in the reporting scheme of the A and B IPPC installations;
- Developing CO_2 emission factors for metal production and cement production and improving the reliability of the relevant activity data;
- Establishing a farm register and Integrated Administration & Control System (IACS), for reliable agricultural statistics (including the population number of goats, mules, and asses and practical measurements of some of the country's livestock characteristics;
- Developing a new forestry inventory including reliable data on wood decay, forest fires, and illegal logging;
- Collecting data on the quantity and composition of the waste disposed at least at the bigger solid waste disposal sites.

Furthermore, **a set of institutional and legislative measures** needs to be undertaken in order to further develop the national capacity for archiving and updating the GHG inventory. Deeper involvement of national institutions obliged for data collection (the State Statistical Office) is of crucial importance in order to make adjustments of the data collection methodology, aiming to cover identified GHG-related data. Adoption of a secondary legislation will improve the data management process, concerning data supply, processing, systematization, archiving both from the monitoring networks, as well as in accordance with the ratified international agreements. For mutual benefit, it is necessary to ensure linkages between GHG inventory and other pollutants' inventories/cadastre, such as the Air Pollutants and Cadastre of Polluters.

Seen **in the light of EU accession**, the more sophisticated GHG inventory will contribute towards providing a background for establishment of a national registry system, which will be a country requirement. Before starting the designing process, a few amendments to the existing framework, the Law on Environment and to the Law on Energy, are necessary in order to create background for creation of a Law on GHG Allowance Trading and to transpose the Emission Allowance Trading Directive (EATD) into national legislation and for establishment of a Scheme for GHG Emission Allowance Trading. In that line, introduction of a learning-by-doing "pilot phase" for Emissions' Trading for a two-year period, aiming to strengthen capacities of the local authorities and companies, which for the implementation of the system will be very helpful.

1.3. Vulnerability and Adaptation to Climate Change

1.3.1. Climate Change Scenarios up to 2100

Information on climate variability up to 2006 is based on the comparative analysis of two thirty-year series, i.e. 1961-1990 in comparison with 1971-2000. The period 1971-2000 was annually warmer than the period 1961-1990 in almost all climate areas in the country, while mean monthly temperatures varied during the year. Winter and summer months were warmer in comparison with the period 1961-1990. Despite this, autumn and summer months were colder compared to the previous thirty-year period. The highest values of mean annual deviations of the air temperature in the Republic of Macedonia appear in the region with sub-Mediterranean climate (Valandovo 0.7 °C, Gevgelija 0.5 °C, and Nov Dojran 0.2 °C).

The quantity of the annual sum of precipitation for the 1971-2000 period at all meteorological stations in the Republic of Macedonia decreased in comparison with the 1961-1990 period. The decrease was most pronounced at the meteorological stations at Mavrovi Anovi (to -96.6 mm) and Popova Sapka (to -108.0 mm), i.e. in regions with subalpine and alpine climates.

Climate change projections of the main climate elements (temperature and precipitation) have been made up to the year 2100, i.e. for the periods 1996-2025 (labelled 2025), 2021-2050 (labelled 2050), 2050-2075 (labelled 2075), and 2071-2100 (labelled 2100) in comparison with 1961-1990 (reference period labelled 1990). Results of four Global Circulation Models (GCMs) were used together with the NCEP/NCAR reanalysis data (Kalnay et al., 1996; Kistler et al., 2001). In addition, local climate scenarios were developed for the first time according to national climate sub-regions, by further scaling to other marker SRES emission scenarios (A1T, A1b, A1FI, B1) using the pattern scaling method (Mitchell, 2003).

According to the results, **the average increase of temperature** is between 1.0°C in 2025, 1.9°C in 2050, 2.9°C in 2075, and 3.8°C in 2100, while t**he average decrease of precipitation** ranges from -3% in 2025, -5% in 2050, -8% in 2075 to -13% in 2100 in comparison with the reference period.

Table 1: Projected changes of average daily air temperature (°C) and precipitation for the Republic of Macedonia based on direct GCM output interpolated into geographic location 21.5°E and 41.5°N with regards to the period 1990

	Changes of temperature (°C)				Changes of precipitation (%)			
	ANNUAL				ANNUAL			
Sensitivity	2025	2050	2075	2100	2025	2050	2075	2100
Low	0.9	1.6	2.2	2.7	-1	-2	-4	-5
Mean	1.0	1.9	2.9	3.8	-3	-5	-8	-13
High	1.1	2.1	3.6	5.4	-6	-7	-12	-21

The largest increase of air temperature in the Republic of Macedonia is expected in the summer season, associated with a strong decrease in precipitation. Almost no change in precipitation is expected for the winter season in general, but a decrease is expected in all other seasons. Nevertheless, the scientists agree that if the temperature rises above the threshold of 2°C, human development risks will increase along with ecological disasters.

According to the comparison of the results from the empirical downscaling and the direct GCM output, local projections show a more intensive increase in air temperature in winter and spring. In addition, local projections show a less severe decrease of precipitation in the summer season. The projected air temperature change is most intensive in the three climatic subtypes in the north-western part of the country under a dominant alpine climate influence, presented by the meteorological stations at Lazaropole, Popova Sapka, and Solunska Glava.

Although empirical downscaling projections of climate change on a local level (developed for the first time) contain uncertainties relating to the results, they present a step forward towards the needed knowledge about how different sub-regions of Macedonia might respond to large-scale climate change.

1.3.2. Sectoral Analyses

1.3.2.1. Agriculture

The sub-sectors of crop production, soils, and animal production are involved in the vulnerability analyses. The most important findings and recommendations relate to crop production. Hence, the following can be summarized regarding the expected **yield decrease** for vulnerable areas and crops as result of climate change impact.

In Stip, where most important crop is winter wheat, yield decrease could reach 17% in 2050. Yield decrease in alfalfa in Bitola could reach 62% in 2050, as with yield decrease in apples in Resen and grape in Kavadarci regions (50%). The most dramatic projections are for yield decrease in tomatoes in Gevgelija (78% in 2050). The projections are prepared with the assumption that crops will be planted without irrigation.

The total **direct economical damage** from yield decrease for winter wheat, grape, and alfalfa will amount to almost €30 million in 2025 and will increase up to €40 million in 2100.

The **adaptation measures** involve introducing water-saving irrigation measures, soil and water conservation, genetic and plant breeding measures, new agricultural practices, etc.

Climatic conditions, especially the increase of air temperature and aridity, will affect soil organic matter decline and acceleration of organic matter decomposition. Spatial distribution of cultivated soil with intensive loss of organic matter partially overlaps with most vulnerable agricultural areas like Central Povardarie and Ovce Pole.

The most important recommended adaptation measures are: application of organic fertilizers (manure, sideration), cultivation of legumes for enrichment of the soil, etc.

Soil erosion is also expected to accelerate due to climate change. The most vulnerable identified regions of cultivated soil are: Central Povardarie, especially the area of the confluence of the Crna and Bregalnica rivers with Vardar and South Povardarie.

Identified adaptation measures are afforestation of the sloping terrain, implementation in practice of new irrigation techniques which enable efficient use of water, etc.

Climate change will also contribute to an increase of soil salinization. As a result of higher air temperatures and reduced precipitation, and consequently higher evaporation and evapotranspiration, increase of salt content in soils is expected. The most vulnerable areas to soil salinization are parts of Ovce Pole and Pelagonija, especially if intensive irrigation is utilized. Adaptation measures are related to the control of the salt-rich groundwater level by reducing the quantity of surface and ground water, drainage of micro-depressions in the valleys, etc.

Animal production in a broad sense is affected directly and indirectly by climate change.

Direct effects from an increase of air temperature cause heat stress over domestic animals, which lowers their production, especially related to modern high productive breeds that are already adapted to local environmental conditions.

Indirect effects can be foreseen from the projected decrease of the forage production, and emerging of diseases. Reduction of local production of animal food will significantly affect the ability of livestock production.

To minimize the effects of heat stress three strategies can be adopted, e.g. physical modification of the environment, genetic development of heat-tolerant breeds, and improved nutritional management practices.

1.3.2.2. Biodiversity

The alpine zone is the most vulnerable to climate change due to the most intensive air temperature rise in alpine and subalpine regions, according to the local climate scenarios. Loss of the alpine belt can be expected; for example Mt. Pelister is estimated to lose its alpine belt within 50 years. Climate change in the region will force the molika/Macedonian pine forest belt to move upwards and to intrude into part of the current alpine pasture belt in which a lot of Oro-Mediterranean and Arcto-Alpine fauna is present now. In that way, a part of the natural habitats for some high mountain species will be lost and threatened with extinction. These species include: Sand Lizard, Adder, Rock/Water Pipit, Snowfinch, Wallcreeper, Alpine Dunnock, Alpine Chough, Red-billed Chough, Shore Lark, Balkan chamois, etc.).

The most vulnerable flora species from the mountain belt regarding local climate change predictions are: *Colchicum pieperianum*, *Fritillaria macedonica, Ranunculus degenii, Crocus scardicus, Crocus pelistericus, Salix alpine.*

The most endangered flora and fauna species from the lowland belt regarding local climate change predictions are: ***flora*** – *Thymus oehmianus, Ramonda nathaliae, Ramonda serbica, Adianthum capillus-veneris*; ***fauna*** – *Rana balcanica*, *Triturus vulgaris, and Pelobates syriacus balcanicus*.

It is expected that the Mediterranean and sub-Mediterranean elements of the pseudo-maquis will broaden their range towards the central and northern regions of the Republic of Macedonia. However, the extent of the expansion will depend on agricultural activities (especially crop growing and grazing).

Plant communities which grow in habitats with a high level of underground water (*Periploco-Alnetum glutinosae, Periploco-Fraxinetum angustifoliae-palilisae*, *Plantano-Castanetum sativae)* will undergo significant negative impact due to climate change and they will be threatened with extinction.

The lake ecosystem and surrounding wetlands of Lake Dojran will suffer catastrophic consequences due climate change, mainly because of previously recorded water regime disturbances. The most vulnerable species are: *Nuphar lutea, Nymphaea alba, Salvinia natans,* and communities like *Myriophyllo-Nupharetum*. Negative climate change effects threaten flora and fauna from the other two natural lakes, Ohrid and Prespa.

The most important **adaptation measures** involve: preservation of the last remaining riparian communities (*Periploca, Salicetum albae-fragilis, Juglando-Platanetum*, etc.*)* in the Vardar valley; elaboration of a distribution map of the major ecosystem types, map of biomes, and mapping of habitats and vegetation types; development of sufficient network of meteorological stations; strengthening the capacities of the staff.

1.3.2.3. Forestry

The possible climate change impacts on the forestry sector are:

- More intensive process of forest dieback, particularly in the fir and oak belt;
- Increased population of some pests (particularly insects and fungi), because of physiological stress of trees;
- Migration of tree species towards higher altitudes and change of floristic composition of current forests;
- Increase in number of forest fires and burned area.

These impacts will increase expenditure in the forestry sector and are expected to cause significant economic damage.

Economic damage caused by forest fires in July 2007, including expenses for their extinguishment have reached €21 million (estimation made by P.E. 'Macedonian Forests'), i.e. approximately 75% of the damaged caused in the period 1999-2005.

The most important **adaptation measures** involve: adjust forest management to climate change, through introduction of forest species and planning measures, improvement of the species composition of forests (natural and afforested) with endemic tree species, resistant to climate change; strengthen preventive measures that improve and minimize the risks of fires; increase monitoring and observation pilots in the most vulnerable and economically valued forests.

1.3.2.4. Health

Due to climate change, over the next decades, a decrease by several percentage points in the total annual monthly mortality in some of the colder months is expected (January 4%, October 4%, November 2%). On the other hand, in the warmer months an increase of 4-11% of the total annual monthly mortality is expected (mostly in April, May, June and it will be an average of 10% higher than the period 1996-2000).

Persons with health problems, especially cardiovascular and respiratory diseases have a high risk of increased mortality during heat waves. Deprived communities, lacking wealth, social institutions, environmental security, and robust health, are likely to be at greatest risk of adverse health effects from climate and other environmental changes.

The projection for 2030 of the seasonal index by months for food-borne diseases caused by salmonellosis, due to air temperature rise, shows two peaks in the summer months and one possible peak in winter months because of decreasing the average monthly temperature in the future period;

The most important **adaptation measures** involve: control and monitoring of the entire food chain; implementation of a Weather Early Warning System to inform the population in time, particularly vulnerable groups, about extreme weather events; education, awareness raising, and creation of legal frameworks, institutions, and an environment that enables people to take well-informed decisions.

1.3.2.5. Tourism

Mountain and lakeside tourism are the most attractive in the country. On the other hand, these destinations are considered particularly vulnerable to climate change, as they are nature-based tourism destinations and all outdoor tourism activities are dependent on favourable climate conditions.

The summer season could be extended as a result of the temperature rise, but also larger water consumption is expected in tourist destinations (especially the Crn Drim catchment). However, increased duration of peak periods and heat waves can have adverse affects on water quality. Bigger water consumption would require provision of new potable water supply resources, and construction of new sewage systems for both households and industry, especially for tourist destinations. Inevitably, energy consumption will increase, also as the need for cooling of indoor premises becomes essential with the temperature increase.

The increase in the wintertime temperature, accompanied with less snow coverage and a later start to the skiing season, will have a negative effect on skiing as a main winter tourist attraction. Bearing in mind the shortening of the skiing season, financial losses are possible, unless artificial snow-making takes place.

In order to respond to climate change, the tourist industry will have to shift towards new attractions, such as from skiing to hiking during the winter, but also horse riding, improvement of the spa tourism, and linkages with the cultural and natural heritage during other seasons.

1.3.2.6. Water Resources

The rate of reduction of the effective rain for 2050 is assessed at around 15% for the regions under the prevailing mountainous-Alpine climate impacts (represented by the stations at Lazaropole, Popova Sapka, and Solunska Glava), around 20% to 23% for south-western part of Macedonia under the continental climate impacts (represented by the stations at Ohrid and Resen), and around 35% to 40% for other regions of Macedonia. The reduction of the average annual discharges is the most pronounced for the river Bregalnica at the Stip hydrological station and for the river Strumica at the hydrological station of Novo Selo, i.e. in the region with a moderate-continental-sub-Mediterranean climate. The percentage of average annual discharge reduction for the period 2000-2003, compared with the decade 1961-1970 is 36 to 58%.

Oscillations in the minimum, average, and maximum annual water levels for the Dojran and Prespa lakes show an extreme drop in the water levels of both lakes that started almost at the same time (in 1986) and had almost the same duration (until 2002). These oscillations in the water levels occurred as a result of the anthropogenic impact and change of the climate. In the last few years, due to extremely bad climate conditions, the water level of the lakes has again reached its minimum.

Oscillations in the water quantities which flow out from Macedonia have been much higher in the last 40 years, with a drop of around 70 million m^3 on an annual level.

Performed analyses have confirmed that climate change conditions have had a negative impact on the water quality, regarding all three aspects: a) reduced hydrological resources leave less dilution flow in the river, leading to degraded water quality; b) higher temperatures reduce dissolved

oxygen content in water bodies; and c) in response to climate change, water uses, especially those for agriculture, may increase the concentration of pollution being released into the rivers.

The assessment of the future climate change effect on the rivers Vardar, Treska, and Bregalnica, performed with MIKE SHE software, shows a decreasing trend of annual discharges of approximately 4% for Treska, 11-16% for Vardar and Bregalnica up to year 2050. Mean reduction of available water resources for 2100 in the Bregalnica catchment area could reach 24% compared to the 7% decrease in the Treska catchment area. More frequent drought periods are expected and storm waters with increased intensity, and total national water availability (Vardar catchment area) is expected to decrease by approximately 18% by 2100.

High priority **adaptation measures** are proposed in the following domains: irrigation and water supply of population, floods and droughts, erosion and sedimentation, water resources' management; water quality and monitoring.

The most persisting **constraint and gap** is data availability, consistency, and transparency. Existing monitoring in climate and ground water conducted by the Hydro-Meteorology Service in the country is facing permanent problems in operation, slow modernization of equipment, reducing of monitoring network, etc. Soil monitoring does not exist, as well as groundwater monitoring. Basic maps and databases are very old and/or hardly available (soil map, vegetation map, land-use map, etc.). Modern tools for vulnerability assessment are needed almost in all vulnerable sectors (hardware, software, and training of personnel).

Opportunities for implementation of adaptation measures are related to accumulated knowledge and awareness among scientific community about climate change and knowledge about vulnerable sectors and adaptation measures. One very important opportunity, especially in the agricultural sector, is the accumulated experience to cope with drought and high temperatures and existing indigenous technologies and crop varieties used in the country. Decision makers, especially from the MOEPP, are aware of the problem and there is interest for adaptation strategies. Recently the NGO sector became more interested in climate change issues especially due to the GEF Small Grant Programme that is supporting activities in climate change operational programmes. On the other hand, **the barriers** lie in the capacity constraints at systemic, institutional, and individual levels.

An **Intersectoral Adaptation Action Plan** was developed for the period 2008-2011. It involves four major areas: institutional and legal measures; identification, assessment, and mitigation of climate change negative impact; monitoring; strengthening capacities at institutional, systemic, and individual levels.

Also, some **specific projects** were proposed for financing: three from the water resources sector, one from agriculture, and two from biodiversity. Further efforts should be employed in order to **set national criteria** and to make **prioritization** among and within the vulnerable sectors. The **most attractive projects** would be those coming from the highest priority sectors and also from the intersection of two or more vulnerable sectors (**synergetic approach**). The **linkages with climate change mitigation** should also be considered, as well as possibilities for **realization of the adaptation projects at the regional level.**

1.4. Climate Change Mitigation

The **main aim** of the analyses is to assess the climate change mitigation potential of the country following the projected developmental lines of the national economy. Under Macedonia's conditions the mitigation analyses target the following **sectors**: electric power, industrial energy transformations and heating, transport, waste, and agriculture. For each of the sectors several developmental scenarios for the **period 2008-2025** have been defined – **baseline (business-as-usual) scenario** and **mitigation scenarios** which include appropriate mitigation measures/practices/projects/interventions. The optimum year of implementation for most of the measures was defined, imposing maximum emission reduction and minimum expenses as optimization criteria.

Electric Power

In line with the projected growth of the national economy, electricity consumption will constantly increase with an assumed annual growth rate of 3.5% in the first ten years and of 3% in the second ten years of the analysed period. The goal of the power system expansion planning is to cover the electricity needs, taking into account the production capacity over the analysed period of the existing power plants (including reserves of the existing energy sources), as well as the real possibilities for building new generating capacities.

The **baseline scenario** is based on the thermal power plants with domestic lignite. On the list of candidates are the following TPPs: TPP Mariovo with 209 MW nett, the fourth unit of TPP Bitola with the same capacity of 209 MW nett, new TPP Negotino at the same location as the existing one with 300 MW nett (supplied with domestic lignite from the new mine nearby).

The **first mitigation scenario** is the variant of utilizing the capacity of the gas pipeline for electricity generation in two gas CHPs. One of them is the planned CHP Skopje with an installed power of 234 MW which is under construction, and the second one is a CHP with an installed power of 300 MW with as yet still undefined location. These CHPs would replace the lignite-fired candidates from the baseline scenario (TPP Mariovo and TPP Negotino).

The **second mitigation scenario**, besides CHPs, assumes reduction in electricity needs by about 2000 GWh, which is a result of the liberalization of the electricity market for large industrial consumers (FENI, SILMAK, and the steel industry). Furthermore, it assumes that at the end of the planning period, the year 2025, the cumulative effect of the progressively increasing utilization of renewable energy sources (small hydropower, wind, and biomass) for electricity generation would annually generate 180 GWh. In the applied model for power system expansion planning, this effect is embodied by introduction of a small hydropower plant with a capacity of 25 MW and annual production of 45 GWh every four years (2010, 2014, 2018, and 2022).

All three developmental scenarios assume operation of the existing thermal power plants – TPP Bitola (3 x 209 MW nett) and TPP Oslomej (1 x 109 MW nett) and hydropower plants until 2025. Also all three scenarios incorporate the same HPP candidates: Boskov Most, Cebren, and Galiste.

The scenarios have been developed by making use of the **software tool WASP**, which provides for full satisfaction of the electricity needs, with minimum emissions related to electricity production and with minimum total costs (investments, fuel, and O&M costs).

Other sectors

The **baseline scenarios** in all other sectors are based on the assumptions in the respective sectoral strategies, although it should be noted that the mitigation analysis was constrained by the lack of sectoral development plans, relevant data (historical and present), as well as other relevant national studies. Reduction in GHG emissions (**mitigation scenarios**) from other sectors would be achieved through improving energy efficiency in the industrial sector and households, promotion of sustainable transport, implementation of landfill gas collection and flaring technology, implementation of systems for biogas collection and combustion at pig farms, etc.

The **environmental evaluation of the scenarios** (detailed calculations of GHG emissions and local pollution) is performed by making use of the **software tool LEAP**. As per the projections for GHG emissions presented in Table 2, a considerable increase in the total GHG emissions by the year 2025 will occur compared to the projected value for the year 2008 (with an absolute value of 9,900 kt CO_2-eq, or relatively about 71%) if the usual practice is applied without imposing the constraint for GHG emissions reduction (baseline scenario).

The situation can be improved if the developmental paths integrate practices/measures leading to GHG emission reductions. Hence, the first mitigation scenario (as defined in the sectoral analyses) leads to a 46% increase of the 2025 value of the total emissions compared to the total 2008 emissions or an absolute difference of 6,400 kt CO_2-eq. This increase in the total emissions is further reduced to 32% (absolute difference of 4,000 kt CO_2-eq) if the developmental paths follow the second mitigation scenario.

Table 2. Total GHG emissions at the beginning and at the end of the analysed period

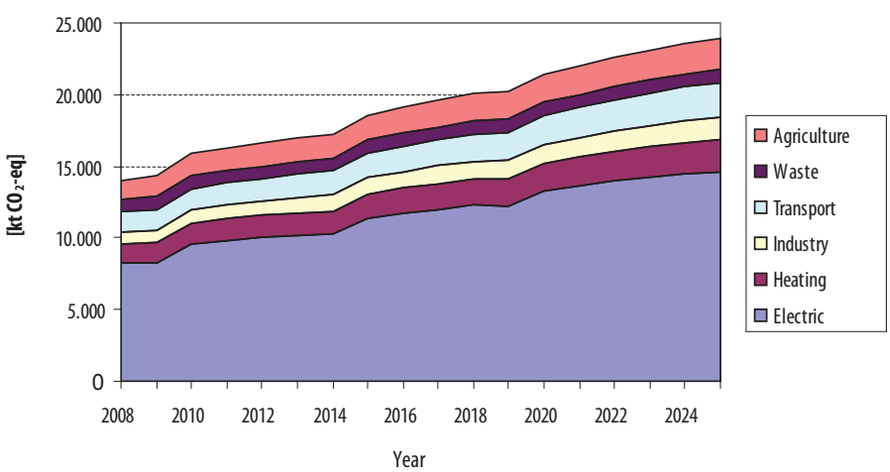
	2008-total GHG emissions [kt CO_2-eq]	**2025-total GHG emissions [kt CO_2-eq]**
Baseline scenario	14,040	23,947
First mitigation scenario	13,904	20,348
Second mitigation scenario	12,645	16,713

The largest achievement under the mitigation scenarios is associated with the electricity sector. Namely, the relative increase of the electricity-related emissions is reduced to 14% by the second mitigation scenario as a result of the introduction of the gas-fired CHPs, a reduction of electricity consumption of the large consumers and introduction of renewable energy sources (Figure 2b).

The mitigation analysis was finalized with the **National Action Plan for Climate Change Mitigation** which incorporates measures/practices/projects/interventions in each of the sectors that contribute to reduction in GHG emissions. In a wider sense, the National Action Plan also defines country specific instruments which will enable implementation of the proposed direct measures (economic and fiscal instruments; regulations and standards, voluntary agreements; information and public awareness; research and development).

These "non-technical" measures of the national climate change mitigation action plan, in fact, provide linkages and **diffusion of the climate change mitigation objective into all the other relevant national policies** (energy, industry, transport, agriculture, forestry, environment, waste management, etc.). This will enable implementation of direct measures/activities/projects/interventions suggested in the mitigation scenarios.

a)



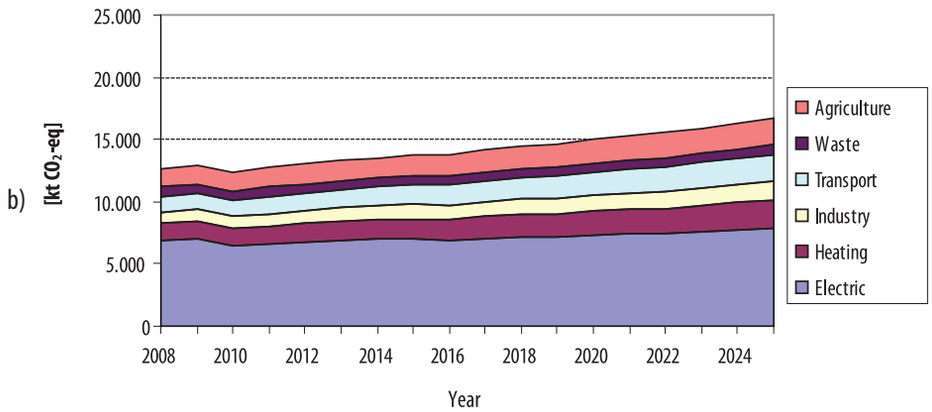


Figure 2. Projections of the sectoral and the total GHG emissions:
a) Baseline scenario; b) Second mitigation scenario

1.5. Other Relevant Information

1.5.1. Transfer of Technologies

The comprehensive assessment of the prospects for transfer and diffusion of climate-change-friendly technologies in Macedonia was realized under the top-up activity between the two National Communications. Sixteen mitigation options were evaluated, along with the emerging barriers and ways for their removal. The evaluation is performed using the GACMO costing model, which compares each mitigation option with the baseline and determines its economic and environmental effectiveness. The resulting marginal cost curve indicates a **total achievable reduction** of 20% with respect to baseline emissions. The finding that almost half of the considered options are of a win-win type represents the **main driving factor** for the technology transfer, although, reducing the baseline emissions by less than 3%, these options have a relatively low environmental effectiveness. On the other hand, options with the largest mitigation potential are most difficult for implementation, mainly due to the lack of financing and low prospects for attracting foreign investments. Furthermore, there is a limited awareness for the need to incorporate energy efficient and environmentally favourable technologies into private and public decision making, which is additionally impaired by the uncertainty related to the energy and economic savings expected from those technologies. Also, the country lacks a necessary infrastructure in terms of institutions, legislative framework, and economic incentives, as well as individuals capable of delivering the required technical, managerial, and financial services.

1.5.2. Systematic Observation

Measurements, monitoring, and research related to the climate-meteorological and hydrological parameters in the country are performed by the **Hydro-Meteorological Service (HMS).** The meteorological observing system in the country consists of 14 main meteorological stations, 19 regular climatological stations, 26 phenological stations, one aerological station, six hail-suppression centres, and about 200 precipitation stations as well. There are also two automatic stations installed in Gostivar and Skopje-Zajcev Rid. Twenty-seven meteorological stations in the country provide different types of meteorological reports as a part of the World Weather Watch. The HMS also monitors surface and ground water quantities.

The **River Monitoring System in Macedonia** (RIMSYS) project supports the authorities of Macedonia in strengthening their capacity to document long-term changes in the water pollution and the hydrological regimes of the most important rivers of the country. RIMSYS started its first phase in 2000, with the objective of improving the monitoring system on rivers by the installation of 18 river monitoring stations and the environmental laboratory at the HMS.

Regarding the air pollution, monitoring includes: air quality monitoring; measuring of stationary sources emission; monitoring and assessment of trans-boundary, long-range distribution of air pollutants; monitoring of those pollutants which have a great impact on human health.

1.5.3. Research and Development

Climate change is to be found within the research remit of many academic institutions in the country. Hence, the Research Centre for Energy, Informatics, and Materials of the Macedonian Academy of Sciences and Arts **(ICEIM-MANU)** has been acting in the field of climate change for more than a decade, preparing the National Inventory and Mitigation Analyses for the purpose of the National Communications as well as carrying out climate-change-and-energy related research at national and international level. The **Faculty of Civil Engineering** is involved in the bilateral research project dealing with advanced water management practices. The **Institute of Agriculture** is active in the similar field, participating in regional research focussed on trans-boundary lakes in south-east Europe. The **Faculty of Agricultural Sciences and Food** is participating in several regional projects aimed at exchange and transfer of know-how and expertise for adaptation to climate change. Furthermore, the **Faculty of Mechanical Engineering**, with its **Centre for Climate Change and Energy Technologies** and **Centre for Cleaner Production**, is active in the field of climate change mitigation and technology transfer. A good example of partnership between science and policy-making is the cooperation of the **Faculty of Technology and Metallurgy** which with the MOEPP jointly participated in the EU FP6 project related to eco-houses and innovative eco-efficient materials.

It can be concluded that under Macedonian conditions the Research and Development (R&D) becomes a decisive factor in all the efforts to limit climate change and its costs and negative effects to society and the environment. Moreover, the climate-change-related R&D is being built upon the following two elements: **translational research** (establishing/strengthening the partnerships types of academia-businesses, academia-policy-making, or even academia-businesses-policy-making) and **international cooperation** (in particular, participation in EU Framework Programme 7, where climate change is among the top priorities for cooperation).

1.5.4. Education and Training

The environmental issues, especially climate change are not sufficiently present in the educational curricula of primary and secondary schools, as well as the universities. However, the relevant institutions and individuals are aware of the need to increase the coverage of these issues at all educational levels. Good examples of integrating climate change issues in their syllabuses are: the postgraduate programmes at the Faculty of Mechanical Engineering, and Faculty of Agriculture, as well as the Environmental Management Postgraduate Study at the South-East European University.

1.5.5. Public Awareness

A variety of public awareness activities with different means and target groups with have been implemented by the MOEPP, the Climate Change Project Office, NGOs, national experts, and policy-makers, as well as intergovernmental multilateral organizations (such as UNDP).

However, in order to provide for an organized and synchronized approach, development of a **National Survey** to assess needs and requirements for implementation of Article 6 of the UNFCCC is to be recommended. The survey should be followed by the overall **Communication Strategy on Climate Change** which after its implementation stage will bring change to our behaviour and ways of doing things. The main goal of the strategy will be not only to raise visibility in this direction, but also to mobilize and promote new partnerships in order to achieve a higher degree of general awareness and encourage actions to be taken by all stakeholders (government, private sector, donor community, civil society, media, and general public). The partnership-building component will aim at creating synergies with all the interested parties, a range of actors whose contribution is critical and in particular the private sector. By such an approach, a better mutual understanding between policy-makers and the public on climate change issues, with a special focus on the private sector as key driver, will be achieved.

1.5.6. Capacity Strengthening

The capacity strengthening (institutional set-up, legislation and regulation, human capacities) is addressed in all thematic areas of climate change, as part of the respective action plans and follow-up recommendations. The MOEPP's draft institutional development plan recommends capacity strengthening on an institutional level of several sectors of the ministry, as well as relevant sectors in the ministries in charge of: agriculture, forestry, energy, transport, health, and industrial politics.

For coordination of activities related to climate change in the Republic of Macedonia, enhancement of the functionality of the National Climate Change Committee, which is composed of representatives from all involved authorities and institutions.

1.5.7. Information and Networking

The national climate change website www.unfccc.org.mk and the website of the MOEPP are the most important national sources of information. There are many good examples of networking and regional/international partnerships and exchanges: successful cooperation and knowledge exchange with recognized Slovenian climatologists; the Belgrade Initiative, aimed at enhancing regional cooperation of interested south-east European countries in the field of climate change; experience sharing among experts worldwide, as well establishing links for future cooperation in potential regional projects through the Knowledge Network for Second National Communications from Non-Annex I Parties to UNFCCC, established by the National Communication Support Programme.

1.5.8. Financial Resources and Technical Support

Respectable climate change addressing requires engagement of additional financial resources. In general, the available financial support (particularly the national one) of climate change activities in the country is scarce and limited, so there is an urgent need for fundraising, involvement of private sector, and awareness raising of policy-makers. The budgets of the relevant ministries (MOEPP, Ministry of Education and Science, MOAFWE) do not contain direct allocations for climate change issues, so these projects are mainly financed/co-financed by international institutions (UNDP, GEF, GEF Small Grant Programme). In the future, financing provided by international finance institutions (World Bank), UNFCCC adaptation fund, and bilateral assistance through use of climate change initiatives will remain the main source of funding.

Active involvement in EU Framework Research Programmes (FP Programmes), as well as allocation of additional funds in the state budget of relevant governmental institutions is necessary.

NATIONAL CIRCUMSTANCES

2.

2. NATIONAL CIRCUMSTANCES

2.1. Country Profile

2.1.1. Geography

Macedonia is situated in southern Europe, in the central part of the Balkan Peninsula, at a latitude of approximately 42° North and a longitude of 22° East. The total surface area of Macedonia is 25,713 km^2, out of which hills and mountain terrains cover 79%, plains account for 19.1%, and about 1.9% are water surfaces. The significance of the geographical position of Macedonia as a central Balkan state with bordering countries, different in their economic potentials and development, is especially underlined by the fact that they are directed towards each other in terms of trade, complementariness of their economies, with the main routes passing exactly through the territory of the country.

The hydrographical territory of Macedonia is a unique natural basin in the Balkan Peninsula and wider area, due to 84% of the available water quantities being domicile waters while only 16% are external waters. According to the hydrographical conditions of the country there are four river basins: Vardar, Crn Drim, Strumica, and Juzna Morava. The river basin areas of the River Vardar and River Strumica gravitate towards the Aegean Sea, covering 86.9% of the total territory.

There are three major natural lakes in Macedonia: Ohrid, Prespa, and Dojran. All of them are shared with neighbouring countries. From the 4,414 springs that exist in the country, only three are located in the area of the middle flow of the Vardar, while the remaining are in the western regions. Only seven springs with very small yields have been registered in the eastern part of Macedonia.

The annual water resources per capita are about 3,150m^3/year, which categorize the country in the middle category of the European countries upon the available water resources per capita. Also, these data are close to the limit threshold of water resources needed for sustainable development.

The predominate areas (44.01%) are at an elevation of 500-1,000 m. The highest mountain peak is Golem Korab on the Korab mountain, at 2,764 m. Forests cover around 30% (947,653 ha.) of the territory of the country. The total agricultural cultivable area in 2005 covered 546,000 hectares, out of which 82% were arable land and gardens. Pastures cover 682,000 hectares. The agricultural sector is prioritized as one of the most important sectors of the Macedonian economy due to its importance for social security and poverty reduction. It provides sustenance to the absolute majority of the population and accounts for 14% of GDP in 2006. Agriculture and natural resource-based rural economies are particularly vulnerable to various anthropogenic stressors, including climatic hazards, variability, and a long-term climate change.

There are three national parks: Mavrovo, Pelister, and Galicica; four strict natural reserves and 44 sites of natural significance, all of them state owned. They offer great possibilities for development of tourism, preservation of natural resources, and scientific research.

2.1.2. Climate

In spite of the relatively small area of Macedonia, the climate is diverse. The following, more homogeneous climate regions and sub-regions are differentiated:

- Region with a sub-Mediterranean climate (50 - 500 m);
- Region with a moderate-continental-sub-Mediterranean climate (to 600 m);
- Region with a hot continental climate (600 - 900 m);
- Region with a cold continental climate (900 – 1,100 m);
- Region with a sub-forest-continental-mountainous climate (1,100 -1,300 m);
- Region with a forest-continental mountainous climate (1,300 – 1,650 m);
- Region with a sub-alpine mountainous climate (1,650 – 2,250 m);
- Region with an alpine mountainous climate (hs >2,250 m).

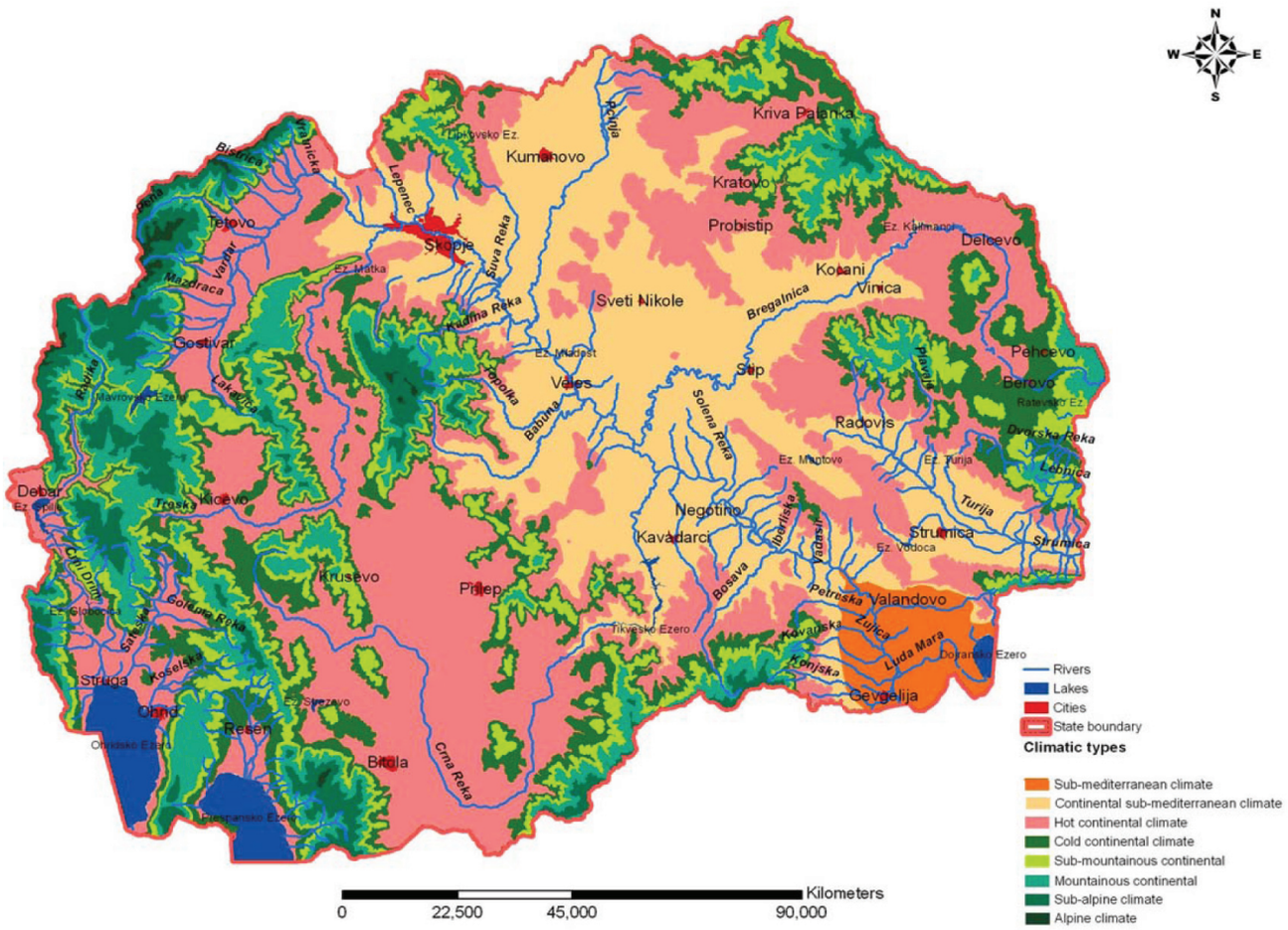


Figure 2.1.2.1 Climatic types in Macedonia

The period 1971-2000 at the annual level was warmer than the period 1961-1990. Differences of average mean annual air temperatures for the mentioned thirty-year periods are in the range of -0.1°C to 0.2°C. The highest values of mean annual deviations of the air temperature are recorded in the sub-Mediterranean zone (Valandovo 0.7°C, Gevgelija 0.5°C, and Nov Dojran 0.2°C).

The warmest year recorded within the territory of Macedonia was 1994, which was warmer than the general average by 2.0°C (in Skopje), 1.8°C (in Demir Kapija), and 1.6°C (in Bitola). Significantly higher mean annual temperatures were also recorded for 1999, 2002, and 2003, with most dramatic variations of the temperature recorded during the summer period.

The absolute maximum air temperature was recorded in July 2007, with a recorded 45.7°C in Demir Kapija and 45.3°C in Gevgelija. The absolute minimum air temperature of -30.4°C was measured in January 1993 in Bitola.

Precipitation is generally characterized by uneven spatial and temporal distribution over the country, because of the complex orography which affects the pluviometric regime during the months, seasons, and years. Such a distribution is accompanied by the alternating periods of long droughts and of high-intensity rainfalls. These dramatic alterations contribute to soil erosion and land degradation. The most precipitating area is the area of mountain massifs in the western Macedonia, the area of mountains Sar Planina, Bistra, and Stogovo as well as mountain massifs Jakupica with its peak Solunska Glava and Baba with its peak Pelister, where the annual precipitation sum is about 1000 mm. The most arid areas are Ovce Pole, Tikves, and surroundings of Gradsko with an annual precipitation sum of about 400 mm.

At the annual level, in the last twenty years compared to the period 1961-90, a decrease of precipitation has been recorded, especially in 1988-1990, 1992-1994, 2000, and 2001.

The greatest annual sum of sunny hours appears in the central and southern part of Povardarie with about 2,400 hours, while on the mountain massifs this sum is about 2,200 hours.

2.1.3. Population

Since the end of the Second World War, Macedonia's population has grown steadily, with the greatest increases occurring in the ethnic Albanian community. The western part of the country is the most heavily populated. Most of the population is concentrated in the urban areas. The average population density for 2002 (official census data) was 78.7 inhabitants per km^2, and about 25% of total population live in Skopje, the capital city of Macedonia. The average household had 4.68 members in 1971, reduced to 3.58 members in 2002.

As in many other countries, people have migrated into the cities, looking for employment. Macedonia has also experienced sustained high rates of permanent or seasonal emigration.

Life expectancy for the period 2003-2005 was 71.44 years for men and 75.88 years for women. The average age of population for the country for the year 2005 was 35.9 years. Natural increase in 1990 was 20,758 inhabitants, and had reduced to 4,076 in 2005.

Table 2.1.3.1. Enumerated and estimated population (Source: State Statistical Office)

Year	1921	1931	1948	1953	1961	1971	1981	1991	1994	2002	2003	2004	2005
Population (in '000)	809	950	1153	1305	1406	1647	1909	2034	1946	2023	2027	2032	2037

2.1.4. Politics

The Republic of Macedonia became an independent state on 8 September 1991, following the disintegration of the former Socialist Federal Republic of Yugoslavia. The political system of Macedonia is parliamentary democracy. The country received its status of candidate for an EU membership in December 2005.

The state authority is organized on the principle of distribution of powers into the legislative (Parliament), the executive (the President of the Republic, the Government), and the judicial.

The Parliament consists of 120 members, with a four-year mandate. Members are elected by popular vote from party lists, based on the percentage that parties gain of the overall vote in each of the six election districts, each district having 20 seats.

The President is elected by general, direct ballot for a term of five years, with the right to one re-election. The President exercises his/her rights and duties on the basis and within the framework of the Constitution and laws.

The Prime Minister is the head of government and is selected by the party or coalition that gains a majority of seats in parliament. The Prime Minister and other ministers must not be members of parliament. The government consists of 15 ministries. The General Secretariat of the Government provides logistic and expert support to the government, to the President of the Government, Vice-Presidents of the Government, ministers (members of the government).

The court system consists of a Supreme Court, Constitutional Court, Administrative court, and appeal courts. The Judicial Council of the Republic of Macedonia governs the ethical conduct of judges and recommends to parliament the election of judges. The Supreme Court is the highest court in the country and is responsible for the equal administration of laws by all courts. Its judges are appointed by parliament without a time limit. The Constitutional Court is responsible for the protection of constitutional and legal rights and for resolving conflicts of power between the three branches of government. An independent Public Prosecutor is appointed by parliament with a six-year mandate.

2.1.5. Economy

The Macedonian economy is small, with a nominal gross domestic product (GDP) of about USD 5.8 billion in 2005. In the last few years, a considerable increase in the Macedonian economy has been achieved. Namely, the nominal GDP in 2007 amounted to USD 7.5 billion, which corresponds to a growth rate of 5% compared to 2006.

Agriculture and industry have been the two most important sectors of the economy, but the services' sector has gained prominence in the past few years. Like most transitional economies, problems persist, even as Macedonia takes steps towards reform. Economic problems persist, even as Macedonia undertakes structural reforms to finish the transition to a market-oriented economy. A largely obsolete industrial infrastructure has not seen much investment during the transitional period. Labour force education and skills are competitive, but without adequate job opportunities, many with the best skills seek employment abroad. A low standard of living, high unemployment rate, and relatively modest economic growth rate are the central economic problems. In 2004, the Government passed a progressive Trade Companies Law aimed at easing impediments to foreign investment, providing tax and investment incentives, and guaranteeing shareholder rights. In 2006, the Government began implementing a one-stop procedure for business registration that considerably shortened the time required to register a new business. The Government's fiscal policy, aligned with International Monetary Fund (IMF) and World Bank policies, helped maintain a stable macroeconomic environment. Legislation that would further liberalize the telecommunications market, and completion of the first phase of privatization of the electricity sector, sent promising signals to investors.

Table 2.1.5.1. Selected macroeconomic indicators, 1998-2007
(Source: Ministry of Finance of the Republic of Macedonia, National Bank of the Republic of Macedonia)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GDP (million MKD)	194,979	209,010	236,390	233,841	243,970	251,486	265,257	286,620	310,932	339,097
Real GDP growth rate (%)	3.4	4.3	4.5	-4.5	0.9	2.8	4.1	4.1	4.0	5.0
GDP per capita (USD)	1,783	1,821	1,771	1,689	1,866	2,285	2,641	2,855	3,124	3,709
Inflation (CPI, average) (%)	-0.1	-0.7	5.6	5.5	1.6	1.2	-0.4	0.5	3.2	2.3
Exports f.o.b (million USD)	1,291.50	1,190.00	1,320.70	1,155.40	1,112.10	1,362.70	1,674.90	2,040.60	2,396.30	3,349.00
Imports f.o.b (million USD)	1,807.10	1,685.90	2,011.60	1,682.20	1,917.70	2,213.70	2,813.80	3,103.60	3,681.20	4,976.00
Current account deficit (% of GDP)	-7.8	-1.8	-2.7	-6.9	-10.0	-4.0	-8.4	-2.7	-0.9	-3.1
General governmental balance (% of GDP)	-1.7	0.0	2.5	-6.3	-5.6	-1.0	0.0	0.2	-0.5	0.6
Gross external debt (million USD)	/	/	/	/	/	/	2,816.90	2,970.60	6,286.20	3,983.00
Gross external debt (as % of GDP)[1]	/	/	/	/	/	/	52.5	51.5	51.6	51

[1] Calculated on the basis of SSO nominal GDP in denars converted into dollars using average exchange rate denar/USD.

Positive trends have been recorded in all sectors of the economy. The service sector, as the main driving force of the economy's growth, has a dominant and increasing share in GDP, followed by industrial production, which has lower but stable growth. This reconfirms the trend of restructuring of the domestic production towards services, common in all successful economies in transition. Intensive structural reforms have been undertaken to enable a rapid development of the Macedonian economy. The success of these reforms was recognized by several eminent world institutions, such as the World Bank and International Finance corporation, which ranked Macedonia fourth in the list of the top reformists in the field of economy ('Doing Business', 2008 report), and Transparency International which in 2007 ranked Macedonia 84th according to the corruption perceptions index, or 21 positions higher than the previous year. Direct foreign investments have increased, enabling entrance of fresh capital and job creation. Also, the number of capital infrastructural projects has increased. In order to attract more direct foreign investments, the Government has launched significant reform activities. One of the reforms is the introduction of a flat tax rate, applying a single rate of 10% for the Profit Tax and Personal Income Tax. This makes the Republic of Macedonia a country with the lowest taxes in the region and wider.

2.2. Climate Change-related Institutional and Policy Framework

As part of government, the **Ministry of Environment and Physical Planning (MOEPP)** is only a *coordinator* of the environmental policy, whereas the actual implementation depends on a wide range of entities from both public and private sectors, on national and local levels. The MOEPP makes efforts to integrate the environmental policy into other policies developed by the Republic of Macedonia, through establishment of closer coordination and cooperation with other authorities. At the same time, the other authorities/relevant bodies have shown their willingness to accept their responsibility for implementing environmental protection in their sectoral policies, and to include it in the overall development policy of the country. The integration of the environmental policy in other policies as a process is becoming more intensive and is reflected in the strategic and programme documents adopted by the authorities.

In accordance with its responsibilities, the MOEPP carries out regular collection, processing, formatting, and proper keeping of the data from the monitoring networks of all the environmental media and areas: air, water, noise, soil, waste. It also submits data to the **European Environmental Agency** and other relevant international organizations. The MOEPP is leading the process of development of **National Set of Environmental Indicators for the Republic of Macedonia**. Twelve Working Groups have been formed for verification and supplementing the indicators for the objective of their final adoption for the chapters: air, biological diversity, climate change, soil, waste, water, agriculture, energy, fishery, transport, health, and tourism.

Specifically for climate change, the Republic of Macedonia **ratified** the UN Framework Convention on Climate Change (UNFCCC) on 4 December 1997, and the Kyoto Protocol in July 2004. The MOEPP coordinated all activities related to ratification of the Convention and Protocol including activities on raising public awareness (Figure 2.2.1).

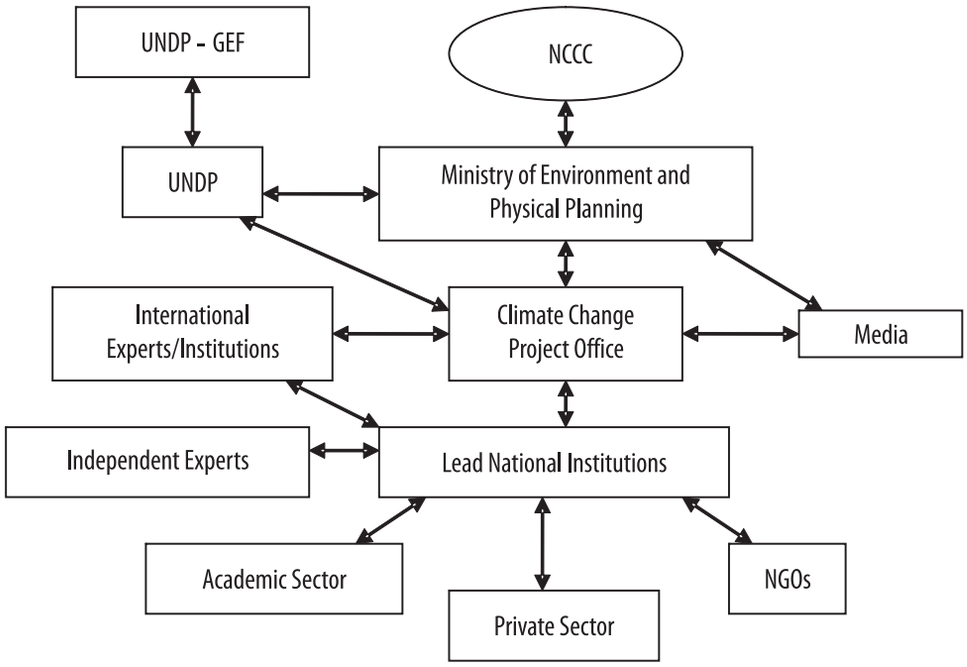


Figure 2.2.1. Flow-chart of the relevant sectors included in climate change issues

In January 2000, the **Climate Change Project Office** was set up within the ministry. Furthermore, a **National Climate Change Committee (NCCC)** was established as an advisory body for policy-making related to climate change issues. It is composed of thirteen representatives of key governmental agencies, non-governmental organizations, private entities, and academia. The committee is chaired by a representative of the Macedonian Academy of Science and Arts.

As a country which does not belong to the group of highly industrialized countries, the Republic of Macedonia shares only the common obligations for response to climate change: establishment of an inventory of greenhouse gas (GHG) emissions and national reporting on the actions taken in compliance with the Convention. The **First National Communication on Climate Change (FNC)** was adopted by the Government of Macedonia and submitted to the UNFCCC Secretariat in March 2003. Its preparation was supported by UNDP/GEF. In December 2003, it was presented to the Conference of Parties (COP) to the UNFCCC. All components of the National Communication are reviewed and approved by the NCCC.

The FNC was followed by the project 'Technology Needs Assessment in the Energy Sector' (TNA top-up phase) wherein the most prospective technologies were analysed from economic and environmental aspects.

The MOEPP has been designated as the **National Focal Point to the UNFCCC** and as **Designated National Authority** (**DNA)** for the Kyoto Protocol implementation (Figure 2.2.2). It is a key governmental body responsible for policy-making and coordination of implementation of the provisions of the UNFCCC and Kyoto Protocol.

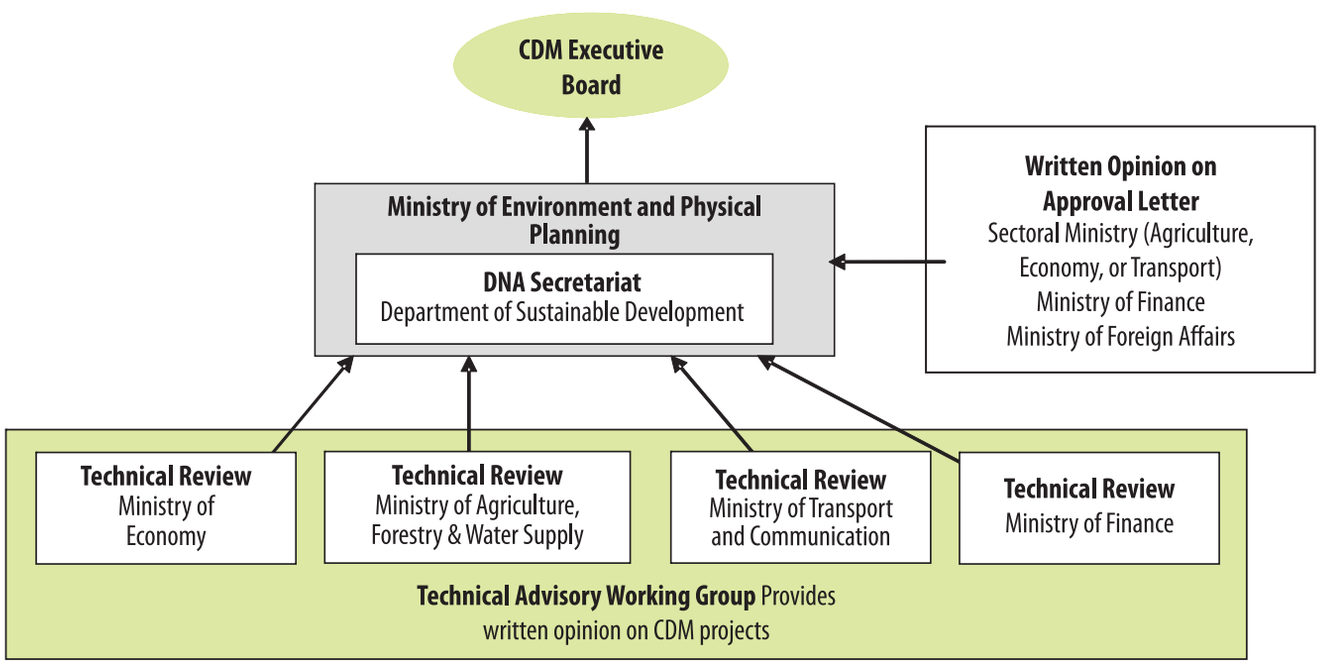


Figure 2.2.2. DNA structure in Macedonia

In addition to the institutional set-up, the Republic of Macedonia in addressing climate change is focussing its activities at several levels: strategic, legislative, regional, bilateral, and multilateral levels.

The climate change issue is included in the Second National Environmental Action Plan. Furthermore, the Republic of Macedonia has recognized the possibilities for achieving the goals of economic, social, and sustainable development, as well as those for transfer of knowledge and technologies and promotion of environmental investments through the implementation of the Clean Development Mechanism (CDM) of the Kyoto Protocol. Its practical application contributes to the general commitment of the Government of the Republic of Macedonia towards attraction of investments, in this case manifested through environmental investments. In February 2007, the Government adopted the **National Strategy for the first commitment period 2008-2012 according to the Kyoto Protocol**. Carbon financing is treated as an additional source of financing within the **National Strategy on Environmental Investments.**

At the legislative level, climate change issues are incorporated within the **Law on Environment**, including details on preparation of inventories of GHG emissions and removals by sinks as well as an action plan on measures and activities to abate increase of GHG emissions and to mitigate the adverse impacts of climate change. In the Law on Environment it is stipulated that a National Plan for climate change be adopted, for the purpose of stabilization of GHG concentration at a level that would prevent any dangerous anthropogenic impact on the climate system within a timeframe sufficient to allow the ecosystems to naturally adapt to the climate change, in accordance with the principle of international cooperation and the goals of the national social and economic development. In addition, provisions on the Clean Development Mechanism were introduced into the amended Law on Environment.

2.3. National and Regional Development Priorities and Objectives

The Republic of Macedonia has identified several key priorities for its future development, where achieving EU membership can be considered as the overriding strategic policy objective. The driving forces for creation and implementation of the environmental policy in the Republic of Macedonia can be grouped into two major categories:

- National context – the country focuses its activities at several levels: strategic, legislative, institutional/organizational, bilateral, cooperation with the EU, and the multilateral level; includes the Ohrid Framework Agreement, the Law on Local Self-Government, the Action Plan on Accession Partnership, and the National Programme for Adoption of the Acquis Communautaire in the environment sector.
- International context – including the Stabilization and Association Agreement (SAA) with the European Communities and their Member States, the Analytical Report on the Opinion concerning the Application of the Republic of Macedonia for Membership of the European Union of the European Commission, the Council Decision on the principles, priorities, and terms contained in the European Partnership with the Republic of Macedonia, and the multilateral and bilateral agreements in the field of environment.

2.3.1. National Context

For the purpose of providing consistent and coordinated implementation of the policy in the areas of its competence, except for the regular annual programming of the activities, the MOEPP has adopted the **Strategic Plan** for the period 2008-2010. It is adopted according to the proposed budget for 2008-2010. The plan contains precise strategic objectives and environmental priorities, as well as activities for their realization for the next three-year period. Special attention is given to the development element, and to the identification of the necessary human and financial resources that will enable feasible implementation of the plan.

At the strategic level, environmental policy (as a component of sustainable development policy as well as by itself) is covered by the following documents: **National Strategy for Sustainable Development (NSSD)** and the **Second National Environmental Action Plan (NEAP).**

The European Partnership concluded in June 2004 provides the main priority areas for further integration into the European Union. Within it, the development of a National Strategy for Sustainable Development (NSSD) has been identified as a short-term priority. The principles of sustainable development are covered by the Constitution of the country as well as being incorporated into the Law on Environment. Preparation of the National Strategy for Sustainable Development (NSSD) is in a final stage. It is funded by SIDA (the Swedish Development Agency) as a cooperation project with the Ministry of Environment and Physical Planning and is envisaged to be adopted by the Government of the Republic of Macedonia by the end of December 2008.

The strategy identifies several key driving priorities for making the Republic of Macedonia sustainable: EU membership, policy, and legal framework (as the backbone of any strategy development and implementation), administrative and enforcement capacity for environmental improvement, structural changes in energy mixing and pricing, comprehensive strategic work and plans in rural development; identifies unemployment as a key social issue and identifies small and medium-sized enterprises, infrastructure, and industry as solid industrial groundwork. Climate change together with energy is identified as a key challenge under Macedonia's conditions also, which is in line with the European strategy for sustainable development.

The strategy should direct the fulfilment of the obligations made by the Republic of Macedonia internationally and to the EU but its primary purpose is to provide an effective framework for sustainable development that, via reviews of existing policies and sector strategies, offers practical guidelines for service delivery in the public and private sectors and serves to encourage incremental domestic and external investments.

According to the Article 103 of SAA, as well as in accordance with the Law on Environment, the Second National Environmental Action Plan – **NEAP 2** was developed and adopted**.** This plan is an especially important strategic document for the environment in the Republic of Macedonia,

defining the environmental problems and the policy in the respective area through establishing measures, directions, and activities for its promotion over the next six years; identifies the instruments and mechanisms for its implementation, financing in the environment and the role of the international community on this issue, as well as the monitoring and updating of NEAP 2 itself. Based on this document, Local Self-Governmental Units (LSGUs) prepare the strategic documents on a local level in accordance with the Law on Environment – LEAPs. Preparations of LEAPs are financially supported by the Ministry of Environment and other international donors. Also, the Methodology for Preparation of LEAPs was adopted by the government of the country. The future activities should be focused on preparation or updating of climate change local action plans which will define mitigatory and adaptive measures at the local level.

Currently, preparations have been initiated for implementation of part of the projects identified as priorities in NEAP 2. In that context, the project for preparation of the National Strategy on Environmental Investments started, co-financed by the Austrian Government and implemented by the Austrian Development Agency (ADA), MOEPP, and the Regional Environmental Centre (REC). The development of the Strategy on Waste Management, financed by the Government of the Republic of Slovenia has been adopted, while the beginning of the preparation of the Strategy on Nature Protection, financed by the MOEPP, is expected.

2.3.2 Transposition and Harmonization of Legislation and SAA Implementation

In the environmental sector, the SAA anticipates approximation with the EU legislation, including, *inter alia,* environmental policy, resources management, and pollution control. The technical assistance as part of the CARDS Programme, which has been focussing on strengthening capacities for legal reform and harmonization of the legislation, came to its end in June 2007. Several projects for overall strengthening of the environmental management processes on national and local levels (including the business and the private sector) have been implemented. The National Strategy for Environmental Approximation containing plans for implementation of certain directives, and enhancement of the trans-boundary water resources management process has been adopted. During 2007 the Parliament of the Republic of Macedonia adopted a package of four amendments to the following environmental laws: Law on Environment, Law on Waste Management, Law on Nature Protection, and Law on Ambient Air Quality.

Since 2006, progress monitoring of the national legislation approximation with the EU acquis has been carried out for the periods 2006/2007 and 2007/2008. In the first phase of the monitoring assessment considered 69 directives (while the second phase 64 directives) including the Emission Trading Directive, and tables of concordance and implementation questionnaires have been filled in.

The state administration of the Republic of Macedonia (including the MOEPP) has been strengthening its capacity in the management of the Instrument of Pre-accession Assistance (IPA) for the period 2007-2013. The assistance to be provided under this instrument derives from the **pre-accession process** (European Partnerships, Pre-accession partnerships, negotiations by chapters, regular reporting, etc.) and its specific requirements and especially from the need for a more flexible approach in order to enable fast achievement of new priorities. The new instrument will consist of five components: Component for Transition and Institutional Building Assistance, Component for Cross-Border Cooperation, Component for Regional Development, Component for Human Resource Development, and Component for Rural Development.

2.3.3. Bilateral, Regional, and Multilateral Activities

The MOEPP has ratified Memoranda of Understanding with the Republic of Italy and the Republic of Slovenia on implementation of projects in compliance with the CDM of the Kyoto Protocol. With the Republic of Italy, through an Annex to the Memorandum, the manner and procedure of cooperation between the relevant ministries of both countries are further specified. The MOEPP has signed the Memorandum of Understanding with UNDP on the cooperation regarding the Carbon Fund of the Millennium Development Goals. In February 2007, the World Bank mission for capacity-building activities and identification of possible CDM projects in accordance with their terms was carried out in the country. Pipelines of already identified CDM projects under above-mentioned collaborations are available at the website of the MOEPP. For some of them, activities for preparation of necessary documents under the CDM cycle have been started.

The MOEPP as an appointed DNA for the country communicates with different projects/proponents and promotes national specific activities and achievements to international investors.

As a part of the 'Environment for Europe' process under the **United Nations Economic Commission for Europe (UNECE),** the ministers and heads of delegation from 51 countries in the UNECE region and the Representative of the European Commission, met at Belgrade in October 2007, when the declaration named 'Building Bridges to the Future' was adopted. In the declaration, the region's needs to address the urgent challenge of climate change were recognized through:

- Enhancing regional cooperation of interested south-east European countries in the field of climate change;
- Developing Climate Change Framework Action Plan (CCFAP) to support implementation of UNFCCC, particularly its Nairobi Work Programme;
- Establishing a sub-regional virtual climate change-related centre in Belgrade, which would provide a means to develop and implement programmes and projects under the sub-regional CCFAPs designed for interested countries of south-east Europe;
- Strengthening international partnerships which foster exchanges of experience and expertise in the fields of climate research and observation, education, public awareness-raising, and capacity building.

In addition, the need for further integrating policies on climate change, the environment, sustainable development, and energy in the region is recognized. Through the Belgrade Declaration, the signatory countries call for further efforts to improve energy efficiency in order to meet environmental and sustainable energy objectives. They welcome the project on 'Financing Energy Efficiency Investments for Climate Change Mitigation' and they consider participation of the public-sector investors in the energy efficiency investment fund, which is being created through the Energy Efficiency 21 Project. For increasing energy efficiency, they recognize the importance of using the flexibility mechanisms of the Kyoto Protocol.

The Republic of Macedonia participated in the regional project on 'Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)', in the period 2003-2006, funded by UNDP-GEF and Switzerland, parallel co-financing. Under the project, a regional programmatic approach was initiated to build capacity for improving the quality of data inputs into GHG inventories using the good practice guidance of the Intergovernmental Panel for Climate Change. By strengthening institutional capacity to prepare inventories and establishing a trained, sustainable inventory team, the project helped countries to reduce uncertainties and improve the quality of inventories for the Second National Communication.

In addition, the Republic of Macedonia participated in the regional UNDP project: 'Regional Project on Building Capacities to access Carbon Financing in Eastern Europe and CIS'. As a result, the National Strategy for CDM was prepared. Currently, the country is taking part in the REC sub-regional project 'Enhance Regional South-East European (SEE) Cooperation in the Field of Climate Policy'.

In line with international obligations, in 2005 Macedonia finalized the project 'Macedonia's National Capacity Needs Assessment for Global Environmental Management'. The overall objective of the assessment was to assess the capacities of the country to meet the obligations under the global environmental conventions pertaining to biodiversity (UNCBD), climate change (UNFCCC), and land degradation and desertification (UNCCD). The assessment uses the cross-cutting approach in defining the efficient use of the national resources and achieving synergetic effects to meet the requirements of these three Rio Conventions.

NATIONAL GREENHOUSE GAS INVENTORY

3.

3. NATIONAL GREENHOUSE GAS INVENTORY

3.1. Scope

The GHG Inventory in Macedonia was prepared for the first time as a part of the First National Communication on Climate Change using Revised 1996 IPCC methodology, where the three main GHGs – CO_2, CH_4, and N_2O – are inventoried for the period 1990-1998. As prescribed by this methodology, the GHG inventory comprised the following sectors: Energy, Industrial Processes, Agriculture, Land-Use Change and Forestry, and Waste. This inventory has undergone substantial national peer-review, and also received technical feedback from international expert, provided by the National Communications Support Unit (NCSU).

In general, the GHG Inventory process for the First National Communication on Climate Change did not incorporate many of the good practice elements defined in IPCC Good Practice Guidance and Uncertainty Management, 2000. Also, in accordance with the national circumstances many data gaps in the activity data (particularly in the waste sector) were identified, as well as the simplest methods (Tier 1) for emissions' calculation were applied.

Under the Second National Communication the main goal regarding GHG inventorying was to prepare national GHG inventories for the years 1999-2002 (with 2000 as the base year), according to the guidelines for the preparation of National Communications (17/CP.8). The main source of information was the State Statistical Office (official yearbooks), as well as official data from other national institutions, such the Ministry of Agriculture, Forestry, and Water Economy and the Ministry of Interior. In addition, the following specific tasks were undertaken:

- Inclusion of information on the other non-direct GHGs: HFCs, PFCs, and SF6 as well as CO, NOx, SOx, and NMVOCs;
- Revision of the input data, taking into consideration data gaps and areas needing improvement identified in the stocktaking exercise;
- Identifying and developing methods for overcoming data gaps;
- Application of higher Tiers (more sophisticated methods) for emissions' calculation wherever possible;
- Inclusion of the sector 'Solvent and Other Product Use' into the national inventory whenever possible (for the years when the relevant activity data are available);
- Recalculation of the time series for the period 1990-1998;
- Developing a full documentation of activity data and emission factors for the year 2000;
- Implementation of good practice elements to the maximum possible extent.

This in turn resulted in a (more) reliable time series 1990-2002 for the national GHG Inventories, reported in the National Inventory Report (NIR), complete and consistent EXCEL database (1996 IPCC EXCEL Spreadsheets), appended by the full documentation of activity data and emission factors for the year 2000 (documented material).

The GHG inventory process under the Second National Communication involved the following steps:

1. Identification of Data Sources;
2. Entering the Activity Data and Emission Factors;
3. Calculating the Emissions;
4. Checking and Validation of Input Data;
5. Recalculation and Validation of Emissions' Estimates;
6. Key Source Analysis;
7. Uncertainty Management;
8. National Expert and Public Review;
9. International Peer-review;
10. Reporting the Emissions.

3.2. Team

The national GHG inventory team was structured in a way that it enables control and assurance of quality of input data and estimated emissions to the maximum possible extent. It involved the following entities (Figure 3.2.1):

Ministry of Environment and Physical Planning (MOEPP), having the responsibilities for:

- Supervising the national inventory process, and
- Internationally reporting the emissions.

National Institution, who

- Acts as a National Inventory Team Leader,
- Maintains the whole GHG inventory,
- Incorporates good practice elements such as key source analyses, uncertainty management, QA/QC procedures, documenting and archiving, and
- Reports the emissions to MOEPP,
- Coordinates and supervises the Sectoral Experts (two experts for each sector):
- **Enterer**, responsible for identification/verification of data sources, entering and documenting the input data, and
- **Checker**, responsible for checking and validating the input data and emission estimates.

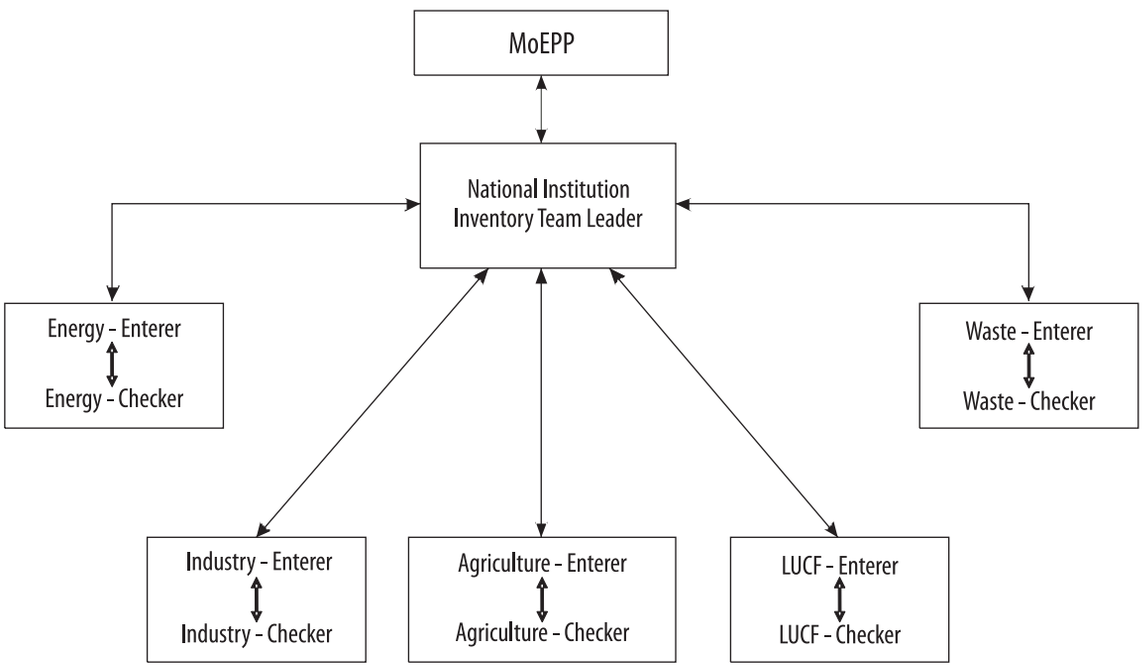


Figure 3.2.1. Structure of the national GHG inventory team

The national institution appointed as National Inventory Team Leader, was the Research Centre for Energy Informatics and Materials of the Macedonian Academy of Sciences and Arts (ICEIM-MANU).

3.3. Sectoral Inventories

3.3.1. Energy

The inventory for the energy sector has been prepared for the period 1990-2002, with consideration of the three main GHGs: CO_2, CH_4, and N_2O, as well as the indirect gases CO, NO_x, NMVOCs, and SO_2.

The CO_2 emissions are calculated by two methods: reference approach (top-down) uses the fuel consumption accounting for the carbon flows into and out of the country; sectoral approach (bottom-up) accounts for the fuel consumption by sectors.

The situation concerning the availability of activity data for the energy sector, compared to the period within the First National Communication, has improved. The existing sectoral inventory was completely reconstructed and new inventories for the years 1999-2002 were calculated using the high quality data from the energy balances. Still, fuel consumption data should be disaggregated down to the last combustion technology regardless of its size and contribution to the total emissions, in order to provide possibility for application of a higher Tier in subsequent inventories.

The emissions have been calculated with the IPCC Excel software using the emission factors provided in the IPCC Guidelines for all fuels except lignite, since the national CO_2 emission factor for the lignite was developed and applied.

The CO_2-eq emissions by subsectors from the energy sector for the period 1990-2002 are presented in Table 3.3.1.1. In addition, in the lower part of the table the contribution of individual subsectors to the total CO_2-eq emissions in the energy sector is presented. The table clearly indicates that the main contributor to the CO_2-eq emissions within the energy sector is the energy industries' subsector, which produces about 70-75% of the total emissions. The contribution of the other sub-sectors within the energy sector, such as manufacturing industries and construction (industrial boiler plants and energy systems, district heating plants, etc.), transport, commercial/institutional, and residential, etc., is significant as well. Since a variety of fuels and combustion technologies is used in these categories, the grouping in sufficiently homogenous technology types (or, at least, beginning of such activity) should be addressed in the advanced follow-up activities, as a preparation phase for implementation of higher Tier methodologies.

Table 3.3.1.2. presents the contribution of individual GHGs to the total CO_2-eq emissions in the energy sector. About 97% of the equivalent emissions are direct CO_2 emissions from fuel burning and nearly 3% are the fugitive CH_4 emissions. The N_2O emissions are negligible.

Comparing the recalculated CO_2-eq emissions for the years 1990-1998 with the corresponding ones reported in the First National Communication, a significant difference can be noticed. The recalculated emissions are about 6-14% lower exclusively due to the different lignite emissions, i.e. as a result of application of a correct emission factor for both direct CO_2 emissions from lignite burning and the fugitive CH_4 emissions from lignite mining. In absolute values the emissions are 650-1,350 kt CO_2-eq lower for the period 1990-1998. The frequent alternation of approaches and methods for lignite conversion and emission factors calculation clearly indicates that this might be considered as a gap.

Table 3.3.1.1. Contribution of individual subsectors to the total CO_2-eq emissions in the energy sector

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	Energy industries	6,937.771	6,314.560	5,951.331	6,122.003	6,333.226	6,409.249	5,958.255	6,583.705	7,492.262	7,079.011	6,876.433	7,345.690	6,540.728
	Fugitive emissions	151.042	140.236	136.268	139.772	148.134	153.553	146.884	157.479	180.890	169.827	181.077	200.583	190.498
	Transport	1,055.464	1,032.945	860.248	1,209.582	1,097.153	1,095.501	1,145.692	1,122.715	1,061.918	1,191.280	1,068.395	1,011.427	1,083.900
	Manufacturing industries and construction	968.942	918.637	812.913	844.301	656.479	665.074	704.429	731.958	585.356	438.427	569.913	380.541	448.143
	Commercial/Institutional & Residential	580.388	552.107	518.134	531.570	431.879	426.797	436.837	405.706	205.197	222.952	242.597	213.053	223.074
	Agriculture/Forestry/ Fishing	246.228	231.973	205.273	221.160	172.691	174.837	186.188	196.717	144.438	102.361	131.134	108.230	59.810
	Other	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	269.081	512.521	157.358	96.175	1,209.377
	Total	**9,939.834**	**9,190.459**	**8,484.167**	**9,068.388**	**8,839.563**	**8,925.011**	**8,578.286**	**9,198.279**	**9,939.144**	**9,716.381**	**9,226.906**	**9,355.699**	**9,755.530**
[%]	Energy industries	69.80	68.71	70.15	67.51	71.65	71.81	69.46	71.58	75.38	72.86	74.53	78.52	67.05
	Fugitive emissions	1.52	1.53	1.61	1.54	1.68	1.72	1.71	1.71	1.82	1.75	1.96	2.14	1.95
	Transport	10.62	11.24	10.14	13.34	12.41	12.27	13.36	12.21	10.68	12.26	11.58	10.81	11.11
	Manufacturing industries and construction	9.75	10.00	9.58	9.31	7.43	7.45	8.21	7.96	5.89	4.51	6.18	4.07	4.59
	Commercial/Institutional & Residential	5.84	6.01	6.11	5.86	4.89	4.78	5.09	4.41	2.06	2.29	2.63	2.28	2.29
	Agriculture/Forestry/ Fishing	2.48	2.52	2.42	2.44	1.95	1.96	2.17	2.14	1.45	1.05	1.42	1.16	0.61
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.71	5.27	1.71	1.03	12.40
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 3.3.1.2. Contribution of individual GHGs to the total CO_2-eq emissions in the energy sector

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	CO_2	9,469.008	8,737.395	8,049.026	8,592.552	8,377.756	8,469.744	8,136.003	8,796.541	9,509.592	9,288.604	8,791.000	8,934.373	9,348.403
	CH_4	227.778	215.088	213.850	219.343	220.734	222.182	212.375	203.411	228.359	219.408	237.438	245.461	235.068
	N_2O	47.401	44.352	42.829	44.747	43.306	42.959	40.857	39.450	43.907	42.644	42.478	41.783	38.941
	CO	195.648	193.624	178.462	211.745	197.768	190.127	189.050	158.877	157.285	165.724	155.991	134.082	133.118
	Total	9,939.834	9,190.459	8,484.167	9,068.388	8,839.563	8,925.011	8,578.286	9,198.279	9,939.144	9,716.381	9,226.906	9,355.699	9,755.530

3.3.2. Industrial Processes

The industry sector, besides recalculation of the existing emissions on CO_2, N_2O, and CH_4 from mineral, chemical, and metals' industries up to 1998, also includes data on emissions of other gases: CO_2, CH_4, CO, SO_2, NO_x, NMVOCs and HFCs, SF_6, for the period 1999-2002.

The period covered by the Second National Communication was the most turbulent from the point of view of the industrial activities. During the process of restructuring and privatization, many companies ceased to operate or had reduced their production rate to a minimum. There are companies that have reduced their production rate down to 10% of the designed capacity. Very few industrial activities remained steady over the period 1999-2002 such as: cement production, beer, zinc, sulphuric acid, etc. Some of these, however, have either further reduced production rates or have been shut down since 2002.

Due to the disintegration of some of the biggest companies into several smaller ones (iron and steel production and manufacturing), a divergence occurs between production and manufacture and the GHG emissions.

Dominant GHG source categories are: mineral industry, with cement production in particular, metallurgy, with production of ferroalloys (ferronickel and ferrosilicon), zinc, iron and steel. Cement production is by far the most significant source of CO_2 emission within the mineral sector. The share of HFCs in the total GHG emissions in the recent years should not be neglected. Sulphuric acid production in chemical industry is a significant source of SO_2 emissions, along with the metal production activities and the chemical industry, whose only significant source is one single company, the lead and zinc smelter. The food and beverage industry has been added to the list of industries, which is considered dominant from the point of view of the NMVOC emissions. Small emissions of NO_x arise from metal manufacturing (steel rolling) and the chemical industry (polyvinyl chloride production).

Several characteristic features have to be kept in mind while assessing the GHG emissions from Macedonia's industry:

- The overall industrial production in the country has substantially dropped in the period from 1990 to 1999. The reduction in some industrial sub-sectors was even up to 50% (State Statistical Office).
- Data on some industrial sub-sectors are available only for the recent years, thus leading to a false conclusion of a sudden increase of emission of certain gas.
- Some industries have been almost or completely eradicated, such as: production of PVC, pig iron, ferrochromium, and as of 2003, the production of zinc.

Most of the greenhouse gases, both direct and indirect, have been reported in this inventory, but uncertainties have not been dealt with. As the industrial production rate stabilizes, more reliable data will be provided including the assessment on reliability.

Most of the emissions are generated from a rather small number of installations. This fact should be considered as an advantage and be used for reducing uncertainties. Direct communication with the specific industry preferably throughout the reporting period is the best possible way of enabling application of Tier 2 to some sub-sectors.

Table 3.3.2.1. GHG emissions from the industrial sector [kt]

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	Mineral Industry	350.80	327.14	285.90	273.03	258.18	277.11	254.65	311.10	234.14	290.39	411.54	304.53	367.66
	Metal Industry	538.49	581.56	671.87	558.21	458.27	516.00	565.01	599.14	659.12	452.04	448.95	504.02	385.67
	Chemical Industry	0.00	0.00	0.00	0.21	0.21	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Food and Drinks	0	0	0	0	0	0	0	0	0	0	0	0	0
	Use of HFCs and SF_6										8.35	33.57	128.84	39.04
	Total	**889.29**	**908.70**	**957.77**	**831.46**	**716.66**	**793.32**	**819.66**	**910.24**	**893.26**	**750.79**	**894.06**	**937.39**	**792.37**
[%]	Mineral Industry	39.45	36.00	29.85	32.84	36.02	34.93	31.07	34.18	26.21	38.68	46.03	32.49	46.40
	Metal Industry	60.55	64.00	70.15	67.14	63.95	65.04	68.93	65.82	73.79	60.21	50.21	53.77	48.67
	Chemical Industry	0.00	0.00	0.00	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Food and Drinks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Use of HFCs and SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	3.75	13.74	4.93

Table 3.3.2.2. Contribution of individual GHGs to the total CO2-eq emissions from the industrial sector

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	CO_2	818.59	838.81	886.89	766.53	664.13	738.18	755.52	835.86	828.86	676.01	780.65	733.13	679.02
	CH_4	-	0.19	-	0.12	0.11	0.17	0.05	0.05	0.05	-	0.01	-	-
	CO	70.70	69.89	70.89	64.71	52.32	54.93	74.04	74.39	73.35	66.43	79.84	75.41	74.31
	$HFC_s + SF_6$	-	-	-	-	-	-	-	-	-	8.33	33.53	128.80	36.04
	Total	**889.29**	**908.89**	**957.78**	**831.36**	**716.56**	**793.28**	**829.61**	**910.30**	**902.27**	**750.77**	**894.03**	**937.35**	**789.38**

3.3.3. Solvent and Other Product Use

GHG inventory for this sector was prepared for the first time covering the period of 1997-2002, since, due to lack of data, this chapter had not been covered in the First National Communication. The Revised 1996 IPCC Guidelines were applied, and to some extent, the CORINAIR methodology.

No data have been found so far on consumption of paint other than the industrial consumption. However, having in mind that the average annual consumption of paint per capita in Europe is about 4.5 kg and that no car industry, which is the biggest consumer of paint, exists in Macedonia, one can assume that the annual consumption of paint per capita in Macedonia is about 3 kg.

An emission factor of 1 has been used for all organic solvents and other volatile organic compounds, while the emissions of the NMVOCs from paint have been calculated using an emission factor of 0.5 according to the CORINAIR Guidelines.

The emissions of the NMVOCs from the use of organic solvents and similar compounds over the reported period are summarized in Table 3.3.3.1.

Table 3.3.3.1. Paint and solvents consumed and associated emissions in the period 1997-2002 (kt)

Year	Consumption	Emission
1997	14.993	11.997
1998	15.540	12.528
1999	14.848	11.823
2000	14.331	11.292
2001	13.831	10.779
2002	13.071	10.037

Apart from organic paint, a variety of organic solvents have been used among which trichlorethylene, ethyleneglicol, tholuene, xylene, sulphoderivatives, and ethyl alcohol comprise over 90% of the consumption.

The next inventory should be improved by refining the list of compounds, improving the knowledge of the pattern of consumption, including the emission abatement systems in the process of assessment and precisely following the IPCC guidelines once they have been established.

Process integrated measures should be focussed on substituting the use of solvents wherever this is possible. Where substitution is not possible, regeneration and onsite recycling are strongly advised.

3.3.4. Agriculture

Agriculture is the second largest source of GHG emissions among the sectors considered in the country. The GHG Inventory for Agriculture, both for the recalculated period up to 1998, and the newly calculated series up to 2002, has been done for the following gases: CH_4, N_2O, and CO_2-eq, i.e. their emission from the following source categories: (CH_4) emissions from enteric fermentation in domestic livestock, manure management and rice production, (N_2O) emissions from manure management, direct emissions from agricultural soils, and (CH_4 and N_2O) indirect emissions from nitrogen used in agriculture, emissions from agricultural residue burning. Gases such as: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) and SO_2 are not characteristic for agriculture.

One of the major problems is absence of relevant statistical department within the Ministry of Agriculture, Forestry, and Water Economy (MOAFWE), and non-existence of appropriate systems, to serve as a reliable and constant source of data, which will be further on statistically elaborated and delivered to the State Statistical Office.

The emissions of CO_2-eq from agriculture for the period 1990-2002 are given by sub-sectors in Table 3.3.4.1. In addition, in the lower part of the table the contribution of the individual sub-sectors is presented. It is evident that the main sources of the emissions are agricultural soils and enteric fermentation, both with about 40-50% of the total CO_2-eq emissions, while manure management and flooded rice fields account for a smaller share. Table 3.3.4.2 presents the contributions of the individual GHGs in the total CO_2-eq for agriculture.

Table 3.3.4.1. Contribution of individual sub-sectors to the total CO_2-eq emissions in agriculture

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	Enteric Fermentation	694.38	684.25	697.77	703.11	704.98	692.21	659.46	634.65	567.86	570.48	559.46	560.30	545.42
	Manure Management	170.07	166.09	163.20	163.72	166.81	167.90	172.96	170.27	163.05	165.81	162.22	159.89	158.12
	Rice Cultivation	9.32	9.13	8.89	5.40	1.82	1.32	4.36	5.52	4.69	4.41	4.06	1.59	1.96
	Agricultural Soils	1,034.49	1,006.61	1,011.76	985.84	1,014.92	963.61	845.33	760.57	727.35	636.85	653.78	591.51	367.89
	Total	**1,908.27**	**1,866.08**	**1,881.62**	**1,858.08**	**1,888.54**	**1,825.04**	**1,682.11**	**1,571.02**	**1,462.96**	**1,377.56**	**1,379.52**	**1,313.29**	**1,073.39**
[%]	Enteric Fermentation	36.39	36.67	37.08	37.84	37.33	37.93	39.20	40.40	38.82	41.41	40.55	42.66	50.81
	Manure Management	8.91	8.90	8.67	8.81	8.83	9.20	10.28	10.84	11.15	12.04	11.76	12.17	14.73
	Rice Cultivation	0.49	0.49	0.47	0.29	0.10	0.07	0.26	0.35	0.32	0.32	0.29	0.12	0.18
	Agricultural Soils	54.21	53.94	53.77	53.06	53.74	52.80	50.25	48.41	49.72	46.23	47.39	45.04	34.27
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 3.3.4.2. Contribution of individual GHGs to the total CO_2-eq emissions in agriculture

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	CH_4	757.53	745.80	759.62	762.30	759.66	746.60	718.37	693.25	623.59	628.67	615.04	611.88	597.20
	N_2O	1,150.74	1,120.28	1,122.00	1,095.77	1,128.88	1,078.44	963.75	877.77	839.37	748.88	764.48	701.41	476.19
	Total	**1,908.27**	**1,866.08**	**1,881.62**	**1,858.08**	**1,888.54**	**1,825.04**	**1,682.11**	**1,571.02**	**1,462.96**	**1,377.56**	**1,379.52**	**1,313.29**	**1,073.39**

3.3.5. Land Use Change and Forestry

This sectoral inventory covers emissions of CO_2, CH_4, N_2O, and CO using the Tier 1 methodology, both for the recalculated period within the Initial National Communication, and for the period 1999-2002. No new gases were included.

The main problems during this inventorying were located in the uncertainty of the activity data for the forest area, stock and annual forest growth, changes in land use, as well as loss of biomass due to the commercial logging, illegal logging, wood decay in forest, or the processed industry.

The annual balance of emissions of the GHG gases, as well as the percentiles for different gases, for the period 1990-2002, in this sector are shown in Table 3.3.5.1.

The highest contribution of the GHG gases comes from the sub-sector Conversion of the Forest and Grassland, as well as from the on- and offsite burning of biomass.

Land-Use Change and Forestry is a very important sector for investigation for the overall balance of GHG gases for specific countries and globally, because it is the only sector that absorbs the emissions that are emitted from this and other sectors. The main emissions from this sector come from the annual loss of biomass for commercial harvest, the changes in biomass stock, on- and offsite burning of biomass, wood decay, and changes in land use. For the analysed period, this sector absorbs all of its emissions at the national level, except for the year 2000, because of the enormous number of forest fires, where the balance between absorption and emission is negative.

Table 3.3.5.1. Contribution of individual GHGs to the total CO_2-eq emissions in the LUCF sector

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	CO_2	257.73	21.87	385.30	689.47	248.31	5.15	46.78	161.39	81.01	90.47	1,711.95	291.90	31.65
	CH_4	14.76	1.25	22.07	39.49	14.22	0.30	2.68	9.24	4.64	5.18	98.05	16.72	1.81
	N_2O	1.50	0.13	2.24	4.01	1.44	0.03	0.27	0.94	0.47	0.53	99.51	16.97	1.84
	CO	9.66	0.82	14.45	25.85	9.31	0.19	1.75	6.05	3.04	3.39	64.20	10.95	1.19
	Total	**283.66**	**24.07**	**424.06**	**758.82**	**273.29**	**5.67**	**51.49**	**177.63**	**89.16**	**99.57**	**1973.70**	**336.53**	**36.49**
[%]	CO_2	90.86	90.86	90.86	90.86	90.86	90.86	90.86	90.86	90.86	90.86	86.74	86.74	86.74
	CH_4	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	4.97	4.97	4.97
	N_2O	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	5.04	5.04	5.04
	CO	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.25	3.25	3.25
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

3.3.6. Waste

This sectoral inventory consists of the inventory of methane emission from different sub-sectoral sources (solid waste disposal sites, domestic/commercial organic wastewater and sludge, and industrial wastewater and sludge) and N_2O emissions from human sewage for the period of 1999-2002, as well the corrected data for the inventory for the period of 1990-1998 (Initial National Communication). A GHG Inventory for the waste sector was not extended with non-direct GHGs (HFCs, PFCs, and SF_6, as well as CO, NO_x, SO_x, and NMVOCs). It is known that there are no emissions of HFCs, PFCs, and SF_6 gases from the waste sector. CO, NO_x, SO_x, and NMVOCs could be emitted mainly from the municipal solid waste incineration, but there is no such activity in the country. Very small amounts of CO, NO_x, and NMVOCs could arise from solid waste disposal sites (SWDSs) and wastewater treatment plants (approx. 0.3% of the CH_4 emission from SWDSs) which is a negligible amount in the total CO_2-equivalent emission for the country.

Using corrected values for methane (solid waste disposal sites, domestic/commercial organic wastewater and sludge, and from industrial wastewater and sludge) and N_2O (from human sewage), and CO_2-equivalent emission for the period from 1990 to 2002 the total emissions (kt) from the waste sector are obtained. Summarized results are presented in Tables 3.3.6.1 and 3.3.6.2 giving the annual emissions of CO_2-equivalent emissions (kt) and the share of each GHG from the waste sector.

Methane and N_2O emission for the whole analysed period is relatively constant, ranging from 755.15 kt CO_2-equivilent in 1994 to an 843.56 kt CO_2-equivilent emission in 2000. It is obvious that the bigger part of the GHG emission from the waste sector goes to the methane emission (about 93-94% from the total emission in the sector), while the smaller is the N_2O emission (6-7%, calculated as CO_2-equivalent). The main emission of the GHG in the waste sector is the methane emission from the SWDSs (between 86-89%), while the methane emission from domestic/commercial and industrial wastewaters and sludge is very small.

There are plans for building managed SWDSs in the country, which will increase the emission of methane from the waste sector. Increase of methane emission could be also expected by introducing the wastewater treatment plants for domestic/commercial and industrial wastewaters.

Table 3.3.6.1. CO_2-eq emission from sub-sectors in the waste sector

	Sebsector/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	SWDSs	677.67	682.50	695.73	699.09	655.41	675.78	691.95	728.70	736.05	735.84	749.91	742.56	748.65
	Domestic/ Commercial Organic Wastewater and Sludge	33.81	34.23	34.86	35.28	33.39	33.81	28.56	28.77	28.77	28.98	29.19	29.19	28.98
	Industrial Wastewater and Sludge	21.21	24.36	21.21	19.32	13.65	17.01	12.18	12.18	12.60	10.29	11.76	10.92	9.45
	Human sewage	52.70	52.70	55.80	55.80	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70
	Total	**785.39**	**793.79**	**807.60**	**809.49**	**755.15**	**779.30**	**785.39**	**822.35**	**830.12**	**827.81**	**843.56**	**835.37**	**839.77**
[%]	SWDSs	86.28	85.98	86.14	86.36	86.79	86.72	88.10	88.61	88.67	88.89	88.90	88.89	89.15
	Domestic/ Commercial Organic Wastewater and Sludge	4.31	4.31	4.32	4.36	4.42	4.34	3.64	3.50	3.46	3.50	3.46	3.49	3.45
	Industrial Wastewater and Sludge	2.70	3.07	2.63	2.39	1.81	2.18	1.55	1.48	1.52	1.24	1.39	1.31	1.12
	Human sewage	6.71	6.64	6.91	6.89	6.98	6.76	6.71	6.41	6.35	6.37	6.25	6.31	6.28
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 3.3.6.2. Contribution of GHGs in CO_2-eq emission in the waste sector

	GHGs/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	CH_4	732.69	741.09	751.80	753.69	702.45	726.60	732.69	769.65	777.42	775.11	790.86	782.67	787.08
	NO_2	52.70	52.70	55.80	55.80	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70
	Total	**785.39**	**793.79**	**807.60**	**809.49**	**755.15**	**779.30**	**785.39**	**822.35**	**830.12**	**827.81**	**843.56**	**835.37**	**839.77**

3.4. Overall Emissions

The total CO_2-eq emissions in Macedonia for the year 2000 amount to 14,318 kt CO_2-eq. The time series of the emissions for the period 1990-2002 are presented in Table 3.4.1 and Figure 3.4.1. It is obvious that the main contributor to the total CO_2-eq emissions is the energy sector with about 70% of the total emissions. The second biggest contribution comes from the agricultural sector with about 8-15%, while all other sectors are contributing with less than 10% each. The only exception to this general conclusion is in the year 2000, when due to enormous forest fires, the emissions from the LUCF sector were about 14% of the total national emissions. Table 3.4.2 presents the contribution of individual GHGs to the total CO_2-eq emissions, both in absolute values and in percentages. About 75-80% of the equivalent emissions are direct CO_2 emissions from burning, 12-14% are the CH4 emissions, 5-9% are the N_2O emissions, and about 2% are the CO emissions.

Comparing the recalculated CO_2-eq emissions for the years 1990-1998 with the corresponding ones reported in the First National Communication, a decrease in the range of 7.5-13.5% is noticeable. All sectors report smaller emissions except the LUCF sector where the recalculated emissions are about three times bigger. In the energy sector recalculated emissions are about 6-14% lower due to the different lignite emissions, both direct CO_2 emission from lignite burning and the fugitive CH_4 emissions from lignite mining. The most important factor leading to emission reduction was the correction in the fugitive emission factor for lignite mining, which was taken as for underground mines in the Initial National Communication, although lignite mines in Macedonia are surface ones.

In relative values (percentages), the biggest differences in the recalculated emissions are found in the sector of industrial processes (6-46%) and in the waste sector (30-34%), followed by agricultural sector emissions (4-7%).

One of the indicators for the emission level, which may be used in comparative analyses with other countries, is the CO_2-eq emissions per capita. For Macedonia, for the year 2000, according to the official census data, the average value of this indicator amounts to 7.16 t CO_2-eq/capita. The emissions per capita are lower than those in the other countries with economies in transition, which may reflect the overall economic situation in the country. This is partially true since the total CO_2-eq emissions do not necessarily correspond with the general economic trend of the country. Some countries with a large hydroelectric share in energy production may report low GHG emissions despite the relatively good economic position (e.g. Croatia). It is interesting to note that Macedonia's emissions per capita are higher than the corresponding emissions in some large and economically growing countries such as: Turkey, Mexico, Brazil, China, Indonesia, Pakistan, and India (descending order of emissions in the range of 5 to 2 t CO_2-eq/capita).

Table 3.4.1. Sectoral CO_2-equivalent emissions[1]

	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	Energy	9,939.83	9,190.47	8,484.18	9,068.37	8,839.56	8,925.02	8,578.29	9,198.29	9,939.13	9,716.39	9,226.90	9,355.70	9,755.52
	Industry	889.29	908.89	957.78	831.36	716.56	793.28	819.71	910.30	893.31	750.76	894.03	937.35	792.38
	Agriculture	1,908.27	1,866.08	1,881.62	1,858.08	1,888.54	1,825.04	1,682.11	1,571.02	1,462.96	1,377.56	1,379.52	1,313.29	1,073.39
	LUCF	283.66	24.07	424.06	758.82	273.29	5.67	51.49	177.63	89.16	99.57	1,973.70	336.53	36.49
	Waste	785.39	793.79	807.60	809.49	755.15	779.30	785.39	822.35	830.12	827.81	843.56	835.37	839.78
	Total	**13,806.44**	**12,783.29**	**12,555.23**	**13,326.12**	**12,473.10**	**12,328.31**	**11,916.99**	**12,679.59**	**13,214.69**	**12,772.10**	**14,317.71**	**12,778.24**	**12,497.56**
[%]	Energy	71.99	71.89	67.57	68.05	70.87	72.39	71.98	72.54	75.21	76.08	64.44	73.22	78.06
	Industry	6.44	7.11	7.63	6.24	5.74	6.43	6.88	7.18	6.76	5.88	6.24	7.34	6.34
	Agriculture	13.82	14.60	14.99	13.94	15.14	14.80	14.12	12.39	11.07	10.79	9.64	10.28	8.59
	LUCF	2.05	0.19	3.38	5.69	2.19	0.05	0.43	1.40	0.67	0.78	13.79	2.63	0.29
	Waste	5.69	6.21	6.43	6.07	6.05	6.32	6.59	6.49	6.28	6.48	5.89	6.54	6.72
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

[1] National GHG inventories for the period 1990-2002 can be assessed on following web sites: project office www.unfccc.org.mk and UNFCCC www.unfccc.int
The summary reporting tables (prescribed in the Guidelines) are presented in Annex 4.

Table 3.4.2. Contribution of CO_2, CH_4, N_2O, CO, and HFCs to CO_2-eq. emissions for all sectors

	Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
[kt]	CO_2	10,545.33	9,598.08	9,321.21	10,048.55	9,290.20	9,213.08	8,928.41	9,793.79	10,408.98	10,055.09	11,283.60	9,959.41	10,059.08
	CH_4	1,732.78	1,703.43	1,747.30	1,775.03	1,697.21	1,695.97	1,666.20	1,675.40	1,630.70	1,628.35	1,741.23	1,656.67	1,621.23
	N_2O	1,253.22	1,218.64	1,221.40	1,199.10	1,224.80	1,173.38	1,057.27	970.94	936.79	845.36	959.99	813.94	570.40
	CO	276.01	264.33	263.80	302.31	259.40	245.25	264.85	239.32	233.68	235.54	300.03	220.44	208.62
	HFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.20	120.47	30.71
	Total	**13,807.34**	**12,784.47**	**12,553.72**	**13,324.99**	**12,471.61**	**12,327.68**	**11,916.72**	**12,679.45**	**13,210.15**	**12,764.34**	**14,310.05**	**12,770.92**	**12,490.04**
[%]	CO_2	76.37	75.08	74.25	75.41	74.49	74.73	74.92	77.24	78.80	78.77	78.85	77.99	80.54
	CH_4	12.55	13.32	13.92	13.32	13.61	13.76	13.98	13.21	12.34	12.76	12.17	12.97	12.98
	N_2O	9.08	9.53	9.73	9.00	9.82	9.52	8.87	7.66	7.09	6.62	6.71	6.37	4.57
	CO	2.00	2.07	2.10	2.27	2.08	1.99	2.22	1.89	1.77	1.85	2.10	1.73	1.67
	HFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.94	0.25
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

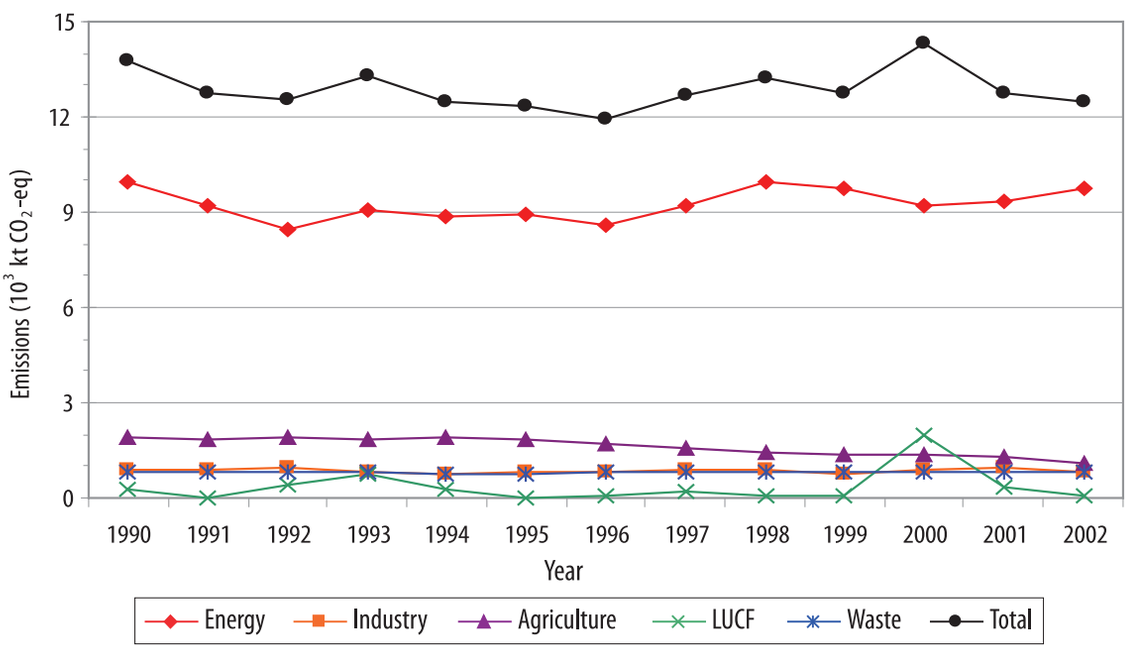


Figure 3.4.1. Sectoral and overall GHG emissions (as per Table 3.4.1)

3.5. Key Source Analysis

When using the Tier 1 approach, key source categories are identified using a predetermined cumulative emissions threshold of 95% of the total national emissions. Table 3.5.1 summarizes the results of the analysis, presenting the Key Source Categories. The table lists all the source categories which appeared to be a key source at least in one year of the period 1990-2002.

In the last two columns of Table 3.5.1 the level of each key source category for the base year (2000) and for the year 2002 are presented. Bearing in mind enormous forest fires in 2000, which contributed with a staggering 12% of the total emissions and distorted the usual pattern of key source categories, conclusions about the key sources are drawn regarding emission levels for the last year in the inventory, 2002. In addition, it is important to note that the emission levels for all categories are more-or-less the same for all other years except for the base year.

It is obvious that the **most important key source** in Macedonia is the energy industry (51.3%), which consists practically of GHG emissions from the lignite-fired power plants. The other key sources are road transport (7.4%), solid waste disposal on land (6%), enteric fermentation (4.4%), agricultural soils (2.9%), cement production (2.9%), and manufacturing industries and construction (2.9%).

Table 3.5.1. Key Source Analysis – Summary Results

No.	Source category	Gas	Number of years being a key source	Level (%) in 2000	Level (%) in 2002
1	1.1.1. Energy Industries - CO_2 from Oil	CO_2	13	5.607	4.507
2	1.1.2. Energy Industries - CO_2 from Coal	CO_2	13	41.466	46.835
3	1.2.1. Manufacturing Industries and Construction - CO_2	CO_2	13	3.320	2.900
4	1.3.3. Road Transportation - CO_2	CO_2	13	6.711	7.448
5	1.5.1. Residential - CO_2	CO_2	13	0.855	1.040
6	1.8.1. Fugitive Emissions - Coal	CH_4	13	1.108	1.281
7	2.1.1. Cement Production	CO_2	13	2.791	2.857
8	2.3.2. Ferroalloys Production	CO_2	13	1.320	0.904
9	3.1. Enteric Fermentation	CH_4	13	3.910	4.367
10	3.4. Agricultural Soils	N_2O	13	4.569	2.945
11	5.1. Solid Waste Disposal on Land	CH_4	13	5.240	5.994
12	1.6.1. Agriculture / Forestry / Fishing - CO_2	CO_2	12	0.910	0.475
13	3.2.2. Manure Management - N_2O	N_2O	12	0.774	0.867
14	1.5.2. Residential - Non-CO_2	CO_2-eq.	11	0.840	0.746
15	4.1.1. Forest and Grass Land Conversion - CO_2	CO_2	7	11.963	0.253
16	2.3.3. Zinc Production	CO_2	6	0.837	0.893
17	1.3.4. Road Transportation - Non-CO_2	CO_2-eq.	6	0.674	0.704
18	1.7.1. Other - CO_2	CO_2	5	1.100	9.683
19	1.3.1. Civil Aviation - CO_2	CO_2	2	0.610	1.112
20	1.1.3. Energy Industries - CO_2 from Gas	CO_2	2	0.762	0.789
21	4.1.2. Forest and Grass Land Conversion - Non-CO_2	CO_2-eq.	1	1.829	0.039
22	6. HFCs	CO_2-eq.	1	0.176	0.246

Identification of national key source categories is important because the resources available for preparing inventories are finite and their use should be prioritized. It is essential that estimates be prepared for all source categories, in order to ensure completeness. As far as possible, key source categories should receive special consideration in terms of three important inventory aspects:

- Additional attention has to be focussed on key source categories with respect to the methodological choice. For many source categories, higher tier (i.e. Tier 2) methods are suggested, although this is not always possible.
- It is good practice that key source categories receive additional attention with respect to quality assurance and quality control (QA/QC).
- Definition of mitigation measures for GHG abatement.

3.6. Estimation of Uncertainties

The principle of the Monte Carlo analysis (which is the Tier 2 method for uncertainties estimation) is to select random values of emission factor and activity data within their individual probability density functions, and to calculate the corresponding emission values. This procedure is repeated many times, using a computer, and the results of each calculation run build up the overall emission probability density function. The Monte Carlo analysis can be performed at the source category level, for aggregations of source categories or for the inventory as a whole.

Due to uncertainties in the results, based on lack of sound input, requirements for a successful implementation of the Monte Carlo analysis are not met for all source categories within the Macedonian inventory of GHGs. Therefore, estimation of the uncertainties is done only for the Sectoral Approach of the Energy Sector, applying the software package Simulación 4.0 (http://www.cema.edu.ar/~jvarela), which was fully developed in VBA (Visual Basic for Applications) and it is compatible with Excel 97 and above.

The mean value and standard deviation for each variable were defined, i.e. the values of 10% for the activity data and 5% for conversion and emission factors were set.

The reported emissions for the Sectoral Approach for the Energy Sector for the base year (2000) are presented in Table 3.6.1. After 20,000 Monte Carlo simulations, the maximum, minimum, and mean values, as well as the standard deviation for the emission for each sub-sector and for the whole energy sector, have been calculated. The results are presented in Table 3.6.2. The last column of Table 3.6.2, the ratio of the standard deviation and the mean value may be practically interpreted as uncertainty of the emission estimated for the sub-sectors within the Sectoral Approach and for the whole Energy Sector for the year 2000.

Table 3.6.1. CO_2 emissions from the energy sector for the year 2000 – sectoral approach

Sub-sector	(kt)
Energy Industries	6,845.23
Manufacturing Industries and Construction	475.04
Transport	1,060.80
Residential Sector	122.38
Agriculture / Forestry / Fishing	130.19
Other	157.36
Total	**8,791.00**

Table 3.6.2. Summary results of the Monte Carlo simulation of the CO_2 emissions from the energy sector for the year 2000 – sectoral approach

Subsector	Maximum	Minimum	Mean	Std. Dev.	Dev./Mean
Energy Industries	9,921.42	4,104.27	6,842.49	735.76	10.75%
Manufacturing Industries and Construction	651.85	333.82	474.96	37.04	7.80%
Transport	1,406.76	738.24	1,060.85	83.58	7.88%
Residential Sector	165.38	87.05	122.46	10.60	8.65%
Agriculture / Forestry / Fishing	192.54	87.29	130.30	12.05	9.25%
Other	208.63	107.05	157.31	13.13	8.35%
Total	**11,774.20**	**6,070.84**	**8,788.37**	**742.36**	**8.45%**

Under the Tier 1 method, the uncertainties in the source categories can be combined using analytical formulae to provide uncertainty estimates for the entire inventory in any year. There are two convenient rules for combining uncorrelated uncertainties under addition and multiplication which are practically the only mathematical operation employed in the emissions' calculation. In order to confirm the results of the uncertainty calculation with the Monte Carlo simulation, uncertainties with the Tier 1 method for the energy industries were calculated. The calculated total uncertainty of 10.70% for the energy industries is very close to the value obtained by the Monte Carlo simulation, which is 10.75%. The total uncertainty for the whole energy sector calculated by the Tier 1 approach is 8.44%, which is practically the same as the value obtained by the Monte Carlo simulation, confirming that the simulation was properly carried out.

3.7. Recommendations for GHG Inventory Improvement

In order to apply higher Tier in the subsequent inventories, some of the activities that need to be taken are the following:

Energy sector

- Development of a study, which will either theoretically and/or experimentally produce reliable lignite conversion and CO2 emission factors, as well as CH4 emission factors for the fugitive emissions and CO emission factor for lignite thermal power plants and lignite mines in Macedonia (TPP Bitola and TPP Oslomej). The current emission factors need improvement and adjustment, bearing in mind the new lignite mines, both underground and surface ones. The fugitive emissions from the coal mines should be considered in the same study as well.
- Development of a study/analysis for obtaining/identifying characteristics of combustion technologies in the non-energy industries (manufacturing industries and construction (industrial boiler plants and energy systems, district heating plants, etc.), transport, commercial institutional and residential, etc.), which will result in reliable data for categorization/grouping in homogenous technologies.
- Development of individual CO emission factor for each technology considered in the Tier 2 method will contribute significantly in enhancement of future inventories.

Industrial processes

- It would be useful to incorporate GHG emissions in the reporting scheme of the A and B IPPC installations, according to IPPC EU directive. It may be a matter of a separate project to train the responsible staff within the industry on the IPCC methodology.
- Although asphalt production and road paving with asphalt was intended to be included within this inventory, data unavailability did not permit that. Efforts should be made to enable this source to be included in subsequent inventories.
- Determination of accurate CO2 emission factors for metal production (tonne CO2/tonne reducing agent: coal, coke from coal, petrol coke or pre-baked anodes, and coal electrodes), along with reliable activity data on the amount of reducing agent, would be an important precondition for estimation of reliable GHG emissions. Investigation with the aim of setting up a reliable CO2 emission factor for the cement production process should be conducted, including: 1) determination of an average CaO fraction in clinker and the amount of gypsum that is mixed with clinker or 2) assembling country or regional data on clinker production by type and CaO content in clinker by type and then calculating an average CaO content for cement lime in the country.

Agriculture

- Establishing a farm register and Integrated Administration & Control System (IACS), which will represent a sophisticated and accurate system for gathering of data which refer to the agricultural statistics (crop pattern, land use, number of animals, etc.) and agricultural management (animal waste treatment, quantities of mineral fertilizers applied, etc.).
- Practical measurement of the emissions from different sources and other parameters for the country's livestock characteristics.
- Inclusion in periodic (annual) statistical data for the population number of goats, mules, and asses.

Forestry

- Developing a new forestry inventory that will determine the area, stock, annual growth, species, and other information, needed for higher precision in GHG emissions estimates.
- Collection of reliable data on wood decay, number of forest fires, areas that are burned, and percentage of burned wood.
- Estimation of wood used for heating that is illegally cut and sold.

Waste

- Development of study on quantity of waste disposed, i.e. average annual waste acceptance rate during the SWDS active life (in the regions of the country and for the bigger solid waste disposal sites, in particular).
- Development of study on average composition of waste in order to obtain reliable information on degradable organic carbon (DOC) content, a parameter that depends upon the composition of waste, important in the application of the theoretical gas yield methodology.

GHG Inventory in the Light of EU Accession

- To ensure sustainability of the inventory process it is crucial to develop and maintain the existing, as well as to build new national capacities for inventories preparation.
- Deeper involvement of national institutions obliged for data collection (the State Statistical Office) is of crucial importance in order to make adjustments of the data collection methodology, aiming to cover identified GHG-related data in the above sectors.
- A set of institutional, legislative, and technical measures need to be undertaken, which will not only put a more sophisticated GHG inventory in place, but will also contribute towards providing a background for establishment of a national registry system, which will be a country requirement within its process of EU accession. Before starting the designing process, a few amendments to the existing framework of the Law on Environment and to the Law on Energy are necessary in order to create background for creation of a Law on GHG Allowance Trading and to transpose the Emission Allowance Trading Directive (EATD) into national legislation and establishment of a Scheme for GHG Emission Allowance Trading.
- Introduction of a learning-by-doing "pilot phase" for Emissions Trading for a two-year period, aiming to strengthen capacities at the local authorities, companies and for the implementation of the system will be very helpful.
- It is also planned to develop secondary legislation concerning data supply, processing, systematization, archiving both from the monitoring networks, as well as in accordance with the ratified international agreements, which will contribute towards improvement of the process of data management.
- For mutual benefit, it is necessary to ensure linkages between GHG inventory and other pollutants inventories/cadastre, such as the Air Pollutants and Cadastre of Polluters.

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

4.

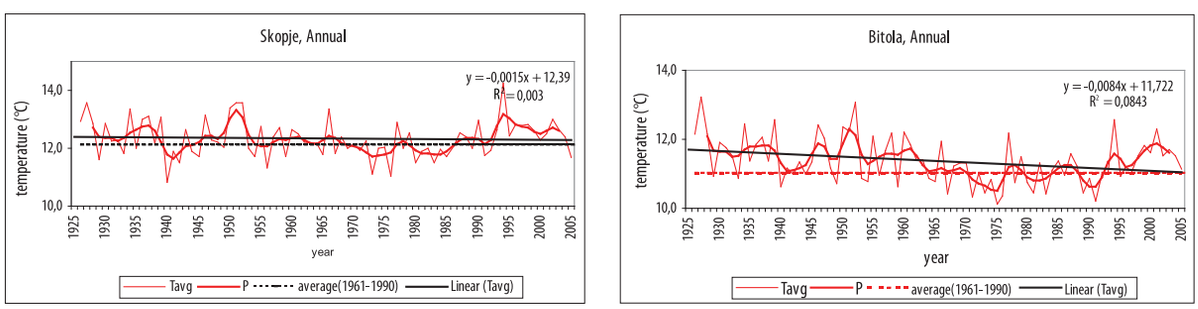
4. VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

4.1 National Climate and Climate Change Scenarios

4.1.1 Climate Variability up to 2006

To define climate characteristics and to prepare national climate valorization, the following climate elements were analysed: air temperature, precipitation, snow and snow cover, insolation, cloud cover, and fog. Analysis of the existing data from 1971 to 2000 for 34 meteorological stations was performed in order to define the climate of certain regions and to describe characteristics of the spatial distribution of meteorological-climatological elements and phenomena. The valorization was needed in order to define climate types and subtypes in the country.

Climate variability has been analysed on the basis of the comparison of the data of two series, each with a duration of 30 years, i.e. period 1961-1990 is compared to the period 1971-2000. Taking into consideration the air temperature, the period 1971-2000 at an annual level is warmer than the period 1961-1990, in almost all climate areas over the territory of the country, while the mean monthly temperatures show various differences during the year. Winters and summers during the last thirty-year period are warmer compared to the previous period. In spite of this, the autumn and spring months are colder than the previous thirty-year period. The highest values of mean annual deviations of the air temperature in the country are registered for regions with a sub-Mediterranean climate (Valandovo 0.7°C, Gevgelija 0.5°C, and Nov Dojran 0.2°C).



Picture 4.1.1 Variations of mean annual air temperature and linear trends for the period 1926-2005 for meteorological the stations at Skopje and Bitola

The hottest year recorded on the territory of the country is 1994, which is warmer than the multi-annual average by 2.0°C (in Skopje), 1.8°C (in Demir Kapija), and 1.6°C (in Bitola). Significantly higher average annual temperatures are recorded in 1999, 2002, and 2003.

Although 2007 had not then come to the end when analyses were performed and the meteorological data have not officially been published, extremely high air temperatures were recorded on 24 July, such as 45.7°C in Demir Kapija, 45.3°C in Gevgelija, and 43.4° C in Skopje-Zajcev Rid. These temperatures exceed the absolute maximum air temperature ever recorded.

The quantity of the annual sum of precipitation in the period 1971-2000 at all meteorological stations in the Republic of Macedonia is less in comparison with the period 1961-1990. The decrease of the precipitation at the annual level is most represented at the meteorological stations at Mavrovi Anovi (up to -96.6 mm) and Popova Sapka (up to -108.0 mm), i.e. in mountainous areas with a subalpine and alpine climate. Also, greater negative amounts in the differences of precipitation, at the annual level, are recorded for the meteorological stations at Prilep -35.0 mm, Gevgelija -32.4 mm, Ohrid -36.0 mm, and Lazaropole -38.5 mm.

The average annual number of days with snow cover for the period 1971-2000 has increased for the meteorological stations at Strumica, Bitola, Gevgelija, Kriva Palanka, Berovo, Ohrid, Skopje-Petrovec, Prilep, Lazaropole, and Popova Sapka.

The largest annual sum of insolation, around 2,400 hours, appears in areas with a sub-Mediterranean climate, while in regions with alpine and subalpine climate the annual sum of insolation is approximately 2,200 hours. A positive deviation of the annual sum of insolation is registered in both regions.

Statistical analysis from thirty-year series of cloud at the meteorological stations in the Republic of Macedonia, systemized by average monthly and annual values, shows a range of the average annual cloud cover from 3.8 tenths in Strumica up to 5,3 tenths in Kriva Palanka. The greatest cloud cover is to be found in regions in western Macedonia in winter, and the lowest in the regions with a sub-Mediterranean climate.

The average number of days when fog occurs has decreased by six days for Gevgelija, Bitola, and Tetovo. At some meteorological stations an increase in the annual number of days when fog appears, such as: Demir Kapija and Strumica (two days), three days in Kicevo, and five days in Kratovo and Krusevo.

4.1.2 Climate Change Scenarios up to 2100

Climate change projections of the main climate elements (temperature and precipitation) have been made up to year 2100, i.e. for the periods 1996-2025 (labelled 2025), 2021-2050 (labelled 2050), 2050-2075 (labelled 2075), and 2071-2100 (labelled 2100) in comparison with 1961-1990 (reference period labelled 1990). To describe the relationship between large-scale climate variability across south-east Europe and local-climate variability in Macedonia, results of four Global Circulation Models (GCMs) were used together with the NCEP/NCAR reanalysis data (Kalnay et al., 1996; Kistler et al., 2001). The GCMs are: Australian CSIRO/Mk2, the UKMO/HadCM3, the USA DOE-NCAR/PCM, and the German MPI-DMI/ECHAM4-OPYC3. As the simulations of future climate with GCMs are based on a limited number of emission scenarios, usually SRES A2 and B2, the local climate change projection, developed for the first time, was additionally scaled to other marker SRES emission scenarios (A1T, A1b, A1FI, B1) using the pattern scaling method (Mitchell, 2003).

Estimated changes in mean daily air temperature, as well as precipitation for the entire country, based on direct GCM output, are presented in Table 4.1.2.1.

According to the results, the average increase of temperature in the Republic of Macedonia is between 1.0°C in 2025, 1.9°C in 2050, 2.9°C in 2075, and 3.8°C in 2100. The average sum of precipitation is expected to decrease from -3% in 2025, -5% in 2050, -8% in 2075 to -13% in 2100 in comparison with the reference period.

Table 4.1.2.1. Projected changes in average daily air temperature (°C) and precipitation (%) for the Republic of Macedonia, based on direct GCM output interpolated to geographic location 21.5 °E and 41.4 °N (base period 1990)

	Average temperature change [°C]				Precipitation change [%]			
	annual				annual			
Year	2025	2050	2075	2100	2025	2050	2075	2100
Low	0.9	1.6	2.2	2.7	-1	-2	-4	-5
Mean	1.0	1.9	2.9	3.8	-3	-5	-8	-13
High	1.1	2.1	3.6	5.4	-6	-7	-12	-21

The highest increase in air temperature by the end of the century at the country level is projected for the summer season, together with the most intensive decrease in precipitation. In the case of precipitation, practically no change is expected in winter, but a decrease in all other seasons is. However, scientists agree that beyond a threshold of 2°C the risks of large-scale human development setbacks and irreversible ecological catastrophes will increase sharply.

Table 4.1.2.2. Projected changes in average daily air temperature (°C) based on direct GCM output

Average temperature change [°C]																
	winter				spring				summer				autumn			
	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100
Low	0.7	1.4	1.8	2.2	0.7	1.3	1.8	2.2	1.2	2.2	3.2	3.7	0.8	1.5	2.2	2.6
Mean	0.8	1.7	2.3	3.0	0.8	1.5	2.2	3.2	1.4	2.5	4.1	5.4	0.9	1.7	2.8	3.7
High	0.9	1.9	2.9	4.2	0.9	1.8	2.9	4.6	1.7	2.9	5.1	7.6	1.1	2.0	3.6	5.3

Table 4.1.2.3. Projected changes in precipitation (%) based on direct GCM output

Precipitation change [%]																
	winter				spring				summer				autumn			
	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100
Low	1	5	3	4	-3	-2	-7	-5	2	-16	-21	-21	2	-2	0	-5
Mean	0	1	2	-1	-5	-6	-10	-13	-7	-17	-27	-37	-1	-4	-9	-13
High	-2	-1	1	-3	-7	-10	-13	-22	-24	-18	-33	-53	-3	-7	-17	-23

Additional projections of changes in scalar wind speed (wind in m/s) and incident solar radiation (W/m^2) were performed. For both variables relative expected changes are very small, practically not exceeding 10% in either direction when considering the expected range. A minor increase in solar radiation is expected in all seasons, the highest in summer. Practically no change is expected in wind speed over Macedonia when considering direct GCM output of the four GCMs.

Projected changes in average daily air temperature (°C) and precipitation (%) for the different seasons and on an annual level, values are presented separately for the different seasons and are based on projections of results from four GCMs scaled to six emission scenarios (SRES A1T, A1FI, A1B, A2, B1, and B2).

For the region of south-east Macedonia with a prevailing sub-Mediterranean climate impact (represented by the stations at Gevgelija and Nov Dojran), a slight decrease of precipitation is expected by the end of the 21st Century in winter. More intense decrease of precipitation is expected in all other seasons, reaching the value of -19% in summer. However, a dramatic increase of temperature by 6°C in summer is projected. The difference between winter and summer increase in air temperature is especially evident for this region. Projected changes of air temperature and precipitation for the south-eastern part of Macedonia are presented in Table 4.1.2.4.

The region of central Macedonia, which is under a combination of continental and sub-Mediterranean climate impacts (represented by the stations at Veles, Skopje-Petrovec, Strumica, and Štip), shows a more intensive temperature change in winter and less intensive in summer and autumn compared to the region of south-east Macedonia. The highest increase of air temperature by 5.4°C for the year 2100 is expected in summer. Practically no change in precipitation is expected in the winter season and a decrease in precipitation in all other seasons, reaching the maximum value of -23% in summer. Projected changes of air temperature and precipitation for the central part of Macedonia are presented in Table 4.1.2.5.

Table 4.1.2.4. Projected changes of average daily air temperature (°C) and precipitation (%) for the south-eastern part of Macedonia (sub-Mediterranean and continental climate impacts represented by the Gevgelija and Nov Dojran stations)

	Average temperature change [°C]				Precipitation change [%]			
	annual				annual			
	2025	2050	2075	2100	2025	2050	2075	2100
Low	1.1	2.0	2.7	3.2	-1	-1	-4	-5
Mean	1.2	2.3	3.4	4.6	-3	-5	-9	-12
High	1.3	2.6	4.3	6.5	-5	-7	-12	-20

Table 4.1.2.5. Projected changes of average daily air temperature (°C) and precipitation (%) for the central part of Macedonia (sub-Mediterranean and continental climate impacts, represented by the Veles, Strumica, Skopje-Petrovec, and Štip stations)

	Average temperature change [°C]				Precipitation change [%]			
	annual				annual			
	2025	2050	2075	2100	2025	2050	2075	2100
Low	1.0	1.9	2.6	3.1	-1	-3	-5	-6
Mean	1.1	2.2	3.3	4.5	-3	-6	-9	-13
High	1.2	2.5	4.2	6.3	-6	-8	-13	-21

In the case of the southern region, represented by Bitola and Prilep, almost no change in precipitation is expected in winter while a decrease is expected in all other seasons, the greatest being in summer. A slightly stronger signal in temperature change is expected for this region in comparison with regions with sub-Mediterranean climate impacts. On the contrary, projections of temperature changes for the south-western region represented by Ohrid and Resen are much lower than those for the region represented by Bitola and Prilep. Additionally, even a slight increase of precipitation is expected for winter, but an evident decrease in other seasons. The different response of these two regions in large scale climate variability could be related to the proximity of large bodies of water (lakes Prespa and Ohrid) in the case of the Resen and Ohrid stations.

For the eastern part of Macedonia with a prevailing continental climate impacts, represented by the stations at Berovo and Kriva Palanka, a slight increase in precipitation, by 6%, is expected in winter, but a decrease in all other seasons, most intensive (-20%) in summer. In summer as well as in autumn, an increase in daily air temperature is expected, reaching the maximum value of 5.2°C in summer 2100.

For all three climate subtypes found in the north-western part of Macedonia, under the prevailing alpine climate impacts represented by the stations at Lazaropole, Popova Sapka, and Solunska Glava, the projections of air-temperature change and precipitation are very similar. An increase of precipitation by 5% until the end of 21st Century is expected in winter and a more intense decrease in all other seasons. The most intensive decrease of

precipitation by 18% is expected in summer. The expected air temperature change is the strongest in this region of the country. The highest increase in the air temperature, of 5.9°C, is expected in summer, but the difference between seasons is not large. Such dramatic temperature changes will have a strong ecological impact, which is further detailed in the most vulnerable sectors. Projected changes of air temperature and precipitation for the north-western part of Macedonia are presented in Table 4.1.2.6.

Table 4.1.2.6. Projected changes of average daily air temperature (°C) and precipitation (%) for the north-western part of Macedonia (prevailing alpine climate impacts, represented by the stations at Lazaropole, Popova Sapka, and Solunska Glava)

	Average temperature change [°C]				Precipitation change [%]			
	annual				annual			
	2025	2050	2075	2100	2025	2050	2075	2100
Low	1.2	2.3	3.0	3.7	0	-1	-2	-2
Mean	1.3	2.6	3.9	5.3	-2	-3	-5	-8
High	1.5	3.0	5.0	7.4	-4	-5	-8	-15

The direct GCM output projected for Macedonia shows a more intensive increase in air temperature in the winter and spring seasons. Almost no change in precipitation is expected for the winter season in general over the area of Macedonia, but quite a strong decrease in summer precipitation is. Also the projected relative precipitation decrease for the summer period is more dramatic in the case of direct GCM output in comparison with the local projections. Changes of the average daily air temperature and precipitation for the other seasons are compatible for both methods. Although empirical downscaling projections of climate change on a local level (developed for the first time) contain uncertainties related to the results, they present a step forward towards the needed knowledge about how the different sub-regions of Macedonia might respond to large-scale climate change.

4.2 Sectoral Vulnerability and Adaptation Analyses

Long-range impacts of climate change in Macedonia were assessed in the most vulnerable sectors: agriculture, forestry, water resources, biodiversity, and human health. Assessments were made taking into consideration climate change scenarios developed for the sub-regions within the country. In order to mitigate negative climate change impacts on the above sectors, adaptation priorities must be addressed within an intersectoral national plan. For developing countries, such as Macedonia, which are not contributing significantly to global greenhouse gas emissions, adaptation is a necessity and priority. However, the country will need international assistance in order to improve its capacity to adapt to climate change, and to cope with severe impacts. Those challenges have to be met by government, operating under severe financing constraints, and by the affected people themselves.

4.2.1 Agriculture

Agriculture in the Republic of Macedonia accounts for 14% of GDP in 2006. Furthermore, 14% of the total working population is engaged in agriculture and 43% of the population lives in rural areas. Subsequently, the agricultural sector is prioritized as one of the most important sectors of the Macedonian economy in almost all strategic documents, especially due to its importance for social security and poverty reduction.

An analysis of climate change impact on the agricultural sector was performed for: temperature (average temperature and sum of active temperatures), duration of growing period, rainfalls (sum of total rainfalls), evapotranspiration, water deficit, aridity index by De Martonne, and rainfall index by Lang. Comparison was made for the periods 1961-1990 and 1971-2000 in order to see if there have been some changes in the long-term average and if climate change already affects the territory of the Republic of Macedonia. The comparison between two periods is presented in a tabular, graphical way and in a map that was configured with a GIS map calculator. More than 45 maps, 35 tables and graphs were developed for this sectoral report, using GIS spatial models.

The analysis results show that all necessary parameters needed for proper agricultural production head towards the direction of creating an adverse impact on agricultural production. The most important factors that cause constraints in agricultural production are water deficit, aridity, and emergence of a period of drought, i.e. increase of regions with an arid climate. Climate change will have a negative impact in almost all important agricultural regions, but the largest changes are expected in central and south-eastern parts of the country. The agricultural study further analyses three very vulnerable sub-sectors: crop production, soils, and animal production.

4.2.1.1 Crop Production

The vulnerability assessment analyses are based on the results of the climate change scenarios up to 2100, both at the national level and the down-scaled ones.

1. The most vulnerable agricultural zone is Povardarie region, especially the area of the confluence of the Crna and Bregalnica rivers with the River Vardar (Kavadarci as a corresponding meteorological station)
2. Highly vulnerable zones with corresponding meteorological stations are:
   - South-eastern part of the country (Strumica);
   - Southern Vardar Valley (Gevgelija);
   - Skopje-Kumanovo Valley (Skopje);
   - Ovce Pole (Stip).
3. Less vulnerable zones with corresponding meteorological stations are:
   - Pelagonija Valley (Bitola);
   - Polog (Tetovo and Gostivar – no climate scenario);
   - Prespa/Ohrid region (Resen).

Identification of the most vulnerable crops was made according to the cropping pattern in the vulnerable areas. The crops that predominate in vulnerable regions were determined as vulnerable crops. The following crops were defined as vulnerable crops:

1. Vines/grape as the most important crop in Povardarie Region;
2. Tomatoes as the most important vegetable crop in a predominantly vegetable growing agriculture in the south-eastern part of the country (Gevgelija – Strumica);
3. Winter wheat as the most important cereal in Skopje – Kumanovo and Ovce Pole region;
4. Apples in the Prespa/Ohrid region, especially Resen;
5. Alfalfa as a crop with a very high water demand and huge importance in the livestock sector that is vulnerable in all agricultural regions of the country, especially for the Bitola region.

Expected yield decrease was calculated using the FAO Crop Yield Response to Water Deficit methodology. Data are presented in Table 4.2.1.1.

Table 4.2.1.1. Expected yield decrease for vulnerable areas and crops as a result of climate change impact in %

Area	Crop	2025	2050	2075	2100
Kavadarci	Grape	46	50	55	59
Gevgelija	Tomato	75	78	81	84
Strumica	Tomato	72	75	79	82
Stip	Winter wheat	14	17	21	25
Skopje	Winter wheat	8	12	16	21
Bitola	Alfalfa	58	62	66	70
Resen	Apple	46	50	55	59

Results are obtained under the assumption that crops would be planted without irrigation; therefore, the yield decrease is so dramatic. The estimation of economical losses, based on the assumption that the whole country will be equally affected by climate change and adaptation measures will not be applied, is presented in the Table 4.2.1.2.

Decrease of winter wheat will result in reduced food security, since it is the essential crop for food supply in the country. Decrease of grape production will affect not only farmers, but also the wine-producing industry that is in rapid development in the country. Decrease of alfalfa production will mean the decrease of livestock production and increased deficit in animal products (milk, meat, etc.) with a further negative impact on food security in the country.

Table 4.2.1.2. Estimated economic losses caused by expected climate change for winter wheat, grape, and alfalfa

Year	Decrease of production due to climate change (t)			Cost of decreased production (€)		
	winter wheat	grape	alfalfa	winter wheat	grape	alfalfa
2025	31,806	112,910	62204	4,104,004	18,211,370	7,023,001
2050	41,926	122,729	66,494	5,409,823	19,794,968	7,507,346
2075	53,492	135,002	70,784	6,902,188	21,774,465	7,991,691
2100	66,504	144,820	75,073	8,581,099	23,358,062	8,476,036

The total direct economical damage for the three analysed crops would be almost €30 million in 2025 and it would increase up to €40 million in 2100.

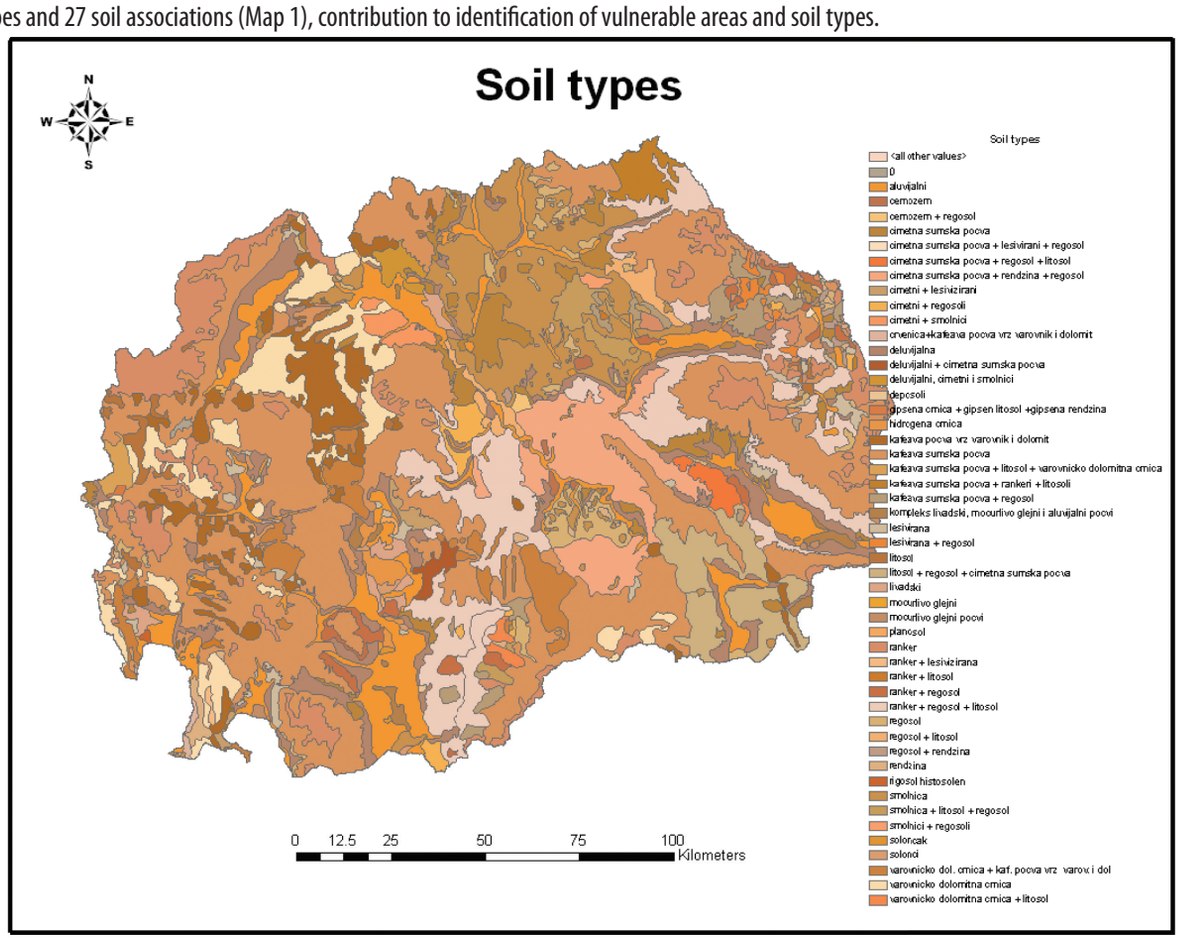
Adaptation techniques for crop production in the country should be divided into two parts:

- **Irrigated agriculture:** Having in mind unfavourable irrigation agricultural land (only one quarter of the agricultural land is irrigated and this number is permanently decreasing, the best adaptation strategy for irrigated areas will be spreading of water-saving techniques in irrigated agriculture, in order to maintain the same or even increased irrigated areas with the same water amount. The best available practice will be increased irrigation efficiency through micro-irrigation (micro-irrigation, 90% efficiency; furrow irrigation, less than 50% efficiency; and sprinkler irrigation, less than 70% efficiency). The priority is to determine the real price of irrigation water and to raise awareness about the importance of water-saving techniques. Structural changes in water management and increased level of know-how of all participants in the sector should follow these measures.
- **Rainfeed Agriculture:** The best available adaptation technology – irrigation – is hardly applicable in areas without irrigation schemes and infrastructure. Due to this, adaptation technologies should be oriented towards mitigation of the negative effects of drought and heat stress on crop development and yield. Adaptation measures for rainfeed agriculture should be divided into six groups:
  - Genetic measures (new, more drought tolerant crops and varieties such as wheat, barley, sunflower, industrial crops, etc.);
  - Land reclamation measures (to increase soil water holding capacity – manure, organic matter increase, some polymers);
  - Agricultural practices (soil and water conservation soil cultivation – reduced tillage, water harvesting, mulching, etc.);
  - Irrigation – building of new irrigation schemes and rehabilitation of existing schemes;
  - Increased level of knowledge through education of farmers;
  - Increased public awareness for new adaptation techniques.

4.2.1.2 Soils

Although the country is spread over a small surface area, due to the intense spatial variability of the main pedogenetic factors – geology, vegetation, relief, and climate – soil cover shows an immense variability.

A recent version of the soil map to the scale of 1:100,000, drafted in digital format for the purposes of this study, has been developed, based on a copy of a soil map to the scale of 1:250,000 and relevant researches and observations. This map represents just a plain graphical view of the soil types' special distribution, i.e. no chemical and physical soil characteristics are included. In the soil map, the whole territory has been divided into 22 soil types and 27 soil associations (Map 1), contribution to identification of vulnerable areas and soil types.



Map. 1 Soil map of Macedonia (scale, 1:200,000)

4.2.1.2.1 Soil organic matter decline

Organic matter is also an important 'building block' for soil structure and for the formation of stable aggregates. Other benefits are related to the improvement of infiltration rates and the increase in storage capacity for water. Furthermore, organic matter serves as a buffer against rapid changes in soil reaction (pH) and it acts as an energy source for soil micro-organisms. Without organic matter, biochemical activity in soil would effectively be negligible.

Climatic conditions will cause a decrease in the amounts of organic matter found in soils, due to an increase of air temperature and aridity, and acceleration of its decomposition.

Water and wind erosion can be responsible for physically removing organic matter from soils, because organic matter is concentrated in the top 30 centimetres and this is the layer that is normally removed first.

The most vulnerable soil types in the selected areas are identified on the basis of climate change scenarios, effect of sloping terrains, plant cover, texture classification, and moisture index. These are soils under intensive agriculture production on sloping terrains with heavy texture and shallow soil profile. The soils on the hilly relief are identified as the most vulnerable soil types. Any decreasing of organic matter in these soils especially in litosoils (shallow soil profile) and vertisoils (heavy textured soils) can cause serious and prompt damage to their production capability. Spatial distribution of agricultural soils with intensive decline of organic matter partially covers the most vulnerable agricultural areas such as central Povardarie and Ovce Pole.

Adaptation measures

In a situation of the non-existence of a reliable long-term series field dataset regarding the content and turnover of the soil's organic matter and its depletion, experience, analyses, and many studies have been used to define precise adaptation measures for successful combating of the negative impact of climate change on soil organic matter depletion.

Proposed adaptation measures include:

- Application of organic fertilizers (manure, sideration);
- System for recommending the amount of fertilizer to be applied, based on soil or plant tissue analyses;
- Cultivation of legumes;
- Crop rotation and leaving the soil for several years as uncultivated (fallow);
- Reduced or no-tillage cultivation.

4.2.1.2.2 Soil erosion

Even though soil erosion is normally a natural process occurring over geological timescales, climate change will accelerate soil erosion. Around 96.5% of the total area in the Republic of Macedonia is affected by the processes of soil erosion, and 36.65% of the total state territory is encompassed by stronger categories (I – III).

Annual soil loss represents an annual average loss of the arable soil layer of 20 millimetres in depth over an area of 8,500 ha. The economic cost of erosion impact is thus considerable.

Central Povardare (catchment areas of Crna Reka and Bregalnica) and south Povardarie are identified as the most vulnerable soil erosion regions.

Adaptation measures

- Afforestation of the sloping terrains is one of the measures that will decrease the process of soil erosion, protecting the soil surface from the devastation impact of actual rain drops and will preserve the surface flow of water. Production of biomass and content of SOM will increase.
- Implementation in practice of new irrigation techniques which enable efficient use of water, eliminate the surface flow of water, especially important on sloping terrains, and decrease the water scarcity, part of which is a result of decreased rainfalls due to the climatic change.
- Demonstration and increasing of the awareness of farmers on the management of the land, through changing the crop/vegetation cover, adequate cultivation (contour ploughing, reduced or no-tillage cultivation)

4.2.1.2.3 Soil salinization

Salinization is the process that leads to an excessive increase of water-soluble salts in the soil. The accumulated salts include sodium, potassium, magnesium, calcium, chloride, sulphate, carbonate, and bicarbonate. The possible risks that affect the soil production capability are as follows: plant life (soil fertility), life and function of soil biota (biodiversity); soil deteriorations (increased erosion potential, desertification, structure destruction, aggregate failure, and compaction).

Soil salinization is expected to increase due to climate change. Resulting from higher temperatures and reduced precipitation, salinization in surface layers of the soil can increase due to increased evaporation and evapotranspiration.

The basic source for materialization of the ground water in the Ovce Pole valley where the main part of salinized soils are situated, are the paleogenic geological sediments. With a total content of 0.813% of salts the paleogenic sediments of Ovce Pole are very saline and represent an excellent source for enrichment of ground and surface water with salts.

In such an environment of mineralized ground water, dry climate, and intensive agriculture the formation of salty soils is unavoidable.

Most vulnerable soil salinization areas are parts of Ovce Pole and Pelagonija, especially if intensive irrigation is applied.

Adaptation measures

Adaptation measures should be aimed towards controlling the level of the salt-rich ground water:

- Reducing the quantity of surface and ground water that inflows from the surrounding hilly areas, through afforestation and terracing. This will lead to the improvement of the hydrological status of the valleys prone to salinization.
- Drainage of micro-depressions in the valleys will evacuate excess water and decrease the level of the ground water in the valleys.
- Precise irrigation with small and accurate quantities of water which will preserve the desirable level of ground water and will maintain the soil moisture to field capacity.

4.2.1.3 Animal Breeding

According to the Annual Report of the Ministry of Agriculture, Forestry, and Water Economy (MOAFWE) for the year 2005, the animal breeding sector has been rather stable over the last seven years. Breed structure in ruminants is still based on local breeds (54% of total cattle population is Busha and crossbreeds of Busha with grey cattle mountain breeds; over 90% of sheep population are two local breeds). Pig and poultry production in large farms are based on modern, genetically superior crossbreeds and modern hybrids. Animal production in a broad sense is affected directly and indirectly by climate change.

Direct effects are correlated to projected temperature increase and increased heat stress on domestic animals. Heat stress decreases productivity of domestic animals especially for modern high productive breeds in comparison with local breeds already adapted to the local environment.

Indirect effects are correlated to the projected decrease of forage production, as well as in emerging diseases. It is expected that a shortage of locally produced animal fodder will decrease the amount of animal products in the country. It can be foreseen that some tropical diseases, especially those transmitted by insects, will leave their natural basin of endemia to spread to other countries out of their natural habitat (possible appearance of such animal diseases in the country).

Since intensive animal production (pig, poultry, and dairy cattle) consider highly productive animals in combination with intensive breeding techniques, the outcome can be only with a strictly conditioned environment. Recently in the country, existing pig and poultry farms, faced with ensuring a suitable barn environment in a tolerable zone, have begun to invest in isolation, heating, cooling (sprinkler systems), and ventilation. On the other hand traditional, extensive breeding techniques involving low energy output, reduced work, and low costs, based on local breeds, have shown a high adaptation ability to diverse climate conditions.

To minimize the effects of heat stress three strategies can be adopted: e.g., physical modification of the environment; genetic development of heat tolerant breeds; and improved nutritional management practices. The implementation of the best adaptation strategy is necessary:

- Determination of regions suitable for particular species and type of livestock production, according available technology and crops;
- Identification and introduction of breeds resistant to climate change and tropical diseases;
- Continuous work on productivity improvement of local breeds;
- Intensive production will depend on highly selected animals with some tolerance to heat, recurring special husbandry and technology practice, under specific nutritional management;
- Continuous education and training of farmers to adopt technology and practice;
- It is important for policy-makers to update or develop new and more accurate norms and regulations to be applied to the production of food products. This will contribute to determining specific quality parameters linked to environmental, animal, or human factors, not only for the purpose of protecting the domestic agricultural and food sector, but also to protect animal and public health against the negative effects of climate change;
- To create knowledge in decision making based on analytical work;
- To support research programmes related to the maintenance of the genetic resources, animals with greater heat tolerance, improved nutritional exploration, disease resistant, and welfare;
- Dissemination of results and public awareness.

4.2.1.4 Socio-Economic Impact

Future food security will mainly depend on the interrelationships between political and socio-economic stability, technological progress, agricultural policies and prices, growth of per capita and national incomes, poverty reduction, women's education, trade, and climate variability. Major losses in agricultural production lead to increased malnutrition and reduced opportunities for poverty reduction. Climate change, however, may affect the physical availability of food production by shifts in temperature and rainfall. Unless irrigation measures are implemented, the poverty will increase in non-irrigated agricultural areas, thus leading to migration from these areas to areas with higher development.

Some groups are particularly vulnerable to climate change: low-income groups in drought-prone areas with poor infrastructure and market distribution systems; low to medium-income groups in flood-prone areas who may lose stored food or assets; farmers who may have their land damaged or submerged by increased floods; and fishermen who may lose their catch due to decreased water level in the lakes (lakes Dojran and Prespa, for example).

However, it is thought that in the forthcoming period when bigger problems related to climate change are expected, the economy in the country will be improved, as well as infrastructure and institutions, and there will be capacities for compensating for the impact of climate change on domestic production, even through food imports from elsewhere.

4.2.1.5 Gender Issue

Women have a high share of agricultural activities but only little decision-making power or control over inputs and outputs. While men prefer mechanized agriculture and are responsible for irrigation, women are usually involved in a very labour-intensive agriculture. They do not receive formal salaries or benefits from their work.

Very few women are organized into farmers' associations, water users' associations, etc. Men participate in almost all training programmes while women are more engaged with the farm work. Such disproportion puts women in an unfavourable condition, being less well educated and skilled to cope with modern technologies (adaptation, mitigation, etc.). At the same time, women's traditional knowledge and skills have helped families and communities cope with severe weather. As crop yields will reduce with climate change, and resources become scarcer, women's workloads will only become more time-consuming and burdensome. Moreover, women can be expected to contribute much of the labour that will go into coping with climate risks through soil and water conservation, the building of anti-flood embankments, and increased off-farm employment.

It is clear that women in the agricultural sector are crucial players; therefore, women's participation in any planning process for adaptation to climate change is of crucial importance.

4.2.2 Biodiversity

Considering the zonal character of the biodiversity in Macedonia, global climate change on a regional level could affect it through changes of the temperature and precipitation in different zones.

Overall, 79 fungi and lichen species, 74 species of algae, 392 higher plants, and 113 vertebrates are considered to be at threat.

It is most probable that the global climate change impact is combined with many other factors, mostly anthropogenic – the construction of roads, railways, hydrosystems, power lines, pylons, industrial buildings, expansion and abandonment of the agricultural lands, water extraction systems, uncontrolled forest exploitation all modify the species distribution.

Water extraction (springs, streams, and rivers above 1,000 m elevation) in synergy with climate change have increased pressure on water ecosystems, can threaten and even exterminate the mountainous wetlands, including springs and peat bogs.

The alpine zone is the most vulnerable to climate change due to the most intensive air temperature rise in alpine and subalpine regions, according to the local climate scenarios. Loss of the alpine belt can be expected; for example Mt. Pelister is expected to have lost its alpine belt within 50 years. Alpine grasslands, rocky habitats, scree, and rock vegetation are distributed only on the highest parts of mountain summits and occupy very small areas (only 0.5% of the country territory). Vertical movement of these communities will be hindered by many relief-related obstacles, ecological preferences, and especially available space. Only north-facing slopes would offer suitable ecological conditions since the alpine zone in Macedonian mountains will disappear.

The most vulnerable flora and fauna species from the **mountain belt** regarding local climate change predictions are: ***flora*** – *Crocus cvijici*, *Colchicum pieperianum*, *Fritillaria macedonica, Ranunculus degenii, Sphagnum spp., Crocus scardicus, Trollius europaeus, Salix alpine, Rhododendron myrthifolium, Rhododendron ferrugineum, Empetrum nigrum, Loiseleuria procumbens, Dryas octopetala, Listera cordata*; ***fauna – invertebrates***: Daddy longlegs, Spiders, Millipedes, Grasshoppers, Beetles, Moths, and Butterflies; ***vertebrates***: Common Frog (*Rana temporaria*), Alpine Newt (*Triturus alpestris*), Sand Lizard (*Lacerta agilis*), Viviparous Lizard (*Lacerta vivipara*), Adder (*Vipera berus*), Orsini's Viper (*Vipera ursinii*), Snowfinch (*Montifringila nivalis*), Wallcreeper (*Tichodroma muraria*), Alpine Dunnock (*Prunella collaris*), Alpine Chough (*Pyrrocorax graculus*), Red-billed Chough (*Pyrrocorax pyrrocorax*), Shore Lark (*Eremophila alpestris*), European souslik (*Spermophilus citellus karamani*), and Balkan chamois (*Rupicapra rupicapra balcanica*).

Most endangered flora and fauna species from the **lowland belt** are**:** ***flora*** – *Thymus oehmianus, Ramonda nathaliae, Ramonda serbica, Adianthum capillus-veneris*, *Drosera rotundifolia, Blackstonia perfoliata, Cladium mariscus, Carex elata, Marsilea quadrifolia, Salvinia natans;* ***fauna*** – Marsh Frog (*Rana balcanica*), Common Newt (*Triturus vulgaris*), and Eastern Spadefoot (*Pelobates syriacus balcanicus)*.

Climate change impact on **swamps and marshes** will be at most expressed in relict communities and species characterized with fragmented distribution – ass. *Caricetum elatae,* subass. *Iysymachietosum* (Ohrid and Struga Marshes), ass. *Mariscetum* (Marsh at the Negorci Spa), ass. *Cypero-Caricetum acutiformis* (Gostivar), ass. *Osmundo-Thelipteretum* (Bansko Spa), ass. *Scirpo-Alopecuretum cretici* (Monospitovo Swamp). The Fairy Shrimp *Chirocephalus pelagonicus* is a striking example of a critically endangered species (the only localities are wetland ecosystems in upper Pelagonija valley, vulnerable region due to decrease of precipitation).

In the three large natural lakes in the Republic of Macedonia the flora and fauna that are most vulnerable to climate change are:

a) **Dojran Lake**: flora - *Nuphar lutea, Nymphaea alba, and Salvinia natan;* communities - ass. *Myriophyllo-Nuphraetum;* fauna - *Sabanejewia doiranica*, *Eunapius carteri dojranesis,* Freshwater Blenny - *Salaria fluviatilis, Graecoanatolica macedonica, Isochaeta dojranensis.*

b) **Prespa Lake**: flora - *Aldrovanda vesiculosaa, Salvinia natans* and *Trapa natan;* communities - ass. *Lemno-Spirodelletum polyrhizae* subass. *aldrovandetosum;* fauna - Pelister Trout (*Salmo peristericus)*, Prespa Loach (*Cobitis meridionalis)*, Prespa Bleak (*Alburnus belvica)*, Prespa Barbel (*Barbus prespensis)*, Prespa Nase (*Chondrostoma prespense)*, Prespa Minnow (*Phoxinellus prespensis),* Prespa Roach (*Rutilus prespensis),* Carp (*Cyprinus carpio*).

c) **Ohrid Lake**: flora - *Carex elata, Senecio paludosus, Ranunculus lingua;* communities: ass. *Caricetum elatae* subass*. Lysymachietosum;* fauna - Ohrid Minnow (*Phoxinellus epiroticus)*, Ohrid Roach (*Rutilus ohridanus)*, Ohrid Salmon (*Acantholingua ohridana),* Struga Trout (*Salmo balcanicus),* Ohrid Trout (*Salmo letnica)*.

The negative influence of climate change has been identified for the following refugial zones:

1. **Lower Povardarie-Valandovo-Strumica-Dojran refugial region:** It is expected that the Mediterranean and sub-Mediterranean elements of the pseudo-maquis will broaden their range towards the central and northern regions of the Republic of Macedonia, i.e. the global climate change will cause widening of the range of the zonal vegetation.

   Plant communities which grow in habitats with a high level of underground water (*Periploco-Alnetum glutinosae, Periploco-Fraxinetum angustifoliae-palilisae*, *Plantano-Castanetum sativae)* will experience a significant negative impact due to climate change and will be threatened with extinction. Other more xerothermic communities will have a trend towards expansion of their range. The anthropogenic influence will have critical importance for their performance. The fauna in this refugial zone will undergo significant changes due to climate warming. The penetration of faunal elements from Aegean-Anatolian semi-deserts, as well as faunal elements characteristic for Iran-Turanian semi-deserts is possible, similar to the Tikves refugial region.

2. **Refugial region of the Taorska Klisura gorge along the Vardar including the river Pchinja gorge:** Climate change will impact on this refugial region in a positive way, i.e. it will stimulate spreading of the distribution ranges of the refugial forest communities. The climate induced changes will force movement of characteristic fauna for a sub-Mediterranean-Balkan Forests towards the north and penetration of Ponto-Mediterranean and Ponto-Caspian faunal elements will be favoured.

3. **Refugial region of Crna Reka including the gorges of the rivers Raec and Blashnica:** The regional climate change will impact on the refugial region of Crna Reka and its thermophyllic forests (with pseudo-maquis elements) in the direction of spreading of the existing forest communities. Faunal elements from sub-Mediterranean-Balkan Forests dominate in this refugial zone, with a strongly expressed presence of Ponto-Mediterranean faunal elements. The fauna with Aegean-Anatolian and Iran-Turanian, as well as Ponto-Caspian origin will also colonize the area, but with less intensity.

4. **Refugial region Mavrovo-Radika:** The regional climate change will impact on the spruce stands in the upper flow of the river Radika (Adzhina Reka), which are already considerably degraded (dieback has already been recorded). The faunal characteristic for Balkan-Middle-European Broadleaf Forests dominates in this refugial zone, with a significant contribution of European Forests of the Taiga Type at higher altitudes. At the same time, along the river Radika's flow, Mediterranean faunal elements penetrate. The regional climate change will affect the vertical distribution of faunal species to a limited extent.

5. **Refugial region Strazha:** The faunal species characteristic for Balkan-Middle-European Broadleaf Forests dominate in this refugial zone. Considering that this zone is restricted to a very narrow belt of only 100 metres approximately (between 1,050 and 1,150 m a.s.l.), regional climate change will cause penetration of faunal elements from lower belts (sub-Mediterranean-Balkan Forests).

6. **Refugial region Pelister:** A large part of the subalpine region of Mt. Pelister is occupied by the relict species *Pinus peuce* (Molika or Macedonian pine). The global climate change impact on Macedonia can be explained by the example of the past and recent distribution pattern of the Molika pine. It is a subalpine species that forms a continuous belt up to 2,100 m a.s.l. There is a clear tendency towards spreading of the Molika pine distribution to higher altitudes. The connection is due to changed climatic conditions and abandonment of the sheep and cattle breeding in this area during last 50 years. If the same pattern continues, it will force the Molika-pine forest belt to move upwards and to intrude into part of the current alpine pastures' belt in which a lot of Oro-Mediterranean and Arcto-Alpine faunal elements are present now. In that way, a part of the natural habitats for some high mountain species will be lost and will be threatened with extinction (Sand Lizard, Adder, Rock/Water Pipit, Snowfinch, Wallcreeper, Alpine Dunnock, Alpine Chough, Red-billed Chough, Shore Lark, Balkan chamois, etc.).

7. **Ohrid-Prespa refugial region:** Due to climate change, penetration of the Balkan-Middle-European Forests (beech) is expected at the higher elevations causing the loss of current high mountain pastures and rocky sites. Thus, the current natural habitats of many relict paleo-Balkan mountain faunal elements will be lost, leading to extinction of their characteristic faunal elements.

The most important economic activities resulting from the social status of the citizens of the country (predominately local communities and rural areas) that may have a negative impact on biodiversity, as well as low law enforcement can be summarized as follows:

- Sheep breeding will be even more important in the future to keep the tree line at its current altitude, but in case of a dryer climate overgrazing could have a negative effect on vegetation and could provoke erosion. This situation will be even more pronounced in the hilly region (winter pastures) where dryer winters are expected (see: regional climate scenarios). Although not a high priority, these possibilities have to be considered and discussed within the agricultural sector.
- Climate change will have a cumulative effect on threats arising from a less sustainable use of wild medicinal and aromatic plants and mushrooms. Climate change will force these communities to "climb" higher into the mountains on the smaller area and less suitable habitats, where they will be much more vulnerable.
- Notwithstanding the fact that the Balkan chamois (as an example) by the Law on Hunting (*Official Gazette of RM* no. 20/96) is a seasonally protected game species, its population has been highly reduced (below the ecological optimum) on all high mountains in Macedonia except on the Mt. Korab (due to the inaccessible terrain). Since the high mountain plant communities are highly endangered by climate change, chamois are also endangered. Urgent measures are necessary to safeguard their existence during changing climate.
- Water ecosystems will be changed due to the rise of temperature and decrease of precipitation, so they are considered as endangered. The general assessment of changes to fishing in open water bodies within Macedonia is negative, due to noted drastic reductions in the annual fish catch in the three natural lakes. Thus, the fishing practices have to be adjusted to changing climate in the future.

Adaptation measures

Some of the highest priority adaptation measures are stated below:

- Preservation of the last remaining riparian communities (*Periploca, Salicetum albae-fragilis, Juglando-Platanetum*, etc.) in the Vardar valley in order to enable them to survive the expected periodical spring floods, since it was predicted that there will be more snow in the mountains;
- Elaboration of a distribution map of the major ecosystem types, map of biomes, and mapping of habitats and vegetation types for precise inventorying of the biodiversity in Macedonia and implementation of appropriate measures;
- Development of a sufficient network of meteorological stations in order to serve for the precise determination of climate conditions on meso- and microclimatic levels, which is the starting point for modelling the future changes;
- Strengthening the capacities of the staff in order to implement the above-mentioned adaptation measures and monitoring.

4.2.3 Forestry

The total forest land in the country is 11,596 km^2 (1,159,600 ha.) out of which forests comprise 947,653 ha. The total wood mass is 74,343,000 m^3, and the total annual increment is 1,830,000 m^3 with an average annual increment of 2.02 m^3 per hectare.

Some of the main threats and problems in forest management and governance are: illegal logging, forest fires which have affected nearly 100,000 ha. in the last ten years, climate change impact through the increased forests dieback process, insect calamities, and diseases.

Based on past experience, as well as on the results from climate change scenarios, climate change impacts on forestry might be manifested through: a more intensive process of morphological changes to oak and fir; increased number of forest fires and burned area, due to the increased percentage of dead trees; and migration of tree species towards higher altitudes.

4.2.3.1 Assessment of Certain Morphological Changes in Oak and Fir

Parameters that give a clear picture of climate change influence on the health condition of trees/forests are: (a) crown transparency and (b) dieback of certain parts of the crown and whole trees.

Data analyses of both, crown transparency and dieback for oak and fir in the period 1991-1999 provide negative results about health conditions. On the other hand, in the period 2000-2003, health conditions for both oak and fir improved. The latest assessment of the symptoms of dieback of parts of crown or whole trees in 2006 show that this process is in stagnation, i.e. neither any significant positive nor negative development occurred.

The most affected forest areas and plant communities (where the above-stated morphological changes have been perceived) have been detected in regions with an altitude of approximately 1,200 m a.s.l. are:

1. ass. *Coccifero-Carpinetum orientalis* **Oberd.emend.Ht –** Region with a sub-Mediterranean climate;
2. ass. *Querco-Carpinetum* orientalis macedonicum **Rud.apud.Ht –** Region with a moderate-continental-sub-Mediterranean climate;
3. ass. *Quercetum fraineto-ceris macedonicum* **Oberd. Em end Ht –** Region with a hot continental climate;
4. ass. *Orno-Quercetum petraeae* **Em –** Region with a cold continental climate**.**

4.2.3.2 Forest fires

Among the most important factors influencing forest fires, often decisive, are the weather conditions, more precisely the climate characteristics of the region.

In the period 1999-2005 a total of 1,191 forest fires were recorded, with a burned area of 59,500 ha. and over €28 million total economic loss. The largest damage occurred in 2000, when the burned area was 46,000 ha, and damage cost was estimated to be about €10 million.

In the summer of 2007 Macedonia experienced extended wildfires, which severely affected forests and other vegetation over an area exceeding 40,000 hectares. One of the contributing factors was climate conditions, i.e. a dramatic heat wave and the highest temperatures ever recorded along with the prolonged dry period pushed the usual summer forest-fire season drastically beyond its usual pattern. As of July 2007, the damage in fire-affected forests, as well as the costs for suppression, amounts to about €21 million (assessment made by the Public Enterprise "Macedonian Forests"), i.e. approximately 75% of the damage occurred in the period 1999-2005.

It is evident that forest fires not only destroy the biodiversity, change the micro-climate, and create potentials for erosion, but also cause enormous economic losses which will take decades to be recovered.

4.2.3.3 Migration of Tree Species

As an adaptation measure towards increased air temperature and decreased precipitation, migration of certain tree species at the highest altitudes and latitudes is evident over the last ten years. The Macedonian, or Molika, pine (*Pinus peuce*), which originally emerged at a maximum latitude of 2,200 m a.s.l. on Mt. Pelister ten years ago, nowadays has migrated towards higher latitudes such as 2,600 m a.s.l. The situation is very similar on almost all abandoned pastureland in Macedonia (for example Bistra), where the presence of some pioneer plant species, such as juniper, which are predecessors of the forest tree species, such as beech, is registered. Climate change is the largest factor that causes this tree migration, as well as abandoned pastureland, i.e. a small number of cattle and almost no human presence.

Adaptation measures

Proposed adaptation measures are based on previous experience of climate change impacts on forestry, having in mind climate change scenarios. The priorities are:

- Forest rehabilitation with the local endemic oak species and other endemic varieties through introduction of silvicultural and planning measures, improvement of species composition of forests (natural and afforested) with endemic tree species, resistant to climate change;
- Strengthen preventive measures that improve forest management and minimize the risks of fires;
- Increase monitoring and observation pilots in the most vulnerable and economically valued forests. This will enable government and the foresters to take a more systematic and longer-term approach towards the most viable (economically and ecologically) and pro-sustainable options for forest management, thus minimizing the occurrence and magnitude of damage from wildfires;
- Existence of a good quality databases is essential. With reconstruction of the Integrated Crop Protection forests network in the country, there are preconditions for monitoring of health conditions of national forests. But, this will satisfy only part of the real needs.

Establishment of sample plots of certain forests types is the next step in order to measure all meteorological elements regarding climate change. However, the existing network of meteorological stations in the country is insufficient to monitor climate change influence on forests and forestry, and its modernization and enhancement is essential.

Afforestation is one of the measures on bare lands and cleared areas usually in oak forests. The following endemic species of oak are the most resistant to climate change: (a) *Quercus pubescens* – Downy Oak, (b) *Quercus macedonica* – Macedonian Oak, (c) *Quercus coccifera* – Kermes Oak. Another group of species resistant to climate change is: (a) *Carpinus orientallis* – Oriental Hornbeam, (b) *Fraxinus ornus* – Manna Ash, (c) *Pistacia terebinthus* – Turpentine tree. Beside broadleaved species, for afforestation, the following endemic coniferous species can be used: *Pinus nigra* and *Juniperus excelsa*.

4.2.4. Human Health

Climate change has a complex connection with health. This includes direct influences such as illnesses and conditions that may end with a fatal outcome and which are connected with the changes in temperature; health impacts of extreme weather events (floods, droughts, and storms); and the effects of air pollution. Other impacts such as those from disease distribution related to drinking water, food or vector-translated and zoönoses, or health conditions resulting from lack of food and water, follow indirect ways.

Sex, age, and type of personality, are factors which are not changeable in relation to the aetiology of Cardiovascular Diseases (CVD). There are lots of risk factors which often have an influence on the health integrity of the person, but there are also those where that type of influence is not possible: genetic factors, sex, age, and congenital anomalies. Persons with CVD are highly dependent on the outside temperature. In the research conducted to identify the influence of the outside temperature on the mortality in Skopje and the country at large, it is noticeable that the average total mortality is higher in the colder period of the year, 7% higher than the average total mortality, and 13% higher than the average total mortality in the warmer period of the year. The most common reasons for mortality during the colder period of the year are cardiovascular, cerebrovascular,

circulatory, and respiratory diseases. Women's winter mortality is higher than men's. One possible explanation of the increased risk in women could be related to existence of the sexes' difference in thermoregulation, as well as the proven longer needed time for regaining the body temperature after physical efforts in men. Beside factors associated with a biological or genetic origin which cause a deterioration of health, health of the population in general is determined by various other factors.

Climate impact assessments have pointed to higher summer-season temperatures, with increasing frequency and duration of heat waves. The prognosis is for a projected increase in summer-season heat stress mortality, particularly among the elderly poor.

According to predicted scenarios (using software SPSS and *What if?*) for trends of mortality in the country and Skopje for the period after 2035, projected mortality with changes in average monthly temperatures of only 1°C compared to the period 1996-2000, will significantly influence the change of the distribution of total mortality expressed as a monthly average. This increase of the monthly mortality rate in the country would be higher in the months of April, May, June, and in average 10% compared to the period April, May, June 1995-2004. A significant difference considering the distribution by sex is not expected, i.e. the trend of four to five years of difference between men and women's life expectancy, which started in the 1960s, is expected to continue in following decades with no significant impact from climate change. Factors defining this difference are complex and determine the population's health.

Drinking water and food-translated diseases could be affected by climate change. Seasonal appearance is most often noticed with peaks in summer in the cases of food poisoning. Floods, droughts, and storms bring in their wake, increased health risks, such as diarrhoea among children.

Recent studies on following the food-translated diseases show that in the cases caused by salmonella there is an increase of 5-10% for every raising of the temperature by 1°C of the weekly average outside temperature under 5°C. For trends of salmonella as a function of monthly distribution and the influence of ambient temperature, there is a seasonal index constructed for the period 1989-2005, for registered patients having salmonella. The seasonal index by month for the period 1980-2005 in the country and the projection of the seasonal index for the year 2030 in relation to an increase of average monthly temperatures with scenarios for climate change, show that besides the two peaks in summer months which were not that significant, there is a possible peak during the winter months as a result of an increase in average monthly temperatures in the period to come.

Adaptation measures

Lots of influences of climate change including health effects, could be diminished or avoided with different adaptations. The primary goal of adaptation is to decrease the burden of diseases, injuries, disabilities, suffering, and mortality. Important mechanisms for disease prevention originating from water and food are traceability, microbiological risk assessment, risk communication, and risk management. The number of cases of salmonella could be diminished by control and monitoring of the entire food chain. A high level of control measures should be reached along with the potential climate risk and potential storage information, and strengthening of measures of food processing.

A proposed alert and reporting system for possible health impacts caused by weather impacts aims to assess health risks and to diminish them. Instruments for that would contribute to promotion and on time alarming of the population, particularly vulnerable groups, of an extreme weather event before its appearance. NGOs play an important role in the system, particularly in the part of access to information of the population with social risk factors. The obtained database will provide extrapolation to the future expected climate change. Strengthening of capacities is an essential step towards preparedness of sustainable, adaptable strategies and palliative strategies. That includes education, raising awareness, creation of a legal framework, as well as institutions which will inform people of decisions providing them higher, long-term benefits.

Both, by strengthening and implementation of an Weather Early Warning System, as well as preparedness and response of the healthcare system services on the one hand and by adequate physical planning and housing on the other, the reduction of mortality among the people is feasible. The system should include the implementation of preventive and action plans for heat waves and inclusion of strategies for vulnerable groups' identification, as well as public health monitoring and citizens' campaign promotion with a financial estimation of reduction assurance with an explanation that inactivity is, in the end, the most expensive option.

4.2.5 Tourism

Truly, Macedonia is a treasury of culture and art, with numerous historical monuments to be found all over the country, which also abounds in natural beauties and rarities; the visitors who have come to Macedonia often name it "The Pearl of the Balkans". The cultural heritage, combined with a beautiful landscape, makes Macedonia an attractive place with great ambitions to become a must-see destination for foreign visitors. With over 1,000 churches and monasteries, and more than 4,200 archaeological sites, Macedonia has the potential to be at the very top of the list for cultural tourism in Europe.

This, initial assessment of climate change impacts on tourism, in the absence of previous expertise and relevant data, is based on a qualitative judgment.

Mountain and lakeside tourism are the most attractive and revenue-raising in the country. On the other hand, these destinations are considered particularly vulnerable to climate change, as they are nature-based tourism destinations and all outdoor tourism activities are dependent on favourable climate conditions.

Lakeside tourism is attractive mainly in the summer season. The most popular natural lakeside destinations are located in the western parts of the country (lakes Ohrid and Prespa). The summer season could be extended as a result of the temperature rise, as per climate change scenarios, which could be of benefit, bearing in mind that these sites generate the highest revenues from tourism. The climate in this region is hot continental

and the predicted temperature rise is lower than that in the south-eastern part of the country. The water consumption needs of tourists have to be considered, especially in the Crn Drim catchment area (where both lakes are located tourism is also a large consumer of water per capita – above the global average). Bigger water consumption would require provision of a new potable water supply resources, and construction of new sewage systems for both households and industry, especially for the tourist destinations. Inevitably, energy consumption will increase, also as the need for cooling of indoor premises becomes essential with the temperature increase.

Lake Dojran, which has suffered water loss during the last decade due to both anthropogenic and climate change factors, might be endangered. The most pessimistic scenario for dramatic climate change in terms of precipitation decrease and temperature increase is derived for the south-eastern part of the country, where this lake is located. Increased duration of peak periods and heat waves can have adverse affects on water quality, and can also be related to the higher risk of forest fires in tourist areas. This may also change the timing of holidays, i.e. to favour travel at the beginning and end of the seasons, rather than in the middle of summer.

Scenarios of climate change developed at the national level show an increase in the winter temperature, also accompanied with less snow coverage and later start of the skiing season. The mountain tourism, whose main attraction was skiing, would suffer due to shortening of the skiing season, unless artificial snow-making takes place.

Adaptation measures

In order to respond to climate change, the tourist industry will have to shift towards new attractions, such as skiing to hiking during the winter, but also horse riding, improvement of the spa tourism, linkages with the cultural and natural heritage during other seasons.

Good cooperation between central and local government, private sector, and other stakeholders in the tourist industry is essential in order to improve not only the infrastructure, but also in planning new resorts or upgrading current facilities, in terms of the long-term future of their business.

In order to contribute towards efforts for climate change mitigation at national level, and to reduce the industry's own contributions to national emissions, some improvements should be made to the tourist destinations. Ensuring proper management of the waste generated by both households and tourist industry is of immense importance for the environment, thus mitigating potential health risks and damage to the natural resources. Energy efficiency standards in the new tourist accommodation, as well as mechanisms for energy conservation should be implemented, after improvement of the current legislation is made. The government should provide incentives, such as a tax free regime, etc., for implementation of energy conservation measures, instalment of solar panels, energy saving mechanisms, etc., in the tourist accommodation facilities. In addition, sustainable transport within the tourist zones should be provided, such as electric trains and minivans instead of cars, gas-fuelled buses, etc. Agricultural product supplies and furniture in the facilities should be provided by local producers and produced in a sustainable way.

4.2.6. Water Resources Sector

The total water resources of Macedonia are estimated at: 18.8×10^9 m^3 from rainfall (with a 733 mm average rainfall); 6.36×10^9 m^3 discharged from the river basin areas; 0.52×10^9 m^3 groundwater; and 0.42×10^9 m^3 from the largest springs. According to the World Resources Institute, the annual water resources per capita for the Republic of Macedonia are about 3.137 m^3/year, while the average value for Europe is 10,680 m^3/year.

Irrigation is the major user of the total water demands in the country, about 40%. According to the 2002 census, the number of households connected to public systems for water supply in urban areas is 82% to 100%. In rural areas, this percentage varies between 10 and 100. For urban water supply, both surface and ground water are used, as well as a combination of the two sources.

The variations in the hydrological cycles of the rivers in the country are determined by the seasonality of the precipitation and the temperature. The assessed rate of reduction of the effective rain for 2050 is around 15% for the regions under the prevailing mountainous-Alpine climate impacts (represented by the stations at Lazaropole, Popova Sapka, and Solunska Glava), around 20% to 23% for the south-western part of Macedonia under the continental climate impacts (represented by the stations at Ohrid and Resen), and around 35% to 40% for other regions of Macedonia. The estimated rate of reduction of the effective rain for 2100 is around 30% for the regions under the prevailing mountainous-Alpine climate impacts, around 45% for the south-western part of Macedonia under the continental climate impacts and around 70% for other regions of Macedonia. Taking into consideration the reduction of effective rain and the fact that 84% of the available water quantities are formed on the territory of the country, it is obvious that this high rate of reduction of effective rain is going to cause a drastic reduction of the available water quantities until the end of this century.

In order to estimate the impacts of climate change on hydrological resources in the Republic of Macedonia, an assessment on climate change impact on water quantity and quality should be made. Analysis of the water resources quantity has been carried out for twelve hydrological stations in the three watersheds (catchment areas) and for the surface water level of the three natural lakes. The methodology used for a sensitivity analysis of the water resources includes the analysis of the variability of the historical time-series and the trend lines, homogeneity and confidence analysis of the respective time-series elements, and creation of a correlation graph of the time-series. Since every projection of the future hydrological variables based on historical data requires that conclusions be drawn from datasets without considerable non-homogeneity, only data of homogenous time-series have been used for presentation of variations and trend lines of the annual discharge values.

There is a general trend of reduction of the annual values of the average discharges for all river basins in the country. The same trend is defined for the minimum and maximum annual discharges for the whole territory of Macedonia. The reduction of the average annual discharges is the most pronounced for the river Bregalnica at the Stip hydrological station and for the river Strumica at the Novo Selo hydrological station, i.e. in the region with a moderate-continental-sub-Mediterranean climate. The results indicate that river basins with a low precipitation would be severely affected by climate change.

The series of average annual discharges for river Bregalnica at the Oci Pale hydrological station is characterized by a descending linear trend. Reduction of the decade discharges for the period 2000-2003 compared with 1961-1970 is 36%. The situation with the average annual discharges recorded for the same river at the downstream hydrological station at Stip shows a more drastic reduction, which, for the period 2000-2003, compared with the decade 1961-1970 is 58%.

For the river Strumica at the Susevo hydrological station, it is noticeable that for the series of the minimum annual discharges it is typical that in some years, during summer period, the river has had very low water discharges or even there has been no water at all. For the same river at the downstream hydrological station of Novo Selo, for the series of the average annual discharges, which is homogeneous, it can be concluded that percentage of reduction of the discharges for the period 2000-2003 compared with the decade 1961-1970 is 43.7%.

Oscillations in the minimum, average, and maximum annual water levels for the lakes at Dojran and Prespa show significant variations with an extreme drop in the water levels of both lakes that started almost at the same time (in 1986) and had almost the same duration (until 2002). From 2003 onwards, there is an increase of the water levels of both lakes. These oscillations in the water levels occurred as a result of the anthropogenic impact and change of the climate.

Oscillations in the water quantities which flow out from Macedonia have been much higher in the last 40 years. Minimum values of water quantities which flow out from the country have been recorded for the period 1987-1995, and after 2001, there is a light increase of the water quantities. In the last ten years the average annual temperature is continuously higher than the long-range average. Consequently, reduction of the water quantities, which flow out from the country is not only due to an increased use of the water resources (anthropogenic impact), but primarily due to the changed climate conditions.

In order to analyse the climate change impact on the water quality, the data from the monitoring of the water quality of the river Vardar at the sample point of Skopje and Demir Kapija have been processed. The analysis of a functional dependence of: dissolved oxygen, Nitrogen Ammonia, Nitrogen Nitrite, Nitrogen Nitrate and Phosphate with the river discharges, shows that climate change can affect the water quality aspect in three manners: a) reduced hydrological resources may leave less dilution flow in the river, leading to degraded water quality or increased investments in wastewater treatment; b) higher temperatures reduce dissolved oxygen content in water bodies; and c) in response to climate change, water uses, especially those for agriculture, may increase the concentration of pollution being released into the rivers.

Plausible estimates of the impact of regional future climate change on the water resources were made by applying MIKE SHE Software, for the river Vardar and its major tributaries, representing 80.4% of the country territory.

For the development of future scenarios in the model, the predicted changes in temperature, precipitation and other hydrological parameters developed within the climate change scenarios were used as input (the base year 2000 and the four future periods: 2025, 2050, 2075, and 2100).

Developed scenarios for climate change impact on the water resources show that:

- Groundwater recharge for the river Vardar catchment area will continuously decrease in the future reaching approximately 57.6% of the current recharge quantity in 2100;
- Annual discharges for the rivers Vardar, Treska, and Bregalnica show a decreasing trend. Assuming 100% discharge in 2000, the model predicts that in the years 2025, 2050, 2075, and 2100, the total annual discharges will reach the following values (in %),

Vardar	**2000**	**2025**	**2050**	**2075**	**2100**
MEAN	100	92.4	88.6	85.6	81.8
Treska	**2000**	**2025**	**2050**	**2075**	**2100**
MEAN	100	97.6	96.6	95.2	93.0
Bregalnica	**2000**	**2025**	**2050**	**2075**	**2100**
MEAN	100	90.0	83.9	80.7	76.2

- Dry spells and flash floods are expected to occur more often and with increased intensity;
- The eastern part of the country shall experience more severe and longer water deficiency than the western part. The predicted average reduction in water availability for the year 2100 for the Bregalnica river basin is almost 24%, while it is 7% for the Treska river basin;
- In conclusion, the overall water availability in the country (Vardar river basin) for the year 2100 is expected to be reduced by 18% (estimate ranging from 13 to 23%).

Climate Change Impact on the Social and Economic Conditions

Water demand in the country up to the end of the 21st Century will depend not only on climate change but also on the country's socio-economic developments. There is no available national study of long-term expectations on socio-economic development for 2050 and 2100.

Climate change manifested through extreme events, such as high temperatures and droughts, is expected to increase the drinking water demands. The prognostic value of any increase upon the drinking water demands of Skopje could be around 30%.

Climate change is expected to have a negative impact on the irrigation through increasing the irrigation water requirements. Since the major irrigation systems are located in the most vulnerable regions of the country, they will be directly affected by the reduced available resources. The hydroplants for energy production located in the western part of the country, which is a less vulnerable region, have not experienced any significant losses in energy production due to the reduced discharges.

The occurrences of extreme hydrological events (floods and droughts) have increased in frequency and intensity over the past decades due to climate change. For example, during the last three decades regional floods caused by the biggest rivers in Macedonia – Vardar, Crna Reka, Strumica, Treska, Pcinja, Lepenec, and Bregalnica – caused an estimated total damage worth USD 193.8 million (Skoklevski, 2003).

The damage caused by floods directly affects the already fragile agriculture and local rural economies. In June 2004 climate change manifested through the occurrence of high, intensive rainfall, causing floods and flash floods in 26 municipalities in the country located in the upper Vardar and in the central south and south-eastern part of the country.

Economic losses experienced during the flash floods in 2004 show that 91.3% of the total damage is attributed to the agricultural production mainly in the south-eastern part of the country (Report of the State Commission, 2004). The biggest losses have been experienced in the rural areas where households and cultivated areas have been flooded. Similarly, frequent and intensive droughts exacerbate social and economic conditions in the rural parts of southern and eastern Macedonia. For example, a prolonged drought in 1993 damaged most of the crop yields and in many cases resulted in a total crop failure. At the countrywide level, the damage caused by this drought amounted to 7.6% of the total national income.

In general, the country has difficulties coping with extreme hydrological events (droughts and floods) due to a lack of finance, technical, and institutional capacities as well as legal instruments.

Analysis of climate change impact on water resources points to reduced discharges with significant regional variability. Even average climate change can cause large problems in water resource management in river basins where water resources are insufficient, such as the Strumica river basin.

Adaptation Strategies

Water resources in the country are a priority as key driver for many other systems and sectors. Thus, adaptation in this sector can be considered as the main objective.

Adaptation measures related to water resources are divided into two major classes: adaptation of the supply and adaptation of the demands. The first class is linked to the reduced available water resources and the other one to the increased water demands. The supply adaptations mainly could be realized through rehabilitation of the existing physical infrastructure, construction of a new water infrastructure, and adapted management of the existing water management systems to climate change conditions. The demand adaptation can be implemented by improved efficiency, technological change, and market/price-driven transfers to other activities. All types of measures, classified into two groups – structural (hard engineering solutions) and non-structural – can be presented for each domain of intervention (irrigation, water supply, flood and droughts, erosion and sedimentation, water resources management, monitoring, and water quality). Some of the adaptation measures that are considered as intersectoral are presented in the Action Plan. The high priority adaptation measures proposed for the sectors are the following:

- Implementation of improved design standards for each domain of intervention.
- In the domain of irrigation and water supply of the population: reducing of the water losses by reconstruction of the water delivery network of both irrigation and water supply systems; implementation of water efficiency schemes; water pricing; credit facilities; insurance. For water supply, adaptation measures are: use of a dual water supply network and other sources of water (for drinking and for technical purposes – watering parks and lawns, washing the streets, etc.); recycling of water for non-potable use and construction of new water supply systems in rural areas.
- For floods and droughts the following adaptation measures are necessary: rehabilitation of the existing and construction of new flood protection and drainage systems; improvement of forecasting system; adaptation of the operational management practices of the capacity of the reservoirs to the climate change conditions including droughts and floods; upgrade of wastewater and storm-water systems; preparation of flood defence and protection plans; improving insurance schemes against flood and drought damage.
- The proposed measures for the domain of erosion and sedimentation include: reforestation of upstream river basins; technical protective measures for torrent regulation and regular dredging of the sediments from the riverbeds and reservoirs; control over illegal logging of the forests and update of the Erosion Map.
- In the domain of water resources management, the following structural measures are: increase of reservoir capacity; integration of separate reservoirs into a single system; construction of new dams (reservoirs); water transfer from one river basin to another (for example, to the Strumica river basin).

- The most successful structural adaptation measure in the domain of water quality is construction of the wastewater treatment plants, especially for the larger cities in the country.
- The proposed structural measures for adaptation in the domain of monitoring lead to improvement of the data processing; implementation of the predictive models in real time; strengthening of the capacities of the institutions responsible for monitoring and provision of sufficient funds on a regular basis for monitoring activities.

Constraints and Gaps for Vulnerability Assessment

Several major constraints and gaps were identified during preparation of the thematic studies on the vulnerability assessment. The most persisting one is a problem of data availability, consistency, and transparency. Existing monitoring in climate and ground water conducted by the Hydro-Meteorological Service in the country is facing permanent problems in operation, slow modernization of equipment, reducing of monitoring network, etc. Therefore, improvement of the hydrological monitoring stations (for surface and especially for ground water) including stations for monitoring the water quality, improvement of the data processing, implementation of the predictive models in real time and modernization of the equipment (in the field, in laboratory, software, and hardware) are of the highest importance in the near future. Soil monitoring does not exist, as well as groundwater monitoring. Basic maps and databases are very old and/or hardly available (soil map, vegetation map, land-use map, etc.). There is a need for increasing technical capacities for monitoring and updating of basic data sets. Modern tools for vulnerability assessment are needed almost in all vulnerable sectors (hardware, software, and training of personnel). Training of experts in modern technologies for adaptation is also requested, to overcome the gap in personal capacities.

Determination of the climate system components should be modernized by establishment of a new revised (modern) climate observing system which would be established over the whole territory of the Republic of Macedonia, that is, in all climatic areas, as well as by all climate parameters. It means that an automated climate observing system should be established by which the following climate system components would be performed in every moment and their changes: daily, ten-day period, monthly, seasonal, annual, and many-year period in all climatic areas in the Republic of Macedonia.

Establishment of an automated climate observing system in the Republic of Macedonia, as well as in other National Meteorological Services is necessary because of the following aspects:

1. Measurements and observations should be performed in a unique and non-subjective way;
2. Investigation of data homogeneity should be performed as well as testing of the quality of obtained information;
3. Information should be delivered to the national climatic centres, everyday by special climate telecommunication centres or by Internet communications;
4. The way of data processing should be performed by unique methodology of processing;
5. Results of the measurements should be delivered to the public precisely, and they should be comparable with other average climate data which are available at each meteorological station in all climatic areas in the Republic of Macedonia;
6. Information should be accessible to the public by Internet and its exchange should be also performed for the necessity of other users and media.

In future, special projects for modernization and establishment of the whole climate system in the Republic of Macedonia and other local climate observing systems should be made for this activity, as well as for the activities referring to the capacity building of employees in the climatolological-meteorological branch of the activities in the Meteorological Department at the Hydro-Meteorological Service.

In some cases modern technology was supplied through some projects, but the operational cost is high and the sustainability cannot be provided. For example, the country was part of the system of hydrological data exchange between Mediterranean countries (MED-HYCOS), but the automated measuring stations are currently non-operational. A similar case has occurred with use of modern software (such as hydrology software MIKE SHE). Although software is available and training was provided, initial databases (such as the cross-sections, slope of the riverbed, roughness coefficients, and other parameters at several points along the watercourse for accurate modelling of the runoff and for discharge routing) are still missing, thus limiting the software's ability to be used efficiently.

4.3. Opportunities and Barriers for the Implementation of Adaptation Measures

Opportunities for implementation of adaptation measures are related to accumulated knowledge and awareness among the scientific community about climate change and knowledge about vulnerable sectors and adaptation measures. One very important opportunity, especially in the agricultural sector, is accumulated experience to cope with drought and high temperatures and existing indigenous technologies and crop varieties used in the country. Decision makers, especially from the Ministry of Environment and Physical Planning are aware of the problem and there is interest for adaptation strategies. In the country there is a well-informed group of researchers who have worked with climate change issues for a certain period. The capacities of these researchers are increasing and they are establishing contacts with international scientific communities in order to catch step with modern research in climate change issues. Recently, the NGO sector has become more interested in climate change issues, especially due to the GEF Small Grant Programme that is supporting activities in the climate change operational programme. Such an environment

of increased awareness in the problem among decision makers and existing capacities among researchers and NGOs is favourable and is one of the most important opportunities. Overcoming of existing barriers will allow using of these opportunities and achieving much higher effects through existing capacities.

The report on Macedonia's National Capacity Needs Self-Assessment for Global Environmental Management (2005) details barriers in the area of climate change. The report shows the existence of capacity constraints at systemic, institutional, and individual levels.

The highest appearance of the capacity constraints is at the institutional level. The Ministry of Environment and Physical Planning, in their draft plan for institutional development, recommends the introduction of new positions in the agricultural and forestry departments, whose terms of reference would include implementation of climate change adaptation measures and influence records. New positions are also recommended in the energy department within the Ministry of Economy, to perform climate change-related activities.

State-appointed civil servants are needed, to include climate change policy in other sectoral policies, both in decision-making departments and in the ministries for transport, health, and industry.

Enhancement of the role of the National Climate Change Committee (comprising representatives from all relevant institutions) is recommended, for coordination of climate change activities in the Republic of Macedonia. This intersectoral body should be coordinated by the Ministry of Environment and Physical Planning.

Proper response in the most vulnerable sectors and adaptation measures require significant financial means. Active use of EU Framework research programmes (FP) and allocation of funds in the relevant institutions is recommended. The individual level is not so weak and is a low-level constraint, due to the level of education; knowledge and experience seem to be sufficient. The access to up-to-date information technology is however, low. Individual environmental awareness in scientific community is estimated as very high; however, the overall public awareness is still low. The utilization of individual experts' experience is not sufficient.

As well as the barriers stated in the above-mentioned report, there are some other barriers are present in the country: shortage of relevant research for adaptation, shortage of well-qualified and trained personnel for implementation of adaptation measures, some of relevant issues are not properly covered by existing institutions and public enterprises (soils, erosion, etc.), there is shortage of monitoring data for some of the vulnerable areas (soils, agricultural practices, land cover, water resources, vegetation, etc.). Relevant and readily available databases and GIS layers in appropriate scale do not exist (climate, soil, vegetation, hydrology, geology, ground waters, and aquifers, land use, etc.) and become constraints to more advanced and detailed research, analyses, and decision making.

However, some activities, implemented in the Republic of Macedonian in the last couple of years, even though not part of the adaptation strategy, contribute to capacity strengthening as a response to climate change and can be identified as climate change adaptation measures: rehabilitation of irrigation systems, more efficient use of water for irrigation in agriculture by promotion of the drop-by-drop system, biodiversity protection, afforestation, etc.

4.4. Intersectoral Adaptation Action Plan

While policies for human development are the most secure foundation for adaptation, even the best human development practices will have to take into account emerging climate change risks. Early action to improve seasonal climate forecasts, food security, disaster and emergency response, early warning systems, and insurance coverage can minimize the damage from climate change.

A National Action Plan was developed within the framework of this study for the period 2008-2011. Each sectoral study developed an action plan for adaptation to climate change. The National Action Plan was developed as a summary of all vulnerable sectors action plans and involves four major areas:

- Institutional and legal measures;
- Identification, assessment, and mitigation of climate change negative impact;
- Monitoring;
- Strengthening capacities at institutional, systemic, and individual levels.

Identified problems in each of these areas are presented and measures for overcoming of these problems are proposed. Each of the proposed measures is accompanied by a number of actions that should be undertaken, with a timeframe and responsible stakeholder.

The cost estimation for each action is anticipated through approximate budget categories. These categories give a rough cost assessment: category III – up to €100,000; category II – from €100,000 to €500,000; and category I – more than €500,000.

Institutional and legal measures

	Problem identified	Measures	Actions	Responsible party	Time frame	Budget €
1	No approximated legislation and strategic development documents from climate change aspect	Legislation approximation and strategic development of documents from climate change aspect	Incorporate climate change adaptation measures in: - Spatial plan - Agricultural strategic development documents - Strategic and planning documents stemming from the draft law on waters (development of national strategy on water, finalization of water master plan, and river basin management plans, including change of available and demanded water resources due to climate change impact, priority by-laws) - physical and urban plans - NEHAP[1] - Strategic impact assessment - Action plan on environment and children's health	MOEPP[2], MOAFWE[3], MOTC[4], MOH[5]	2008/09	III

Measures for identification, assessment and mitigation of climate change negative impact

	Problem identified	Measures	Actions	Responsible party	Time frame	Budget €
2	Data unavailability for all sectors	Continuous data collection, development of databases and their management	Development of database of extremes (droughts and floods)	HMS[6], MOEPP, MOH	2008-2010	II
			Preparation of basic maps of RM in GIS format to a scale of 1:50,000 (soil, vegetation, erosion, eol etc.)	MOAFWE, MOEPP, HMS	2008-2010	III
3	Climate change vulnerability	Adaptation measures	Development of adaptation programme on climate change in forestry sector	MOAFWE	2008-2010	
			Production of native species plants and afforestation of 700 ha. of bare land/year	MOAFWE, MOF[7], MOEPP	2008-2010	I
			Identification and introduction of species resistant to climate change, implementing measures for agricultural support	MOAFWE	2009-2015	II
			Introducing adaptation measures and techniques concerning climate change (organic matter turnover/ water protection and agro-techniques) in central Povardarie	MOAFWE, Public water management enterprises	2008-2010	II
			Modernization of irrigation systems in Tikves and Strumica regions	MOAFWE, Public water management enterprises, scientific community	2008-2011	II

[1] National Environmental Health Action Plan.
[2] The Ministry of Environment and Physical Planning.
[3] The Ministry of Agriculture, Forestry, and Water Economy.
[4] The Ministry of Transport and Communications.
[5] The Ministry of Health.
[6] The State Hydro-Meteorological Service.
[7] The Ministry of Finance.

Monitoring

	Problem identified	Measures	Actions	Responsible party	Time frame	Budget €
4	Lack of quality monitoring system for climate change impact on different sectors	Improvement of monitoring system	Establishment of groundwater monitoring system (quality and quantity)	HMS, MOAFWE, RIHP[8]	2008-2011	I
			Establishing the Early Warning System in Skopje due to harmful effects of weather variables on human health, settled in RIHP	RIHP, HMS, MOEPP, MOAFWE, MOH	2008-2010	II
			Establishing the Early Warning System for floods and droughts	MOEPP, MOAFWE, HMS	2008-2010	II
			Enlargement and modernization of existing network of hydro-meteorological stations and introduction of monitoring on basic soil indicators	HMS, MOAFWE, MOEPP	2008-2011	I
			Establishment of a pilot network of mountain meteorological stations in Jakupica with vertical and slope distribution for biodiversity vulnerability assessment	HMS, MOEPP	2008/09	II
			Establishment of five monitoring stations in forest regions throughout Macedonia for monitoring climate change in forestry	MOAFWE, HMS, MOEPP	2008-2009	I
			Monitoring of the status of upper forest border (vertical and horizontal spreading of the forest species ranges and migration of animals)	MOEPP, MOAFWE	2008-	II

Measures for strengthening capacities at institutional, systemic and individual level

	Problem identified	Measures	Actions	Responsible party	Time frame	Budget €
5	Lack of capacities in institutional, systemic and individual level	Strengthening capacities in institutional, systemic and individual level	Raising climate change on higher level in relevant ministries	HMS, MOAFWE, MOEPP	2008	III
			Establishment of support unit within MOEPP, sector atmosphere	MOEPP	2008	III
			Providing additional equipment and staff in institutions responsible for environmental monitoring	All ministries	2008-	
			Training and equipment for water management organizations and operators	Public water management enterprises	2008-2010	II
			Training of institutions and farmers for adopting best available practices for climate change adaptation	MOAFWE	2009	II
			Training of national experts for development of socio-economic scenarios regarding climate change	MOEPP	2008-2009	III
			Introduction of syllabus programmes on climate change and adaptation within the educational system in RM	MOEPP, MES[9]	2009	III
			Acceptance of best laboratory practice and technique evidence based and strengthening the existing ones in order to improve the diagnostics and treatment as secondary adaptation measure	MOH, HIF[10]	2008-2015	III
			Establishment of a system for monitoring the status of biodiversity components through monitoring of the phenology of bioindicator species; defining climate change sensitive species	MOEPP, NGOs	2008-2009	III

[8] Republic Institute for Health Protection.
[9] Ministry of Education and Science
[10] Health Insurance Fund.

4.5. List of Projects Proposed for Financing

In the process of preparation of the sectoral analysis, most priority projects for each of the sectors were identified. Some of them (as a project concept) are attached to this report.

In the water resources sector these projects were proposed for financing:

- Adaptation Measures to Reducing Vulnerability to Climate Change of the Irrigation System in the South-Eastern Part of Macedonia;
- Development of Methodology for Groundwater Vulnerability Assessment in the Republic of Macedonia under Climate Change Conditions;
- Simulation of Water Balance for the Republic of Macedonia under Climate Change Conditions.

One project (in a form of GEF PDF A) is proposed by the agricultural sector for financing entitled as:

- Development of Adaptation Measures to Combat Negative Effects of Climate Change in Agricultural Production in the Republic of Macedonia.

Analyses of the climate change impacts on biodiversity have indentified mountain and high-mountain ecosystems, as well as aquatic-wetland ecosystems as the most threatened. Thus, the following projects are proposed as urgent measures for planning of adaptation activities:

- Vulnerability Assessment of Wetland Ecosystems in the Republic of Macedonia under Global Climate Change;
- Vulnerability Assessment of Mountain Ecosystems in the Republic of Macedonia under Global Climate Change.

Another project proposal has been developed in coordination with all hydro-meteorological stations in the region under the guidance of Slovenia, which has been selected as a host country for the Balkan drought centre. The proposal represented an integrated sub-regional programme to coordinate and facilitate the development, assessment, and application of drought risk management tools and policies in south-east Europe with the goal of improving drought preparedness and reducing drought impacts and leading towards the potential establishment of a European Drought Management Centre.

CLIMATE CHANGE MITIGATION

5.

5. CLIMATE CHANGE MITIGATION

The main aim of Climate Change Mitigation Analyses is to assess the climate change mitigation potential of the country following the projected developmental lines of the national economy. This aim is realized through identification of appropriate measures/practices/projects/interventions in various sectors starting from electricity, heating, industry, transport through to waste and agriculture, which will be undertaken during the period 2008-2025. Then, to the greatest extent possible, the environmental effectiveness of the proposed measures was calculated, expressed in a reduced amount of GHG emissions in case the given measure/practice/project/intervention is implemented, as well as the economic effectiveness, estimating the price of GHG emission reduction (USD per tonne of CO_2-eq reduced). The optimum year of implementation for most of the measures was defined, imposing the maximum emission reduction and the minimum expenses as optimization criteria.

It should be noted that the mitigation analysis was constrained by the lack of sectoral developmental plans, relevant data (historical and present), as well as other relevant national studies. Still, this study is indicative concerning the country's mitigation potential, and should be permanently revised taking into account all the relevant occurrences in the national economy.

5.1. Sectoral Analysis

5.1.1. Electric Power

a) Assumptions on input data

The planning of the development of the Electric Power Sector is based upon the performance data of the power system in the period from 1991 up and until today, as well as on the realistic assumptions about the possibilities for future expansions.

The Existing Power Generation

In the last two decades there has been a degree of stagnation in building new generating capacities in the country (with only the HPP Kozjak being built in 2004; and the existing thermal and hydropower units being revitalized). On the other hand, following the economic growth (with an annual rate of around 5%), there has been a considerable growth of energy needs. Over the years, this has certainly been an enhancing of the gap between electricity demand and supply. The shortage of electricity is covered by importation, which amounted to around 2,000 GWh in 2007, or almost 25% of the total needs. Therefore, it is necessary to start some very intensive activities towards building new thermal and hydroplants in Macedonia as a country which is expecting a rapid economical growth in the next period.

The thermal power units in Bitola and Oslomej, which cover over 60% of the total electricity needs, have been operating for almost 25 years, and are entering the second phase of their operating lives. One of the proposals in the Study for Expansion Planning of the Macedonian Power System is ensuring the fuel (lignite) supply for the existing thermal power plants until the end of their lifetime, which is the year 2025. The cumulative operating time of TPP Negotino is only a few years, which is very low compared to the age of the plant (built 30 years ago). The reasons behind this are the relatively low electricity consumption until the middle of the 1990s, when Negotino served as a cold reserve in the Macedonian Power System. In the last few years the price of oil has been constantly increasing which has resulted in the high price of the electricity output from Negotino. With a little reconstruction in the technological process, according to the electricity needs, TPP Negotino can operate in the base load as well as in the peak load. The hydropower potential contributes with 15% of the total electricity needs which is nearly the level of the technical losses in the power system in Macedonia.

Growth rate of the electricity consumption

The system for electricity generation in Macedonia has been operating with the same power plants over the last 30 years, but the electricity demand is continually increasing, and in the last few years the needs have exceeded the maximum capacity of the existing generating system.

The data for the first year (2006) in the developing scenarios are given according to real hour-by-hour consumption with a total electrical energy of 8,300 GWh. An annual growth rate of 3.5% in the first ten years is assumed and 3% in the second ten years of the analysed period until 2025. These assumptions are based on the forecast for the economic development of the country, which is around 5% annually. The power system as the basis for economic development for each country should follow the development dynamics with a slightly lower percentage of development compared to total economic and industrial development. The reason is that the recent economic development in Macedonia was based on the low energy efficiency technologies, which means more energy was spent for an output product compared to the advanced and sophisticated technologies in the most developed countries in the world.

The growth rate for the electricity consumption of around 6% in the last few years in Macedonia is a result of the restarting of the heavy industrial and electrometallurgical capacities such as FENI, SILMAK, the steel industry, etc. These capacities from 1991 until the period of their privatization at the beginning of this century had not been in operation, so their reactivation in the last few years is a big step with regard to the electricity needs in Macedonia. The last administrative changes in the energy sector with the liberalization of the electricity market in Macedonia,

which were undertaken by the Government, resulted in new rules for the big industrial consumers, which means that ELEM and MEPSO as state-owned companies are not obligated for their electricity supply. From an environmental point of view it means that if the consumers import the electricity, the environmental impacts depend on the technologies for electricity production of the country from which the electricity was bought.

Prospects for new generation units

As a result of the stagnation of building new power plants, the obsolete existing capacities, and especially the effect of increased electricity demand in Macedonia, it is necessary to begin with an intensive investment activity in building new generating capacities. All the realistic options have been taken into consideration in the development scenarios for the Macedonian Power System. Macedonia, as a poor country regarding energy resources, has additional limitations in the transport of large amounts of energy resources (coal, oil, etc.), due to its geographical position. Taking into account all limitations and conditions, real options for energy development of Macedonia are the following:

- domestic lignite with limited capacities for fuel supply to the existing thermal power plants in Bitola and Oslomej until 2025;
- domestic lignite for new thermal power plant candidates Mariovo and Negotino;
- imported coal with high caloric value;
- using the natural gas of the gas pipeline with capacity of 800 million m^3 per year;
- crude oil for TPP Negotino (from the OKTA Refinery or imported);
- hydroelectric potential;
- renewable sources (small hydropower plants, wind power, etc.).

Based on these options three scenarios for power system expansion have been developed: baseline scenario, the first mitigation and the second mitigation scenarios.

Domestic lignite has a low caloric value and limited reserves. The open mines of Suvodol and Oslomej are already at the end of their reserves (maximum of up to five years of exploitation). The fuel supply for the existing thermal power plants in Bitola and Oslomej until 2025 can be ensured with the existing lignite mines and with opening new ones, as follows:

- opening the new mine in Brod Gneotino (for TPP Bitola);
- exploitation of underground lignite in Suvodol (for TPP Bitola);
- opening a new mine in Popovjani (for TPP Oslomej);
- importation of coal or lignite (Kosovo, Greece, ...) .

Mariovo and Negotino are locations near lignite mines, but their exploitation may be very expensive.

Imported coal with a high caloric value is the second option for fuel supply to the existing thermal power plants, but with limited capacities for continuous transport of large amounts of coal. Anyway, this possibility has been taken into consideration as the worst environmental scenario for development of Macedonia's power system.

Natural gas as an energy resource is the second option for fuel supply to the thermal power plants in Macedonia. The existing gas pipeline with a capacity of 800 million m^3 per year, and with the possibility of increasing the capacity up to 1,200 million m^3 per year is not being utilized by more than 15% (the gas consumption in Macedonia is up to 100 million m^3 per year). Therefore, the possibility for electricity generation from natural gas should be used in the next period. In the first and in the second mitigation scenarios, the building of the new thermal power plant candidates is based on gas-fired power plants, mainly with combined cycle (CC), and with combined heat and power production (CHP). These power plants have high efficiency and small heat rate, which can be more cost effective than the thermal power plants run on other fossil fuels. The first gas power plant in Macedonia is CHP Skopje which is under construction, and which is expected to start operating in 2009.

The operation of TPP Negotino is based on **crude oil,** which can be provided from the OKTA refinery or by importation. The infrastructure and the location of TPP Negotino enable its oil supply by rail transport.

Macedonia, as a poor country regarding fossil energy resources, should have maximum use of its **hydroelectric potential.** The new candidates for hydropower plants for which there is a good technical and hydrological foundation are mainly located in the western part of the country. Activities for their building have been initiated by tenders and by giving them under concession to foreign or domestic investors. All planned hydropower plants have been taken into consideration in the developing of the scenarios in the study.

Using the **renewable sources** for electricity generation is limited only to small hydropower plants, wind power plants, and solar power. Activities in building small hydropower plants have been initiated with the tender for the building of 60 small hydropower plants with a total installed power of around 43 MW.[1] The use of wind power is in an initial stage, of testing suitable locations in Macedonia. Solar power is still an expensive option for electricity production and lately there is a certain delay in the world compared to the wind power. Anyway, investments in small hydropower plants and in wind power plants are a more expensive option in comparison with the conventional thermal and hydropower plants. These solutions for using the renewable sources in electricity production can make a local contribution to the reduction of the electricity and energy needs.

Wind power is a cost effective if wind speed is over 8 m/s. This value of wind speed in Macedonia is on the mountains near the 2,000 m altitude above sea level, which can be an expensive technical solution for wind power. The best locations in Macedonia for wind power are Povardarie (around the river Vardar) and Ovce Pole (in the eastern part between the towns of Kocani and Stip). The greatest distribution of winds in Macedonia is those

[1] According to tender documentation from ELEM.

winds up to 4 m/s, so the wind potential in Macedonia as a continental country will be operated with a small capacity factor (below 10%). Some investors from Austria and Slovenia are interested in investments in wind power in Macedonia, but it is still far away from realization. The decision of the investors will follow after the measurements of the wind speed and the testing of the locations.

Solar power in Macedonia as a country with large a number of sun hours per year, can be used mainly in solar thermal systems for water heating because photovoltaics (PV) are still an expensive option for electricity production. It means that solar energy can be analysed from the energy efficiency point of view in households, residential, commercial, or industrial facilities, but mainly depends on the investment possibilities of the owners.

Geothermal energy in Macedonia is mostly used in locations near Kocani and Strumica. The thermal parameters of the water are low and insufficient for converting the geothermal energy into electrical energy. Geothermal energy in Macedonia can be used for recreation and for medical or tourist purposes (in spa centres), as well as for heating facilities and greenhouses. It means that geothermal energy in Macedonia can be taken into consideration locally, from the aspect of energy efficiency in the agricultural and industrial sectors, as well as for heating.

b) Scenarios for future expansion of the electricity generation system

The following three software tools: OPTIM, WASP, and LEAP have been used in the development of the system for electricity generation in Macedonia in the analysis of the study. The input data for hydropower plants as well as the technical characteristics for the water reservoirs and hydrological data have been processed with the OPTIM software tool. The electricity consumption in the first year (2006) was 8,300 GWh. The optimum solutions for a long-term expansion planning of the generating system in Macedonia have been processed with the WASP software tool. The output results from the WASP according to the input data give three different scenarios for planning the expansion generating as follows: the baseline scenario, the first mitigation scenario, and the second mitigation scenario. At the end of each development scenario analysis the LEAP software tool is used for evaluating the environmental impacts of each scenario.

- **The baseline scenario** assumes a maximum use of domestic lignite in the thermal power plants for covering the electricity needs in Macedonia, supposing there will be a fuel supply for the existing thermal power plants in Bitola (3×209 MW nett) and Oslomej (1×109 MW nett)[2] until 2025. Candidates on the list of thermal power plants are: TPP Mariovo with installed power of 209 MW[3] nett, the fourth unit of TPP Bitola with an installed power of the same size as the existing ones. Another lignite thermal power plant candidate is the TPP Negotino with installed power of 300 MW and with a mine near the location of the power plant. This scenario is mainly based on domestic lignite and it is the most destructive environmental scenario for the development of the Macedonian power system.
- **The first mitigation scenario** operates only with the existing thermal power plants in Macedonia. Apart from the candidates from the list of thermal power plants there are also two gas CHP power plants. One of them is the planned CHP Skopje with an installed power of 234 MW which is under construction, and the second one is CHP with an installed power of 300 MW, location still not defined. Therefore, the lignite-fired TPP Mariovo and TPP Negotino from the base scenario are not included in the first mitigation scenario.
- Additional assumption in **the second mitigation scenario** reduces the electricity consumption in the initial year of 2006 for the big industrial consumers (FENI, SILMAK, and the steel industry). Instead of the previous consumption of 8,300 GWh, the annual electricity needs in 2006 have been reduced to 6,700 GWh). The consumption is calculated according to hour-by-hour chronological values of loads in MW, and the distribution of the loads within the year is different with regard to the previous one, which can be noticed from the value of the load factor (for the reduced consumption it is 54% instead of 63% for the previous one). The reduced consumption refers only to distribution needs, and it is the effect of the liberalization of the electricity market for big industrial consumers, according to which they are obligated to provide energy supply for themselves on the market. The second different assumption involves renewable energy sources using small hydropower plants, wind power, and solar power. This is simulated by involving a small hydropower plant with aninstalled power of 25 MW and an annual electricity production of 45 GWh in the power system of Macedonia for every four years (2010, 2014, 2018, and 2022). By modelling such a small hydropower plant at every four years integrally, all renewable energy sources are taken into consideration. It means that at the end of the analysed period until 2025 the installed capacities from renewable energy sources will amount to 100 MW with a total annual electricity output of 180 GWh, which is a relatively optimistic forecast. The renewable energy sources should ease the development of new conventional power plants in Macedonian power system. The third assumption in this scenario is disconnecting the TPP Negotino from the Macedonian electricity system in 2009 by the activation of the new gas CHP in Skopje.

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[2] Nett power capacity is relevant for calculations of power needs planning, but the GHG emissions are calculated according the electrical production.

[3] According ELEM, TPP Mariovo is planning 300 MW. Two TPPs on domestic lignite are taken into consideration in the study (TPP Mariovo with 209 MW and TPP Negotino with 300 MW). These two options of lignite TPPs give possibilities for involving new lignite power plants in Macedonia, one with a 300 MW capacity as the planned one from ELEM, and the other with a capacity as the existing in Bitola.

Environmental impacts of the three scenarios

Detailed calculations for the GHG emission, as well as for other local emissions have been made for the three scenarios. The databases for the emission of the pollutants and the chemical content of different types of fuels according to the IPCC and Tier 2 are integrated in the software tool of LEAP (Long-range Energy Alternatives Planning System). The results from the calculations show the reducing of GHGs begins in 2009, when the CHP in Skopje starts operating according to the first mitigation scenario. (Fig. 5.1.1.1)

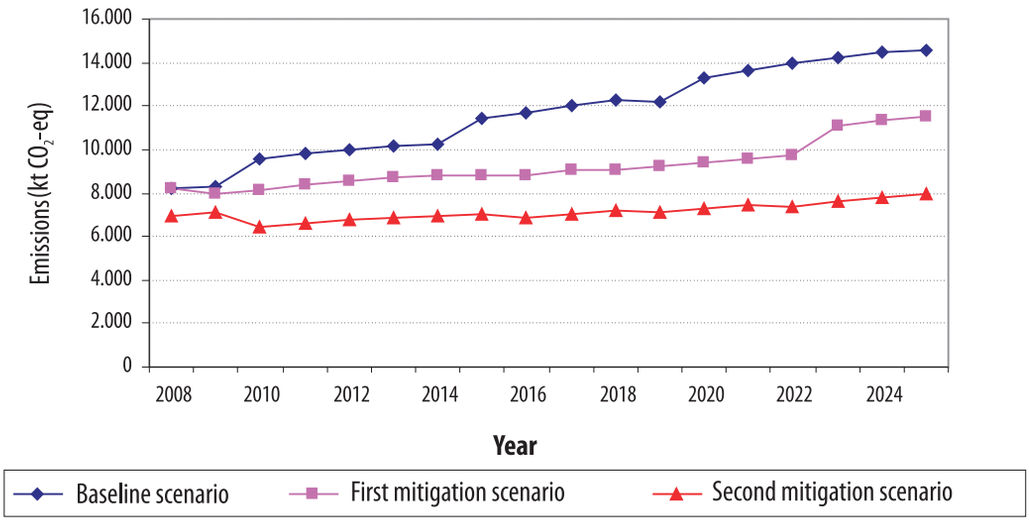


Figure 5.1.1.1 GHG emissions for the baseline scenario and for both mitigation scenarios [kt CO_2-eq]

The additional improving of the environmental impacts by reducing the GHG emission is due to the inclusion of the second CHP with an installed power of 300 MW in 2015. In the second mitigation scenario the additional environmental improvements are due to the reduced electricity production because of the reduced consumption. The final effect in the second mitigation scenario reduces the GHG emission by more than 6,000 kt of CO_2-eq in comparison with the baseline scenario.

5.1.2. Industrial Energy Transformations and Heating

Fossil fuels contribute with the largest share in the structure of the primary energy consumption for heating purposes in the industrial, residential, commercial and public sectors, agriculture, and other sectors in the country. According to the statistical data for the last few years, in this part of the energy sector, liquid fuels, mostly fuel oil and diesel oil, cover over a half of the primary energy for heat production. In the same period, the contribution of firewood is considerable, making about 20% of the total primary energy needs, used mostly in the households. In the liquid fuel supply, the Republic of Macedonia is completely dependent on the importation of crude oil. Domestic consumption of fuel oil products in the last few years ranges 700,000-1,000,000 t/year.

Further on, the contribution of firewood is significant, with about 20%, mostly in the residential sector, as well as the contribution of the solid fuels (lignite, hard coal, and coke), which participated with about 17.6% in 2005, mostly used as heat energy source in industry, agriculture, and other sectors. The share of natural gas (approximately 8% in 2005) and liquefied petrol gas (below 3% in the same year) is much smaller, while geothermal energy covers up to 1% of heat energy needs.

Regarding the final energy consumption, the distribution between various segments of the sector is relatively even, over the last few years. According to the energy balance for 2005, the final energy consumption in the industry amounts to 33.5%, the consumption in the households makes 29%, the transport sector 20.9%, and agriculture, commercial buildings, the public and administrative sector, and other areas contribute with 16.7% in the final consumption.

In developing of the **baseline scenario** for energy transformations in the industry sector and for heating, forecasts for annual growth rates of the economy activities, industrial production, energy needs and, in this framework, necessities for heat, etc., over the period 2006-2025, are assumed in accordance with relevant studies and publications that cover the mentioned period (annual growth rate of 3.5% during the first decade and of 3% during the second decade of the analysed period). The projections for the heat generation and for the consequent emissions of GHGs in the period 2006-2025 are derived by taking into account the following cases: the scenario without significant changes in relation to the actual practices, i.e. so-called "business as usual" scenario and the scenario that includes certain measures for reduction of GHG emission. Having in mind that the heat generation belongs to the wider energy sector, the analysis is done according to the same methodology and using the same emission factors as in the electricity generation sector. The analysis of the industrial energy transformations and heating, in the framework of the energy sector, is accomplished on a basis of the following division: (1) low-temperature heat consumers, that means, district heating systems, heat production and consumption for heating of buildings in the public and commercial sectors (hospitals, schools, administrative buildings, shopping centres, etc.), heat consumption in the residential sector, heat for agriculture and for other sectors; and (2) industrial heat consumers.

The main assumptions of the **mitigation scenario** regarding the GHG emissions originating from this part of the energy sector are:

- The same value of the growth rate of the overall energy needs is assumed as in the baseline scenario, although the optimistic prognoses regarding the expected economic development would lead to larger energy consumption; such necessity on the demand side would be compensated with measures of increased energy efficiency, energy saving, utilization of fewer energy-consuming technologies, etc.
- Certain redistribution regarding the used fuels is done, which is expected to be dictated partly by the market conditions and by the obligations for accomplishment of norms prescribed by the environmental legislation. In that sense, it is assumed that the growth rate of utilization of solid and liquid fuels will be lower, compared to the baseline scenario; a higher growth rate is assumed for biomass and the rest of the needs for thermal energy would be covered with gaseous fuels.
- In the energy transformation for heating purposes, the main point that should lead to mitigation of GHG emissions is introduction into operation of two combined heat and power plants run on natural gas, planned for commissioning in 2009 and 2015.
- Increasing of the share of the renewable energy sources in the country. In that sense, the energy potential of waste biomass of vegetative and animal origin, solar energy, and geothermal energy, in perspective, should get a more important place in the country's energy balance.

Comparison between the GHG emissions of the scenarios considered, presented as CO_2-eq, leads to a conclusion that the reduction of emission is relatively small. That is a result, most of all, of limited opportunities for fuels switching and transition towards energy resources with less potential for GHG production: limited capacity of a natural gas pipeline system, small probability for connection to other regional gas pipeline systems, limited potentials of the renewable energy sources, etc.

5.1.3. Transport

The analyses accomplished in the framework of the inventory of greenhouse gases show that the contribution of the transport sector is 10.6 ÷ 13.4% in the total CO_2-eq emission from the energy sector in the period from 1990 until 2002, while in the total GHG emission in Macedonia, presented as CO_2-eq emission, its contribution is 6.9 ÷ 9.6%. Regarding the energy consumption, road transport dominates ahead of railway and air transport.

In the period of the 1990s passenger and freight transport faced a decline in activities, which has been followed by certain recovery over the last few years. By far the largest share in the GHG emissions in the framework of the transport sector comes from activities in road transport. In the structure of registered motor vehicles, passenger cars dominate (resulting in an average of 124 cars per 1,000 inhabitants), far ahead of road haulage, while a much smaller share belongs to buses. The age structure of the vehicle fleet in the country is not favourable, since a large number of vehicles, which are still in use, were produced ten or more years ago. The railway transport in the country has exhibited a tendency towards stagnation in the last decade, which is characterized by reductions of the number of passenger lines, as well as with the certain decrease of the capacity of available rolling stock (locomotives, passenger carriages, and freight cars). The general trend in the air transport in the Republic of Macedonia in the last few years, when it comes to the number of carried passengers, is characterized with moderate growth. On the other hand, the total quantity of departing and arriving goods shows a permanent decrease in the period after 2001.

The projections of the trend of consumption of various fuels and consequent GHG emissions coming from the transport sector are based on officially published statistical data from the last fifteen years. While developing the **baseline scenario** for this sector over the period until 2025, the following main assumptions are taken into account, which, regarding the fact that the Republic of Macedonia still does not have a document for long-term strategic planning of its goals and development policies in the transport sector, are mostly a result of expert judgment:

- The conditions in the sector are expected to improve steadily (age structure of the vehicles, quality of public transportation, technical characteristics of the equipment, etc.), but the general state of various segments of the sector stays without significant changes, regarding the infrastructure, fuel used, etc.
- It is assumed that the average annual growth rate of the number of motor vehicles in the country will be 2% over the period from 2006 until 2015, followed by a 3% growth rate over the period 2016-2025.
- The average annual growth rate of passenger kilometres in the road transport and railway transport is assumed to be 2%.
- The annual growth rate of carried goods is assumed to be 4%.
- The trend of activities in air transport is based on estimations for increasing of the economic activities in the country and the assumed growth rate is 4% in the case of carried passengers and number of operations. In the case of carried goods, it is foreseen that the trend of decreasing will be stopped in the first years over the considered period and then, followed by a steady growth of the total amount of carried goods.

In the **mitigation scenario**, the main strategic directions that should be followed for reduction of GHG emissions coming from the activities in the transport sector are directed towards the following objectives: improvement of the efficiency in the transport sector and energy efficiency of the vehicles, which means, reduction of the specific energy consumption, improvement of the public urban and inter-city transport and bringing the national legislation into accord with European Union regulations.

When it comes to the type of fuel used in the road motor vehicles, it is assumed that there will be a change in the fuels' correlation, expressed as a steady decreasing of contribution of petrol vehicles, stagnation or moderate increase of the number of diesel vehicles and steady increase of

the contribution of vehicles run on other fuels, between which the dominating are LPG, CNG, and bio-diesel. Although the offer of hybrid petrol-electrical vehicles on the world market permanently increases, because of certain technological and economic reasons, it is very difficult to foresee the penetration of these vehicles onto the domestic market in the middle term and that is why they are not included in the scenarios.

In the mitigation scenario for railway transport, it is foreseen that in the beginning of the analysed period there will not be any significant changes in the railway infrastructure, meaning, mainly, the length and the technical characteristics of the railway tracks. Regarding the locomotives power system, it is assumed that the correlation between the number of electrically driven and diesel locomotives will steadily change, in favour of electric locomotives; that means both, an increased number of electric locomotives and their bigger contribution in transportation of passengers and goods.

Based on comparison of the GHG emission projections, obtained with the scenarios, expressed through CO_2-eq, a conclusion can be drawn that with the proposed measures the obtained reduction of GHG emissions is relatively small. More visible effects could be expected by application of certain qualitative systematic solutions, such as qualitative improvement of the public urban and inter-city transport, development of integrated transport system, spreading, reconditioning, and better maintenance of the road infrastructure, qualitative improvement of the overall railway infrastructure, more intensive use of the railway transport and other measures, which, basically, are the way towards the development of an efficient public transport system.

5.1.4. Waste

GHG emissions in this sector comprise methane (CH_4) and nitrous oxide (N_2O) released during the waste decomposition in anaerobic conditions. According to the GHG emission inventory, the contribution of the waste sector is 5.5 ÷ 7% of the total CO_2-eq emissions. The waste sector includes the following three sub-sectors:

- Municipal Solid Waste (MSW);
- Wastewater handling (domestic and industrial wastewater);
- Human sewage.

Considering that the major part of the emissions comes from the solid waste disposal sites, the mitigation analyses will be made mainly for this sub-sector.

In order to reduce the GHG emissions from the waste decay, a technology for methane collection and flaring was adopted, thus converting the methane content of LFG into CO_2. In this sector following scenarios are considered:

- **Baseline scenario** which assumes that no changes will be made, and the GHG emissions will increase according to the demographic growth rate;
- **Mitigation scenario** which proposes implementation of systems for methane collection and flaring at nine landfills in Macedonia. The selection of these nine landfills is based on the preliminary analyses made for the purpose of the portfolio of potential CDM projects[4], developed under the established climate change related collaboration between the respective Macedonian and the Italian ministries of the environment.

The selected technology applied at the specified landfills, has been evaluated using the GACMO2 model.[5] This option has been compared to the baseline/reference scenario which assumes that the content of the disposed MSW and other organic matter are left to decay at the landfill, so that in the absence of the collection system methane will be emitted into the atmosphere. The mitigation scenario, in fact is a time schedule for implementation of the selected mitigation technology at the considered sites. The criteria for definition of the time schedule mainly involve the potential for emission reduction, geographical distribution of the sites, financial and technical capacities of the corresponding municipalities, etc. One possible mitigation scenario is presented in Table 5.1.4.1.

Table 5.1.4.1 Schedule for the implementation of the GHG mitigation technology in the waste sector (mitigation scenario)

	Landfill	Annual Emission Reductions [t CO_2-eq]	Annual Costs [USD]	Total Investment [USD]	Year of Implementation
1.	Skopje ('Drisla')	77,760	221,333	1,800,000	2009
2.	Veles ('Bunar Dere')	9,694	27,593	224,400	2010
3.	Gostivar ('Sibnica')	5,081	14,461	117,606	2010
4.	Kumanovo ('Krasta')	18,921	43,086	438,000	2011
5.	Bitola ('Meglenci')	15,137	43,086	350,400	2012
6.	Strumica ('Sapkar')	12,856	36,594	297,600	2013
7.	Stip ('Trestena Skala')	15,034	42,791	348,000	2014
8.	Kocani ('Belski Pat')	4,095	11,657	94,800	2014
9.	Vinica ('Leski')	3,888	11,067	90,000	2014

[4] "Assessment of the projects' potential in the fields of renewable energy sources, energy efficiency and forestry management, in the framework of Clean Development Mechanism of the Kyoto Protocol for the Republic of Macedonia", Italian Ministry for the Environment, Land and Sea, May 2007.

[5] Fenham, J., 'Introduction to the GACMO Mitigation Model' in: *Economics of Greenhouse Gas Limitations*. Handbook reports, UNEP, Riso National Laboratory, Denmark, 1999 ISBN: 87-550-2574-9.

As per the assumed mitigation scenario, after the year 2014 about 162 kt CO_2-eq can be reduced annually. That corresponds to 18% of total CO_2-eq of the waste sector. But it is worth mentioning that the selected technology in this study also recognizes non-GHG-related environmental benefits, such as reduced explosion or poison risks from uncontrolled migration of LFG and odour prevention from the landfill site.

5.1.5. Agriculture

The GHG emissions from the agricultural sector account for 8-15% of the total emissions and comprise methane (CH_4) and nitrous oxide (N_2O), originating from the following sources:

- Enteric fermentation (CH_4 emissions);
- Manure management (CH_4 and N_2O emissions);
- Rice cultivation (CH_4 emissions);
- Agricultural soils (N_2O emissions).

A considerable amount of waste is produced by the agricultural sector (around 530,000 tonnes of straw, from which 370,000 tonnes are used for stock-breeding, around 190,000 tonnes of cuttings from winegrowing and orcharding, and also a certain amount of animal waste from livestock breeding); the absence of the collection systems (with the exception of the systems of some individual farms) leads to the significant amount of GHG emissions. The current waste management practices are different, whereupon the waste from the cattle-breeding farms is stacked, burned, and used as a fertilizer; the waste from pig farms is released into the rivers or accumulated in lagoons (which are not properly managed). The crop residues are used as food or as mat for cattle and the pruning residues are burned or used for heating. Livestock breeding and agricultural activities such as crop production generate the largest part of the agricultural waste, therefore are associated with a major negative impact on the local environment.

Several projects related to the improvement of the Animal Waste Management System (AWMS) have been identified in the Republic of Macedonia that will reduce the uncontrolled release of GHG from manure. These projects are based on the technology for biogas collection and combustion at pig-breeding farms. This technology includes installation of covered lagoons creating negative pressure and anaerobic digesters, instead of current anaerobic open lagoons. The system will also include an efficient enclosed flare to combust the digester biogas, converting its methane content to CO_2 and thereby achieving significant GHG reduction. After anaerobic digestion, the solid sludge can be separated and stored for sale to the local farmers for land application as fertilizer.

In this analysis, the following scenarios were developed for the agricultural sector:

- **Baseline scenario** which does not assume introduction of any changes and the GHG emissions will increase in accordance with the growth rate of the number of animals, as well as the arable area in the country and the input of the nitrogen fertilizers;
- **The mitigation scenario** where the main activities are focussed on implementation of systems for biogas collection and combustion at six pig farms in Macedonia.

The implemented systems at the selected farms have been evaluated using the GACMO2 model and the calculated values, as well as the time schedule of the implementation are given in Table 5.1.5.1.

Table 5.1.5.1 Schedule for implementation of the GHG mitigation technology in the agricultural sector (Mitigation scenario)

	Pig farm	Annual Emission Reductions [t CO_2-eq]	Annual Costs [USD]	Total Investment [USD]	Year of implementation
1.	Veles ('Agria group')	6,240	41,802	390,000	2010
2.	Stip ('Tarinci')	2,870	19,229	179,400	2011
3.	Vinica ('Vineam')	1,560	10,450	97,500	2011
4.	Sveti Nikole ('Sveti Nikola')	1,654	11,078	103,350	2011
5.	Berovo ('Zito Males')	1,487	9,963	92,950	2011
6.	Tetovo ('Edinstvo')	3,744	25,081	234,000	2012

According to the mitigation scenario, the total possible GHG emission reduction in the agricultural sector, after 2012, is 17.55 kt CO_2-eq.

There are available technologies for reduction of GHG emissions in agriculture that can be used in Macedonia, but they are mostly related to increased production by unit area/unit head, managing of animal diet, better utilization of fertilizer and water, etc. These technologies should be further analysed and researchers should develop technologies that can be implemented in various regions in the country.

Production of bio-diesel as well as bio-ethanol and their use as energy sources can reduce emission from fossil fuels. There is potential for using of crop residues (straw, pruning residues, etc.) as an energy source. These options should be investigated and serious research should be conducted in order to maintain sustainability of agriculture (to produce energy without disturbing food production, and maintain soil and water quality).

5.2. Projections of the total GHG emissions

Within this chapter the estimated GHG emissions by each sector have been integrated in order to project the total national GHG emissions over the period 2008-2025, following the three assumed scenarios: baseline (Business As Usual – BAU), first mitigation scenario, and second mitigation scenario. Worth mentioning is that the first mitigation and second mitigation scenarios differ only in the electricity sector, whereby the second mitigation scenario incorporates additional abatement measures, which, as will be shown later, will have a considerable contribution to the overall reduction of GHG emissions. The main figures for all scenarios are summarized in Table 5.2.1. Table 5.2.2 (and Figure 5.2.1), Table 5.2.3 (and Figure 5.2.2), and Table 5.2.4 (and Figure 5.2.3) show the GHG emissions by sector and total emissions, for each year of the analysed period and for each scenario, respectively.

Table 5.2.1. Key values for all three scenarios

	2008-total GHG emissions [kt CO_2-eq]	2025 – total GHG emissions [kt CO_2-eq]
BAU scenario	14,040	23,947
First Mitigation scenario	13,904	20,348
Second Mitigation scenario	12,645	16,713

Table 5.2.2. Projections of the total GHG emissions [kt CO_2-eq] – baseline scenario

	Power System	Heating	Industry	Transport	Waste	Agriculture	Total
2008	8,196	1,328	906	1,390	844	1,376	14,040
2009	8,268	1,375	937	1,432	847	1,517	14,376
2010	9,584	1,423	970	1,475	850	1,553	15,855
2011	9,836	1,472	1,004	1,520	853	1,595	16,280
2012	10,025	1,524	1,039	1,566	856	1,637	16,647
2013	10,154	1,577	1,076	1,614	859	1,679	16,959
2014	10,246	1,632	1,113	1,664	862	1,722	17,239
2015	11,388	1,690	1,152	1,715	865	1,764	18,574
2016	11,719	1,740	1,187	1,775	868	1,807	19,096
2017	12,006	1,792	1,222	1,838	871	1,851	19,580
2018	12,261	1,846	1,259	1,902	875	1,894	20,037
2019	12,199	1,902	1,297	1,970	878	1,937	20,183
2020	13,260	1,959	1,336	2,039	881	1,981	21,456
2021	13,628	2,017	1,376	2,112	884	2,025	22,042
2022	13,954	2,078	1,417	2,186	887	2,070	22,592
2023	14,241	2,140	1,459	2,264	891	2,114	23,109
2024	14,463	2,205	1,503	2,344	894	2,159	23,568
2025	14,600	2,271	1,548	2,427	897	2,204	23,947

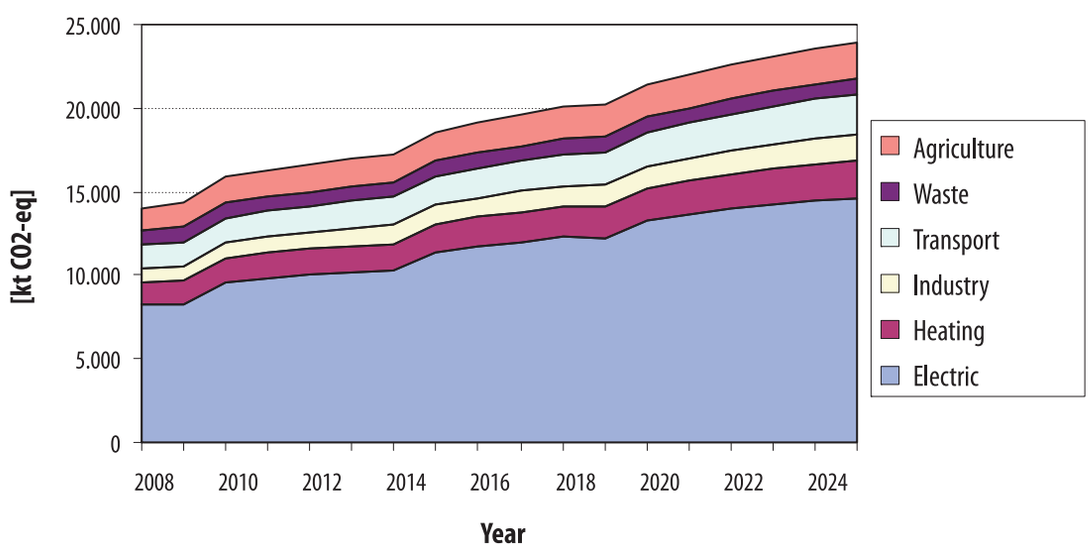


Figure 5.2.1. Projections of the total GHG emissions [kt CO_2-eq] – baseline scenario

Table 5.2.3. Projections of the total GHG emissions [kt CO_2-eq] – first mitigation scenario

	Power System	Heating	Industry	Transport	Waste	Agriculture	Total
2008	8,196	1,328	902	1,258	844	1,376	13,904
2009	7,922	1,353	931	1,296	769	1,517	13,788
2010	8,093	1,401	961	1,335	757	1,512	14,059
2011	8,354	1,451	993	1,375	741	1,546	14,460
2012	8,575	1,502	1,025	1,416	729	1,588	14,835
2013	8,719	1,556	1,059	1,458	720	1,630	15,142
2014	8,831	1,611	1,094	1,502	700	1,673	15,411
2015	8,784	1,647	1,130	1,547	703	1,715	15,526
2016	8,827	1,697	1,163	1,601	706	1,757	15,751
2017	9,071	1,749	1,196	1,656	709	1,800	16,181
2018	9,055	1,803	1,231	1,714	712	1,844	16,359
2019	9,262	1,859	1,267	1,773	715	1,887	16,763
2020	9,428	1,916	1,304	1,834	718	1,930	17,130
2021	9,580	1,975	1,342	1,897	722	1,974	17,490
2022	9,700	2,035	1,381	1,963	725	2,018	17,822
2023	11,131	2,097	1,422	2,031	728	2,063	19,472
2024	11,367	2,162	1,463	2,101	731	2,107	19,931
2025	11,553	2,228	1,506	2,174	735	2,152	20,348

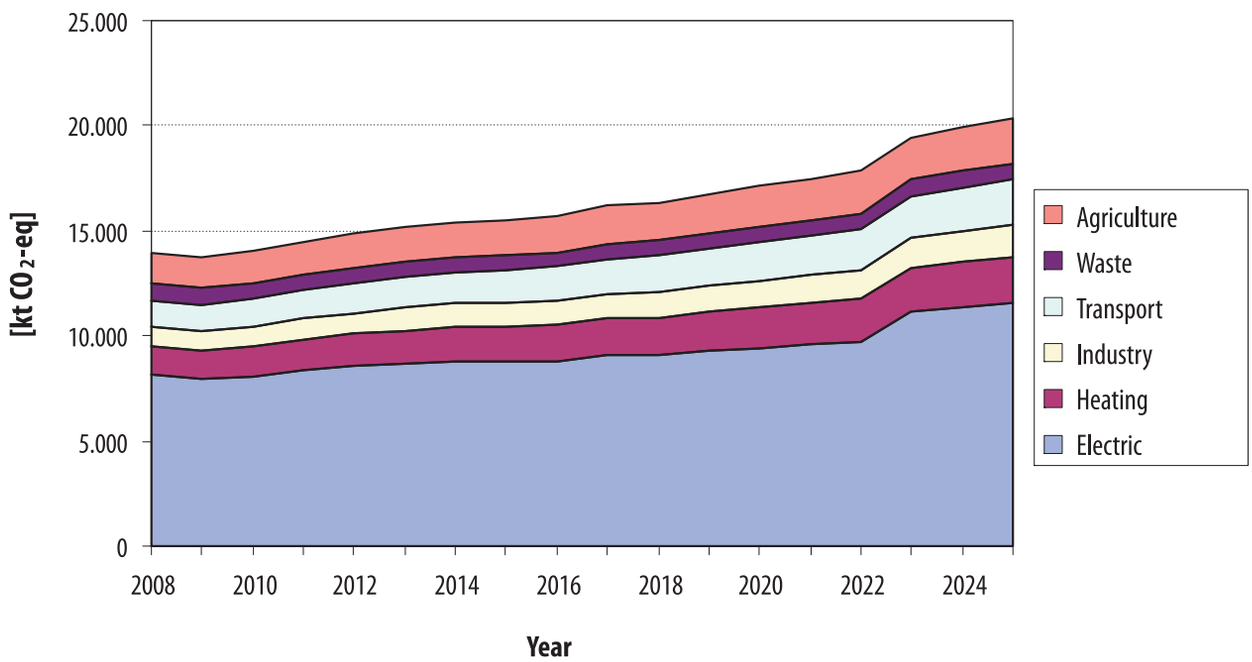


Figure 5.2.2. Projections of the total GHG emissions [kt CO_2-eq] – first mitigation scenario

Table 5.2.4. Projections of the total GHG emissions [kt CO_2-eq] – second mitigation scenario

	Power System	Heating	Industry	Transport	Waste	Agriculture	Total
2008	6,937	1,328	902	1,258	844	1,376	12,645
2009	7,082	1,353	931	1,296	769	1,517	12,948
2010	6,430	1,401	961	1,335	757	1,512	12,396
2011	6,613	1,451	993	1,375	741	1,546	12,719
2012	6,765	1,502	1,025	1,416	729	1,588	13,025
2013	6,881	1,556	1,059	1,458	720	1,630	13,304
2014	6,973	1,611	1,094	1,502	700	1,673	13,553
2015	6,990	1,647	1,130	1,547	703	1,715	13,732
2016	6,878	1,697	1,163	1,601	706	1,757	13,802
2017	7,042	1,749	1,196	1,656	709	1,800	14,152
2018	7,180	1,803	1,231	1,714	712	1,844	14,484
2019	7,143	1,859	1,267	1,773	715	1,887	14,644
2020	7,290	1,916	1,304	1,834	718	1,930	14,992
2021	7,415	1,975	1,342	1,897	722	1,974	15,325
2022	7,398	2,035	1,381	1,963	725	2,018	15,520
2023	7,586	2,097	1,422	2,031	728	2,063	15,927
2024	7,756	2,162	1,463	2,101	731	2,107	16,320
2025	7,918	2,228	1,506	2,174	735	2,152	16,713

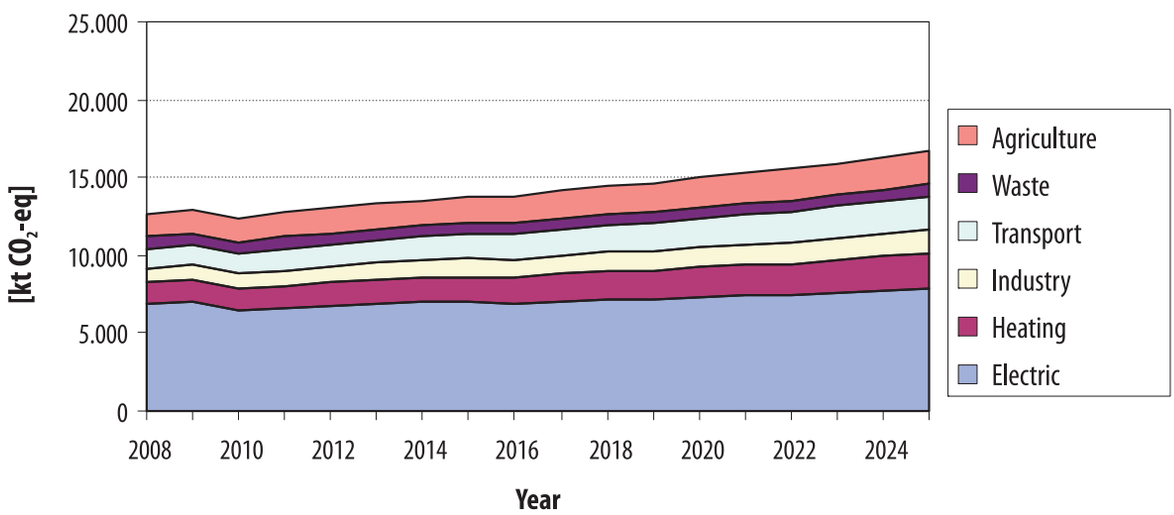


Figure 5.2.3. Projections of the total GHG emissions [kt CO_2-eq] – second mitigation scenario

BAU analyses: as per the projections presented in Table 5.2.2 and Figure 5.2.1 a considerable increase in the total GHG emissions by the year 2025 will occur compared to the projected value for the year 2008 (in absolute value of 9,900 kt CO_2-eq, or relatively about 71%) if the usual practice is applied without imposing the constraint on GHG emission reduction – BAU scenario (Figure 5.2.4 and Figure 5.2.5, last column). This increase is mainly related to the major rise within the electricity sector (absolute difference of 6,400 kt CO_2-eq and 78% relative increase to the 2008 value), which reflects the so-called black, lignite-based development scenario for the national power sector (Figure 5.2.4 and Figure 5.2.5, first column). The other sectors also exhibit significant rise in GHG emissions, as the 2025 values compared to the 2008 values are 75% (transport), 71% (heating and industry), 60% (agriculture), and 6% (waste) higher (Figure 5.2.4 and Figure 5.2.5).

Mitigation scenarios analyses: the situation can be improved if the developmental paths integrate practices/measures leading to GHG emission reductions. Hence, the first mitigation scenario (as defined in the sectoral analyses) leads to a 46% increase of the 2025 value of the total emissions compared to the 2008 total emissions or absolute difference of 6,400 kt CO_2-eq. (Table 5.2.3 and Figure 5.2.2; also Figure 5.2.4 and Figure 5.2.5, last column). This increase in the total emissions is further reduced to 32% (absolute difference of 4,000 kt CO_2-eq) if the developmental paths follow the second mitigation scenario (Table 5.2.4 and Figure 5.2.3; also Figure 5.2.4 and Figure 5.2.5, last column).

With regards to the sectoral projections for the three scenarios, the comparison between 2025 and 2008 emissions points to the largest achievement in the electricity sector. Namely, within this sector, the BAU relative increase of 78% is reduced to 41% by the first mitigation scenario (the first one in 2009 and the second one in 2015). Relative increase is reduced to 14% by the second mitigation scenario as a result of reduction of the electricity consumption for the value of the large consumers, introduction of renewable energy sources, and the disengagement of the TPP

Negotino when the CHP plant will start with operation (Figure 5.2.4 and Figure 5.2.5, last column). As to the other sectors, the effect of the waste sector is noticeable where the 6% BAU relative increase is turned into a negative relative increase (-13%) according to both mitigations scenarios, meaning that in the case of mitigation scenarios the 2025 waste emissions will be 13% lower than the corresponding 2008 values (Figure 5.4 and Figure 5.5, fifth column). The remaining sectors contribute slightly to the overall emission reduction, given the fact that the difference between BAU and mitigation scenarios ranges from 2% to 4%, (Figure 5.2.5).

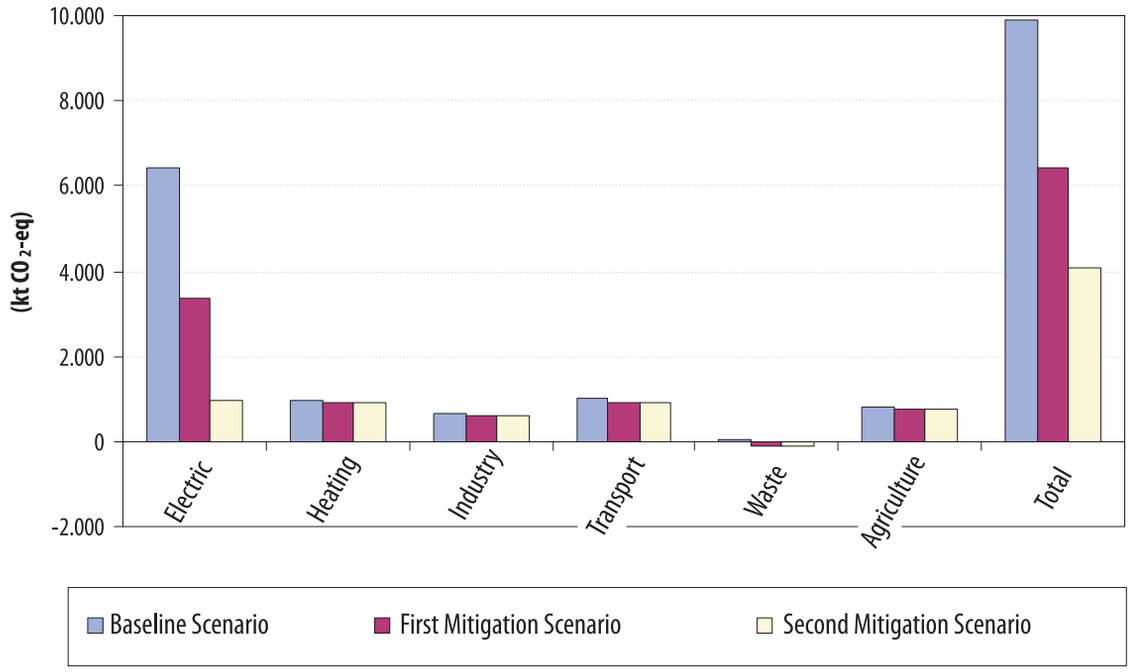


Figure 5.2.4. The effectiveness of the three scenarios expressed as an absolute increase of the 2025 emissions to the 2008 emissions [difference: 2025 emissions minus 2008 emissions in kt CO2-eq]

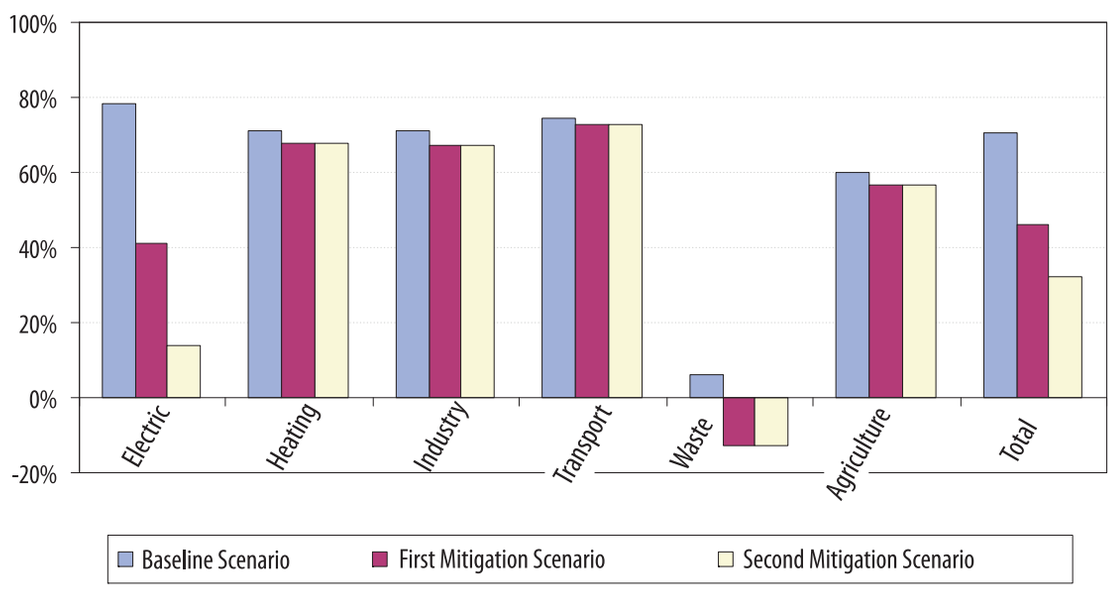


Figure 5.2.5. The effectiveness of the three scenarios expressed as relative increase of the 2025 emissions to the 2008 emissions

Finally, the overview of the projections of total GHG emissions for each year over the analysed period, according to the adopted scenarios is presented in Table 5.2.5 and Figure 5.2.6.

Table 5.2.5 Projections of the total GHG emissions for all three scenarios [kt CO2-eq]

Year	Baseline scenario	First mitigation scenario	Second mitigation scenario
2008	8,196	8,196	6,937
2009	8,268	7,922	7,082
2010	9,584	8,093	6,430
2011	9,836	8,354	6,613
2012	10,025	8,575	6,765
2013	10,154	8,719	6,881
2014	10,246	8,831	6,973
2015	11,388	8,784	6,990
2016	11,719	8,827	6,878
2017	12,006	9,071	7,042
2018	12,261	9,055	7,180
2019	12,199	9,262	7,143
2020	13,260	9,428	7,290
2021	13,628	9,580	7,415
2022	13,954	9,700	7,398
2023	14,241	11,131	7,586
2024	14,463	11,367	7,756
2025	14,600	11,553	7,918

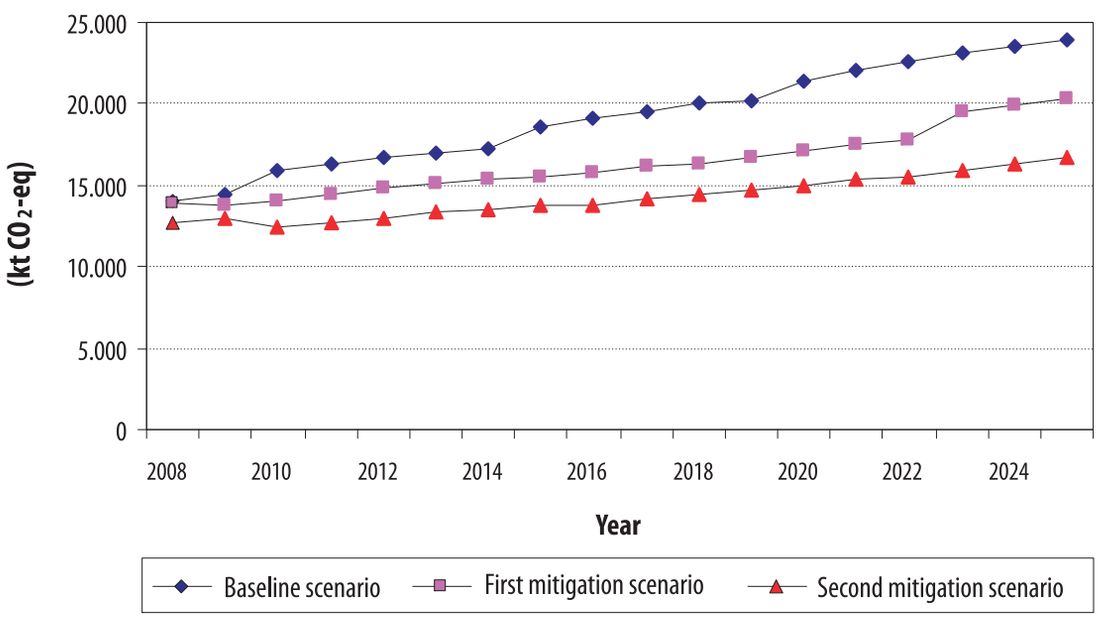


Figure 5.2.6. Projection of the total GHG emissions for all three scenarios [kt CO_2-eq]

In terms of carbon intensity (kt CO_2-eq per capita), Macedonia remains among the countries with relatively high per capita emissions mainly due to predominant use of fossil fuels for electricity generation. This parameter progressively decreases as the gas is introduced under the mitigation scenarios. This parameter is calculated for the three scenarios and presented in Table 5.2.6.

Table 5.2.6. Carbon intensity of Macedonia (GHG emissions per capita – t CO_2-eq per capita)

Year	Projections of the Population (1,000 persons)	BAU scenario	First Mitigation scenario	Second Mitigation scenario
2008	2,055	6.83	6.76	6.15
2012	2,080	8.00	7.13	6.26
2020	2,131	10.07	8.04	7.04
2025	2,163	11.07	9.41	7.73

5.3. National Action Plan for Climate Change Mitigation

5.3.1 Electric Power

According to the development scenarios for the Macedonian power system, some general directions for future activities in building new generating capacities can be given. Table 5.3.1.1 gives the overview of the dynamic activities in building new power plants for the period until 2025. For each of the three scenarios new thermal and hydropower capacities have been identified, as well as the year of the start of their operation. The table is actually a result of the optimization process in the WASP software tool, where the optimization is based on fully satisfying the needs for electric power, with minimum emissions related to electric power production and with minimum total costs (investments, fuel, and O&M costs).

Table 5.3.2.1. Dynamic of building new capacities for electricity production for the three scenarios

	BASELINE SCENARIO		FIRST MITIGATION SCENARIO		SECOND MITIGATION SCENARIO	
Year	Candidate	P (MW)	Candidate	P (MW)	Candidate	P (MW)
2008						
2009			Gas CC (CHP Skopje)	*234*		
2010	HPP Boskov Most	66	HPP Boskov Most	66	HPP Boskov Most	*66*
	TPP Bitola 4	209			Gas CC (CHP Skopje) 25MW (REN)	234
2011						
2012						
2013						
2014					25MW (REN)	
2015	HPP Galiste	194	Gas CC	*300*	HPP Galiste	194
	TPP Negotino coal	300				
2016			HPP Galiste	194	Gas CC	*234*
2017						
2018			HPP Cebren	280	25MW (REN)	
2019	HPP Cebren	280			HPP Cebren	280
2020	TPP Mariovo	209				
2021						
2022					Gas CC 25MW (REN)	*300*
2023			TPP Bitola 4	209		

According to the table, some proposals can be drawn as follows:

Using natural gas as a resource for electric power production. The maximum possibilities of the existing gas pipelines for electricity production are up to 4,000 GWh per year, or for building of two or three gas power plants with a total installed power of 700 MW. CHP Skopje which is under construction is the first one to start operating in 2009. The others should be built every five years in the following period, or in 2015 and around 2020.[6] With such a maximum utilization of the gas system the price of the natural gas can be reasonable for economical operation of the gas power plants.

The environmental effects of gas power plants are much more favourable compared to the environmental impacts from coal or oil-fired thermal power plants. The next table shows the GHG emission from thermal power plants in Macedonia compared to the gas CC power plants.

TPP Bitola	TPP Oslomej	TPP Negotino	Gas CC
(kg CO_2-eq / kWh)			
1,276	1,239	0,776	0,421

GHG emission from gas CC power plants is three times less than the same ones from TPP Bitola and TPP Oslomej, and around two times less than GHG emissions from oil-fired TPP Negotino. These environmental advantages of natural gas compared to lignite and oil without doubt should be the main attribute in favour of gas as a resource for electricity generation and for development of the electric power system in Macedonia.

[6] Two possibilities for the next gas power plants in Macedonia are taken into account: one of 234 MW installed power as the CHP in Skopje and the other one is 300 MW installed power, and both with no specific location. The tender documentation of ELEM is beyond the timeframe of the study, and the deadline of tender procedure is 2 July 2008.

Maximum use of the hydroelectric potential. All three scenarios take into consideration the maximum use of the hydroelectric potential in Macedonia. HPP Boskov Most[7] is the first hydropower plant which should start operating in 2010. The next ones, HPP Galiste and HPP Cebren[8], are planned to start operating after 2015.

Benefits of renewable sources. Renewable sources should be incorporated in the energy system continually without technical, social, or other limitations. In order to have a better implementation of the renewable sources some administrative and tax relief from legal aspects should be implemented, as well as ensuring the electricity output with guaranteed economic cost effective prices. Small hydropower plants and wind power plants should be based on private initiatives and investments which will be continually incorporated according to the locations and the interest of the market. The electricity production of small HPPs and of wind power plants strongly depends on hydrological and meteorological conditions and has a relatively small capacity factor of up to 20%. The low capacity factor cannot be a basis for energy planning, but it can contribute to reducing the operation of the conventional thermal and hydropower plants, and their effect is mainly at local level.

Energy efficiency as a strategy for energy saving. Energy efficiency is one of the main strategies for energy saving in developed countries and should become an imperative for Macedonia and for other developing countries. Energy efficiency is strongly related to the economic possibilities of the country as well as of the people. The technologically developed countries have significantly higher GDP and higher energy consumption per capita compared to Macedonia. It means that the developed countries have reached a high technological and economic level and can invest additional funds in reducing energy consumption.

Investments in energy efficiency projects require great funds, which mean that it may not be cost effective for old technologies or capacities. Energy efficiency by the consumer can be implemented mainly in the heating sector, industry (through energy saving with zero-cost, reducing the temperature in the premises, etc.). In the electricity sector, the contribution to energy efficiency can be made by reducing the electricity consumption by investing in more efficient electrical appliances as well as by replacing the old light bulbs with better ones. An additional imbalance of energy resources used for heating can be made with economically reasonable prices of fuels, in order that the consumers have a choice between different energy resources.

Nowadays, energy efficiency as a strategy is based on private initiatives and individual decision making by the consumers, and cannot be a general and obligatory requirement for all consumers, because it depends on the economic possibilities.

The measures which can contribute to GHG emission reduction in the electric power sector in Macedonia are listed in Table 5.3.1.2.

[7] The planning period for Boskov Most according ELEM is 2012 because of delaying of tender documentation.

[8] According to the development plan of ELEM HPP Cebren and HPP Galiste are being planned for 2014 and 2015 respectively, and in this study they are planned for operation after 2015. This is correct, real, and acceptable when taking into consideration the real possibilities and the uncertainties in hydro-planning (tender and technical documentations, building delay of such projects, financial and technical problems, etc.).

Table 5.3.1.3 Measures for GHG emission reduction in electric power sector

	Target	Objects / Investment	Type	Involved subjects	Timeframe	Finances	Environmental effects	Comments
1	Finalizing the law frame in the energy sector	Opening an electricity market for big consumers	Administrative	Government of RM, Ministry of Economy	In parliamentary procedure			Incorporation of renewable sources in the energy sector in accordance with EU regulations
2	Ensuring stability in energy supply with continual coal (lignite) supply to the existing thermal power plants in Bitola and Oslomej		Technical Energy, Economic	Government of RM, Ministry of Economy, ELEM				
		Brod Gneotino			Activities have started	€100 million		Especially important for continual fuel supply to TPP Bitola
		Underground mines of Suvodol			Middle term up to 10 years			Especially important for continual fuel supply of TPP Bitola
		Popovjani mine			Short-middle term up to five years			Especially important for continual fuel supply of TPP Oslomej
		Mariovo mine			Middle term up to ten years			Considering the possibility of building a new TPP Mariovo
		Importation of coal (lignite)			Activities have started	€30 /tonne	Possibility for more energy efficient and environmentally more suitable resource	- Ensuring fuel supply for the existing TPP Bitola and Oslomej. - Transport limitations for big amounts.
3	Ensuring stability in energy supply with investment activities for building new big hydropower plants		Technical Energy, Economic	Government of RM, Ministry of Economy, ELEM			No GHG emission ; Obligatory EIA	Big investments in capital projects with serious financial investors
		HPP Boskov Most		Concession, Private investors	Short-middle term up to five years; - Tender procedure in progress	€70 million		
		HPP Galiste		Concession, Private investors	Middle term up to ten years; - Tender procedure	€200 million		
		HPP Cebren		Concession, Private investors	Middle term up to ten years; - Tender procedure	€320 million		

	Target	Objects / Investment	Type	Involved subjects	Timeframe	Finances	Environmental effects	Comments
4	Ensuring stability in energy supply with investment activities for building new thermal power plants run on gas		Technical Energy, Economic	Government of RM, Ministry of Economy, ELEM	Short-middle term		Reducing the GHG emission with gradual introduction of gas in the thermal power plants	- Ensuring enough amounts of gas for two or three gas power plants with total installed power from 500 to 700 MW, for which 600 million Nm^3 gas annually are necessary - Strategic and long-term contract with gas suppliers for continual supply are necessary
		CHP Skopje 230 MW		AD Toplifikacija Skopje	Under construction	€135 million		The necessary amounts of natural gas have been provided
		CC gas (200-300 MW)		Government of RM, Ministry of Economy, ELEM	Middle term up to ten years	€250 million		Strategic and long-term contract with gas suppliers for continual supply are necessary
5	Increasing the share of renewable sources in the energy sector		Technical, Energy, Stimulating for sustainable development	Government of RM, Ministry of Economy, Local self-government	Short-middle term		No GHG emission	- Attracting foreign and domestic potential investors. Animation of the interested subjects with favourable legal regulations and other relief. There have already been tariffs introduced for guaranteed and economically suitable disposal of the produced electricity from small HPPs, wind power plants, and biomass. - Possible financial mechanisms: carbon financing and credits through the Programme for Sustainable Energy Development
		Small hydropower plants		Concession, Private investors	Continual construction process	€1500 /kW		The tender procedure for 60 small HPPs has already been finished. There are expectations for building small HPPs in the next few years with total installed power of 43 MW.

	Target	Objects / Investment	Type	Involved subjects	Timeframe	Finances	Environmental effects	Comments
		Wind power plants		Concession, Private investors	Continual construction process			Pilot projects and initial activities of measurements for wind speed in some locations have been started. The results of the decision for investments are expected in a few years.
		Solar thermal and PV panels		Private investors and initiatives, Stimulations from the Government	Continual construction process			- Governmental stimulation in financial support for thermal solar collectors. Other similar initial financial supports for private investments are necessary. - Reduced VAT
6	Improvement of the energy efficiency		Economic, Energy, Stimulating for sustainable development	Enterprises, Institutions, Households	Middle-long term		Saving energy and reduced GHG emission	- Building plants for production of combined heat and electrical energy (CHP). - Measures for reducing the losses in transmission and distribution of electricity. - Measures by the electricity consumers by introducing more efficient light bulbs, more efficient electrical appliances, etc. - Animation of the interested investors with favourable legal regulations and tax relief.

5.3.2. Industrial Energy Transformations and Heating

There are a series of measures identified in the segments of industrial energy transformations and heating, which would contribute to energy savings or would improve the energy efficiency, and, as an ultimate result, a certain reduction of the GHG emission would be achieved. The measures are classified according to the objectives that should be achieved in order to make reduction of the GHG emissions from the sector of industrial energy transformations and heating: reduction of the use of carbon intensive fuels, improvement of the energy efficiency and energy saving, increasing of the contribution of renewable energy sources in the country's energy balance, introduction of economically viable prices of electricity, and raising the awareness of the final consumers. Some of the measures that would give visible results are presented in Table 5.3.2.1.

Table 5.3.2.1 Measures for GHG emission reduction in the industrial energy transformations and heating sector

	Goal	Action	Type	Involved subjects	Timeframe	Financing	Comments
1	Reduction of the use of carbon intensive fuels	Replacement of coal with liquid or gaseous fuels; replacement of liquid fuels with gaseous fuels	Technical, economic, regulatory	MOEPP, ULSG, Industrial subjects, Subjects in the public sector	Short-middle term	Possibility for carbon financing and loans through the Programme for renewable energy	Issuing permits for adjustment of the installation in line with operational plans and integrated environmental permits.
2	Improvement of the energy efficiency and energy saving	- Improvement of the energy efficiency of the boiler plants with permanent maintenance; - Replacement of old equipment in boiler rooms, with regular reconditioning work; - Installation of measurement-regulation equipment and automatic control systems; - Better insulation, maintaining clean heat exchanging surfaces; - Utilization of heat content in flue gases; - Reduction of losses in systems for transportation of fluids; - Heat insulation of pipelines for transport of water, steam, fuels, etc.; - Reduction of specific consumption of energy in the industry by introduction of up-to-date technologies and processes; - Improvements of the performances of thermal cycle; - Improvement of the standards for construction of buildings, better insulation, use of high quality materials	Technical, economic, regulatory	MOE, Energy Agency, MOEPP, MOTC, ULSG, Industrial subjects, Heating plants	Short-middle term	Possibility for carbon financing and loans through the Programme for Renewable Energy; programmes with support of donors community	Investments are favourable, also, from the economic aspect. There is significant potential for GHG emission reduction in this segment.

	Goal	Action	Type	Involved subjects	Timeframe	Financing	Comments
3	Increasing of the contribution of renewable energy sources in the country's energy balance	- Utilization of waste biomass as an energy source and as a raw material for production of briquettes and pellets; - Installation of tens of boiler units on waste biomass in the agro-industry complex, industry sector, and in households; - Rehabilitation, and expanding of the geothermal system Geoterma-Kocani; - Revitalization of other systems on geothermal energy; - Introduction of solar energy systems for heating and hot water supply (in hotels, hospitals, schools, public buildings, health resorts, etc.)	Technical, economic, organizational	MOE, Energy Agency, MOEPP, MOTC, ULSG, Industrial subjects, Public enterprises, Households	Short-middle term	Possibility for carbon financing and loans through the Programme for Renewable Energy	Substitution of firewood with waste biomass, which will contribute to an increased sequestration
4	Introduction of economically viable prices of electricity	- Harmonization of the prices between different kinds of energy	Regulatory	Regulatory commission for energy	Middle term		
5	Awareness raising of the final consumers	- Reduction of electrical energy consumption in the households with measures of energy saving (home electrical appliances) and/or with replacement of electrical energy use with fuels or alternative energy sources; - Introduction of measurement equipment and charging in accordance with the consumption	Organizational	MOEPP, MOE, Energy Agency, NGOs, Media	Continuous	National budget	

5.3.3. Transport

There are a series of measures of a technical-technological, financial, and institutional character, which would result with certain reduction of the GHG emissions from the activities in the transport sector. The measures are classified in accordance with the planned objectives: improvement of the overall efficiency in the transport sector and energy efficiency of the vehicles, improvement of the public urban and inter-city transport and harmonization of the national legislative, regarding the transport sector, with European Union legislation. Some of the measures, which are, more-or-less, appropriate to the circumstances in Macedonia, are listed in Table 5.3.3.1.

Table 5.3.3.1 Measures for GHG emission reduction in the transport

	Goal	Action	Type	Involved subjects	Timeframe	Financing	Comments
1	Improvement of the overall efficiency in the transport sector and energy efficiency of the vehicles	- Revitalization, extension, and better maintenance of the road and railway infrastructure; - Extension-spreading of the electrification of the railway network; - Modernization of the vehicle fleet; - Motivation for wider use of alternative fuels and other power systems (LPG, CNG, bio-diesel, hybrid vehicles, etc.)	Technical, economic, legislative	MOTC, MOE, MOEPP, Institutions, Public and private enterprises, Citizens	Middle term, continuously	- National budget; - Budget of the municipalities; - Finances from the enterprises; - Foreign donations	Application of relevant European standards
2	Improvement of the public urban and inter-city transportation	- Improvement in the planning, organization and control of the traffic; - Measures for regulation of the traffic in central urban areas; - Modernization of the transport equipment for the public traffic; - Synchronization of the road signalization in the towns; - Introduction of electronic pay toll charging; - Introduction of electrically driven types of transport, i.e. tramway; - Railway transport – electrification of the railway network	Technical, economic, regulatory	Fund for national and regional roads, MOTC, MOE, MOEPP	Middle and long term	- National budget; - Budget of the municipalities; - Finances from the enterprises (public and private); - Foreign donations	Improvement of the public urban and inter-city transportation system is a basic condition for decreased use of cars in the urban and other areas, which is the main precondition for achievement of significant reduction of GHG emission from this sector
3	Harmonization of the national legislative, regarding the transport sector, with European Union directives	- Regulation on fuels quality in accordance with European Union norms	Legislation	MOE, MOTC, MOEPP, Legislative institutions, Other institutions	Short-middle term		Besides the necessity in the process of approximation towards EU integration, these measures contribute to the mitigation of GHG emission

5.3.4. Waste

This study takes into account current situation, conditions, and indicators comprised within the National Waste Management Plan. The improvements that will follow the adaptation of the Solid Waste Management Strategy for the Republic of Macedonia are not considered. This strategy is expected to provide a sustainable management concept that will also introduce measures for waste selection and recycling, composting, and reduction of the deposited waste. In the absence of this strategy the GHG emissions can be estimated according to current situations and management practices at the landfills. The mismanagement of the landfills and the lack of technical interventions and protection often are the cause of firing and self-incineration of the landfill sites which will result in uncontrolled burning, generation of dioxins, furans, nitrous oxide, reduction of the methane collection, and will increase the risk of explosions. Selected landfills are not technically structured to deposit a higher layer of waste, which should be well compressed in order to enable better conditions for LFG generation.

The most important measures for GHG mitigation in the waste sector are summarized in Table 5.3.4.1.

Table 5.3.4.1 Measures for GHG emission reduction in the waste sector

	Goal	Action	Type	Stakeholders	Timeframe	Financing	Comments
1	GHG emission reduction at the existing landfills	- Technical improvement of the existing landfills - Installation of methane recovery and flaring systems at selected landfills	Technical	Public enterprises Local authorities	Short-medium term	Municipal budgets, carbon financing (CDM)	Technical improvement is necessary in order to set up methane collection systems. This refers to the larger landfills where the LFG collection is viable
2	Improvement of the possibilities for efficient methane collection	- Construction of regional solid waste disposal sites	Technical	Local authorities	Short-medium term	National budget Municipal budgets Foreign investments	The regional SWDS will assure concentrating the waste at single places, which will enable efficient methane collection.
3	Reduction of the nitrous oxide (N_2O) emissions.	Introduction and realization of legal measures for restriction of the economic activities that include uncontrolled burning of the waste	Legislation Regulation	MOEPP Local authorities	Short term		Restriction of the waste exploitation activities
4	Reduction of the methane emissions from the wastewater	Expansion of the wastewater treatment plant network	Technical	MOEPP Local authorities	Short-medium term	National budget Municipal budgets Foreign investments	This will slightly affect the GHG emission reduction. But it will provide protection of the surface water thus protecting the water flora and fauna.
5	Raising public awareness for restriction of the uncontrolled burning of the waste	- Realization of public campaigns - Enhancement of the inspection and implementation of penalties/ provisions	Public awareness	MOEPP Local authorities Non-governmental sector Media	Continuous	National budget Donations	Involvement of the public (media, NGO, units of the local authorities) is essential for increasing the awareness of the damage caused by uncontrolled burning of the waste.

5.3.5. Agriculture

In the Republic of Macedonia there are scarce analyses for the GHG emission reduction in the agricultural sector. According to the previous analysis, there is a potential for emission reduction, but mobilization of the scientific and research stuff is necessary to identify the possible solutions.

This report provides a partial solution for manure management at animal farms (particularly pig farms).

As for emissions from other sources in the agricultural sector, several solutions are recommended for their reduction, which will target the future research analyses in this sector.

For example, methane emission from enteric fermentation can be reduced by increasing production by animal head, manipulation of dietary composition to minimize bacterial activity in the rumen, then with feed additives, antibiotics, vaccines, etc.

As additional measures that can be suggested in order to reduce the emissions of CH_4 and N_2O from manure management are: adjustment of the diet of animals to increase the amount of N_2O excreted in the manure at the cost of the urine, proper storage, manure combustion, utilization of the animal manure in the winter, etc.

Agriculture also has a great potential to answer the problem of CO_2 emissions from transport by growing oil crops for bio-diesel production and crops for bio-ethanol production.

Table 5.3.5.1 summarizes the main measures for mitigation of the GHG emissions in agriculture.

Table 5.3.5.1 Measures for GHG emission reduction in the agricultural sector

	Goal	Action	Type	Stakeholders	Timeframe	Financing	Comments
1	Enabling favourable pre-conditions for GHG emission reduction (laws, bylaws, institutional measures, support measures)	Approximation of legislation in agricultural sector with EU CAP	Policy Legislation	MOAFWE	Short term	National budget Foreign donations	Better access to EU funds and agricultural products more marketable
		Completion of institutional and legal reforms in irrigation sector	Policy Legislation	MOAFWE	Short term	National budget Foreign donations	Water communities and water management organizations fully operational.
		Increasing of the institutional and individual capacities for application of the available EU funds	Capacity building	MOAFWE	Short term	National budget Foreign donations	IPARD programme is adopted and there is a risk that the means will not be realized due to the lack of capacity
		Development of legislation and system for application of Good Agricultural Practices in the country	Policy Legislation	MOAFWE	Short term	National budget Foreign donations	Good Agricultural Practices can be a useful tool for reduction of GHG emission on the farm level
		Financial support for motivating the farmers to use mitigation technologies	Financial incentives	MOAFWE	Short-medium term	National budget Foreign donations	Farmers use mitigation technologies with economic benefit
2	Introduction/ development of GHG mitigation technologies in agriculture	Installation of methane recovery and flaring systems at selected farms	Technical	MOEPP MOAFWE Public enterprises Local authorities Farms	Short-medium term	Foreign investments Municipal budgets Agriculture support mechanism Carbon financing	Application of this technology will have significant effect on reduction of GHGs
		Research support programme for development of new mitigation technologies and transfer of the existing ones	Research	MOES MOAFWE MOEPP Foresting donation Research community	Short-medium term	National budget Foreign donations EU Research programmes	Allocated budget and developed system for support of projects that develop or upgrade mitigation technologies
		Programme for introduction of practices that use agriculture's potential for renewable energy and carbon sequestration, Programmatic CDM projects	Development	MOAFWE MOEPP MOE	Short term	National budget Foreign donations Private investments Carbon financing	Possibility for implementation of mechanisms for carbon emission reduction
3	Strengthening the national and local capacities for carbon financing	Training for CDM potential in agriculture Training for preparation of CDM documentation		MOEPP NGOs	Medium term	Foreign donation Bilateral projects	

4	Education (of experts/farmers/ decision makers) for application of mitigation measures/ technologies in agriculture	Current curricula and syllabuses upgraded with CC mitigation issues	Education	MOES Universities Vocational schools	Short-medium term	National budget Foreign donations	Students informed about CC mitigation issues and trained to scope problems
		Training of farmers for adopting new technologies	Education	MOAFWE Agency for development of agriculture Educational institutions	Short-medium term	National budget Foreign donations	A training system for farmers is planned through the Strategy for Agriculture and Rural Development 2007-2013
		Familiarization of public and institutions with the problem of CC mitigation	Public awareness	MOAFWE MOEPP NGOs Relevant scientific and educational institutions	Short-medium term	National budget Foreign donations	Public, especially the decision makers and agricultural producers, are not familiar enough with climate change issues

5.3.6. Forestry

Forestry is the only sector that acts like a carbon sink. Therefore, one of the measures for GHG emission reduction in this sector is afforestation. The Ministry of Agriculture, Forestry, and Water Economy has an approved budget of 160,000,000 MKD (€260,000) for 2008 to finance: afforestation of bare lands and coppicing; afforestation of bare land and erosive soils and melioration of degraded forests and coppice; sanitation of burned forest areas and prevention of mass oak forest dieback process; care; preventive protection from insect calamities and diseases and providing seedlings for forestation.

Forest fires are one of the most negative current factors in both Europe and the World, reducing forest areas and their health condition. Motivated by catastrophic national forest fires in 2007, several mass forestation national events have been organized in the last couple of years (on 12 March 2008, more than two million seedlings, equalling the number of citizens in the Republic of Macedonia, were planted in one day).

According to development plans of the Ministry of Agriculture, Forestry, and Water Economy, measures for GHG emission abatement are presented in Table 5.3.6.1.

Table 5.3.6.1 Measures for GHG emission reduction in the forestry sector

	Goal	Action	Type	Stakeholders	Timeframe	Financing	Comments
1	Implementation of the National Strategy for Sustainable Forestry Management	Encouraging afforestation	Policy Technical	MOAFWE PE Macedonian Forests	Continuous	National budget Foreign donations	Prospects for carbon financing
		Fire prevention measures	Policy Legislation Public Awareness	MOAFWE PE Macedonian Forests Inspectorate	Continuous	National budget	
		Measures for prevention of illegal logging	Legislation Public Awareness	MOAFWE PE Macedonian Forests Inspectorate	Continuous		Strengthening of penalties

5.3.7. Prospects for Implementation

The proposed measures/practices/projects/interventions in each of the sectors can be treated as the National Action Plan for climate change mitigation from a technical point of view (technical actions). However, in the wider sense, the National Action Plan also defines country-specific instruments, which will enable implementation of the proposed direct measures (economic and fiscal instruments; regulations and standards; voluntary agreements; information and public awareness; research and development).

One positive example from the national legislation is the Law on Environment, which includes commitment for preparation of national inventories of GHG emissions, as well as an action plan on measures and activities to abate the increase of GHG emissions. Furthermore, as a strategic document of primary importance, there is the National Strategy for Clean Development Mechanism (CDM) for the first commitment period of the Kyoto Protocol 2008-2012. The goal of the National CDM Strategy is to facilitate transfer of investment and technologies through CDM for implementation of projects that reduce GHG emissions and contribute to Macedonia's national sustainable development priorities.

Principally, the "non-technical" actions of the national climate change mitigation action plan, in fact, provide linkages and diffusion of the climate change mitigation objectives into all the other relevant national policies (energy, industry, transport, agriculture, forestry, environment, waste management, etc.). This will certainly enable implementation of the technical measures/practices/projects/interventions proposed under the mitigation scenarios developed within this study.

OTHER RELEVANT INFORMATION

6.

6. OTHER RELEVANT INFORMATION

6.1. Transfer of Technologies

From a climate change perspective, technology transfer entails identification and evaluation of technologies, practices, and reforms that might be implemented in different sectors of a country to reduce GHG emissions and climate vulnerability (referred to as "mitigation technologies"). These technologies and practices are well suited to the needs of development in its broadest sense, since many of them, being developed in response to the needs of mitigation, especially renewable energy and energy efficiency, are now proving to be economically important sources of supplying and utilizing energy efficiently. Therefore, technology transfer is of high importance not only in the context of the UNFCCC, but also from the country developmental perspective.

When selecting country-specific mitigation technologies for economic and environmental evaluation, two criteria were taken into account: the prospects for implementation under national conditions and the existence and availability of relevant studies and other materials providing input data for the evaluation.

Thus, the selected sixteen mitigation technologies include: (1) introduction of liquid fuel into power generation; (2) new hydropower at Boskov Most; (3) Mini-hydropower, four plants of 1 MW; (4) wind power plants; (5) landfill gas power plant; (6) geothermal heating for greenhouses and hotels in Bansko; (7) biogas from sewage water and animal manure in small agricultural industries; (8) grid-connected photovoltaic systems; (9) solar heater for hot water in individual houses; (10) efficient air conditioning; (11) efficient refrigerators; (12) large solar heaters for hot water in public buildings and industry; (13) efficient office lighting; (14) efficient motors; (15) efficient boilers; and (16) replacement of bus diesel engines.

6.1.1. Economic and Environmental Evaluation

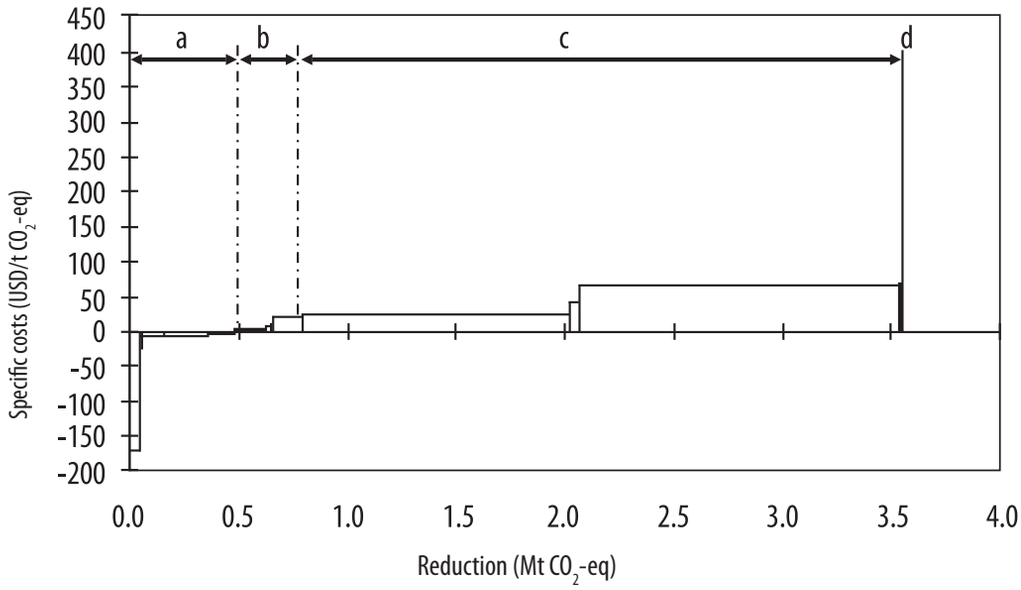
By applying the evaluating model GACMO, specific costs (USD/t CO_2-eq) and environmental effectiveness (reduced tonnes CO_2-eq) of the selected mitigation options were determined (Table 6.1.1.1.). The basis for the mitigation analysis is a baseline scenario for GHG emissions from the base year (2000) to the target year, which is 2010 (mid-year of the first Kyoto commitment period).

Table 6.1.1.1. Costs and environmental effectiveness of the mitigation measures

Mitigation option	Specific costs (USD/t CO_2-eq)	Unit type	Emission reduction (t CO_2-eq per unit)	Units in 2010	Emission reduction in 2010		
						Cumulative	
					Per option Mt/year	Mt/year	Percentage of baseline emissions in 2010
Geothermal heating	-187.15	1 unit	2,269.34	1	0.0023	0.0023	0.01%
Replacem. bus diesel engines	-171.49	1 bus	22.75	2,000	0.0455	0.0478	0.27%
Efficient lighting	-24.98	1000 bulbs	87.60	200	0.0175	0.0653	0.36%
Efficient refrigerators	-8.63	1 refrigerator	0.58	150,000	0.0876	0.1529	0.85%
Hydropower (Boskov Most)	-4.09	1 plant	202,195.87	1	0.2022	0.3551	1.97%
Efficient motors	-3.22	1 kW	0.78	25,000	0.0194	0.3745	2.08%
Landfill gas power	-2.85	1 plant	112,232.58	1	0.1122	0.4868	2.70%
Wind turbines	4.16	1 MW	2,872.98	50	0.1436	0.6304	3.50%
Mini-hydropower	7.21	4 MW plant	12,423.71	1	0.0124	0.6428	3.57%
Large solar heater	11.70	1unit	62.16	200	0.0124	0.6553	3.64%
Resid. solar water heating	19.35	1 unit	1.32	100,000	0.1320	0.7873	4.37%
Liquid fuel in power generat.	22.71	1 plant	1,238,139.75	1	1.2381	2.0254	11.25%
Biogas from agro-industry	43.21	1 digester	11,699.89	3	0.0351	2.0605	11.45%
Efficient indust. boilers	63.93	2 tonnes steam	29,652.40	50	1.4826	3.5431	19.68%
Air con. (residential)	70.51	1 air conditioner	0.16	60,000	0.0094	3.5525	19.74%
PVs connected to electric grid	398.22	1 kW	1.10	500	0.0006	3.5531	19.74%

The mitigation scenario combines the emissions from the baseline scenario with the changes (reductions) in emissions introduced by the various mitigation options being evaluated. A unit type for the new technology has been defined, along with the penetration rate of the mitigation technology in the country.

The combined representation of reduction/cost indicators is shown by a marginal cost mitigation curve (Figure 6.1.1.1), with the achievable reduction in the horizontal axis and the specific cost of the mitigation options in the vertical axis.



a: win-win implementation <0 USD/t; (measures: 6, 16, 13, 11, 2, 14, 5)
b: small specific costs 0-20 USD/t; (4, 3, 12, 9)
c: medium specific costs 20-70 USD/t; (1, 7, 15)
d: high specific costs >70 USD/t; (10, 8)

Figure 6.1.1.1. Marginal cost curve for the considered mitigation measures

The total achievable reduction (if all considered options are implemented with the assumed breakthrough rate) in 2010 is estimated to be 3.55 Mt CO_2-eq, which is 19.74% of the baseline emissions. The application of efficient industrial boilers (annual reduction of 1.48 Mt CO_2-eq) and the introduction of liquid fuel in electricity production (annual reduction of 1.24 Mt CO_2-eq) are the greatest contributors to the overall emission reduction.

The most cost effective option appears to be the application of geothermal energy in greenhouses and hotels followed by the replacement of old bus engines with more efficient ones, having high negative costs as a result of the very poor performances of the old engines. On the other hand, PVs connected to an electric grid is by far the most expensive option due to the present high initial investments. The largest portion of achievable reduction can be realized at a price of between 20 and 70 USD/t CO_2-eq.

6.1.2. Prospects for Transfer and Diffusion of Technologies

The economic and environmental evaluation of the selected country-specific mitigation options, along with the analyses of the emerging barriers and possibilities for their overcoming, leads to the following concluding remarks:

- Typical for Macedonia's conditions is the so-called win-win implementation, as almost half of the considered mitigation options have been shown to have negative specific costs. However, their environmental effectiveness is relatively low, with cumulative potential to reduce the total baseline emissions by 2.7%. These options are a good starting point for promotion and reinforcement of mitigation technologies and practices. The rationale behind this is the full compliance with the leading role of the economic criteria in the decision making. Still, the problem of finding financial sources for initial investments remains to be resolved.
- The present status of technologies used in the energy and industry sectors is far from being satisfactory. The prolonged transitional period has caused delay in accepting contemporary and environmentally favourable technologies. The situation is even worse since the harmful effects of the outdated technologies, as well as of the poor, inadequate, or even neglected maintenance of the equipment, have not reached their real size due to the substantial reduction in the industrial and similar activities during the transitional period.
- The need for quick and almost general replacement of the existing technologies with contemporary ones, characterized by lower energy consumption, improved productivity, lower emission of pollutants, and closed loop cycles is evident. The main constraint against this is the lack of domestic capital to be invested and the absence of foreign investors.

- Macedonia lacks a supportive infrastructure for successful technology transfer. This problem becomes more acute in going from personal to institutional and finally, to the systemic level. At the personal level, the available human resources are not enough and there is a need for training and other types of improving the existing skills and knowledge. Appropriate awareness-raising activities should be undertaken in order to modify the behaviour of the stakeholders, their attitudes towards the new technologies, as well as the criteria according to which their decisions are adopted. The stimulation of demand of energy services when more efficient technologies are applied is not an issue, since in countries such as Macedonia, the energy prices are still considered as social categories. Institutional and systemic capacity building would create the possibility to establish supportive institutions and to design, implement and enforce policies for technology transfer, as well as to monitor their results. It is particularly important to incorporate the technology transfer as a parameter in all policies considered to be a primary priority in the country.
- Efficient transfer and diffusion of technologies would presumably be realized with considerable participation of the private sector by establishing and strengthening national companies that would finance and conduct the introduction of new technologies.

6.2. Systematic Observation

Initial sporadic measurements and observation of meteorological elements in the country started in 1891 in Skopje. A network of meteorological and hydrological stations was established in the 1920s, when organized systematic hydro-meteorological measurements and monitoring started.

Monitoring and research activities of the climate-meteorological and hydrological parameters in the country are performed by the Hydro-Meteorological Service (HMS) within the Ministry of Agriculture, Forestry, and Water Economy. The meteorological observation system in the country consists of 14 main meteorological stations (of which two are airport meteorological stations), 19 regular climatological stations, 26 phenological stations, one aerological station, six hail-suppression centres, and about 200 precipitation stations as well. There are also two automatic stations installed in Gostivar and Skopje-Zajcev Rid. Twenty-seven meteorological stations in the country provide different types of meteorological reports as part of the World Weather Watch, and according to the publication of the World Meteorological Organization – *Reporting Stations Vol.1* five measuring sites of the meteorological stations network are part of the Regional Basic Synoptic Network, five measuring sites are a part of the Regional Basic Climatological Network, and the station at Lazaropole has the status of station in the Global Climate Observing System network. Depending on the rank as well as working programme of the meteorological stations, in accordance with international standardized procedures and recommendations, measurements are performed for: air temperature and humidity, air pressure, wind speed and direction, evaporation, insolation, soil temperature, precipitation, atmospheric conditions, and air quality. In order to determine the climate system and its components the following research is being included: meteorological-climatological elements and phenomena, agrometeorological elements and phenomena, hydrological elements of surface and ground water as well as elements in the field of water, air, and soil quality. However, the series of data are very often inhomogeneous, with lots of gaps due to problems with measuring equipment, data processing, etc.

The HMS also monitors surface and groundwater quantities. Surface water resources are monitored at 110 gauging stations (out of which 68 are active) and 115 measuring points (out of which only 38 are active) are used to monitor the ground water. At 54 gauging stations on rivers, discharge and water level are monitored (45 stations in the River Vardar basin, nine in the River Crn Drim basin, and three stations in the River Strumica basin). On each of the three natural lakes, Ohrid, Prespa, and Dojran, there is one gauging station for monitoring the water level. Monitoring of the ground water started in 1949 in Skopje and its environs, and after two decades it was extended to other regions (Pelagonija, Polog, and Strumica) in Macedonia. Due to budget reduction, this monitoring process was stopped and presently there is no systematic quantity and quality monitoring of the ground water in the country. This is the weakest point in the Macedonian monitoring system.

Monitoring of hydrological parameters includes: measurements of hydrological parameters; permanent monitoring of surface and groundwater levels; monitoring of sediment in rivers and lakes; monitoring of water temperature in rivers and lakes; data control, updating and archiving in hydrological database; public informing and warning on development and appearance of hazardous hydrological phenomena, etc. According to the Law on Hydro-Meteorological Works (*Official Gazette of the Republic of Macedonia* Nos. 03/1994 and 05/2003) the hydro-meteorological data are public and the HMS is obliged to publish them in annual reports. This, however, is not being done. Hence, specific data needed for research or projects are not always readily available, which is the main barrier to conducting more complex analyses.

The quality of surface water is also monitored by HMS. Regional institutes for health protection monitor surface waters within their competences. The monitoring network comprises 20 measuring points located on rivers, lakes, and reservoirs. Quality control relates to analyses of physical-chemical, toxic-chemical, and microbiological parameters. Water quality monitoring of lakes Ohrid, Prespa, and Dojran regarding physical-chemical parameters and bacteriological analysisis performed by the Republic Health Institute. Detailed monitoring of physicochemical and microbiological parameters of the lakes Ohrid and Prespa is performed by the Hydro-Biological Institute from Ohrid. Industrial and domestic waste water are controlled periodically. Also, monitoring of chemical and toxicological water pollution and radiological and biological analyses are carried out periodically.

In 2000 the River Monitoring System in Macedonia (RIMSYS) project was started, funded by the Swiss Agency for Development and Cooperation with an additional Macedonian contribution. The aim of this project is to support the Macedonian authorities in strengthening their capacity to document long-term changes in water pollution and the hydrological regimes of the country's most important rivers. RIMSYS's first phase, in 2000, had the objective of improving the monitoring system on rivers with installation of 18 river monitoring stations and the environmental laboratory at the HMS.

Regarding air pollution, monitoring includes: air quality monitoring; measuring of stationary sources emission; monitoring and assessment of trans-boundary, long-range distribution of air pollutants; monitoring of those pollutants which have a great impact on human health. The air quality monitoring has been performed by the Ministry of Environment and Physical Planning, the HMS, the Republic Health Institute, and its regional

organizations, as well as by the bigger industrial capacities. The National Automatic Monitoring System performing air quality and meteorological measurements under the responsibility of the MOEPP consists of 13 fixed monitoring stations, one mobile station, and one fixed station for urban traffic air pollution monitoring. In Skopje, since 1998, four automatic air quality monitoring stations have been installed for measuring the following parameters: SO_2, NO_2, NO_x, NO, CO, O_3, PM10/opt, PM2.5 (PM – particulate matter), and also the meteorological parameters: wind speed, wind direction, temperature, pressure, humidity, and global radiation. Starting from 2002 additional three monitoring stations have been installed in Kocani, Kumanovo, and Kicevo and since 2003 an additional six monitoring stations have also been installed (two stations in Veles, two stations in Bitola, one station in Tetovo, and one station in the rural monitoring place/village at Lazaropole placed at the top of the mountain for trans-boundary air pollution monitoring according to the EMEP Programme). The mobile station is planned for covering the territory without fixed monitoring stations. The monitoring station for traffic air pollution has been installed at heavy traffic concentrations in the centre of the city of Skopje near the University Library 'Kliment Ohridski'. The results of monitoring are transmitted via a telecommunication network to the central station in the Environmental Information Centre within the Ministry of Environment and Physical Planning. The values of the particular polluters are presented on the webpage of the MOEPP and through other kinds of reports.

There are 19 stations under the air-monitoring network established by the HMS (nine of the stations are placed in Skopje), mainly monitoring SO_2 and black smoke. The Republic Health Institute also has an air monitoring network with ten measuring sites in Macedonia, mainly monitoring SO_2 and black smoke, CO, dust and trace metals, air sediment. There are four measurement points for heavy metals in air sediment as well as seven measurement points for black smoke and CO_2, and one point for lead and CO.

6.3. Research and Development

The scientific community in the country is permanently interested in taking part in research related to measures for mitigation of climate change, adequate adaptation to climate change and other related issues.

The Research Centre for Energy, Informatics, and Materials of the Macedonian Academy of Sciences and Arts (ICEIM-MANU) has been acting in the field of climate change for more than a decade. The main activities include preparation of the National Inventory of GHG Emissions and Mitigation Analyses for the purpose of the National Communications under the UNFCCC. In particular, ICEIM-MANU deals with climate change and energy issues, including environmental and economic evaluation of energy technologies, as well as developing mitigation scenarios for the national energy systems development. One of the ICEIM-MANU members has been nominated as national focal point of the Intergovernmental Panel of Climate Change (IPCC), contributing to the work on mitigation analyses from a perspective of developing countries and countries with economies in transition. Also one of the ICEIM-MANU members was involved in the study group of the World Energy Council (WEC) which prepared the publication 'Energy and Climate Change' (WEC, 2007).

There is an ongoing scientific bilateral research project titled as 'Meeting the Increased Irrigation Demand as a Result of Climate Change' at the Faculty of Civil Engineering, funded by the Macedonian Ministry of Science and Education, and the Slovenian Research Agency. The aim of the project is to define the water management practices and measures for modernizing of irrigation systems in order to meet the increasing irrigation demand as a result of a climate change. Another ongoing regional project related to the water resources sector 'Interdisciplinary Assessment of Water Resource Management in Two Trans-boundary Lakes in South-East Europe (DRIMON)' carried out by the experts from the Institute of Agriculture Skopje, financed by the Norwegian Research Council. Through a comparison – or twinning exercise, in which data and experiences within both natural and social sciences from three lake basins (Lake Prespa and Lake Skadar in the Balkans and Lake Vansjø in Norway) – the project is intended to increase the knowledge base and dialogue among stakeholders for improved trans-boundary management of water resources in the Balkan area.

The Faculty of Agricultural Sciences and Food of the Ss Cyril and Methodius University is conducting a regional project Education, Research, and Training for Global Environmental Change and Sustainable Management of Natural Resources in Western Balkans, financed by SIU, Norwegian Cooperation Programme on Research and High Education with Western Balkans Countries (2006-2010). The same institution is participating in the regional project related to global changes – INTERREG III B – CADSES Project, partially funded by the EU: 'Remotely Accessed Decision Support System for Transnational Environmental Risk Management – STRiM'. The Faculty of Forestry is also participating in the INTERREG III B Programme, in a project titled 'Rick Management, Disaster Management and Prevention against Natural Hazards in Mountain/Forest Regions'. This project addresses soil erosion caused by water and torrential flows in mountainous regions, as well as the expected increase of rainfall intensity due to climate change. The Faculty of Agricultural Sciences and Food has completed several international projects related to the increase of irrigation water use efficiency and environment protection financed by IAEA, UNESCO, SCOPES, etc. It is expected that these projects will contribute to an increased level of know-how and better level of expertise for adaptation to climate change.

Within the Faculty of Mechanical Engineering, a Centre for Climate Change and Energy Technologies has been established, aimed at research, application, and transfer of new energy technologies in fields related to UNFCCC and the Kyoto Protocol. Also the Faculty of Mechanical Engineering is a host institution of the Centre for Cleaner Production, created recently with the support of UNIDO.

The Faculty of Technology and Metallurgy and the MOEPP jointly participated in the EU FP6 project related to eco-houses and innovative eco-efficient materials.

It can be concluded that under Macedonian conditions the **Research and Development** (R&D) becomes a decisive factor in all the efforts to limit climate change and its costs and negative effects to society and the environment. Moreover, the climate-change-related R&D is being built upon the following two elements: **translational research** (establishing/strengthening the partnerships of type academia-businesses, academia-policy-making, or even academia-businesses-policy-making) and **international cooperation** (in particular, participation in EU Framework Programme 7, where climate change is among the top priorities for cooperation).

6.4. Education and Training

In accordance with the findings from the Country Assessment Report on Climate Change issues under the project 'On the Road to Montreal 2005: Intergovernmental Meeting under UNFCCC (COP11) and the Kyoto Protocol (COP/MOP 1)' prepared by the Regional Environmental Centre (REC), education, public awareness, and training about climate change issues in Macedonia are at an insufficient level, although the process of preparing the First National Communication has contributed a lot to the raising of awareness among all relevant stakeholders. The environmental issues, especially climate change are not sufficiently present in the educational curricula of primary and secondary schools, as well as the universities. However, the relevant institutions and individuals are aware of the need to increase the coverage of these issues at all educational levels.

The primary and secondary schools' syllabuses determine compulsory and obligatory subjects of education. The topics of environmental protection and climate change that are included in school syllabuses are not studied as a separate subject, but mainly integrated within other sciences, such as geography, biology, and chemistry. Also, in various forms of optional activities, pupils are stimulated to participate in, and learn more, about environmental and climate change, such as by participation in quizzes, organizing drawing and essay contests, etc.

The MOEPP, in cooperation with the REC country office, since 2006 has been implementing activities as a part of the "Green Pack", a multimedia environmental education curriculum kit primarily intended for primary school teachers and their pupils. National experts were consulted to determine the level of information to be presented, both of regional and national contexts. Although as an optional activity for primary schools in the country, it is a very useful tool which makes pupils partners with the teachers in the accomplishment of various activities, discussions, role-playing, and decision making, all related to the environment and sustainable development. Also, the pack contains a chapter which addresses the climate change issues.

Further, some of the faculties are integrating climate change issues in their syllabuses, such as the postgraduate programmes at the Faculty of Mechanical Engineering, and the Faculty of Agriculture, as well as the Environmental Management Postgraduate Study at the South-East European University. National Focal Point, national experts, and project staff have given lectures at some of the faculties, in order to raise awareness about climate change, the Kyoto Protocol, and the mitigation options among students.

6.5. Public Awareness

The activities in public awareness have been implemented by various interest groups applying different means: the ministry itself, NGOs, as well as through activities of intergovernmental multilateral organizations (such as UNDP). Hence, in order to reach school children, the Climate Change Project Office produced calendar for 2006 and 2008, with pictures and ecological information for each day of the year and distributed to more than 100 schools throughout the country. In such a way, pupils learned more about endangered species, extreme events, but also were encouraged to behave environmentally friendly.

In cooperation with the publisher, in the last four years, the Climate Change Project Office has made available free copies of *Ekologija*, the local environmental magazine, to 115 schools throughout the country, particularly in rural areas. This activity contributed not only to learning more about climate change and other environmental problems, but also encouraged pupils to initiate activities to preserve the environment, to initiate afforestation, to collect waste, etc.

The MOEPP is a key governmental institution concerning awareness-raising activities implementation, especially through its Public Relations Office and through the climate change project office. The PR office of the MOEPP is a link between the ministry and the public. The basic principle of the PR office's activity is two-way communication with the public, i.e. provision of information for and receiving information from the public. The interaction between the government and the public may be fruitful and requires strong social support involving joint responsibility in approaching to and solving the problems in the area of environment. The public has got the right and the need to be informed of procedures related to public participation in environmental decision making and to have free access thereto. The enhanced access to information and public participation in decision making contributes to an improved quality of decisions and improved public awareness of environmental problems.

The MOEPP's PR office includes a library in the area of environment, thus enabling continuous cooperation with population. It responds to the interests of the public by offering domestic and foreign literature: books, magazines, reports, free brochures intended for public environmental awareness raising, CDs, video tapes, i.e. lots of publications with topics in areas closely related to the activity of the ministry.

In addition, by giving interviews to the journalists from different media as well as through the website of the ministry, all of the interested stakeholders can be informed about current and planned activities on climate change. The climate change project office, on the occasion of European mobility week in September 2007, provided 30 bicycles to the City of Skopje. The bicycles, for a very symbolic daily sum, will be rented to interested citizens. The aim of this pilot project is raising awareness among citizens for promotion of environmentally friendly transport, thus changing their behaviour in relation to mobility, and in particular the use of the private cars.

As a result of the extreme events worldwide, as well as global initiatives for raising awareness about climate change issues, local media devoted more space in reporting climate change effects at global and national levels. The daily and weekly press offer coverage of a number of articles related to climate change, Kyoto Protocol, and interviews with relevant national experts about the national context.

National experts participated at a number of broadcasting programmes on national TV and radio programmes. Special episodes of one very popular talk show (*Čumu* on the national station, TV A1 in 2006) was devoted to climate change, at which relevant experts explained possible risks in agriculture, forestry, and human health. The other national TV stations have also supported climate change interactive programmes by organizing energy and climate change-related debates, inviting the public to participate through live phone-ins.

National music radio stations, very popular among the youth population, in cooperation with the MOEPP and climate change office, also included a one-week briefer about climate change, broadcasting facts about global warming, possible impacts and called for action among population

for mitigating climate change. At the sixth CSO Fair – Forum of the Civil Society Organizations in Macedonia – attended by non-governmental organizations, ministries, and government institutions, UNDP organized a roundtable discussion on the same topic as the HDR 2007 with special focus on the climate change and human development issues in the context of Macedonia. A workshop for journalists from the main written and electronic media was also organized in Skopje, enabling the participants to better understand the issues presented at the HDR and thus inform the broader public in a more knowledgeable manner.

The MOEPP and the Climate Change Project Office periodically issue printed materials (brochures, educational booklets, picture-books) about environmental protection and climate change issues, or provide articles in popular school magazines. The main message conveyed is that from the earliest age, children should develop an environmental awareness, since environmental problems require a change in the mentality and habits of the population.

A number of public awareness campaigns were conducted, in cooperation with the PR office of the MOEPP, or with support of the local NGOs. Some of the activities were related to promotion of Earth Day, Car-Free Day, World Environment Day, etc.; through initiating afforestation of bare land, organizing roundtables and giving lectures, promoting cycling and public transport, as well as publishing educative brochures and cards. Under the sponsorship of the MOEPP, the Ministry of Culture, and the municipality of Ohrid, since 2001, the ECO (Ecology, Culture, Ohrid) festival has been organized each year upon the occasion of 5 June, World Environment Day. Supported by national Macedonian television, this festival brings together short world documentary films with an environmental background, including climate change issues.

Through the workshops organized as a part of the process of development of the Second National Communication and National Strategy on Clean Development Mechanism for CDM for the period 2008-2012 under the Kyoto Protocol, climate change-related events, distribution of technical and popular materials, climate change issues have become more understandable for the general population. Evident progress has been made with the national media publishing and broadcasting more articles and programmes on climate change. The ministry website (www.moepp.gov.mk) and the national climate change website (www.unfccc.org.mk) remain the most relevant national source of information, containing, *inter alia*, relevant documents at national, EU, and global levels, all reports and data about GHG emissions, scenarios for climate change at national level, vulnerability reports, mitigation strategy, etc.

NGO 'Front 21/42' in 2005 carried out a New Year campaign 'Happy New Tree!', which was supported by the climate change office, among other donors. The specific goal of the campaign was to motivate an active individual participation. In order to achieve this goal, greeting cards, printed on 100% recycled, chlorine-free paper, were packed together with Christmas tree seeds. Christmas tree seeds were chosen because they materialize the call to end the destruction and begin the reconstruction in the best possible timeframe. Four types of cards carried the New Year wishes: "We wish you pure water"; "We wish you friendly sun"; "We wish you fertile soil"; "We wish you clean air". And one slogan carried by all cards: "Happy New Tree!". Over 35,000 citizens received the awakening message and a total of 100 kg of Christmas tree seeds were distributed with the daily newspaper *Dnevnik*. In 2006 'Front 21/42' organized the Climate Change Awareness-Raising Caravan in four municipalities (Gostivar, Struga, Bitola, and Strumica). Within the Caravan the climate change poster exhibition 'North, South, East, West' was posted in these municipalities. Group school visits were organized and a promotional/educational brochure with a specific focus on climate change and Macedonia was published and distributed to the visitors. During 2007-2008 'Front 21/42' with financial support from the British Embassy in Macedonia work on the national climate change awareness-raising campaign 'Our Climate is Changing – So Must We!'.

The NGO Proaktiva from Skopje also is active in the field of environmental protection, particularly in promotion of renewable energies and energy efficiency; sustainable transport and promotion of sustainable development for mitigation of climate change. Some of the Proactiva's climate change-related projects, realized in the past years have been:

- Energy Efficient Municipality – realized in the municipality of Jegunovce and municipality of Suto Orizari. The main project activity is abatement of CO2 emission from public buildings through the following activities: three practical and three theoretical tuitions for energy efficiency; two practical and two theoretical tuitions for renewable energies; installation of two solar systems based on the principle "do it yourself" and enforcement of energy efficient measures in public objects.
- Implementation of a Bicycle Master Plan for the City of Skopje in Practice, focussed on: preparation of feasibility study for bicycles in cooperation with the City of Skopje – Traffic Department, ensuring coordination among relevant stakeholders that support the reinforcement of good governance principles in the transport management; marking of the city cycle paths and adaptation/construction of the paths and preparation, printing, and distributions of materials for raising public awareness (together with the City of Skopje, UN GEF, business sector, and other local NGOs.

The NGO Movement of the Ecologists of Macedonia – DEM is particularly active in the climate change related awareness raising. Their activities involve:

- European campaign 'Carbon Dinosaur Tour 2004', July 2004. As a member of the Friends of the Earth, Europe, DEM realized this campaign in Macedonia, which is one of the 23 targeted European countries. The City of Skopje hosted the dinosaur Dino, who visited about 60 European cities, ministries, industries, refineries, thermal power plants. As a part of the campaign, the Government was encouraged to sign and ratify the Kyoto Protocol.
- National campaign for promotion of renewable energy sources: "Do not be a fossil, use the sun", September 2005. The campaign was particularly dedicated to solar energy and included a variety of activities: an eco-happening for the primary school pupils, exhibition of solar panels and solar dryers, roundtable entitled 'Solar Potential – Challenge for Cleaner and Healthier Future'.
- European-wide campaign 'Europeans Recommend: Fight against Climate Change!' October 2005. In cooperation with the Friends of the

Earth, Europe, DEM organized the Macedonian citizens in conveying their message for fighting against climate change to the world political leaders.

- Eco-school 'A Call for Rescue from Climate Change – Act Locally, Think Globally!', March 2008. About 30 high school students and representatives of other NGOs from all over Macedonia participated in this three-day event. They were encouraged to prepare their own presentation and share the gathered knowledge on climate change with their mates, friends, and relatives.
- Global action for rescuing from the climate change – translation in Macedonian and production of the interactive CD CLARITY, March 2008. The CD was provided through international cooperation and with authorization of Climate Alliance, it was made available in Macedonian. Covering themes from environment, energy, geography, chemistry, biology, the CD Clarity is a useful educative tool which offers answers to many questions related to climate change – causes, effects, influences, as well as how to protect the climate and adapt to change.

In conclusion, from the awareness-raising perspective, development of a **National Survey** to assess needs and requirements for implementation of Article 6 of the UNFCCC can be recommended. It will assist the country to raise public awareness on climate change, to involve local stakeholders in a dialogue on a perspective national climate strategy as well as to approach various target groups on climate change issues, and to disseminate up-to-date materials on climate change problems.

The survey should be followed by the overall **Communication Strategy on Climate Change** which after its implementation stage will bring change to our behaviour and ways of doing things. The main goal of the strategy will be not only to raise visibility in this direction, but also to mobilize and promote new partnerships in order to achieve a higher degree of general awareness and encourage actions to be taken by all stakeholders (government, private sector, donor community, civil society, media, and general public). The partnership-building component will aim at creating synergies with all the interested parties, a range of actors whose contribution is critical and in particular the private sector. By such an approach, better mutual understanding between policy-makers and the public on climate change issues, with a special focus on the private sector as key driver, will be achieved.

6.6. Capacity Strengthening

Capacity-building activities can be grouped into capacity-building activities at the national, regional, and at global levels.
As a part of the activities at the regional level, Macedonia participated in several regional projects (see Chapter 1.3.3):

- 'Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)', in the period 2003-2006, funded by UNDP-GEF and Switzerland parallel co-financing.
- 'Regional Project on Building Capacities to Access Carbon Financing in Eastern Europe and CIS'.
- Currently, the country is taking part in the REC sub-regional project 'Enhance Regional South-East European (SEE) Cooperation in the Field of Climate Policy'.

The Republic of Macedonia through the Ministry of Environment and Physical Planning organized several workshops (including component on capacity strenghtening) under the bilateral cooperation with the Italian Ministry of Environment and Physical Planning for implementation of the Kyoto Protocol both from legal and technical aspects. As a supporting document of a capacity development for preparation of initial CDM projects' documentation, a Guideline for the project idea note preparation was developed, as a part of the project 'Enhance Regional Collaboration in Climate Change', supported by the Dutch Government, implemented through REC.

General recommendations for capacity needs from the Country Assessment Report on Climate Change issues under the project 'On the Road to Montreal 2005: Intergovernmental Meeting under UNFCCC (COP11) and the Kyoto Protocol (COP/MOP 1)' prepared by the Regional Environmental Centre, can be summarized as follows:

- Improvement of the current institutional set up for preparation, updating, and reporting of the GHG Inventory and National Communication according to the newly proposed Law on Environment;
- Strict definition of the responsibilities of each governmental institution in the process of preparation, updating and reporting according to the newly proposed Law on Environment;
- Strengthening the human capacities related to some relevant climate change issues (for example, "climate potential of the pollution" connected with abatement measures);
- Strengthening the human capacities in the QA/QC verification process;
- Strengthening the national hydro-meteorological observation system especially the meteorological and hydrological systematic monitoring networks;
- Preparation of the secondary legislation for submission of the data from different sectors needed for preparation of the GHG inventory in order to avoid the uncertainties.

Making baseline of existing knowledge and capacity-building activities with different involved parties (including universities, academia, etc.) is foreseen as an activity to be included in the terms of reference of future National Communication Strategy on Climate Change.

6.7. Information and Networking

Gathering and exchange of information is a key factor of successful addressing of climate change issues. The national climate change website www.unfccc.org.mk remains the most relevant national source of information, containing, *inter alia*, all reports and data about GHG emissions, scenarios for climate change at the national level, vulnerability reports, mitigation strategy, etc. The official website of the MOEPP contains information about the mandate of the ministry, policy, strategy documents, and current activities. It is linked with project-based units, as well as with the relevant EU and other sources of information.

As a result of successful cooperation and knowledge exchange with recognized Slovenian climatologists, climate change scenarios for Macedonia have been developed for the first time. In addition, a training was conducted for national experts, in order to develop know-how regarding scale determination by making use of other indicative emission scenarios from SRES (A1T, A1b, A1FI, B1), such as the method for scale determination for a model (Mitchell, 2003).

The scenarios provided the basis for better predictions of the vulnerability to climate change in different sectors in the country (including agriculture, forestry, water resources, biodiversity, and health) and consequently, development of adequate adaptation measures on national and local levels.

Information exchange and networking and strengthening international partnerships that foster exchanges of experience and expertise in the fields of climate research and observation, education, public awareness raising, and capacity building is stipulated in the Belgrade Initiative, enhancing the regional cooperation of interested south-east European countries in the field of climate change (see Chapter 1.3.3).

Macedonian experts who participated in the preparation of the national inventories, as well as vulnerability assessment and adaptation are part of the Knowledge Network for the Second National Communications from Non-Annex I Parties to UNFCCC established by the National Communication Support Programme. Participation in such a network enables experience sharing among experts worldwide, as well as establishing links for future cooperation in potential regional projects.

6.8. Financial Resources and Technical Support

Appropriate addressing of climate change issues requires significant financial resources. In general, available financial support (especially national) for climate change related activities is insufficient and there is an emergency requirement for newly available funds, inclusion of the private sector, and raising awareness at the decision-making level. The budgets of the relevant ministries (MOEPP, Ministry of Education and Science, MOAFWE) do not contain direct allocations for climate change issues, so these projects are mainly financed/co-financed by international institutions (UNDP, GEF, GEF Small Grant Programme). In the future main financial resources will also be obtained from international finance institutions (World Bank), UNFCCC adaptation fund, and bilateral support from various climate change initiatives.

Hence, the GEF Small Grant Programme, having been implemented at the national level since 2005, provided financial support to local NGOs towards addressing climate change, conservation of biodiversity, protection of international waters, reduction of the impact of persistent organic pollutants, and prevention of land degradation while generating sustainable livelihoods. By the end of 2006, a total of 13 projects had been implemented, out of which three addressed climate change issues, such as implementing energy saving measures, facilitating production of bodies by collection of vegetable oil, and production of bio-diesel from crops grown on the agricultural land contaminated with heavy metals. Implementation of projects contributed not only to GHG emission reduction and improving local economy, but also to strengthening capacities at the local level, to dealing with environmental problems, addressing poverty, and providing for the greater participation of women.

Recently, a contract for a World Bank loan has been signed for strengthening the capacities of the MOAFWE. One of the project components is establishment of a Farm Register and the Land Parcel Identification System (LPIS). The establishment of this system will contribute towards providing very accurate and up to date information on crop patterns and land use, which can further on be used for accurate calculations of the emissions of GHGs and can provide a clear picture of water demands and water scarcity in the agricultural sector.

In general, the available financial support (particularly the national one) of climate change activities in the country is scarce and limited, so there is an urgent need for fundraising, involvement of private sector, and awareness raising of policy-makers. Active use of EU Research Programmes (FP Programmes) is also recommended, as well as providing budgets in relevant national institutions.

ANNEX 1

ANNEX 1

Relevant Policies, Institutional, and Legislative Framework by Sectors

Energy

Because of the close interaction between energy production/consumption and GHG emissions, the national policies for Energy Efficiency (EE) and Renewable Energy Sources (RES) contribute to the Climate Change Mitigation, because the realization of their objectives involves GHG emission reduction. The following text gives an overview of the actions realized in Macedonia in the EE and RES area.

The **Ministry of Economy** is the responsible government body for energy issues. The ministry has 12 departments, one of which is the Energy Department. Its main functions include conducting the state energy policy through programmes, measures, and other activities, developing laws, sub-laws, and other legal documents on energy, initiating and implementing the policy for energy sector restructuring, creating, and developing approvals and agreements for any energy activity and exploitation.

The Energy Department is also in charge of collecting and providing all data regarding energy production, supply, demand, balance, etc., and compiling them in public documents. An obligation of the department is to implement energy-related European directives into Macedonian laws.

The **Ministry of the Environment and Physical Planning** is the designated National Focal Point to the UN Framework Convention on Climate Change (UNFCCC) and is the key governmental body responsible for policy-making with regard to the provisions of the UNFCCC. In January 2000, the Climate Change Project Office was set up within the ministry, responsible for coordination and realization of project activities regarding the national climate change communication, as well as for identification of other projects addressing the climate change. Furthermore, a National Climate Change Committee was established as an advisory body for policy-making related to climate change issues. The Ministry of Environment and Physical Planning was also nominated as the country's Designated National Authority (DNA) for Clean Development Mechanism (CDM).[1]

To support the activities of the ministry in the implementation of the energy policy, the state **Energy Agency** was established in December 2005. It is responsible for professional technical support for data management, strategy analysis, policy and project assessment, and implementation coordination. In compliance with the law, the Energy Agency will have the following remit relating to EE and RES: develop initiatives, propose and coordinate studies and projects for energy efficiency and RES; cooperate with the Ministry of Economy for implementation of the Action Plan for realization of the Energy Efficiency Strategy; issue guarantee for origin for electricity produced from RES; propose and incorporate measures for environment protection in the energy projects.

The regulation of the energy market is performed by the independent regulatory body, the **Energy Regulatory Commission (ERC)** of the Republic of Macedonia. The Energy Regulatory Commission was established in June 2003 (by an amendment to the 1997 Energy Law). By law, ERC is a regulatory body which is fully independent from the interests of the energy industry and governmental bodies. The main competences of the Energy Regulatory Commission are to ensure: safe, secure, continual, and quality energy supply to the final consumers; protection of environment and nature; protection of consumers; promotion and protection of a competitive energy market based upon the principles of objectivity, transparency, and non-discrimination. Pursuant to the Energy Law, the Energy Regulatory Commission is authorized to regulate energy activities (including the prices) related to electricity, natural gas, oil and oil derivatives, and thermal and geothermal energy.

The restructuring of the electricity sector started in 2004. The former, vertically integrated state-owned power company, ESM (Elektrostopanstvo na Makedonija), was unbundled into four major companies: **AD ESM** (distribution), **AD MEPSO** (transmission system operator), **AD ELEM** (generation, including thermal and hydropower plants), and **AD TEC Negotino** (generation).

GA-MA JSC is the Macedonian company for transportation of natural gas and managing the natural gas system. It is 50% owned by the government and 50% by **MAKPETROL**. MAKPETROL was formerly Macedonia's state oil and gas company, but since 1998 it has been a totally private joint-stock company. MAKPETROL is the biggest company in the Republic of Macedonia for distribution and trade with oil products, oil derivates, and gas distribution. The company owns 120 petrol stations and 12 storage tanks for oil derivatives. It makes over 60% of the oil derivatives' turnover in Macedonia and practically has a monopolistic position in the oil and gas service market.

The **OKTA Refinery** was privatized in 1999 and is owned by the Greek firm Hellenic Petroleum. The OKTA Refinery produces most of the petroleum products in Macedonia, including the bulk of the petrol and diesel, and almost all of the heavy fuel oil. The refinery is located near Skopje, whose full capacity is 2.5 million tonnes per year, but it usually operates at a much smaller capacity. An important step forward in the development of the oil sector in the country is the construction of the pipeline for transport of crude oil linking the port of Thessalonica to the OKTA refinery. The full length of the pipeline is 214 km and the transport capacity is 2.5 million tonnes of crude oil annually.

The **District Heating (DH) company, Toplifikacija AD,** successfully completed the process of privatization in 1999 as a joint-stock company and in 2001 appeared on the official market on the Macedonian Stock Exchange. The company combines production, distribution, and supply of heat for the territory of the City of Skopje (approximately 47,000 flats with a heating surface of nearly 3 million m^2) and part of the city of Bitola. Toplifikacija AD is one of the investors in the first gas plant with a combined cycle for heat and power production, which is expected to start in early 2010.

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[1] National Strategy for Clean Development Mechanism for the first commitment period of the Kyoto protocol 2008-2012, Ministry of Environment and Physical Planning, 2007: http://www.moepp.gov.mk/WBStorage/Files/Nacionalna%20strategija%20Kyoto%20Protocol,%20mkd.pdf

Regarding the legislation the leading role is with the Energy Law, adopted in May 2006, which clearly targets EE and RES by including a special chapter. The law contains provisions about the development of a Strategy for Improvement of EE for a period of ten years and a five-year programme for the implementation of the strategy. The law includes provisions for EE in the construction of new and reconstruction of existing facilities, including energy audits and buildings certificates. It also calls for applying technical specifications and standards for efficient use of fossil fuels on new motor vehicles, facilities for generation of electricity, heat, and other energy intensive industrial capacities that are sold and/or imported into the territory of the Republic of Macedonia. The law also puts requirements for the EE of new household appliances and the introduction of energy efficiency labelling. These provisions should be elaborated in details with relevant secondary legislation (some rulebooks have already been adopted, for example the rulebook for energy efficiency labelling of household appliances, from July 2007).

In October 2004, the Government adopted the Energy Efficiency Strategy. The strategy is accompanied by implementation plan and technical programmes analyses. Programmes identified for implementation (Residential Building Programme; Commercial Building Programme; Institutional Building Programme; Industrial Programme; Street Lighting Programme) have the potential to realize cost effective reductions in energy use representing approximately 6% of the country's current energy use, as well as helping postpone future investments in a new supply capacity. The initiatives all lie on the demand-side rather than on supply, with particular emphasis on electrical energy use as this is currently the most perturbing end-use issue. Unfortunately, since 2004 there have been no reliable indicators or relevant analyses to monitor the actual realization of the estimations from the Energy Efficiency Strategy.

The Strategy for RES is expected to be adopted by the Government in 2008. This strategy shall define the objectives for utilization of the RES and the ways of achieving such objectives, especially: the potential of the RES, the feasibility potential of the RES, the arranged scope and dynamics for introduction of electricity consumption from RES in the electricity balance, as well as definition of transitional measures for support of the RES utilization. A rulebook for increased RES utilization will also be adopted.

Together with their responsibilities for developing and implementing energy policy on the local level, the local authorities are obliged by the Energy Law to have local EE and RES policy. Local EE and RES programmes for a period of at least five years should be adopted by the Municipal Council or the Council of the City of Skopje. A plan for implementation of the programme should also be approved and monitored. These specific responsibilities of the local authorities require a specific capacity, which is still not commonly available. The decentralization reform has put a number of new responsibilities on local authorities and the process of building all relevant capacities is slowly progressing. As a result, the programmes required by law are not being developed and implemented.

The Energy Law also stipulates the establishment of preferential (feed-in) tariffs for electricity sold by preferential producers. In 2007, the Energy Regulatory Commission published rulebooks on the method and procedure for establishing and approving the use of feed-in tariffs for purchase of electricity produced from small hydropower plants, wind power plants, as well as from power facilities using biomass as fuel. Also, just recently, preferential tariffs for electricity from photovoltaic systems have been established.[2]

In order to stimulate the usage of solar energy in the country, the Macedonian government has decided to invest €150,000 from the state budget in establishing a subsidizing scheme, according to which the Ministry of Economy provided repayment to the amount of 30% (not more than €300) of the costs for the first 500 buyers of solar thermal collector systems, who have properly installed them in their homes. Next to this is the adoption of the law on amending the Law on Value-Added Tax, which anticipates reduction of VAT from 18% to 5% for the thermal solar systems and components.

Transport

The issues regarding environmental management in the area of the transport sector in the Republic of Macedonia are the responsibility of the **Ministry of Transport and Communications**, the **Ministry of Environment and Spatial Planning**, partly in the domain of the **Ministry of Economy**, the **Ministry of Local Self-Government**, certain bodies of the local self-government, and other institutions and bodies. The Ministry of Transport and Communications is responsible for various transport matters in the country, and, through its departments, authorities, and agencies, it undertakes planning, design and monitoring of realization of transport sector projects, including environmental management in the domain of the transport sector.

Among the aforementioned, other institutions have certain functions in the transport sector activities and, indirectly, in the area of environmental protection related to this sector. In that direction, the **Ministry of Finances** registers vehicles and is responsible for the issue of the age limit of the vehicles allowed to enter the country. The **Ministry of Interior** collects information on the vehicle fleet, including aspects related to the age, vehicles' characteristics, insurance, and the use of various fuels.

In the Ministry of Transport and Communications there is no document for strategic planning in the transport sector, which would outline the goals and policies of its general development. An important step in a positive direction has been made with the proclamation of the document 'Technical Support for the Ministry of Transport and Communications in the Preparation of the Draft National Transport Strategy for Road Transport' in 2007. Another important document is 'National Programme for Railway Infrastructure 2008-2012', as an attempt towards a positive move in the segment of the railway transport, after a longer period of stagnation.

The policies regarding separate segments of the transport-environmental system, are, mainly fragmentary and appear from the Ministry of Transport and Communications. The Law on the Environment and Nature Protection and Promotion and the National Environmental Action Plan (NEAP), from 1996 and 2005, provide the framework for all segments of the environmental protection policy in the country. With the 'Energy Efficiency

[2] The rulebooks for feed-in tariffs can be found on the website of the Energy Regulatory Commission: http://www.erc.org.mk/vertikalEn.asp?verID=48.

Strategy of the Republic of Macedonia', from 2003, the ways and measures are suggested for rational use of energy in the industry, transport, and other sectors. One of the objectives of the Law on Physical and Urban Planning and its changes and supplements is to address pressures towards the urban areas and to ensure an appropriate management of the environment.

Over the last decade, relatively significant financial resources have been engaged within the transport sector. However, they can still be rated as insufficient for adequate development of the sector. For the moment, with the exception of the periodical procurement of new vehicles, there are no concrete projects directed towards a significant enhancement of public transportation, improvement of the traffic management, wider use of rail transport, or projects for promotion and development of integrated transport.

Regarding the fuels, with the signing of the Protocol on Persistent Organic Pollutants (POP) and Heavy Metals, the country must phase out leaded petrol. In 2006, on the basis of the Law on Safety of Products, 'Regulation on Liquid Fuels Quality' was proclaimed, which regulates the properties of fuels, including bio-diesel. As of 1998, the country has CO emission limits for vehicles with diesel engines that are equal to the limits according to EU legislation. Specifications for the sulphur content of diesel fuel came into effect in 2005. Although these specifications are a certain improvement, they are not up to EU standards. Limiting values for other emissions from vehicles are prescribed within the legal regulations on air quality control.

Appropriate regulation from 1999 prescribes annual technical inspection of motor vehicles, which also requires testing of the opacity of the exhaust fumes from vehicles with diesel engines, as well as measurement of the CO content in the exhaust gases from vehicles with petrol engines.

Waste

The national legislation related to the waste sector, to some extent incorporates provisions that can indirectly affect the GHG emission reduction. The Strategy for Waste Management (draft version) is the first document to present the key principles for upgrading the biodegradable waste management and therefore contributes to the GHG emission reduction. These key principles should be integrated into the National Waste Management Plan which is still to be developed and adopted, so that, among others, it will become a basic implementation plan for reduction of the GHG emissions in the waste sector. Most of the laws and documents, directly or indirectly related to the possibilities for GHG emission reduction, are listed below:

1. Law on Waste Management (*Official Gazette of RM* No. 68/2004);
2. Law on Modification and Amendment of Law on Waste Management (*Official Gazette of RM* No. 107/2007);
3. National Plan for Solid Waste Management, finished in 2005 (in the framework of CARDS 2001), still in procedure;
4. Decree for Integrated Environmental Permits and Relevant Operational Plans (*Official Gazette of RM* No. 89/2005);
5. Rulebook on the Procedure for Issuing Permit for Adjustment with Operational Plan (*Official Gazette of RM* No. 4/2006);
6. Rulebook on Procedures for Handling, Packing, and Labelling of Dangerous Waste (*Official Gazette of RM* No. 15/2008);
7. NEAP II (Second National Environmental Action Plan) completed in 2006.

During the ongoing decentralization period, all municipalities have been working on new Waste Management Plans, which particularly address the treatment of biodegradable waste. Also, the National Strategy for Sustainable Development will facilitate the application of the principles of sustainability in the waste sector through reduction of waste generation, resources preservation, and proper management of biodegradable waste.

As to industrial waste, the adopted IPPC regulation obliges the industry for proper waste management and reduction of CO_2, CH_4, and N_2O emissions in all production phases.

In conclusion, there is a basic national legislation for GHG emission reduction, but it should be broadened with provisions that will enforce the implementation of the measures identified in this study.

Agriculture

The key institutions from the agricultural sector, that in some way are involved in climate change mitigation are:

- Ministry of Agriculture, Forestry, and Water Economy;
- Agency for Stimulation of Agriculture;
- Scientific Institutes (Institute of Agriculture – Skopje, Institute of Cattle Breeding – Skopje, Institute of Tobacco – Prilep);
- Institutions of higher education (Faculty of Agriculture and Food – Skopje, Faculty of Biotechnical Sciences – Bitola, Faculty of Agriculture – Stip);
- Farmers' federation;
- Farmers' associations;
- Other agricultural corporations, associations, cooperative organizations, and producers.

The legislative framework of agriculture mainly comprises ordinances that directly or indirectly affect the GHG emission reduction. Principally, they are:

- Law on Agriculture and Rural Development (*Official Gazette of RM* No. 134/07);
- Law on Agricultural Activity (*Official Gazette of RM* No. 11/02);
- Law on Agricultural Land, (*Official Gazette of RM* No. 135/07);
- Law on Cattle Breeding (*Official Gazette of RM* No. 07/08);
- Law on Agricultural Inspection (*Official Gazette of RM* No. 38/04);
- Law on Promotion of Agricultural Development;
- Law on Establishment of Agency for Financial Support of Agricultural and Rural Development (*Official Gazette of RM* No. 72/07).

Relevant strategies for this sector are: 'National Strategy for Agricultural and Rural Development 2007-2013' and 'National Strategy with Action Plan for Organic Agriculture in the Republic of Macedonia'. The key issues addressed within these strategies are:

1. Increasing the labour capacity through better production and cattle-breeding techniques;
2. Attainment of food quality and safety;
3. Sustainable management of resources.

The financial support for this sector is realized through national and foreign programmes, which support actions/projects for realization of the strategic policies, such as:

- Programme for Financial Support of Agriculture for 2008 (annually adopted);
- Programme for Financial Support of Rural Development;
- Programme for Promotion of the Organic Production in Agriculture;
- IPARD.

From the climate change mitigation aspect, similar to the all other sectors, the most important issue is to include the requirement for GHG emission reduction among the leading principles in all agriculturally-related national/municipal strategies and other planning documents.

Forestry

- Law on Forests;
- Law on Reproductive Material;
- Law on Hunting;
- Strategy on National Sustainable Development in Forestry and Action Plan.

Hydro-meteorological works

According to the Law on Hydro-Meteorological Works (*Official Gazette of the Republic of Macedonia* nos. 03/1994 and 05/2003), monitoring and research activities of the climate-meteorological and hydrological parameters in the country are performed by the Hydro-Meteorological Service within the Ministry of Agriculture, Forestry, and Water Economy. According to this law (part of which concerns climate change), the Hydro-Meteorological Service performs climate monitoring and special meteorological research within the meteorological station network. This institution also performs basic data processing, research of climate physical basics, systematic observation of variations, and development of weather forecast methods.

ANNEX 2

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)								
2000 year (base year)[1]								
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	**9.572**	**-1.236**	**83**	**3**	**35**	**191**	**18**	**3**
1 Energy	**8.791**	**0**	**11**	**0**	**34**	**99**	**17**	**1**
A Fuel combustion (Sectoral Approach)	8.791		3	0	33	99	16	
1 Energy Industries	6.845		0	0	19	2	0	
2 Manufacturing Industries and Construction	475		0	0	3	1	0	
3 Transport	1.061		0	0	10	58	11	
4 Other sectors	253		2	0	2	39	5	
5 Other (please specify)	157		0	0	0	0	0	
B Fugitive Emissions from Fuel	0		9		0	0	0	1
1 Solid Fuels			8					
2 Oil and Natural Gas			1		0	0	0	1
2 Industrial Processes	**781**	**0**	**0**	**0**	**1**	**51**	**1**	**2**
A Mineral Products	412					0	0	0
B Chemical Industry	0		0	0	0	0	0	1
C Metal Production	369		0	0	0	51	0	1
D Other Production	0				0	0	1	0
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)	0		0	0	0	0	0	0
3 Solvent and Other Product Use	**0**			**0**			**0**	
4 Agriculture			**29**	**2**	**0**	**0**		
A Enteric Fermentation			27					
B Manure Management			2	0				
C Rice Cultivation			0					
D Agricultural Soils				2				
E Prescribed Burning of Savannas			0	0	0	0		
F Field Burning of Agricultural Residues			0	0	0	0		
G Other (please specify)			0	0				

[1] National GHG inventories for the period 1990-2002 can be assessed on following web sites: project office www.unfccc.org.mk and UNFCCC www.unfccc.int

5 Land-Use Change & Forestry	**(1)**	**0**	**(1)**	**-1.236**	**5**	**0**	**1**	**41**		
A Changes in Forest and Other Woody Biomass Stocks	(1)	0	(1)	-2.885						
B Forest and Grassland Conversion		1.712			5	0	1	41		
C Abandonment of Managed Lands				0						
D CO_2 Emissions and Removals from Soil	(1)	0	(1)	-63						
E Other (please specify)		0		0	0	0	0	0		
6 Waste					**38**	**0**	**0**	**0**	**0**	**0**
A Solid Waste Disposal on Land					36					
B Wastewater Handling					2	0				
C Waste Incineration										
D Other (please specify)					0	0				
7 Other (please specify)										
International Bunkers		0		0	0	0	0	0	0	0
Aviation		0		0	0	0	0	0	0	0
Marine		0		0	0	0	0	0	0	0
CO_2 Emissions from Biomass		956								

ANNEX 3

ANNEX 3

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