NATIONAL PLAN
FOR THE PROTECTION OF AMBIENT AIR

July 2012

Abbreviations

GDP – Gross Domestic Product

LCP– Large combustion plants

MEPP – Ministry of Environment and Physical Planning

EMEP – Environmental Monitoring and Evaluation Programme for long-range transboundary air pollutants transfer in Europe

CLRTAP – Convention on Long-Range Transboundary Air Pollution

CORINAIR – Air Pollution Inventory

SNAP – Selective Nomenclature of Air Pollution

TSP – Total Suspended Particles

PHI – Public Health Institute

SAAQMS– State Automatic Air Quality Monitoring System

WHO – World Health Organization

DALY – Disability Adjusted Life Years

YLL – Years of Life Lost

EPS – Electric Power System

SHPPs – Small Hydro Power Plants

ROT – Revitalize Operate and Transfer

IIR – Informative Inventory Report on air emissions in the Republic of Macedonia

IPPC– Integrated Pollution Prevention and Control

NMVOC – Non-Methane Volatile Organic Compounds

PAHs – Polycyclic Aromatic Hydrocarbons

PHBs – Polychlorinated Biphenyls

ICE – Internal combustion engines

TEO – Tetraethyllead

NCE – National Commission for Energy

VOCs – Volatile Organic Compounds

GHGs–Greenhouse gas emissions

UNFCCC – United Nations Framework Directive on Climate Change

MAFWE – Ministry of Agriculture, Forestry and Water Economy

MH – Ministry of Health

PHC – Public Health Centre

LEAP – Local Environmental Action Plan

NEAP – National Environmental Action Plan

PM_{10}- Suspended Particulate Matters sized up to 10 μm

MOI–Ministry of Interior

PRTR – Pollutant Release and Transfer Register

OECD –Organisation for Economic Co-operation and Development

IPARD – Instrument for Pre-accession Assistance in Rural Development

RES – Renewable energy sources

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Based on Article 23 paragraph 1 of the Law on Ambient Air Quality (Official Gazette of the Republic of Macedonia no. 67/04, 92/07, 35/10, 47/11 and 59/12), the Government of the Republic of Macedonia, on its Session held on ___________ adopted this

NATIONAL PLAN
FOR THE PROTECTION OF AMBIENT AIR
IN THE REPUBLIC OF MACEDONIA

Abstract

The development of the National Plan for Ambient Air Protection in the Republic of Macedonia is a roadmap towards protection and improvement of the quality of the air in the Republic of Macedonia. The National Plan for Ambient Air Protection has been prepared in the period 2011 - 2012 based on legal requirements and using the instructions defined in the Rulebook on the detailed content and manner of preparation of the National Plan for Ambient Air Protection (Official Gazette of RM no. 108/2009).

Based on the analysis of the trend of the emissions of the most important air pollutants from stationary and mobile sources in the period 2001-2009, aware of the conditions in individual sectors with greatest contributions to the total air emission, the state of the quality of air in 2010 and potential human health risks, measures for ambient air quality protection and improvement through emission reduction have been defined.

Sectors energy, industry and transport as the most significant sources of pollutants emission were analyzed in detail and their share in the total pollutant emission was presented. Energy sector has greatest contribution to the generation of the total sulphur dioxide emission (ranging between 72 % in 2001 and 99 % in 2009), generates around 60% of the total annual nitrogen oxides emissions, 21% of the total annual volatile organic compound emissions and major part (87 % in 2001 to 92 % in 2009) of the total generated solid particulate emissions. This sector comprises combustion processes in thermal power plants, central heating plants and process of oil distillation, heating boilers in non-industrial facilities and household fireplaces, and combustion processes in industrial production. The type of fuel used in these processes, content of pollutants, calorific capacity of the fuel, manner of combustion management and introduced abatement measures are the main parameters related to pollutants emission. Installations in energy sector are characterized by the fact that to a great extent they are at the same time Large Combustion Plants (LCPs) with input heat capacity of more than 50 MW and they are thus obliged to prepare Plan for reduction of the pollutants sulphur dioxide, nitrogen oxides and dust.

Industry plays an important role in the development of the overall Macedonian economy and secures its stability, has direct impact on employment rate increase, increase in export, as well as social welfare of the population. It contributes around 21% to the structure of the total GDP. The most prominent industrial branches in the Republic of Macedonia with greatest and most significant environmental impact, including the quality of air through emissions of pollutants are metallurgy, chemical and pharmaceutical industry, construction industry, food, beverages and foodstuffs production, electric power production industry and wood and paper manufacturing. Industry contributes around 28% to the total annual emissions of sulphur dioxide, around 14% to the total annual emissions of nitrogen oxides, and it has high share (38%) in the annual emissions of volatile organic compounds and contributes to the generation of around 60% of the annual emissions of solid particles. Industrial facilities are obliged to introduce measures to reduce emissions in all environmental media (by way of obtaining IPPC permit, introducing the Best Available Techniques, efficient use of resources, use of better quality fuels and renewable energy sources, introducing filters and installing systems for pollutants reduction, etc.).

Transport is also significant source of air pollution, and the main emitters are the internal combustion engines installed in different means of transportation. The means of transportation have highest share in nitrogen oxides emissions (within the range of 32-47% in the period 2001-2009) and volatile organic compounds in the range of 38-43% in the same period), and lower share in the generation of sulphur dioxide and solid particles. The main measures that would contribute to the reduction of emissions from mobile sources include: renewal of vehicle fleet and procurement of new vehicles with engine specification EURO 4/5, improvement of the quality of liquid fuels with regard to the content of polluting

substances, promotion of the use of gaseous fuels of natural gas and propane-butane type, bio fuels made of domestic raw materials in the transport, promotion of organized transport in urban areas and larger companies and intensification of public transport and railway transport of goods and passengers.

Although less significant in terms of total pollutants emission, the sectors Agriculture (with specific accent on enteric fermentation contributing 51% and agricultural soils with 34% as main sources of air emissions from this sector) and Waste (inadequate disposal of municipal waste and generation of greenhouse gas emissions – methane, dioxins and furans and heavy metals) contributing around 5.5 – 7% to the total greenhouse gas emissions, have been analyzed as well.

The National Plan for Ambient Air Protection also presents macroeconomic variations and the main factors that can contribute to the future development of Macedonian economy in line with the EU integration and gives general estimate of the required financial resources for the implementation of measures aimed at reducing SO_2 , NO_x, NH_3 and volatile organic compounds.

Continuous monitoring of the quality of the air, emissions from different stationary and mobile sources, broadcasts of development in different economic sectors and various scenarios and simulations of expected pollutants concentrations, regular observation of the introduction of measures for emission reduction and health risks related to deteriorated air quality are challenges for the coming period standing in front of all competent institutions and stakeholders in the protection of the environment of the Republic of Macedonia and creation of sustainable development of the community.

Introduction

The National Plan for Ambient Air Protection presents the state and defines measures for ambient air quality protection and improvement, for the next five years. The obligation for development of the National Plan for Ambient Air Protection derives from the Law on Ambient Air Quality.

The Republic of Macedonia has confirmed its readiness to join the EU through development of relations with EU and setting the EU membership as a national goal of highest priority resulting in its awarded status of candidate country in 2006. Republic of Macedonia has been transposing the EU *acquis* into the national legislation, and the National Programme for Adoption of the Acquis of the European Union contains specific part on environmental law, including the law on the quality of air and air pollutants emission. So far, significant progress has been achieved in the transposition of the EU Directives concerning air emissions from stationary and mobile sources, emissions monitoring, air quality monitoring and preparation of plans and programmes as strategic planning documents for air quality protection and improvement. In parallel with this, at global level, the Republic of Macedonia has ratified high number of multilateral agreements which regulate air pollutants emission and committed itself to undertaking measures towards their reduction.

In the period 2003-2011, the Republic of Macedonia adopted several strategic sectoral planning documents treating directly emissions of air pollutants and greenhouse gas emissions from individual sectors, as well as the status of ambient air quality. These documents are roadmaps towards the settlement of the most priority problems in the area of air quality protection in accordance with the latest EU and global requirements and trends.

In 2011, the Republic of Macedonia initiated the preparation of the National Plan for Ambient Air Protection in order to present the state of air pollutants emission and define measures aimed at improving the quality of the air on the whole territory of the Republic of Macedonia. The Plan also identifies all relevant institutions responsible for the measures implementation, in order to improve the quality of the air at local and global levels, as well as financial resources required for modernization of energy and industrial production processes, introduction of energy efficiency measures and use of renewable energy sources, introduction of the best available techniques, improvement of the quality of fuels, carrying out campaigns to increase public awareness of the quality of the air, etc.

The basic principles applied in the development of the National Plan for Ambient Air Protection are the general principles of environmental protection based on the Law on Environment, that are related to air protection:

a) The principle of careful and responsible behavior concerning activities that might have impact on the quality of the ambient air, where every individual is obliged to behave with care and responsibility in order to avoid and prevent ambient air pollution and avoid and prevent causing of harmful effects on human health and environment as a whole;

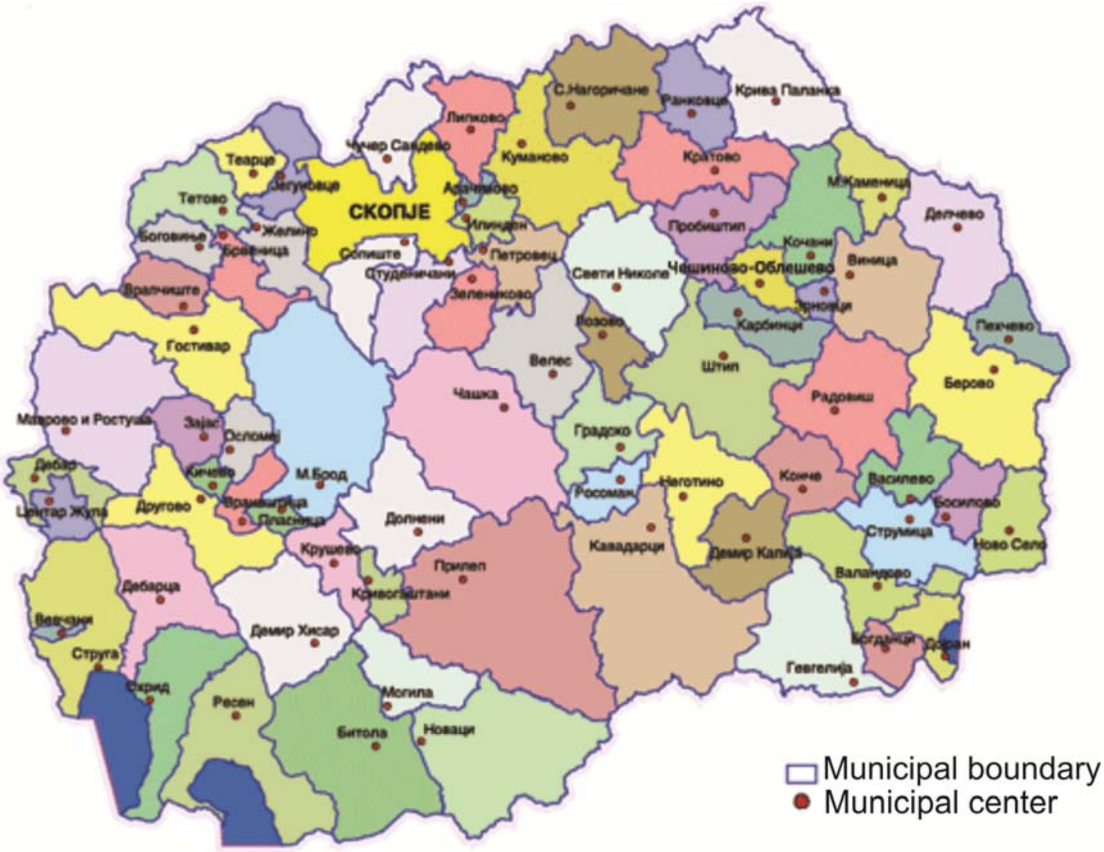
b) The principle of time perspective, deadlines in plans, programmes and decisions on ambient air quality management should correspond with the time perspective of expected effects.

The National Plan for Ambient Air Protection has been developed through participation of all stakeholders, being disseminated and discussed with the public in a transparent manner. This document will provide dynamic roadmap towards efficient and modern overcoming of national and global challenges of air pollution and associated impacts on human health and environment.

1. National context

1.1 Country profile [1,2,3,4]

Republic of Macedonia is situated in southeastern part of Europe and occupies the central part of the Balkan Peninsula. It does not have access to sea, nor to any open water way and is thus a continental country. Yet, the geographical position of the country is very favourable and important roads connecting many countries on the Balkans and in this part of Europe cross on its territory. Corridor 8 and Corridor 10, as well as international road E-75, road section M5 and railroad line passing over its territory are important transport connections. With its position, the Republic of Macedonia borders several countries: Albania on west (191 km), Greece on south (262 km), Bulgaria on east (165 km), Serbia and Kosovo on north (231 km). The total length of its border is 849 km. The territory of the Republic of Macedonia covers an area of 25 713 km^2 and it is populated by 2.022.547 inhabitants (2002 Census) with an average density of population of 78.6 inhabitants / km^2, 60 % of which live in urban areas. Its multi-ethnic composition is an important demographic characteristic influencing all spheres of living and future development. Around 2/3 of the population are ethnic Macedonians, 1/4 ethnic Albanians and 1/10 other communities.



This characteristic is further supplemented by religious composition of the population, represented by 2/3 Orthodox Christians and 1/3 Muslims.

Skopje is the capital with around 507.000 population, and other major urban centres include: Bitola, Kumanovo, Tetovo, Strumica, Ohrid and Shtip. Under the territorial division, the Republic of Macedonia has 84 municipalities and the City of Skopje (as specific unit of the local self-government consisting of 10 municipalities). 22 of the municipalities are urban, and 62 rural. In terms of economic development and for statistical reasons, the country is divided into 8 statistical regions: Skopje, Pelagonia, Polog, Eastern, Southeastern, Northeastern, Southwestern and Vardar regions.

Macedonian economy is small and statistics shows that the gross domestic product reaches around 9.5 billion US dollars, amounting 4.5% in 2010 (GDP trend for the last 5 years is shown in Table 1).

From among industries, the following are represented in the Republic of Macedonia by sectors: agriculture and food processing industry; clothes, textile, leather; mechanical industry; metals and metal products; chemicals; tobacco and cigarettes; energy; information and communication technology; construction and mineral resources; building; tourism.

Table 1 GDP trend 2005 – 2010 [3]

Year	GDP in current prices (million denars)	GDP real growth rates in %
2005	295 052	4.4
2006	320 059	5.0
2007	364 989	6.1
2008	411 728	5.0
2009	410 734	-0.9
2010	424 762	1.8

1.2 Geographical characteristics [1,2]

Republic of Macedonia is characterized with complex geology and well developed relief, resulting in great variations of soil types. Relief is dominated by mountains covering around two thirds of the country's territory, including around 40 distinctive mountains. These are part of the old Rhodope group in the eastern part and Dinaric group in the western part of the country. Rhodope group includes mountains lower than 2000 m, with the highest peak being Ruen - 2.252 m on Osogovo Mountains. Dinaric mountains are much higher reaching above 2.500 m, where Golem Korab with its 2.764 m is the highest. These mountain groups are separated by Vardar and Pelagonia horst anticlinorium in the central part of the country.

Valleys and large fields cut the mountain relief structures, covering around one third of the country's area. The most impressive valleys are those extending along Vardar River, including Skopje valley (1.840 km^2), while Pelagonia is the largest plain area in the southwestern part of the country, occupying around 4.000 km^2 with an average altitude above the sea level of 600 m.

Karst relief is specific for the Republic of Macedonia represented mainly by Paleozoic, Mesozoic, Paleogene and Neogene limestones occurring mostly in its central and western parts. Relief includes surface karstic forms of recesses, depressions, valleys and karstic fields, as well as underground relief forms, including 164 caves and12 pits and craters.

There are three national parks in Macedonia: Mavrovo, Galichica and Pelister, 4 nature reserves, 3 sites with specific natural features, 14 areas with valuable plant and animal species and 50 natural monuments. With more than 18.000 taxa of flora, fauna and fungi – 900 endemites, Macedonia has very rich and highly valued biodiversity and total are of protected areas is 11.6 %.

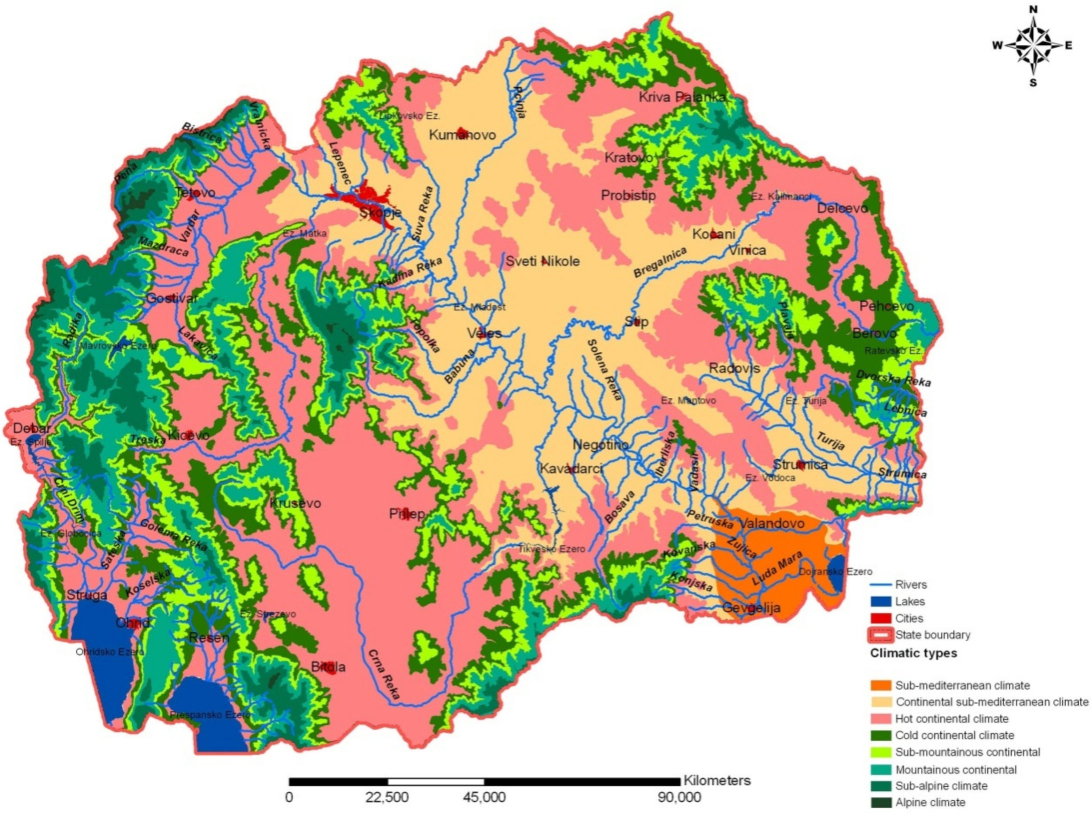
Republic of Macedonia is considered rich in water resources and it has recorded and mapped 4.414 springs in total, with overall annual capacity reaching 6.63 billion m^3 water. From hydrological point of view, the country belongs to three water basins, namely: Adriatic Sea (15 % of the territory) with the main entry watercourse being the river Crn Drim; Aegean Sea (85 % of the territory) with the rivers Vardar and Strumica as the major watercourses; Black Sea, the basin of which has insignificant territory.

Vardar is the largest river with around 80 % of the total water outrun from Macedonia. Its overall length is 388 km, out of which 300 km run through Macedonia, while the rest in Greece. At its exit from Macedonia, its flow rate is 174 m^3 / sec. Major right side tributaries of Vardar are Crna Reka (207 km in length) and Treska (138 km in length), while the rivers Bregalnica (225 km length) and Pchinja (135 km length) are the longest left tributaries.

From among natural lakes in the Republic of Macedonia, tectonic lakes are the most attractive: Ohrid, Prespa and Dojran Lakes. Ohrid Lake is the largest with an area of 358.8 km2, of which 229.9 km^2 belongs to Macedonia and the rest to Albania. The Lake of Ohrid is hidrologically connected with the higher positioned Prespa Lake, which covers and area of 274 km^2, shared with Greece and Albania. The smallest in area lake - Dojran, compared with the two mentioned located in the western part of the country is situated in the southeastern part of the country and covers an area of 42.7 km^2, shared with Greece.

1.3 Meteorological conditions [1,2]

Climate as long-term average condition of meteorological elements temperature, precipitation and wind in an area, is very important geographical factor. It determines water capacity of rivers, richness of flora and fauna, development of agriculture, transport, tourism and life style. Due to specific natural and geographical conditions, Macedonia is characterized with two main types of climate: modified Mediterranean and moderate Continental climate. Influences from Aegean and Adriatic Seas contribute to the development of these climate types, from where humid air masses penetrate, but their deeper break through is prevented by high mountains in southern and western parts of the country. Mountains and valleys in the northern part allow for infiltration of cold air masses from north and therefore temperature drops very low in winter, even in southern parts of the country. Overall currents in the atmosphere also influence the climate in the Republic of Macedonia, so that tropical air masses from Africa often break through in summer, while polar air masses come in from northern parts of Europe and Siberia during winter period. As a result, there are two main distinctive seasons, i.e. cold and humid winters and dry and warm summers, connected with the transitional seasons spring and autumn. In addition to these, there is mountain climate in alpine mountainous areas characterized with short and cold summers and significantly cold and moderately humid winters where precipitation is mainly in a form of snow.



The average annual temperature is 11.3^{0}C. In mountainous climate areas, average annual temperatures are 4.7 ^{0}C on Popova Shapka (1750 m); 6.8 ^{0}C in Lazaropole (1330 m) and 8.2 ^{0}C in Krushevo (1230 m). Average precipitation in Macedonia amounts 683.7 mm per year. Areas with most precipitations include Mavrovi Anovi with 1197 mm and Resen 757.9 mm, while the least precipitation occurs in Ovche Pole with only 490.3 mm.

2. Goal of the National Plan for Air Quality Protection and Improvement

The National Plan for Air Quality Protection and Improvement sets the measures for air quality improvement on the whole territory of the Republic of Macedonia. The Plan is the leading document for all identified relevant institutions responsible for the implementation of the measures aimed at improving the quality of air on local and global level. The implementation of the Plan requires financial resources for modernization of production processes, introduction of energy efficiency, improvement of the quality of fuels, organization of public awareness campaigns related to the quality of air, etc.

2.1 Principles in setting goals and priorities

The National Plan for Ambient Air Protection should *inter alia* also provide:

- maintenance of the quality of ambient air in zones where quality limit values have not been exceeded;
- improvement of the quality of ambient air in zones where quality limit values have been exceeded;
- undertaking of measures to reduce emissions from certain stationary sources of pollution;
- adoption of necessary measures to minimize and fully eliminate negative effects on the quality of ambient air.

The Ministry of Environment and Physical Planning (MEPP) is the main competent body providing implementation of the environmental legislation in this specific area. The Law on Ambient Air Quality recognizes the principles of the Law on Environment and also introduces other principles of relevance for air protection, namely:

The principle of careful and responsible attitude which concerns the activities that may have impact on the quality of ambient air, while every individual is obliged to behave carefully and responsibly in order to avoid and prevent ambient air pollution and avoid and prevent harmful effects on human health and environment as a whole.

The principle of time perspective – deadlines in plans, programmes and decisions for ambient air quality management should correspond with the time perspective of expected effects.

3. Legislation

3.1 National legislation

Constitution of the Republic of Macedonia contains provisions relating to environment. General provisions of the Constitution, in Article 8, introduce one of the basic principles of fundamental values of the constitutional order of the Republic of Macedonia as development and humanization of the space and protection and improvement of environment and nature. The right to a healthy environment is one of the basic freedoms and rights of the citizens, while citizens are at the same time obliged to protect and improve the environment, and the state is obliged to provide conditions for exercise of this right granted to citizens (Article 43).

Under the Law on the Organization and Work of the Bodies of State Administration (Official Gazette of RM no. 58/2000, 44/2002 and 82/2008), the Ministry of Environment and Physical Planning has the legal responsibility to create and implement the environmental policy of the Republic of Macedonia and lead the activities in the area of environment towards careful use of space and natural resources. Constituent bodies of the MEPP are: Administration of Environment, State Environmental Inspectorate and Office of Spatial Information System.

The Law on Ambient Air Quality provides legal basis for the regulation of the following:

- types of sources of pollution
- unique limit and target values

- management of the ambient air quality
- assessment of the ambient air quality
- planning of the protection of the ambient air quality
- monitoring of the ambient air quality and sources of emission
- information system
- protection of the ambient air against pollution
- supervision and competent bodies

Table 2 List of regulations in the area of environment and air quality

	Regulation	Official Gazette	Year of adoption
	LAWS		
1	Law on Environment	Official Gazette of RM no. 53/2005, 81/2005, 24/2007, 159/2008, 83/09, 48/10, 124/10, 51/11	2005
2.	Law on Ambient Air Quality	Official Gazette of RM no. 67/2004, 92/2007, 83/2009, 35/10, 47/11	2004
	AIR EMISSIONS		
1.	Rulebook on the methods, manners and methodology of measuring the air emissions from stationary sources	Official Gazette of RM no. 11/2012	2012
2.	Decree determining combustion facilities that need to undertake measures for ambient air protection against pollution through reduction of air emissions of certain pollutants	Official Gazette of RM no. 112/2011	2011
3.	Rulebook on the format and content of the forms for submission of data on ambient air emissions from stationary sources, manner and time interval of submission based on the capacity of the installation, content and manner of keeping the journal of emissions into the ambient air	Official Gazette of RM no. 79/11	2011
4.	Rulebook on the quantities of pollutant emission ceilings in order to determine projections for a given time period concerning reduction of the quantities of pollutant emissions on annual level	Official Gazette of RM no. 2/10	2010
5,	Rulebook on the limit values of permissible levels of emissions and types of polluting substances in waste gases and vapors released from stationary sources into the air	Official Gazette of RM no. 141/10	2010
6.	Rulebook on the methodology for inventory and establishment of the levels of polluting substances emission into the atmosphere in tons per year concerning all types of activities, as well as other data to be submitted to the European Monitoring and Evaluation Programme (EMEP)	Official Gazette of RM no. 142/07	2007
	AMBIENT AIR QUALITY		
1.	Rulebook on detailed conditions for performance of certain types of technical activities with regard to equipment, devices, instruments and appropriate business premises to be met by entities performing certain technical activities in the area of	Official Gazette of RM no. 69/11	2011

	Regulation	Official Gazette	Year of adoption
	ambient air quality monitoring		
2.	Rulebook on the content and manner of delivery of data and information on the status of ambient air quality management	Official Gazette of RM no. 138/09	2009
3.	Rulebook on the methodology for ambient air quality monitoring	Official Gazette of RM no. 138/09	2009
4.	Rulebook on criteria, methods and procedures for ambient air quality assessment	Official Gazette of RM no. 82/06	2006
5.	Decree on the limit values of the levels and types of polluting substances in the ambient air and alert thresholds, deadlines for limit values achievement, margins of tolerance for the limit values, target values and long-term targets	Official Gazette of RM no. 50/05	2005
6.	GUIDELINES concerning the implementation of the Decree on the limit values of the levels and types of polluting substances in the ambient air and alert thresholds, deadlines for limit values achievement, margins of tolerance for the limit values, target values and long-term targets		2005
	PLANS AND PROGRAMMES		
1.	Rulebook on the detailed content and manner of preparation of the programme for reduction of the pollution and improvement of the quality of ambient air	Official Gazette of RM no. 108/09	2009
2.	Rulebook on the detailed content and manner of preparation of the action plan for ambient air protection	Official Gazette of RM no. 108/09	2009
3.	Rulebook on the detailed content and manner of preparation of the National Plan for Ambient Air Protection	Official Gazette of RM no. 108/09	2009

3.2 Status of transposition of the EU legislation in the area of air

EU Directives in the area of air included in the process of transposition in the Macedonian legislation:

- Directive (2008/50/EC) on the quality of ambient air and cleaner air in Europe – covers major part of the existing legislation (except the fourth Daughter Directive), without changes in the current air quality targets specified under the old Framework Air Quality Directive 96/62/EC and the three daughter directives. This Directive sets new air quality targets for $PM_{2.5}$ (fine particles), including also the requirements on the concentration of exposure and target for reduction in exposure.
- Framework Directive (96/62/EC) on the assessment of the quality of ambient air specifies the standards for air quality, while the four daughter directives (first (1999/30/EC), second (2000/69/EC), third (2002/3/EC) and the fourth (2004/107/EC), set the limit values for specific substances into the ambient air;
- Council Decision (97/101/EC) for exchange of information and data from the networks and individual stations measuring the ambient air pollution within Member States;
- Decision of the Commission (2004/461/EC), establishing the format and the content of the annual report by Member States on the quality of ambient air on their respective territories to the Council;

- Directive 2008/1/EC on integrated pollution prevention and control;
- Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants
- Directive 2001/81/EC on national emission ceilings for individual pollutants;
- Directive 1999/13/EC on the limitation of emissions of volatile organic compounds resulting from use of organic solvents in certain activities and installations;
- Directive 2004/42/EC on the limitation of emissions of volatile organic compounds resulting from use of organic solvents in dyes and lacquers and products for finishing works on automobiles amending Directive 1999/13/EC;
- Directive 94/63/EC on the control of emissions of volatile organic compounds resulting from storage of petrol and its distribution from terminals to petrol stations;
- Directive 1999/32/EC concerning the reduction of the content of sulphur in certain liquid fuels and amending Directive 93/12/EEC;
- Directive 97/68/EC against exhaust gases and particles from internal combustion engines installed in non-passenger mobile machines;
- Directive 98/70/EC on the quality of petrol and diesel fuels amending Directives 2000/71/EC, 2003/17/EC.
- Directive 93/76/EEC on the limitation of emissions of carbon dioxide through improvement of energy efficiency (SAVE);
- Directive 2010/31/EC on energy performance of buildings;
- Directive 2001/77/EC (OJ L 283, 27.10.2001) of the European parliament and of the Council on the promotion of electricity produced from renewable energy sources on internal market;
- Directive 2003/30/EC (OJ L 123, 17.5.2003) of the European parliament and of the Council on the promotion of the use of bio-fuels or other fuels from renewable sources in transport; and
- Directive 2004/101/EC on the establishment of GHG emissions trading scheme in accordance with the Kyoto Protocol.

Table 3 Overview of the extent of transposition and implementation of the EU legislation in the field of air (1 March 2011)

Transposition	
Implementation	

EU Directive	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
2008/50/EC, Directive on the quality of ambient air and cleaner air in Europe								76.9%		
2001/81/EC Directive on air emission ceilings										96.1%
1999/32/EC,									89.3%	

EU Directive	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Directive on the content of sulphur in liquid fuels										
2010/75/EC IPPC						59.6%				
94/63/EC, Directive on VOCs from petrol stations	2.3%									
2004/42/EC, Directive on VOCs from use of organic solvents in dyes and lacquers						54.5%				
1999/13/EC, Directive on VOCs from use of organic solvents *									88.3%	
						55.5%				
2001/80/EC Directive on large combustion plants *										93.5%
								76.9%		

* March 2012

3.3 International obligations in the area of air

The following Conventions and Protocols have been ratified to date:

	Name of multilateral agreement	Official Gazette
1.	Convention on Long-Range Transboundary Air Pollution (Geneva, November 1979)	Official Journal of SFRY, no. 11/86. Adopted by succession on 30.12.1997
2.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution concerning long-term funding of the Programme for cooperation in monitoring and assessment of the long-range transmission of pollutants in the air in Europe (EMEP)	Official Gazette of RM no. 24/10 of 19.02.2010
3.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution to control nitrogen oxides emissions or their transboundary transmission	Official Gazette of RM no. 24/10 of 19.02.2010
4.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution concerning further sulphur emissions reduction	Official Gazette of RM no. 24/10 of 19.02.2010
5.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution to control emissions of volatile organic compounds or their transboundary transmission	Official Gazette of RM no. 24/10 of 19.02.2010
6.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution concerning reduction of sulphur	Official Gazette of RM no. 24/10 of 19.02.2010

	Name of multilateral agreement	Official Gazette
	emissions or their transboundary transmission by at least 30 percents	
7.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants	Official Gazette of RM no. 135/2010 of 08.10.2010
8.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution on the reduction of acidification, eutrophication and ground ozone	Official Gazette of RM no. 135/2010 of 08.10.2010
9.	Law on the Ratification of the Protocol to 1979 Convention on Long-Range Transboundary Air Pollution on Heavy Metals	Official Gazette of RM no. 135/2010 of 08.10.2010
10.	United Nations Framework Convention on Climate Change (New York, May, 1992),	Official Gazette of RM no. 6/97. Entered into force for the Republic of Macedonia on 28 April 1998;
11.	Kyoto Protocol to the United Nations Framework Convention on Climate Change	Official Gazette of RM no.49/04;
12.	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	Official Gazette of RM no. 49/97
13.	Vienna Convention for the Protection of Ozone Layer (Vienna, March 1985)	Official Journal of SFRY no. 1/1990, Ratified by the Republic of Macedonia on 10 March 1994
14.	Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal, September 1987)	Protocol was ratified on 10.03.1994;
15.	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (adopted on the second meeting of Parties in London, on 29 June 1990).	Official Gazette of RM no. 25/98;
16.	Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer – Copenhagen (adopted on the Fourth Meeting of Parties in Copenhagen, on 25 November 1992)	Official Gazette of RM no 25/98
17.	Stockholm Convention on Persistent Organic Pollutants	Republic of Macedonia signed the Stockholm Convention on 23 May 2001 and ratified it on 19 March 2004;
18.	Convention on Environmental Impact Assessment in a Transboundary Context (ESPO Convention, February 1991)	Official Gazette of RM no. 44/99;
19.	Convention on Access to Environmental Information, Public Participation in Environmental Decision Making and Access to Justice in Environmental Matters (Aarhus)	Official Gazette of RM no 40/99.

3.4 National strategic documents

Relevant strategic documents of high importance for ambient air quality protection and improvement I the Republic of Macedonia include:

- National Environmental Action Plan II, adopted in 2006 and Local Environmental Action Plans adopted by municipalities;
- National Strategy for Approximation with EU Environmental Legislation adopted in 2009 with Sectoral Strategy for approximation on air and Detailed Plans for approximation with the most priority EU Directives;
- National Action Plan for ratification and implementation of the Protocol on heavy metals, Protocol on POPs and Gothenburg Protocol to the Convention on Long-Range Transboundary Air Pollution, adopted in 2010;
- National Strategy for Environmental Investment, adopted in 2010;
- Second National Communication on Climate Change, adopted in 2009;
- Strategy for Energy Development of the Republic of Macedonia by 2030;
- Strategy for Promotion of Energy Efficiency in the Republic of Macedonia by 2020;
- Baseline Study on renewable energy sources of the Republic of Macedonia;

- National Strategy and National Plan for Waste Management in the Republic of Macedonia;
- National Transport Strategy of the Republic of Macedonia;
- Industrial Policy 2009-2020.

Strategic documents have been adopted in transparent manner through involvement of public and participation of all stakeholders (bodies and institutions responsible for economy, transport, health, economic chambers and professional organizations).

4. Air quality assessment

4.1 Identification of sources of pollution and their air pollutant emissions for 2010 in the Republic of Macedonia

Emissions of pollutants from pollution sources like transport, industry, agriculture, etc., are transferred at great distances and have significant impacts on the quality of air, and thus on vegetation, animals and man. Therefore, their emission needs to be controlled and quantities released into the air should be reduced.

For the purposes of the above, Convention on Long-Range Transboundary Air Pollution (CLRTAP) has established inventory of air pollutants under the CORINAIR (CoR Inventory for Air Emission) Programme, applied in the Republic of Macedonia as of 2005. This methodology is further regulated by the secondary legislation, i.e. the Rulebook on the methodology for inventory and identification of the level of pollutants emission into the atmosphere in tons per year for all types of activities, as well as other data reported to the European Monitoring and Evaluation Programme (EMEP), adopted in November 2007 [8].

This programme has developed unique nomenclature and methodology (SNAP - Selected Nomenclature of Air Pollution) for presentation of the quantities of the main pollutants, namely: sulphur dioxide, nitrogen oxides, carbon monoxide and total suspended particles in the frames of eleven sectors listed in the Table below:

Table 4 SNAP Nomenclature

SNAP sector	Name
1	Combustion in thermal power plants, district heating plants and refinery
2	Heating boilers in non-industrial plants and small (household) fireplaces
3	Combustion processes in industrial production
4	Production processes
5	Extraction and distribution of fossil fuels and geothermal energy
6	Use of s olvents and other products
7	Road transport
8	Other mobile sources and machinery
9	Waste treatment and disposal
10	Agriculture
11	Other sources and sinks

The above listed main SNAP sectors are further divided into subsectors. This report covers only the main sectors and key subsectors in our country. Detailed overview of this categorization is included in the Informative Inventory Report on air emissions for the Republic of Macedonia.

The text below [9] shows the status of emissions of the main pollutants in the air in 2010 and quantities of emissions calculated by CORINAIR methodology have been taken into account for each pollutant. For certain pollutants, distribution of emissions by sectors and subsectors on which available and reliable data exist, being at the same time relevant for our country, has been presented graphically.

Sulphur dioxide

Significant share in SO_2emissions in the Republic of Macedonia originates from electric power (REK Bitola) and thermal power production plants (Toplifikacija), oil refinery (OKTA) and metallurgy (FENI, Metalstil, Makstil, Skopski Leguri). Domestic low calorific and highly polluting coal – lignite is used for electricity production in southwestern part of Macedonia, while power plants for thermal energy generation in Skopje use crude oil. Fuel combustion in industry, energy production, and transport causes occasional increase in the concentrations of SO_2 in the ambient air in cities and industrial zones.

Proportional distribution of sulphur dioxide emission by sectors and subsectors for 2010 at the level of the Republic of Macedonia is shown on Diagram 1.

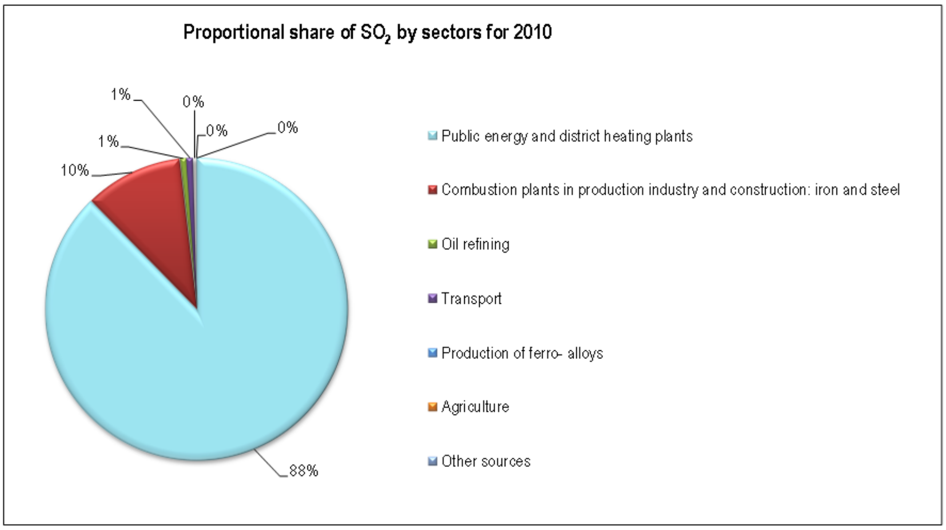


Diagram 1 Proportional share of SO_2 by sectors for 2010

The Diagram clearly shows that the highest proportion of 88 % is released from electricity and heat production, i.e. combustion of fuels in the process of electricity and heat generation. 10 % originates form combustion plants in manufacturing and construction industries and iron and steel industry.

Nitrogen oxides

Distribution of nitrogen oxide emissions by relevant sectors and subsectors for 2010 is shown on Diagram 2.

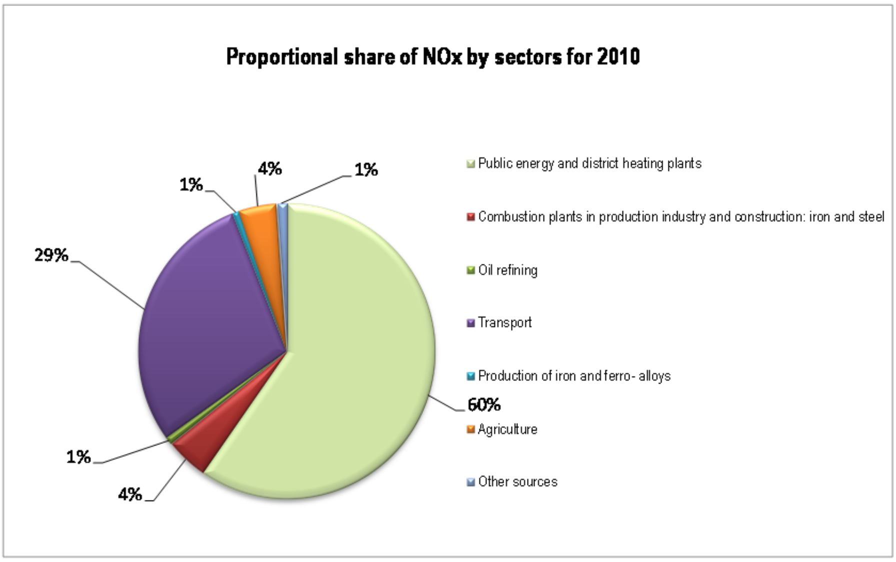


Diagram 2 Proportional share of NOx by sectors for 2010

Diagram 2 indicates that greatest quantities of nitrogen oxide emissions are released during electricity and heat production (60%), and high share also belongs to emissions from road transport (29%).

Carbon monoxide

Proportional distribution of carbon monoxide emissions by sectors and subsectors for 2010 at the level of the Republic of Macedonia is shown on Diagram 3.

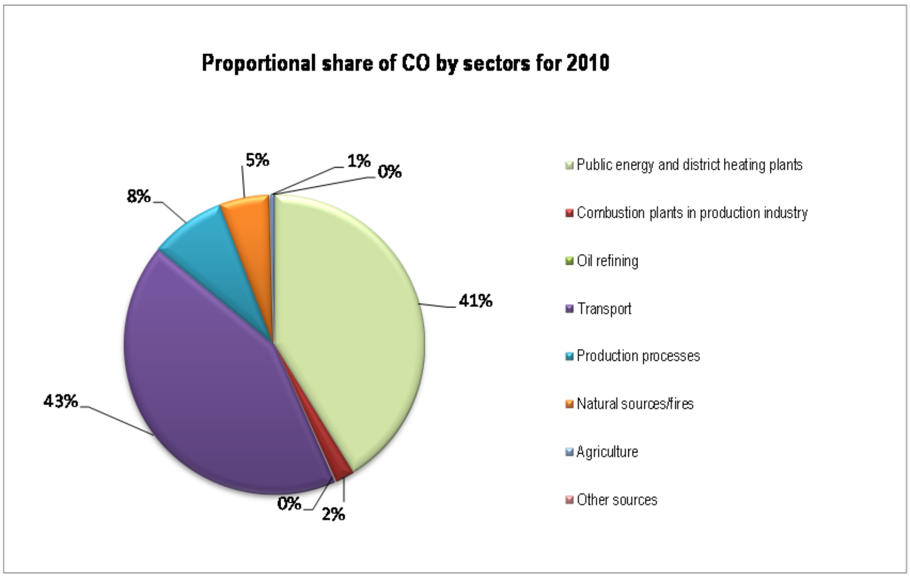


Diagram 3 Proportional share of CO by sectors for 2010

Highest proportion of carbon monoxide emission originates from the sector transport (43%) and sector related to emissions from stationary sources for heat and electricity production by public energy company and central heating plants (41%). This is most probably due to incomplete combustion of solid and liquid fuels used in these two sectors.

Total Suspended Particles

Proportional distribution of total suspended particles emission by sectors and subsectors for 2010 at the level of the Republic of Macedonia is shown on Diagram 4.

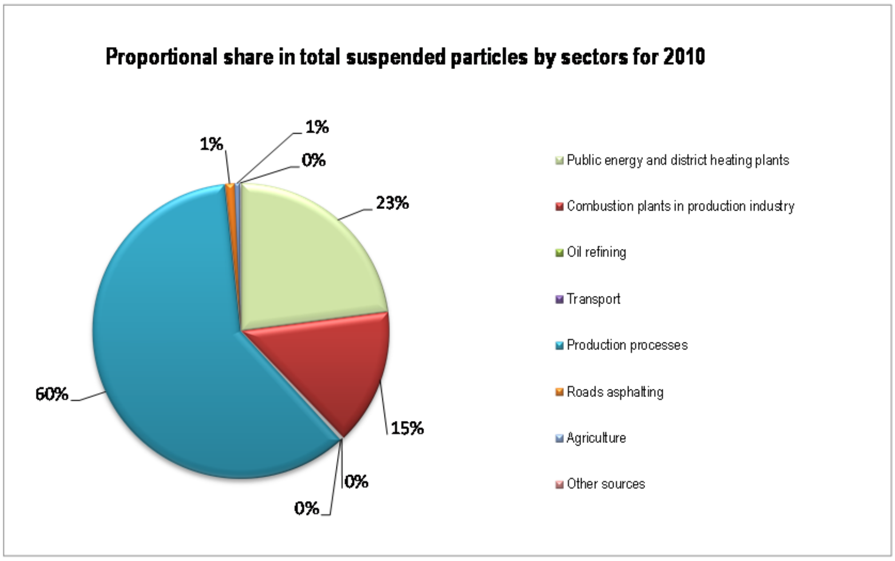


Diagram 4 Proportional share in total suspended particles by sectors for 2010

The highest percentage of suspended particles emission results from production processes (Makstil, Skopski Leguri, Feni, Silmak) and amounts 60%. Also, significant percentage in the total suspended particles is contributed by electricity and heat production with 23 % and combustion plants in manufacturing industry with 15%.

Volatile organic compounds (VOCs)

Volatile organic compounds comprise a wide spectrum of organic substances except methane, which at a temperature of 273.15 K manifest steam pressure of at least 0.01 kPa, or manifest corresponding volatility at certain applied conditions.

These substances influence concentration of ground ozone and contribute to the effect of greenhouse and ozone holes formation. They are released mostly from processes applying dyes, lacquers, pesticides, polishing products and other solvents and products. Another significant source of emission of these pollutants is transport, as well as fuel combustion processes in heat production.

These pollutants have harmful effect on the functioning of ecosystems, causing reduced commercial productivity of forests and haziness.

Share of SNAP sectors in non-methane volatile organic compounds emission is shown on the next Diagram 5.

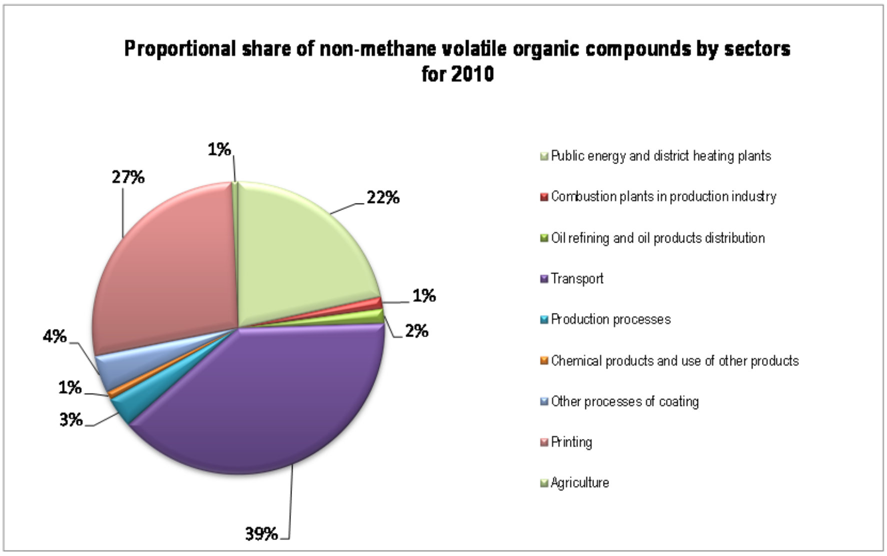


Diagram 5 Proportional share of non-methane volatile organic compounds by sectors for 2010

The highest proportion of volatile organic compounds emission originates from the sector transport amounting 39% and sector involving processes of printing with 27%. This is most probably due to incomplete combustion of solid and liquid fuels used in road transport and evaporations during poring processes. Significant share of 22% in the emission originates from oil distillation and oil derivatives distribution. Emissions from coating processes contribute 4 %.

Ammonia (NH_3)

Ammonia emissions originate mostly from activities performed in agriculture, such as animals breeding, eteric fermentation especially at larger farms, use of fertilizers and irregular combustion of waste at open spaces.

With regard to environment, high concentrations of this pollutant can cause eutrophication affecting natural ecosystems, reduction in growth rate and morphological development, and it is toxic for fish and other aquatic organisms at very high concentrations.

As shown on Diagram 6, almost entire ammonia emission results from livestock breeding sector. The highest share in ammonia emission (44%) originates from milky cows breeding. As shown below, only 1 % of ammonia emission is due to electricity and heat production.

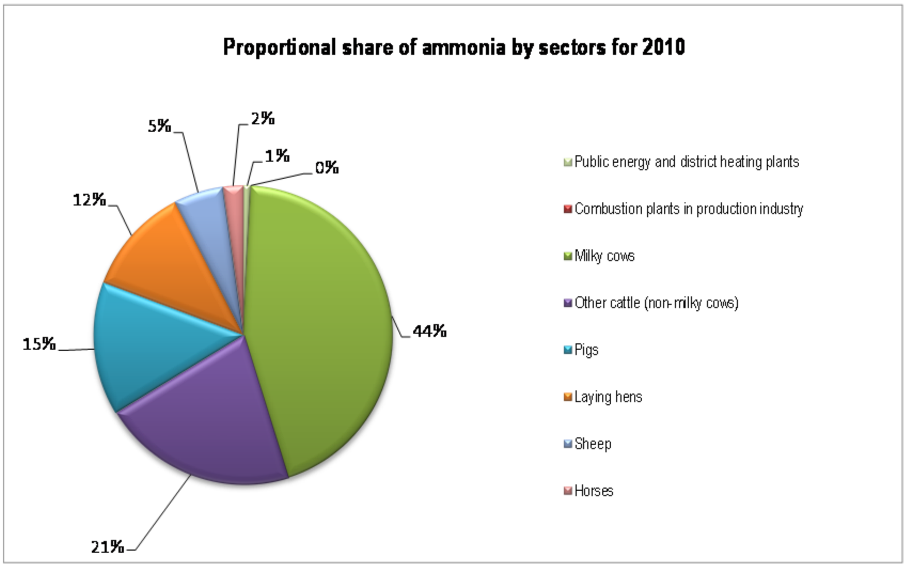


Diagram 6 Proportional share of ammonia by sectors for 2010

4.2 General description relative to historical data on air emission

Considering sources of individual pollutants emissions mentioned in the previous chapter, as well as emissions calculated by the main SNAP sectors (see Table Table 4), analysis was made for emission trends in the period 2001 to 2009 for sulphur dioxide, nitrogen oxides and carbon monoxide, and for the period 2003 to 2009 for total suspended particles sized up to 10 micrometers [12].

Sulphur dioxide

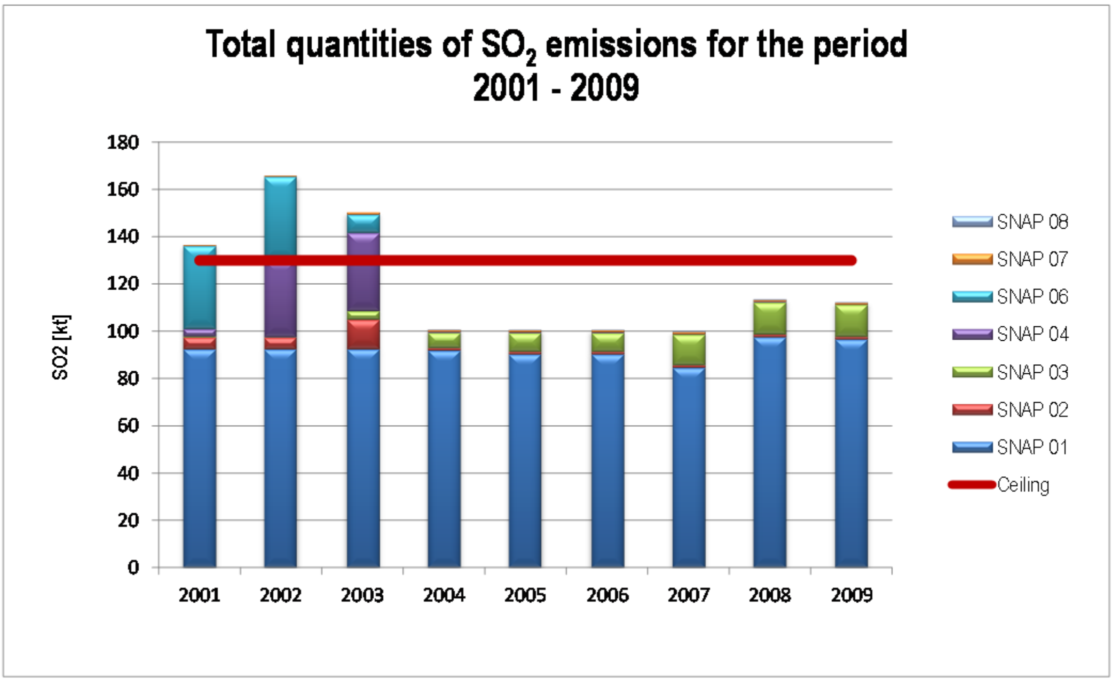


Diagram 7 Trend in SO_2 emissions for the period 2001-2009

The trend indicates that the quantities of SO_2 from 2002 to 2004 had reduced, from 2004 to 2009 had even trend with minor changes of reduction or increase as shown in Diagram. Greatest contribution to SO_2 emission originates from electricity and heating energy production, i.e. SNAP 01 and 02, followed by industrial processes sector SNAP 03 using or combusting fuels, and lower share goes to sectors of road transport SNAP 07 and other machinery SNAP 08.

Nitrogen oxides

Sectors (presented by SNAP methodology) that contribute the most to the quantity of nitrogen oxide emissions are the sectors for electricity and heat production, SNAP 01 and 02, processes in manufacturing, construction, iron and steel industry, SNAP 03 and 04 and transport SNAP 07 and 08. The trend in nitrogen oxide emissions noted increase by 2003 and then stabilized between 2004 and 2008 with slight reductions or increases as shown on Diagram 8, followed by reduction in 2009 relative to 2008 by 11.4%. The reduction is due to production processes SNAP 04 and road traffic sector SNAP 07.

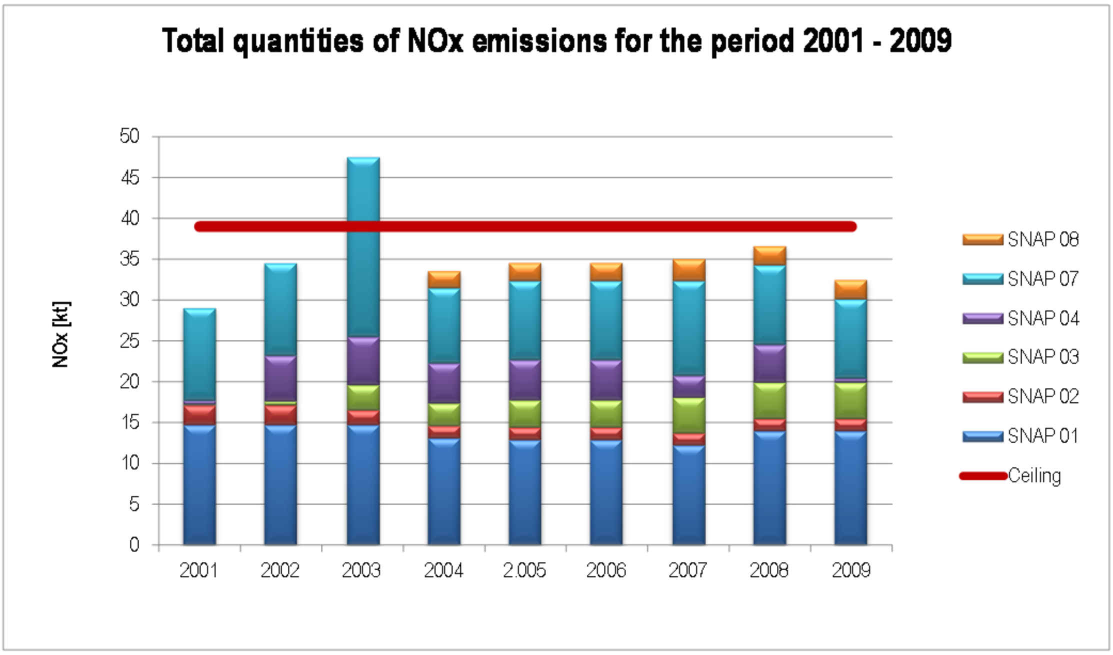


Diagram 8 Trend of NOx emissions for the period 2001-2009

Carbon monoxide

Emissions of CO are mainly evenly distributed to emissions from mobile sources (SNAP 07 and 08), and emissions from wood burning in the subsector households (SNAP 02 small combustion fireplaces - furnaces, hearths, stoves). Other emissions result from production technological processes.

It can be noted that the total CO emissions were the highest in 2003. The reason for this is that the calculation of total CO emission at that time took into account emissions from non-registered vehicles as well. Upon the introduction of the CORINAIR methodology in 2005, following the advice given by external experts, calculation of the emission of this pollutant from road transport has been based only on data on registered vehicles (contained in Statistical Yearbook), as only this data could be considered as relevant. Due to this, the next Diagram shows reduced CO emissions after 2003.

The trend of total emissions of CO in 2009 relative to 2008 shows more prominent fall in the quantities of CO emissions resulting from the sector of production processes and this is most probably due to terminated operation of industrial complex SILMAK (Jugohrom-Jegunovce).

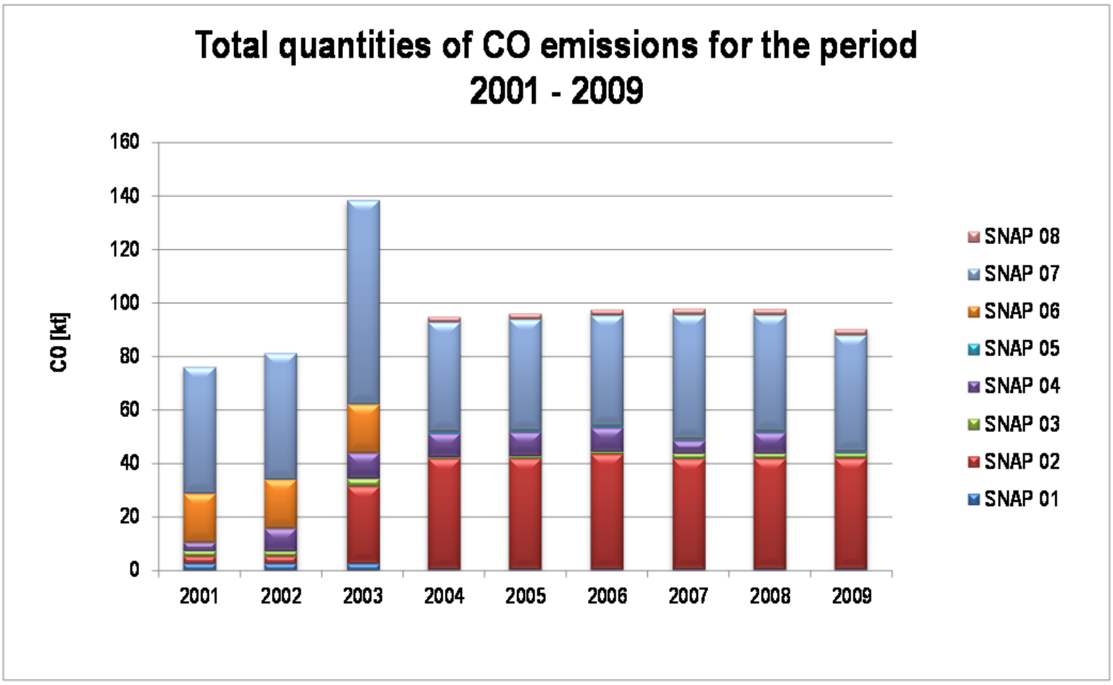


Diagram 9 Trend of CO emissions for the period 2001-2009

Total suspended particles

The highest contribution to TSP emissions in the Republic of Macedonia comes from production processes without combustion processes (SNAP 04). This contribution is variable and depends on the number of plants operating in the course of the year. This concerns the area of metallurgy (Makstil, Skopski Leguri, Feni, Silmak).

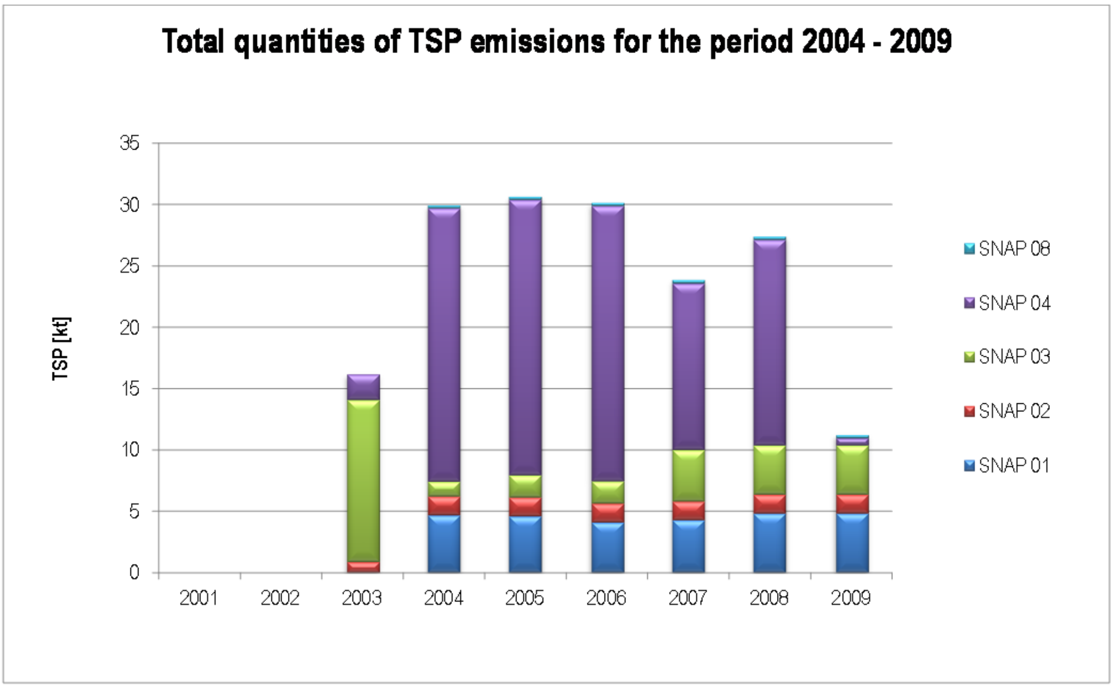


Diagram 10 Trend of TSP emissions for the period 2003-2009

Diagram shows the trend of TSP emissions in the period 2003 to 2009. It is notable that there are drastic oscillations relative to emission quantities in the period from 2006 to 2009 which confirms the above stated. Example of this is the case of 2009 with reduction of the emission resulting from non-operation of the industrial complex SILMAK (Jugohrom-Jegunovce).

Volatile organic compounds (VOCs)

Emissions of volatile organic compounds are mainly result of mobile sources (SNAP 07 and 08), followed by emissions from solvents and other products use (SNAP 06) and other emissions resulting from wood burning in the subsector – households (SNAP 020205, small combustion fireplaces – furnaces, hearths, stoves and other, where incomplete combustion occurs).

Diagram11shows the trend in VOC emissions in the period 2004 to 2009. Under the Rulebook on ceilings, the ceiling concerning this pollutant for 2010 was 30 kilo tones. During 2007, 2008 and 2009, there was increase in the quantities of volatile organic compound emissions by around 10% resulting from increased consumption of fuel in road transport.

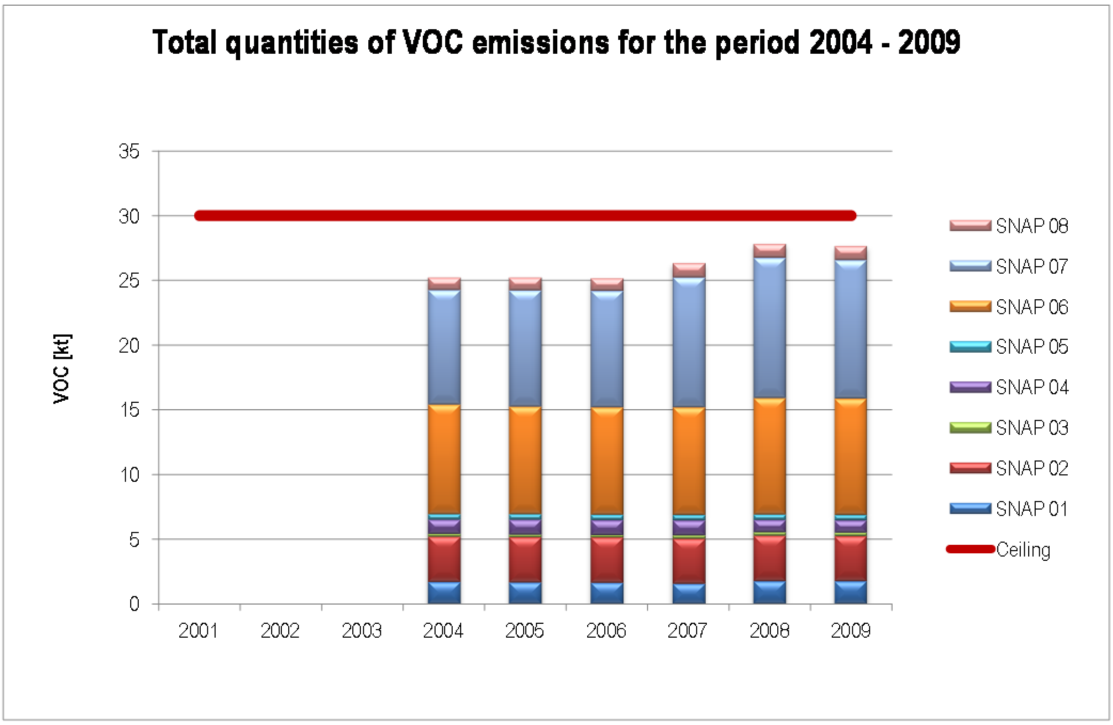


Diagram11 Trend of VOCs emission in the period 2004 to 2009 by SNAP sectors

Ammonia (NH_3)

The biggest source of ammonia emissions is the sector of agriculture, i.e. SNAP 10 (Cattle, pigs and poultry management). Ammonia emissions originating from cattle breeding have highest share (66%), then pigs with 15%, poultry with 12% and other animals with 8%.

Diagram 12 shows the trend in NH_3 emissions in the period 2004 to 2009. According to the Rulebook on emission ceilings, the ceiling applicable for this pollutant for 2010 was 17 kt. The quantities of emission for this period did not exceed the ceiling, being lower by around 10 kt at an average. During the last two years of the analyzed period, there was minor decline in NH_3 emissions, resulting from small drop in the number of cattle.

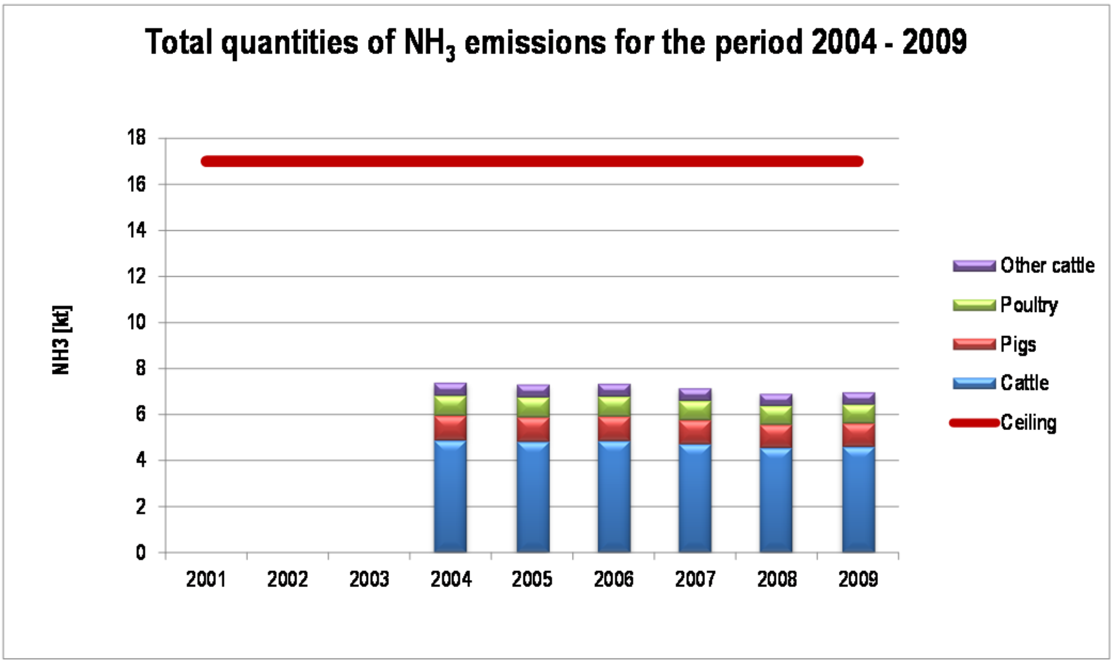


Diagram 12 Trend of NH_3 emissions for the period 2004 to 2009 by sources in livestock breeding

4.3 Projections of emissions of the pollutants SO_2, NOX, NH_3 and VOCs from 2010 to 2020

4.3.1 Introduction

Projections of emissions for a certain period of time (2010-2020) are made to provide awareness of potential broadcasted quantities of specified pollutants, using methodologies for establishment of individual development scenarios. Projections of pollutants emissions are part of the National Programme for gradual reduction of emission quantities for individual pollutants at the level of the Republic of Macedonia [29].

Projections of emissions are important tools in designing of strategies for emission reduction, aimed at achieving emission reductions in future. Projections are defined in the frames of given scenarios of social trends (population development, land use, GDP (Gross Domestic Product), transport and economic sectors like agriculture, energy, industry, etc.).

Reduction of the quantities of emissions in the air in accordance with the measures for their reduction should be allocated in a time and spatial frame and the efficiency of the wide spectrum of measures to be undertaken at present and in future should be evaluated.

Emission reduction is carried out as gradual reduction in emissions of the pollutants sulphur dioxide - SO_2, nitrogen oxides -NOx, ammonia -NH_3 and volatile organic compounds -VOCs. Emission reduction is carried out through implementation of adequate measures by which certain projected values should be achieved for the quantities of the specified pollutants for 2010, 2015 and 2020, respectively, and values of emission ceilings for 2010 are specified in accordance with the Rulebook on emission ceilings.

4.3.2 Definition of scenarios

There are scenarios using projection of air pollutants emission reductions from 2010 to 2020 where those cause acidification and eutrophication, as well as emissions from large combustion plants (LCPs) and transport. These methodology and terminology are in line with United Nations Economic Commission for Europe (UNECE), namely EMEP Protocol and Guidelines of the Convention on Long-Range Transboundary Air Pollution (CLRTAP).

Scenarios are most often defined as combination of existing and assumed future social trends (industry, energy, GDP, etc.) and existing legislation.

Projections broadcasting is based on data contained in the Strategy for Energy Development in the Republic of Macedonia by 2030, Energy Balance of the Republic of Macedonia for the period 2012 to 2016, Strategic Environmental Assessment of Energy Strategy, Strategy for Energy Efficiency Promotion in the Republic of Macedonia by 2020, Baseline Study on Renewable Energy Sources in the Republic of Macedonia, National Strategy for Transport and other documents in energy sector.

Business as usual scenario–baseline scenario (BS)

Determination of projections under the baseline scenario means that determination of emission projections takes into account all policies and measures planned by the year selected as baseline year. The baseline scenario is usually a framework and starting point for each emission projection. It is important that in case of preparation of emission projections under the baseline scenario, official documents, applicable legislation and year of fulfillment of individual emission reduction measures are used.

First mitigation scenario - (FMS)

The scenario of application of measures for emission reductions towards determination of quantities of pollutant emissions in the air involves certain existing, defined, and adopted, as well as future policies and measures for emissions reduction. These include economic and energy projections and impacts of envisaged policies and measures in order to establish their primary goal, i.e. whether they will result in reduction of emissions into the air or not.

Second mitigation scenario - (SMS)

The scenario of additional measures is a reflection of expected results of emissions if the planned policies and measures of realistic chances are adopted and implemented within the timeframe of the period for which emission reductions are projected (2020). This scenario is based on planned, but still not adopted policies and measures, broadcasts for further actions to be included for the purpose of emissions reduction.

4.3.3 Projections for sulphur dioxide emissions

Sulphur dioxide emissions under the baseline scenario-(BS)

In order to determine projections for annual quantities of sulphur dioxide emissions for 2010, 2015 and 2020, respectively, with assumptions taken as baseline scenario, we will first present the overview of the distribution of SO_2 emissions in the Republic of Macedonia by key sectors.

The key sectors for sulphur dioxide emissions are the sectors public energy and heating plants with 85.2% and combustion plants in production and construction industry: iron and steel with 10.5%. These emissions of SO_2 result from combustion of fossil fuels in electricity production by thermal power plants fired on coal (REK Bitola and REK Oslomej) that lack desulphurization plants. Apart from these, there are also emissions originating from combustion of liquid fuels from heat production and processes in industrial production, iron and steel and construction. Other annual quantities of emissions with around 4.3 % result mainly from combustion processes in the remained industrial production and household fireplaces, oil distillation, and minor part from combustion of liquid fuels in mobile sources. The goal is to identify emissions of SO_2 and undertake measures for their reduction.

As already mentioned, development of the baseline scenario while elaborating the projections under this document was based on the baseline scenario from the Strategy for Energy Development. Under it, the demand for energy will be growing by 2020 with average annual rate of 2.6%, but the share of renewable energy sources (RES) will also grow, as will the use of natural gas. This results in expected reductions in the quantities of SO_2 after 2015. The sector for electric and heat energy production, where the share of RES and natural gas is the highest, has been taken to calculate and estimate the reductions in the quantities of SO_2 by 2020, taking into account that the highest share of SO_2 emissions originates from that sector.

In the period 2010 to 2020, for which quantities of sulphur dioxide emissions are broadcasted and projected, under the baseline scenario, the highest rate of increase related to energy production is expected with solar energy, amounting around 14.5%, followed by natural gas with 7.8%, geothermal energy with 9.7% and oil derivatives together with biofuels with 3.1%. The rate of increase for electricity is 2.5%. The lowest rates of increase are broadcasted for coal of 1.6%, heat 1.2% and biomass for combustion - 0.7%.

During the analyzed period, the share of oil derivatives increases, while the share of electricity decreases from 34% to 33%. By this, coal will reduce its share by one percentage. The share of natural gas of 2% will rise by nearly 4%, and the share of geothermal and solar power will increase, too.

Emissions of sulphur dioxide under the first mitigation scenario - (FMS)

Under the first mitigation scenario which envisages reduction measures, determination of the quantities of sulphur dioxide emissions in the air is carried out by way of using certain existing, defined, adopted and further policies and measures for emissions reduction by 2020.

Based on the above, it is evident that the reduction of sulphur dioxide emissions in the area of energy through undertaking measures for reduction of pollution from energy resources will result in significant reductions in the quantities of sulphur dioxide emissions.

Therefore, the first mitigation scenario (FMS) includes measures for energy efficiency by which the demands for energy resources will grow with an average annual rate of 2.16% by 2020.

Improvement in energy diversity in supply with primary energy has been envisaged by 2020. Coal together with oil and oil derivatives will reduce their share by 2020, while the share of natural gas will grow from 2.4% in 2006 to 16% in 2020, while the share of renewable energy sources in the total primary energy in the same period will increase from 11.5% to 13.3%.

The highest rate in growth is again noted with solar energy of 17.8%, followed by geothermal energy with 11.7% and natural gas with 10%.

Under this scenario, natural gas will increase its share, while oil derivatives will decrease, and the share of solar and geothermal energy will increase compared to baseline scenario.

During the analyzed period, 80% of electricity production originates from coal based thermal power plants and 20% from renewable sources.

Sulphur dioxide emissions under the scenario with use of models

Total quantities of SO_2 emission for the period 2005-2020 have been obtained on the basis of the baseline scenario by application of the GAINS model (Greenhouse Gas and Air Pollution Interactions and Synergies), created by IIASA (International Institute for Applied Systems Analysis). This model examines the relation between the control of local and regional air pollution and transfer of greenhouse gas emissions at global level. GAINS is applied in 43 countries in Europe, including Russia. This model takes into account the emissions of the main pollutants, including SO_2. Data on the total quantities of SO_2 emissions was taken over from the Report of CIAM (Centre for Integrated Assessment Modelling).

Conclusion

The above presented scenarios are in compliance and in line with the strategic documents in the area of energy, as there are relevant documents in the domain of energy available at this moment. Based on this, further projections and broadcasts of the quantities of SO_2 emissions for 2015 and 2020 by application of measures for emission reduction will be based on energy production and consumption (electricity, liquid and gaseous fuels, bio-fuels, renewable sources).

Diagram 13 shows the quantities of SO_2 emissions under the three scenarios and emission ceiling, including comparison among them.

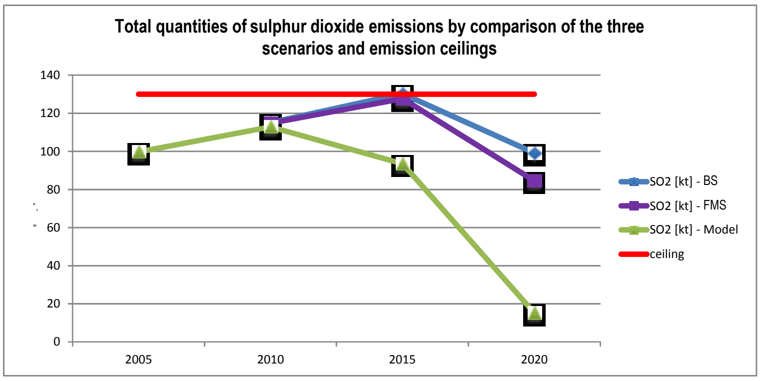


Diagram 13 Total quantities of sulphur dioxide emissions by comparison of the three scenarios

Projections indicate that the trend of reduction of sulphur dioxide emissions for 2010 under the baseline scenario relative to first mitigation scenario is 0.04%, while baseline scenario compared to scenario using broadcasting models results in sulphur dioxide emission reduction of 2%.

For 2015, projections indicate that the reduction of the quantities of sulphur dioxide emissions under the baseline scenario compared to first mitigation scenario is 2%, while baseline scenario compared to scenario using broadcasting models results in sulphur dioxide emission reduction of 28.2%.

The trend of reduction in the quantities of sulphur dioxide emissions, according to projected quantities for 2020 under the baseline scenario relative to first mitigation scenario is 14.7%, while baseline scenario compared to scenario using broadcasting models results in sulphur dioxide emission reduction of 84.7%.

Projected values of the quantities of emissions under the baseline scenario compared to the first mitigation scenario indicate that, from 2010 towards 2020, the percentage of reduction in the quantities of sulfur dioxide emissions increases from 0.04 % to 14.7%, which suggests that it is realistic to achieve it through application of the proposed measures. With reference to scenario developed through use of broadcasting models, the percentage of reduction in the quantities of sulphur dioxide emissions from 2010 to 2020 of 84.7%, considering the production of energy planned by 2020, as well as use of fuels in other sectors, it seems to be too ambitious due to the fact that its implementation is conditioned by huge financial resources.

The above presented analysis is in line with data according to which it is planned that the production of electricity from thermal power plants fired on coal will amount 42%–51% by 2020, depending on the scenario, from natural gas and renewable energy sources 24%–28%, respectively and from thermal power plant fired on crude oil 2%– 3%.

It should be pointed out that in the course of the analyzed period from 2010 to 2015, there are values of sulphur dioxide emissions close to the emission ceiling amounting 130 kilo tons per year, adopted on the basis of the Directive on emission ceiling for certain pollutants (32001L0081), while these quantities have great trend of reduction by 2020. This is most probably due to the fact that sulphur dioxide emissions projected under the baseline scenario and under the scenario involving energy efficiency measures assume implementation of the documents already adopted and documents to be adopted and finalization of projects in this area by 2020. Further reduction of sulphur dioxide emissions to reach values close to those of emissions envisaged by use of models requires as a measure application of recommended BATs in the sectors for energy production, reorganization of electricity production with share higher than 20% for renewable energy sources and modernization of industrial and production processes.

4.3.4 Projections of nitrogen oxides emission

Emissions of nitrogen oxides under the baseline scenario (BS)

In order to determine projections for annual quantities of nitrogen oxide emissions for 2010, 2015 and 2020, respectively, under the baseline scenario, we will first present the overview of the distribution of NOx emissions in the Republic of Macedonia by key sectors.

The key sectors (presented by SNAP methodology) with the greatest contribution to the quantity of nitrogen oxide emissions are the sectors for public energy (production of electricity and heat energy) with 37.2%, processes in production and construction industry: iron and steel with 11.3% and transport with 26.5%. These emissions of NOx result from combustion of fossil fuels in electricity production by thermal power plants fired on coal (REK Bitola and REK Oslomej) that do not use additives to reduce these emissions. Apart from these, there are also emissions originating from combustion of liquid fuels from heat production and processes in industrial production, iron and steel and construction. Other quantities of emissions result mainly from combustion processes in the remained industrial production, household fireplaces and oil distillation.

The growth of vehicles from 2006 to 2009 was 16% and to the most part concerned passenger vehicles. (Source: State Statistical Office).

Emissions of nitrogen oxides from heat and electricity production under the baseline scenario are in line with data presented in strategic documents in the area of energy. Analysis of these emissions is shown in the section on the baseline scenario for sulphur dioxide.

The baseline scenario for the transport sector assumes establishment of the trend in the rate of motorization as of 2010. Under the baseline scenario, the rate of motorization in 2020 will reach the value of around 260 per 1000 inhabitants.

The set scenario of the vehicle structure by the type of fuel is in accordance with the National Strategy for Transport, where the goals of sustainable environment include the requirement for use of cleaner fuels and alternative vehicles. According to this broadcast, the percentage of vehicles with petrol engines will drop from the current 73% to around 63% in 2020 (average reduction rate of 0.67% per year). The percentage of vehicles with diesel engines will increase from the current 23% to around 28.6% in 2020 (average annual growth rate of 0.33%), while the percentage of vehicles with combination petrol-gas will increase from 3.6% to around 8.5% (average annual growth rate of 0.34%).

Under this scenario, it is assumed that the current distribution of 88% passenger cars, 10% commercial vehicles and 2% motorcycles will remain unchanged throughout the broadcasting period.

Under the baseline scenario, relatively slow renewal of the vehicle fleet of only around 3.5% of the whole vehicle fleet is assumed.

Emissions of nitrogen oxides under the first mitigation scenario – (FMS)

Under the scenario assuming implementation of measures presented as basic measures for energy efficiency, there is a trend of decline in the quantities of nitrogen oxides emissions. This is especially a result of projects that are carried out or will be initiated upon 2013 to last up to 2020.

There has been also a scenario for slow growth in the transport sector. The scenario of "slow growth" assumes recovery of the trend in the rate of motorization as of 2013.

Under this scenario of "slow growth", it is envisaged that the number of vehicles will rise to 225 vehicles per 1000 inhabitants.

The total consumption of oil derivatives in 2020 for the transport under the slow growth scenario will be by 13% lower than the broadcasted consumption in the same year under the baseline scenario. Consumption of oil derivatives in the transport in 2020 will be by 63% higher than the one in 2007.

Emissions of nitrogen oxides by use of models

As in the case of SO_2, quantities of NO_x emissions for the period 2005-2020 have been obtained under the baseline scenario with application of GAINS model. Data on the total quantities of NO_x emissions obtained by modeling have been taken over from the Report of CIAM.

Conclusion

Projections and broadcasts of the quantities of NO_x emissions for 2010, 2015 and 2020, respectively through application of measures for emission reductions are based on energy production and consumption (electricity, liquid and gaseous fuels, bio-fuels, renewable sources).

Besides the above described measures, use of available data on transport has played an important role in the definition of scenarios. Also, projection of NO_x quantities has relied on the above listed strategies and documents as in the case of sulphur dioxide

Diagram 14 shows quantities of NO_x emissions under the three scenarios and emission ceiling and comparison among them.

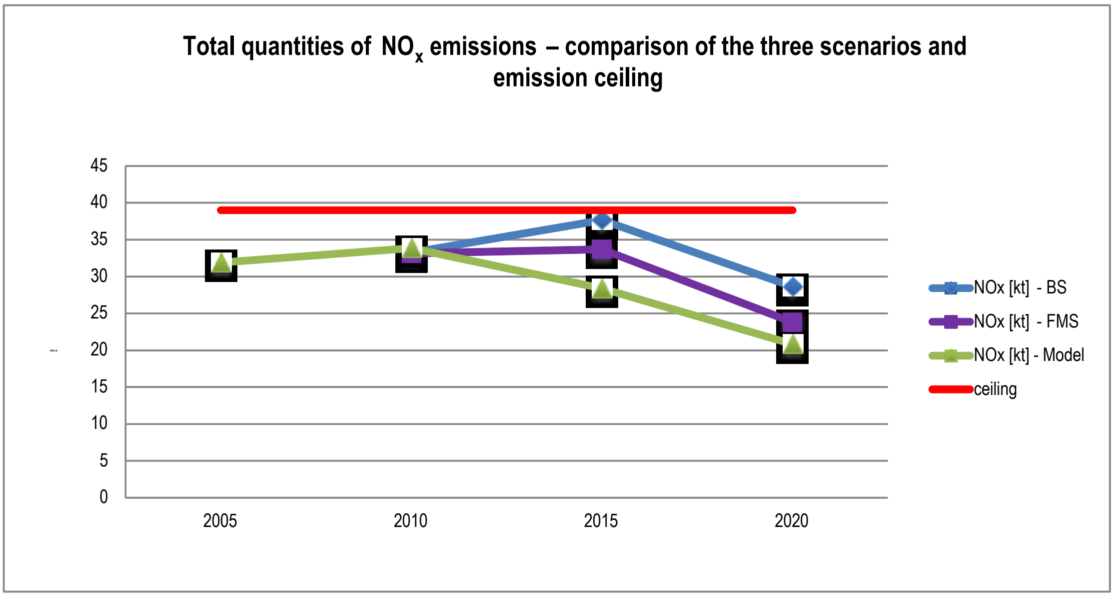


Diagram 14 Total quantities of NO_x emissions- comparison of the three scenarios

According to the presented broadcasts, there is a trend of reduction of nitrogen oxide emissions for 2010 under the baseline scenario relative to first mitigation scenario by 0.4%, while baseline scenario compared to scenario using broadcasting models results in increased emissions of nitrogen oxides by 1.7%.

Projections indicate that there is a trend of reduction in the quantities of nitrogen oxide emissions for 2015 under the baseline scenario relative to first mitigation scenario of 10.5%, while baseline scenario compared to scenario using broadcasting models results in nitrogen oxide emissions reduction of 24.6%.

The trend of reduction of the quantities of nitrogen oxide emissions for 2020 under the baseline scenario relative to first mitigation scenario is 16.9%, while baseline scenario compared to scenario using broadcasting models results in nitrogen oxide emissions reduction of 27.3%.

According to the presented quantities of nitrogen oxide emissions under the baseline scenario from 2010 to 2020, there is a trend of reduction in emissions by 13.7%, while under the first mitigation scenario, the reduction in nitrogen oxide emissions for the same period is 28.3%. Under the scenario involving use of broadcasting models, the achieved reduction is 38.4% of the quantities of nitrogen oxide emissions.

It should be underlined that the ceiling of 39 kilo tons per year, adopted under the Rulebook on emission ceilings, is not exceeded throughout the analyzed period

4.3.5 Projections of volatile organic compound (VOCs) emissions

Emissions of volatile organic compounds (VOCs) under the baseline scenario (BS)

Emissions of volatile organic compounds – VOCs by key sources indicate that they originate mostly from mobile sources (fuels combustion and evaporation) and contribute 39.6% to total emission, 27.4% originate from evaporations in printing industry,15% from households related sources, 6.2 % from evaporations in heat energy production and around 11.8% from other sources.

The trend in emission quantities from 2007 to 2009 shows increase in VOC emissions by around 10% resulting from the increase in the consumption of fuel in road transport.

Under the Rulebook on emission ceilings, the ceiling for VOC is 30 kt. According to presented trends, the emission ceiling has not been exceeded in any case.

It was difficult to provide exact data for the analysis of the quantities of volatile organic compounds (VOCs) in the period from 2010 to 2020 in accordance with the baseline scenario in several sectors (distribution of fuels, VOCs using and releasing industry) and the Strategy for Energy Development and other above mentioned documents were used for the purpose. Also, with regard to the use and quantities of fuels in transport, the analysis presented in the previous chapter (projections for nitrogen oxides) was used. All these analyses were in accordance with the calculations specified in the EMEP/CORINAIR Rulebook.Under this methodology, emissions of VOCs from use of organic solvents and evaporation in oil derivatives transfer stations in particular were determined by way of applying this methodology.

Baseline scenario for VOCs from the transport sector assumes return of the trend in the rate of motorization starting from 2010. Under the baseline scenario, the rate of motorization in 2020 will achieve value of around 260 vehicles per 1000 inhabitants. Also, significant share in the quantities of VOCs is related to uncontrolled emission – fugitive emission from petrol and other transfer stations.

Namely, in the period 2007 to 2012, the number of petrol stations has been assumed to be 300 and based on this data quantity of VOCs is obtained by calculation.

Emissions of volatile organic compounds (VOCs) under the first mitigation scenario

In the projections of the quantities of volatile organic compounds from 2010 to 2020 by use of emission reduction measures, we have taken into account the projections of the quantities of liquid fuels by sectors of energy production, for the consumption of fuels in transport, estimates of fuels evaporation in the course of their transport and distribution, evaporations in transfer stations and petrol stations, as well as projections of the growth in the number of vehicles under the slow growth model.

The "slow growth" scenario assumes establishment of stable economic growth and return to the trend of motorization rate as of 2013.

Under this "slow growth" scenario, it is envisaged that the number of vehicles will increase by 225 vehicles per 1000 inhabitants.

Emissions of volatile organic compounds (VOCs) under the scenario with use of models

Quantities of volatile organic compounds emissions for the period 2005-2020 have been obtained on the basis of the baseline scenario with application of the GAINS model. Data on the total quantities of VOC emissions obtained by modeling is taken over from the Report of CIAM.

Conclusion

The scenario with measures for VOC quantities reduction includes energy production, fugitive emissions, road transport and from stationary sources, as well as the sector of organic solvents application.

Directive 31999L0013, besides ELVs and thresholds of exceeding of given VOCs, also provides a scheme for their reduction. It should be mentioned that this part of the Directive has not been transposed in the Republic of Macedonia yet and VOCs reduction scheme has not been prepared.

With regard to certain processes lacking relevant data on VOCs, and where we thus were not able to use rates of activities and emission factors to calculate or estimate the quantities of emissions, we have taken into account data of international organizations.

Diagram 15 shows the broadcasted quantities of volatile organic compounds (VOCs) emissions through comparison among the three scenarios for the period from 2010 to 2020.

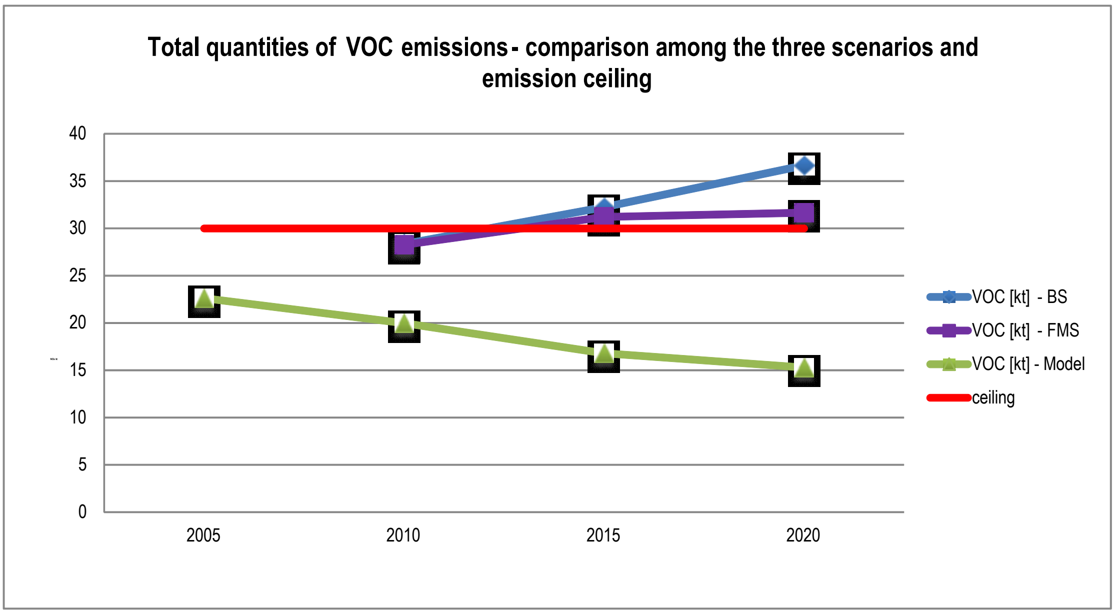


Diagram 15 Total quantities of VOC emissions - comparison among the three scenarios

According to the presented broadcasts, there is a trend of reduction in the quantities of VOC emissions for 2010 under the baseline scenario relative to first mitigation scenario by 0.4%, while baseline scenario compared to scenario using broadcasting models results in VOC emissions reduction by 29.6%.

Projections indicate that there is a trend of reduction in the quantities of VOCs emissions for 2015 under the baseline scenario relative to first mitigation scenario of 3.2%, while baseline scenario compared to scenario using broadcasting models results in VOC emissions reduction of 48 %.

Also, projections indicate a trend of reduction of the quantities of VOC emissions for 2020 under the baseline scenario relative to first mitigation scenario by 13.7%, while baseline scenario compared to scenario using broadcasting models results in VOC emissions reduction of 58.3%.

According to the presented quantities of VOC emissions under the baseline scenario from 2010 to 2020, there is a trend of increase in the emissions by 29.2%, while under the first mitigation scenario, there is increase in VOC emissions for the same period by 12%. This indicates that application of reduction measures for VOCs will in any case result in quantity reduction compared to the status under the baseline scenario. Under the scenario involving use of broadcasting models, the achieved reduction is 33.5% of the quantities of VOC emissions.

Throughout the analyzed period, there is excess of the emission ceiling of 30 kt per year, adopted in accordance with the Rulebook on emission ceilings, both under the baseline scenario and under the first mitigation scenario.

4.3.6 Projections for ammonia emissions

Emissions of ammonia under the baseline scenario

Emissions of ammonia into the air originate mainly from agricultural sector, with the segment of milky cows contributing 44.4% and other cattle breeding 21.1%, pigs 14.4%, laying hens 11.7% and sheep and horses 7.5%.

The trend of NH_3 emissions in the period from 2004 to 2009 did not exceed the emission ceiling for this pollutant for 2010 the value being set at 17 kt per year. During the last two years of the analyzed period, there was insignificant decline in emissions resulting from reduced number of cattle and sheep.

Identification of ammonia emissions is carried out on the basis of the methodology specified in the EMEP/CORINAIR Rulebook, in line with the Convention on Long-Range Transboundary Air Pollution, as well as official data of the State Statistical Office.

Calculation of emissions under the baseline scenario relies upon emissions in 2008 and correcting coefficient has been derived from coefficients of ammonia emissions reduction or increase in line with the trends in the period 2005 to 2009. The reason for this approach is that there were insignificant variations in ammonia emissions in the period 2005 to 2009.

Final and accurate determination of projections for ammonia quantities also require elaboration of the adopted Common Basic Cattle Breeding Programme (CBCBP) and the Code of Good Agricultural and Hygiene Practice, adopted in the course of this document elaboration. It was not possible to use the measures for improved cattle breeding contained in it to define the scenario for ammonia projections for the period from 2010 to 2020 by application of reduction measures.

Emissions of ammonia under the scenario with use of models

As in the case of determining the quantities of previous core pollutants, GAINS model was also used with regard to the quantities of ammonia emissions. Data on ammonia obtained by modeling was taken over from the Report of CIAM.However, in the case of ammonia, the CAPRI model (Common Agricultural Policy Regionalised Impact) was applied to determine emissions from agriculture.

The said economic model was developed by the European Commission, being applicable for a decade. It has been based on scientific quantitative analysis, related to legislation in the area of agriculture and it is used to assess the effects of the application of legislation in the areas of agriculture, trade in products, markets, benefits and environment, as well as for scientific research purposes. This global economic model is focused on EU Member States, Norway, Turkey and West Balkan countries.

Conclusion

Very rapid changes in legislation concerning cattle breeding are expected in the period 2011 to 2014, as it is approximated with the one of the EU and common market. This period should be used to increase the number of cattle and total production (Common Basic Cattle Breeding Programme 2011-2020).

In the period by 2019, increased number of cattle per farmer is expected, as well as increased production per cow, but also gradual stagnation or reduction in the total number of cattle for meat and milk.

We should also point out that identification of ammonia from agricultural sector (breeding of cattle, sheep, goats, poultry, etc.) should be in line with the Code of Good Agricultural and Hygiene Practice (Official Gazette of the Republic of Macedonia" no. 112/10) and Common Basic Cattle Breeding Programme for the period 2011-2020 (Official Gazette of the Republic of Macedonia no. 43/2011)

As already mentioned, due to the lack of data availability concerning the quantity of used fertilizers, projections of ammonia for the coming period by 2020 have not been elaborated for this segment.

Diagram 16 shows total quantities of ammonia emissions by comparison of the two scenarios.

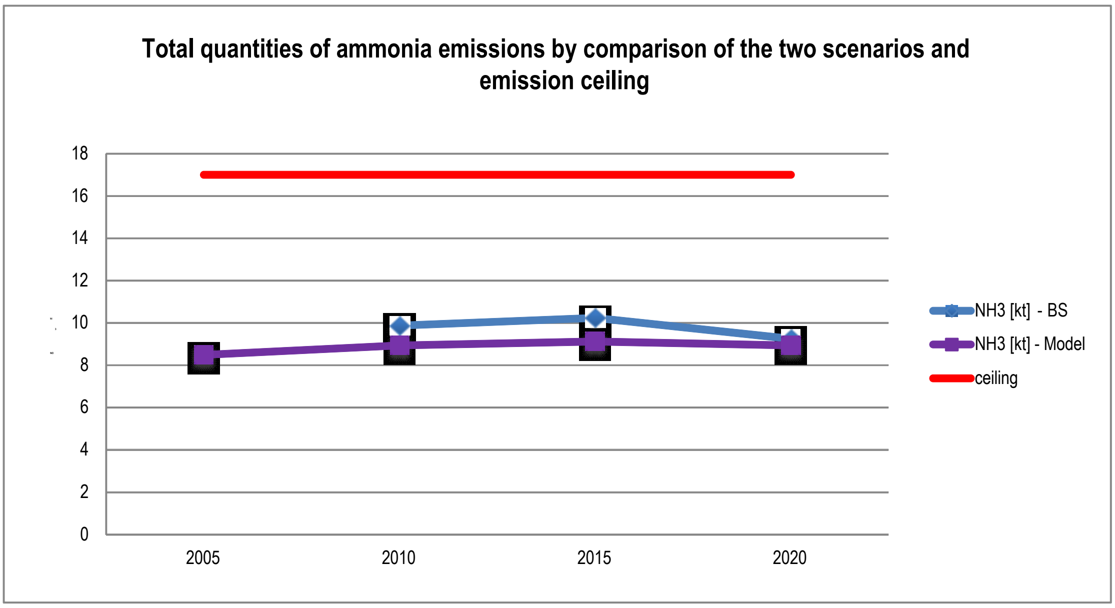


Diagram 16 Total quantities of ammonia emissions by comparison of the two scenarios

With reference to ammonia emission projections for the period 2010 to 2020, it is a general assessment that under both scenarios quantities grow by 2015, though not by high percentage, and then fall by 2020 also by low percentage. Increase by 2015 is due to the fact that the relevant legislation in this area is expected to be prepared and introduced for enforcement upon 2014, which should contribute to further reduction of ammonia emissions.

Based on data processed for the purposes of this document, we may conclude that the increase in the quantities of ammonia emissions under the baseline scenario in the period from 2010 to 2015 is 3.7%, to fall by 6.3% until 2020 compared to 2010.

In relation to the scenario obtained by use of models, in the period from 2010 to 2015, there is increase in the ammonia quantities by 2.1%, i.e. quantities of 2010 will be retained.

It is evident that the quantities determined under the baseline scenario and under the scenario involving use of models are close in value, being much lower than the specified emission ceiling for ammonia for 2010 which is 17 kt per year. This may indicate the fact that it is necessary to re-assess the quantities of ammonia emissions, as well as the value of the emission ceiling for ammonia for 2010. It is necessary to carry out further comprehensive analysis of all ammonia releases in order to identify its more probable quantities and projections, using the documents Code of Good Agricultural and Hygiene Practice and Common Basic Cattle Breeding Programme- CBCBP for the period 2011-2020.

4.4Air quality measurement on the territory of the Republic of Macedonia (description of measuring networks)

Quantities of the emissions of pollutants released from the above mentioned sectors have impact on their concentrations in the air. In order to undertake measures for their reduction and achieve better quality of the air, it is necessary to monitor the state of the air quality, i.e. carry out monitoring of pollutants for their qualitative and quantitative identification.

Air quality monitoring – State network

The monitoring of the ambient air quality in the Republic of Macedonia is performed by the Ministry of Environment and Physical Planning which manages the State Automatic Air Quality Monitoring System, as well as the Public Health Institute (PHI) with the Public Health Centres from Skopje and Veles. These institutions form the state network for air quality monitoring.

The Ministry of Environment and Physical Planning manages the State Automatic Air Quality Monitoring System, composed of 17 monitoring stations, namely: 5 measuring stations in Skopje (located at measuring points in Karposh, Centar, Lisiche, Gazi Baba and in the yard of the Rector's Office of the University "St. Cyril and Methodius", or measuring point Rektorat), 2 measuring stations in Bitola, 2 measuring stations in Veles, 2 measuring stations in Ilinden (located in the village Miladinovci and village Mrshevci near OKTA Refinery), and one measuring station in each Kichevo, Kumanovo, Tetovo, Kavadarci and village Lazaropole.

Automatic air quality monitoring stations carry out monitoring of the following pollutants:

- sulphur dioxide
- nitrogen dioxide
- carbon monoxide
- ozone
- suspended particles sized up to 10 micrometers (PM_{10})
- suspended particles sized up to 2.5 micrometers ($PM_{2.5}$)
- benzene, toluene, ethyl-benzene, ortho and para xylene (BTX)

Measuring points in the village Mrshevci and Gazi Baba do not measure concentration of ozone, the measuring point Rektorat does not measure concentration of sulphur dioxide, Lazaropole measuring point does not measure concentration of carbon monoxide, while BTX is measured only in Miladinovci and Rektorat points. Concentration of solid particles sized up to 2.5 micrometers commenced to be measured at the measuring points Karposh and Centar as of September 2011.

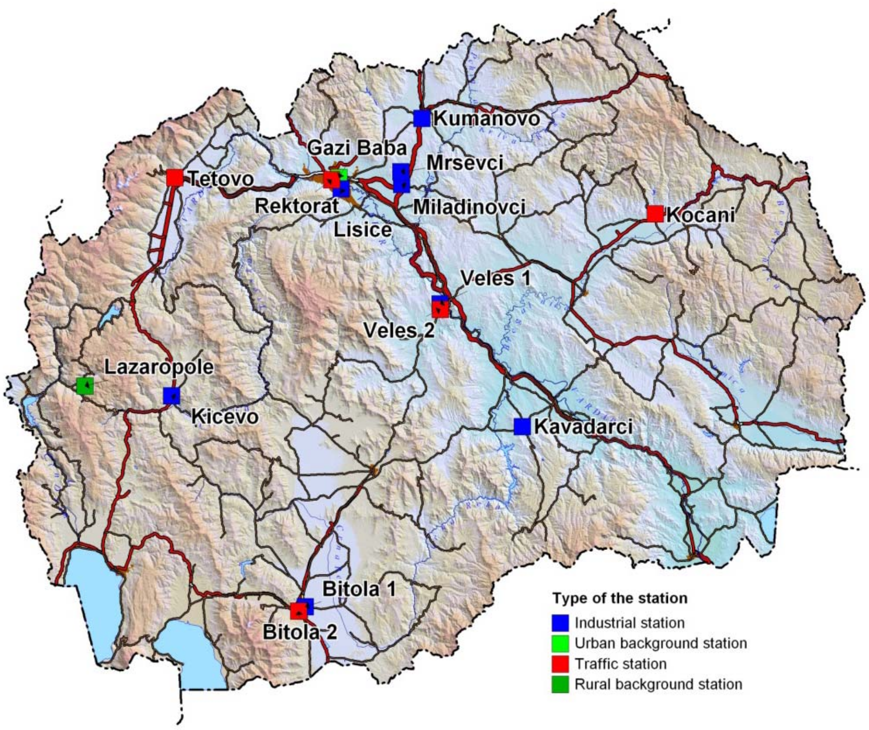


Figure1 State Automatic Ambient Air Quality Monitoring System

The Ministry of Environment and Physical Planning also has four high volume automatic sampling devices located in Kumanovo, Kochani, Lazaropole and Bitola, as well as six low volume sampling devices located in Jegunovce, Karposh, Lisiche, Veles, Kavadarci and Kichevo. By these devices, air samples are taken in fraction of PM10 and concentrations of Pb, Cd, Ni, As, Zn, Cr, Hg, V, Mn, Mg, Cu and Fe are determined. Locations of sampling devices are shown on Figure 2.

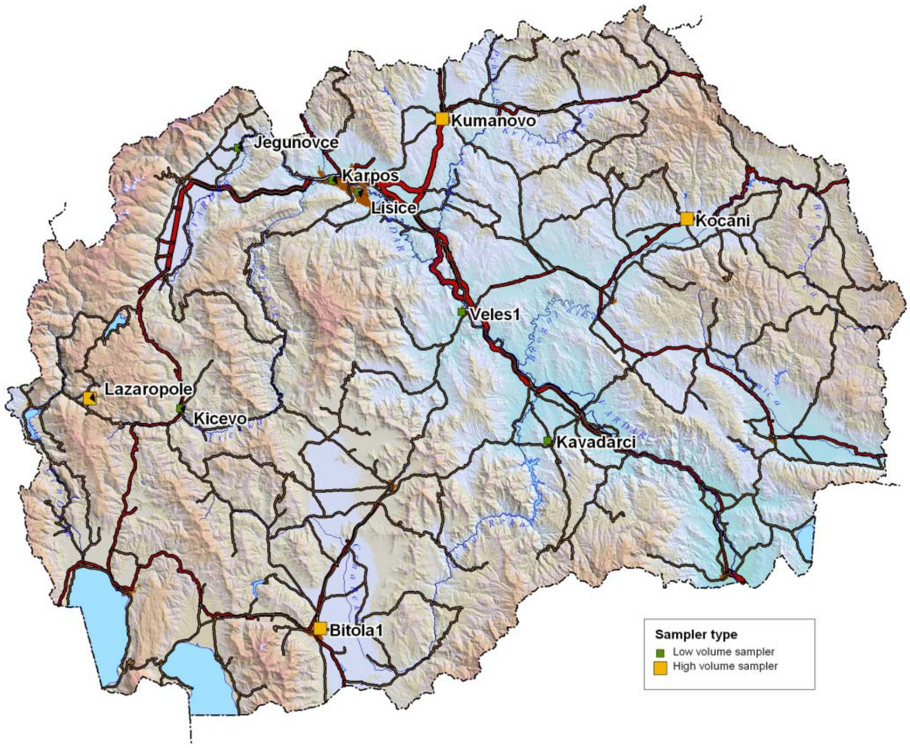


Figure 2 Location of automatic ambient air quality sampling devices

Public Health Institute performs monitoring of the ambient air quality through public health centres in Skopje and Veles.

Public Health Centre – Skopje performs measurements of sulphur dioxide and smoke at 7 measuring points in the city: DDD, Dimo Hadzi Dimov, Panorama, PHI, Evropa, Usje and Srnichka. Measurement of lead is carried out at one measuring point.

Public Health Centre – Veles performs measurements of sulphur dioxide and smoke at 3 measuring points in the city: Employment Bureau, Nova Naselba and Tunel, as well as measurements of zinc, cadmium and lead at one measuring point.

Air quality monitoring – Local network

Under Article 39 of the Law on Ambient Air Quality, Municipalities and the City of Skopje may, upon prior obtained opinion by the MEPP and under conditions and in a manner defined in the Law on Ambient Air Quality, establish local monitoring networks in settlements and industrial areas. In accordance with this, in February 2011, the City of Skopje set automatic monitoring station on Makedonija Street to measure the following parameters:

- sulphur dioxide
- nitrogen dioxide

- carbon monoxide
- suspended particles sized up to 10 micrometers (PM10)

In February 2011, display was placed to present the measured concentrations [9].

4.5Overview of the current status of ambient air quality

This chapter describes the status of the air quality in the Republic of Macedonia in 2010, regarding sulphur dioxide, nitrogen oxides, carbon monoxide, suspended particles sized up to ten micrometers and ozone. Data on the listed pollutants, except sulphur dioxide, has been obtained from the automatic monitoring stations within the State Automatic Air Quality Monitoring System (SAAQMS). As far as sulphur dioxide is concerned, besides measuring stations of the MEPP, data presented and analyzed originate from manual measuring stations of Public Health Centres in Skopje and Veles (see previous chapter).

The overview of conducted analysis of data on measured concentrations of pollutants regarding limit values, target values, alert and information thresholds and long-term targets has been taken over from the Annual Report of processed environmental quality data for 2010 [9].

Sulphur dioxide

Concentration of sulphur dioxide in 2010 was measured at 14 measuring stations within SAAQMS and 9 measuring points managed by PHC Skopje and Veles. Data obtained has been compared with the limit values for human health protection shown in **Error! Unknown switch argument.**.

Table 5 Limit values for human health protection for sulphur dioxide

Pollutant	Average period	Limit value to be achieved in 2012	Permissible number of exceedings during a year	Margin of tolerance for 2010	Limit value for 2010	Alert threshold
SO_2	1 hour	350 μg/m^3	24	60 μg/m^3	410 μg/m^3	
	24 hours	125 μg/m^3	3	-	125 μg/m^3	
	3 consecutive hours					500 μg/m^3

Table 6 Limit values for ecosystems protection for sulphur dioxide

Pollutant	Protection	Average period	Limit value to be achieved in 2012	Margin of tolerance for 2010	Limit value for 2010
SO_2	Ecosystems	Year Winter period	20 μg/m^3	-	20 μg/m^3

On the next Diagram, it can be noted that data from the measuring stations Kumanovo and Veles-1 are not presented. This derives from the fact that the data coverage for these measuring stations is not sufficient to meet the requirements specified in the Rulebook on criteria, methods and procedures for ambient air quality assessment [11].

The next Diagram shows data on average annual concentrations and average annual concentrations in winter period for sulphur dioxide from the monitoring network of MEPP.

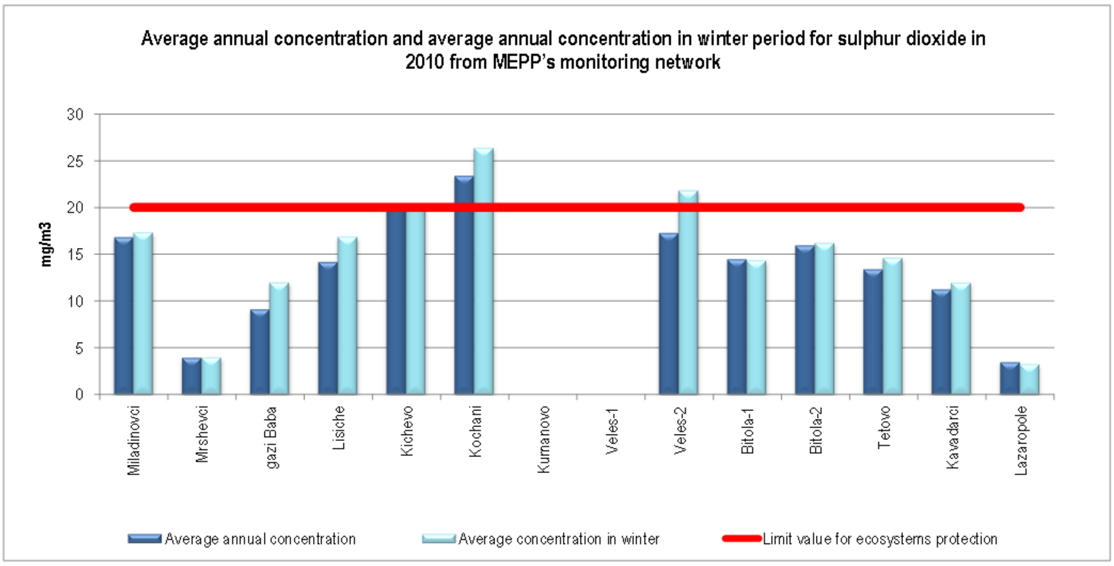


Diagram 17 Average annual concentration and average annual concentration in winter period for sulphur dioxide in 2010 from MEPP's monitoring network

Diagram 17 shows that the average concentration of sulphur dioxide measured in winter period is higher than the average annual concentration at all measuring points. This results from the higher frequency of traffic and operation of heat energy producing facilities in winter period.

Exceedings of the limit value for ecosystems protection relative to the average annual concentration and average annual concentration in winter period have been noted on the measuring point in Kochani. Exceedings of the limit value for ecosystems protection relative to average concentration in winter period have been noted on the measuring points in Veles (Veles 2). Exceedings have not been recorded on the measuring points in Gazi Baba, Lisiche, Miladinovci, Mrshevci, Kichevo, Bitola 1, Bitola 2,Tetovo, Kavadarci and Lazaropole.

The lowest average annual concentration of 3.48 $\mu g/m^3$ of sulphur dioxide has been recorded in Lazaropole, and the highest one in Kochani of23.41$\mu g/m^3$.

Data on average annual concentrations and average annual concentrations in winter period for sulphur dioxide from the monitoring network of PHC Skopje and Veles are presented on Diagram 18.

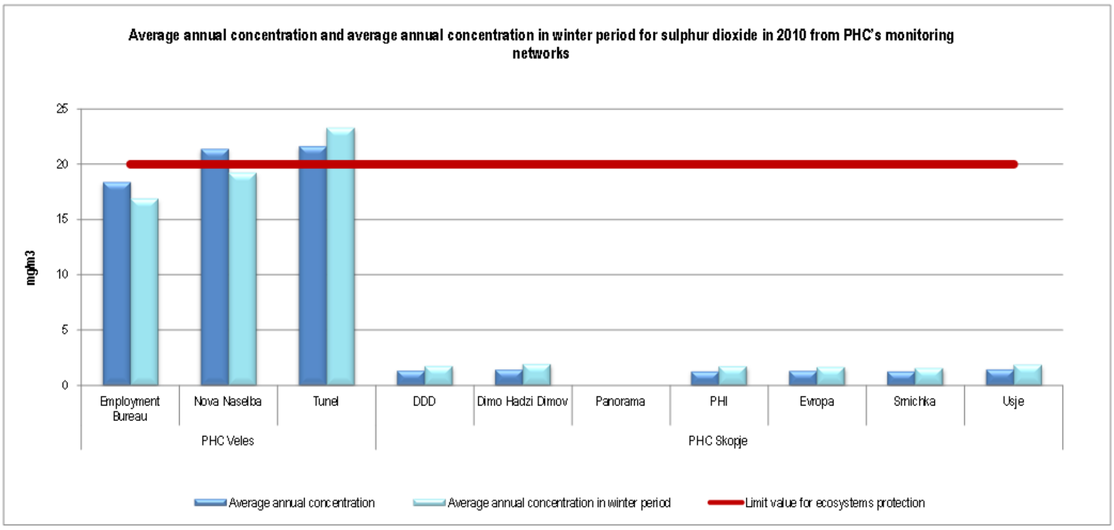


Diagram 18 Average annual concentration and average annual concentration in winter period for sulphur dioxide in 2010 from PHC's monitoring networks

As in the previous case, average annual concentration of sulphur dioxide measured in winter period is higher than the average annual concentration, except on the measuring points Employment Bureau and Nova Naselba.

Exceedings of the limit value for ecosystems protection relative to the average annual concentration and average annual concentration in winter period have been recorded on the measuring point Nova Naselba. Exceedings of the limit value for ecosystems protection relative to average concentration in winter period have been recorded on the measuring points in Employment Bureau, DDD, Dimo Hadzi Dimov, PHI, Evropa, Srnichka and Usje.

The lowest average annual concentration of sulphur dioxide of 1.26 $\mu g/m^3$has been recorded in PHI, and the highest one of 21.64 $\mu g/m^3$ in Tunel.

In 2010, no exceeding was recorded of the number of permissible exceedings of hourly limit value from human health protection point of view at any of the stations. Permissible number of exceedings of daily limit value from human health protection point of view was not recorded at any of the stations of the MEPPs monitoring network. No exceeding was recorded of the number of permissible exceedings of daily limit value from human health protection point of view at any of the stations of the monitoring network managed by PHCs Skopje and Veles, either.

As far as alert threshold is concerned (500 $\mu g/m^3$) in the course of three consecutive hours, it has not been exceeded at any measuring point.

Nitrogen oxides

Concentration of nitrogen oxides in 2010 was measured at 15 measuring stations within SAAQMS. Comparison of data obtained with the limit values for human health protection for nitrogen dioxide is presented in Table 7 and shown on Diagram 19.

Table 7 Limit values for human health protection for nitrogen dioxide

Pollutant	Average period	Limit value to be achieved in 2012	Permissible number of exceeding during a year	Margin of tolerance for 2010	Limit value for 2010	Alert threshold

NO_2	1 hour	200 µg/m³	18	40 µg/m³	240 µg/m³	
	1 year	40 µg/m³	0	8 µg/m³	48 µg/m³	
	3 consecutive hours					400 µg/m³

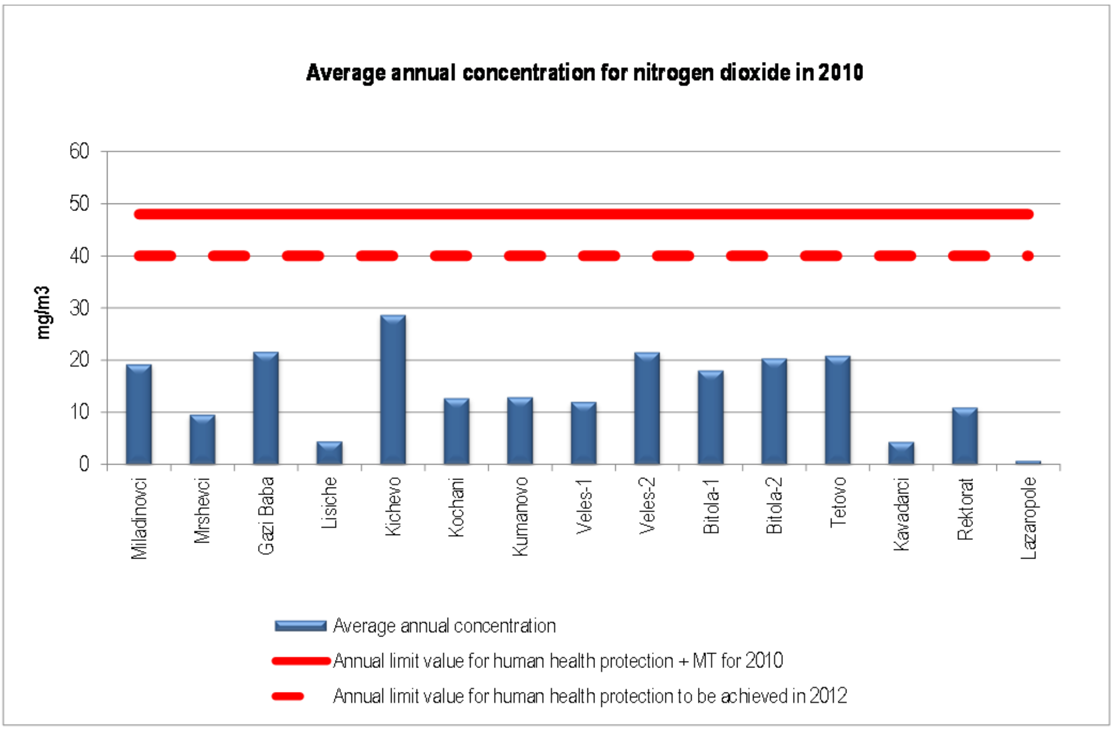


Diagram 19 Average annual concentration for nitrogen dioxide in 2010

The Diagram shows that the average annual concentration of nitrogen dioxide compared to limit value for human health protection plus margin of tolerance for 2010 (48 µg/m³) was not exceeded at any measuring point.

The average annual concentration of nitrogen dioxide compared to limit value for human health protection to be achieved in 2012 (40 µg/m³), has also not been exceeded in any of the measuring points.

The lowest average annual concentration of nitrogen dioxide of 0.73 µg/m³ has been recorded in Lazaropole, and the highest one of 28.66 µg/m³ in Kichevo.

In 2010, number of permissible exceeding of the hourly limit value from human health protection point, as well as alert threshold, was not exceeded in any of the measuring stations.

Suspended particles

With regard to suspended particles for 2010, data is available from all 15 measuring points. This data on measures concentrations of suspended particles sized up to 10 micrometers is compared to limit values for human health protection shown in Table 8.

Table 8 Limit values for human health protection for PM_{10}

Pollutant	Average	Limit value to be	Permissible number of exceeding during	Margin of	Limit value	Alert threshold

	period	achieved in 2012	a year	tolerance for 2010	for 2010	
PM10	24 hours	50 μg/m³	35	0 μg/m³	50 μg/m³	
	1 year	40 μg/m³	0	0 μg/m³	40 μg/m³	

Analysis conducted is presented on the next two Diagrams.

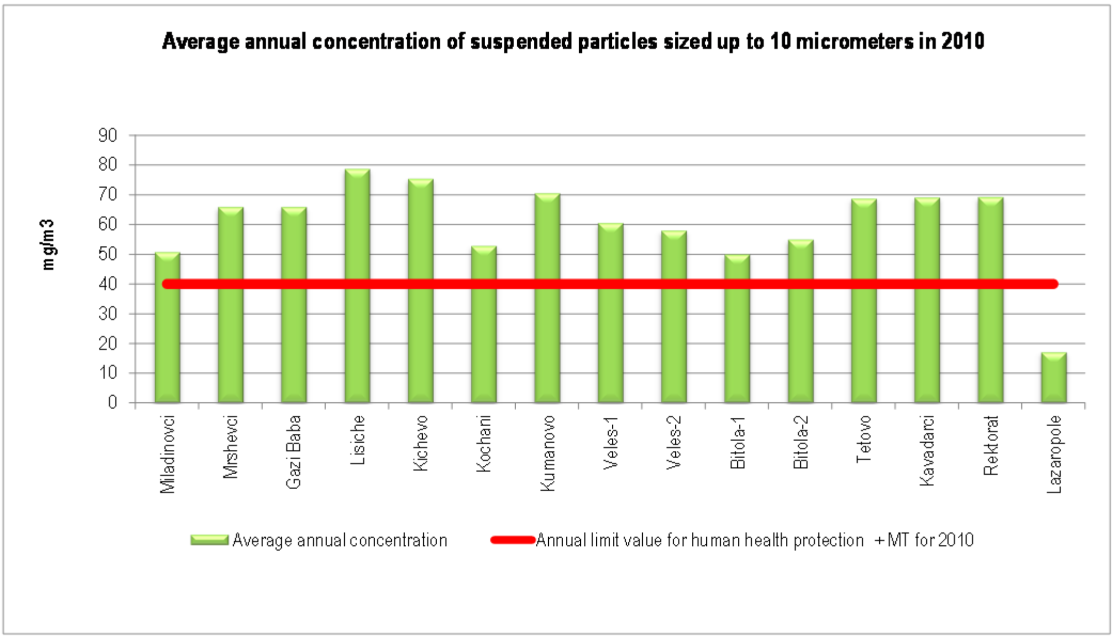


Diagram 20 Average annual concentration of suspended particles sized up to 10 micrometers in 2010

The average annual concentration relative to the annual limit value for human health protection for 2010 was not exceeded only on the measuring point Lazaropole.

The lowest average annual concentration of PM10 of 17.04 μg/m³ has been recorded in Lazaropole, and the highest one of 78.65 μg/m³ in Lisiche.

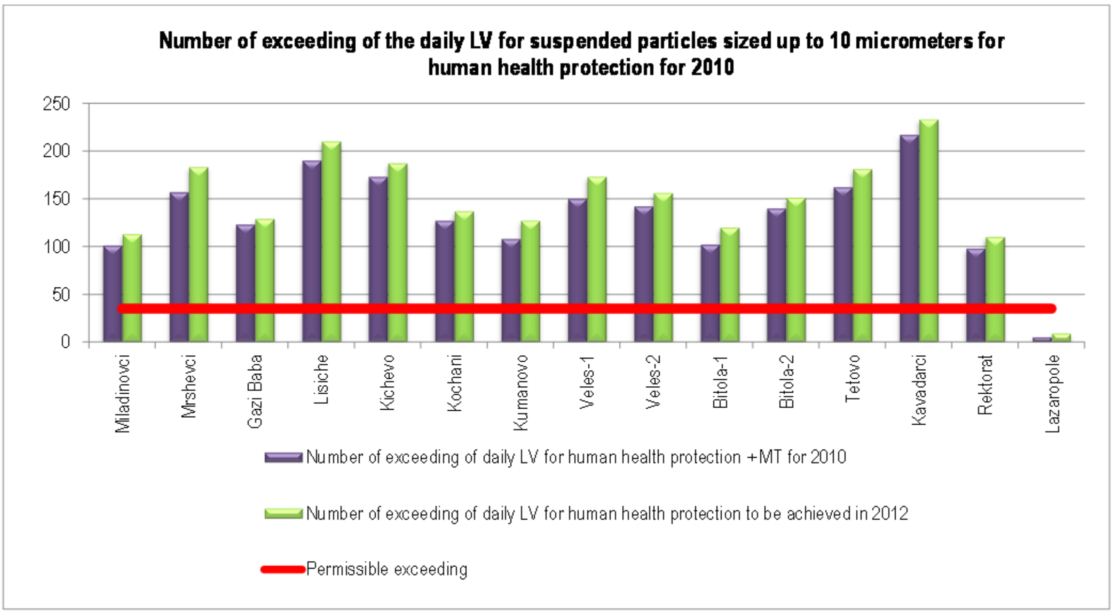


Diagram 21 Number of exceeding of the daily LV for suspended particles sized up to 10 micrometers for human health protection for 2010

Diagram 21 shows that in 2010, the number of permissible exceeding of the daily limit value from human health protection point of view was exceeded in all measuring stations, except in Lazaropole.

Carbon monoxide

As far as carbon monoxide is concerned, as mentioned above, it is measured at all measuring stations except Lazaropole. With regard to this pollutant, there is no sufficient data available for 2010 from the measuring station located in Kochani. Data obtained from the remaining 13 stations has been compared to the maximum daily 8 hour average value given in Table 9.

Table 9 Limit values for human health protection for carbon monoxide

Pollutant	Average period	Limit value to be achieved in 2012	Permissible number of exceeding during a year	Margin of tolerance for 2010	Limit value for 2010	Alert threshold
CO	Maximum daily 8 hour average value	10 mg/m³	0	2 mg/m³	12 mg/m³	

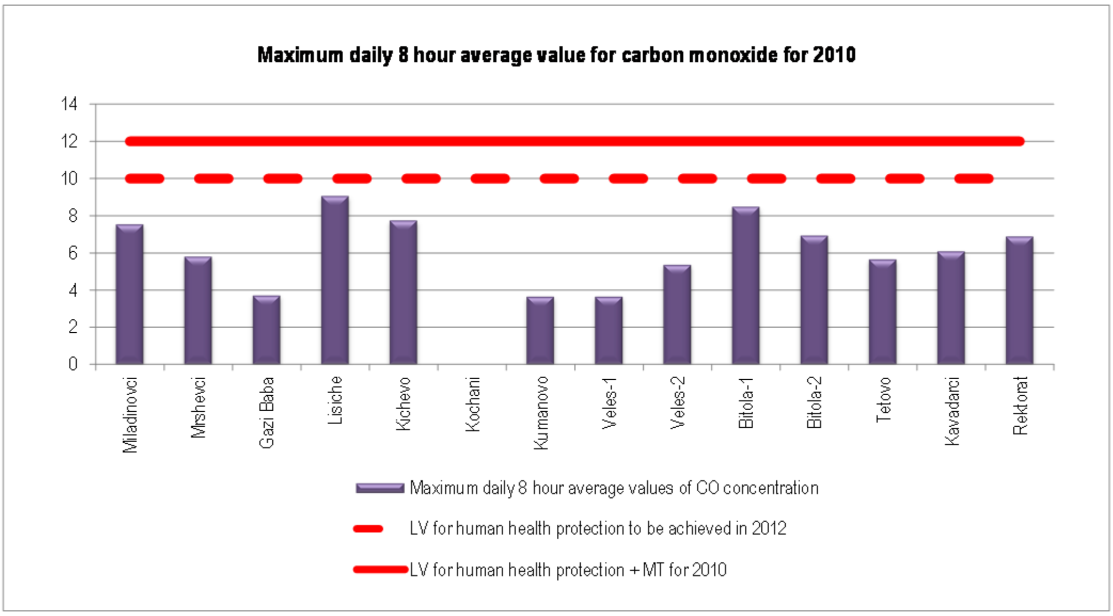


Diagram 22 Maximum daily 8 hour average value for carbon monoxide for 2010

Diagram 22 shows that the maximum daily 8 hour average values of carbon monoxide concentrations did not exceed the limit value for human health protection for 2010, nor the value to be achieved in 2012.

Ozone

Analysis of measured data on ozone for 2010 obtained from 13 measuring stations was carried out by way of their comparison with the target values and long-term targets for human health and vegetation protection for this pollutant, as well as alert and information threshold given in Table 10.

Table 10 Target values for ozone

Pollutant	Average period	Target value for 2010	
Ozone	Maximum daily 8 hour average value	Target value for human health protection	120 μg/m3 shall not be exceeded in more than 25 days in a calendar year with an average value measured for a period of three years
	AOT40, calculated from one hourly values from May to July	Target value for vegetation protection	18000 μg/m3*h calculated average value for a period of 5 years
	Average value	Long-term target	
	Maximum daily 8 hour average value of the concentration during a calendar year	Long-term target for human health protection	120 μg/m3
	AOT40, calculated from one hourly values from May to July	Long-term target for vegetation protection	6000 μg/m3*h
	Average period	Thresholds	
	3 consecutive hours	Warning threshold	180 μg/m3
	3 consecutive hours	Alert threshold	240 μg/m3

The next Diagram shows the number of exceeding of the target value for human health protection in 2010.

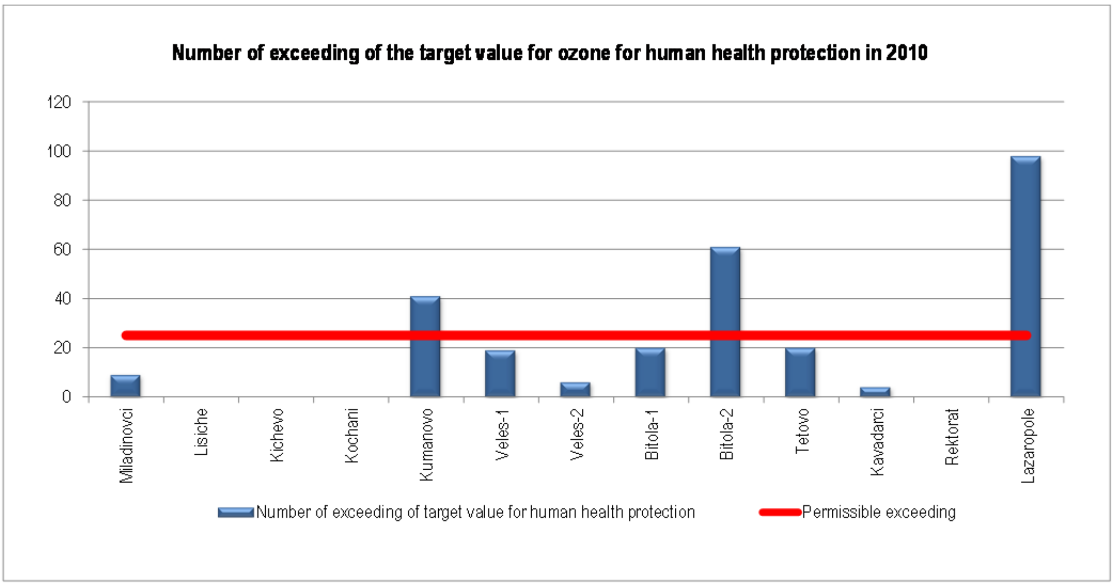


Diagram 23 Number of exceeding of the target value for ozone for human health protection in 2010

The Diagram shows that the number of exceeding of the target value for ozone for human health protection was exceeded in Kumanovo, Bitola-2 and most of all the rural area the village Lazaropole.

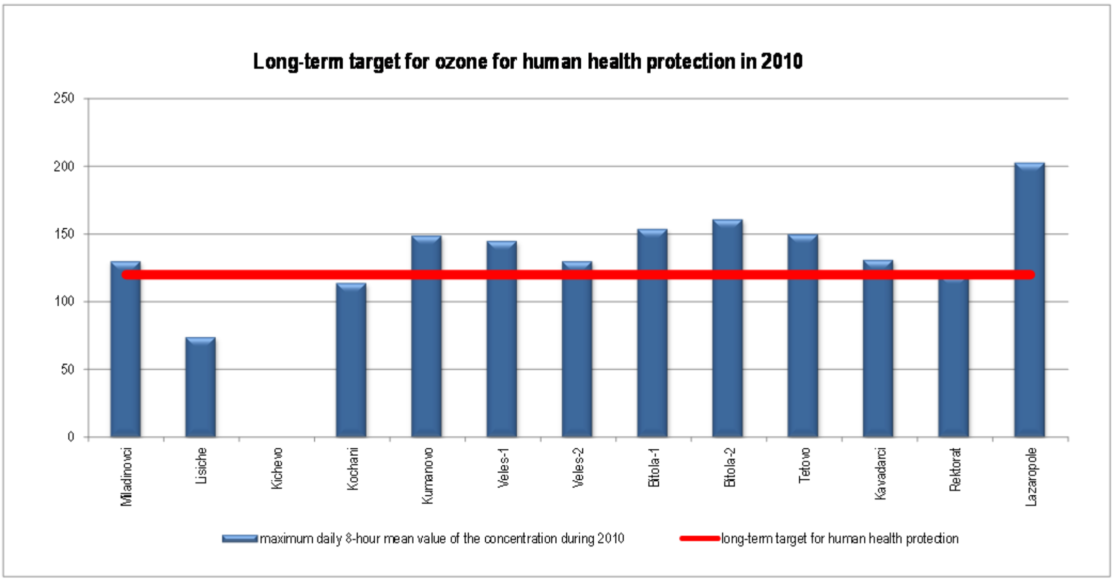


Diagram 24 Long-term target for ozone for human health protection in 2010

Long-term target for human health protection was exceeding in the measuring points Miladinovci, Kumanovo, Veles-1, Veles-2, Bitola-1, Bitola-2, Tetovo, Kavadarci and Lazaropole.

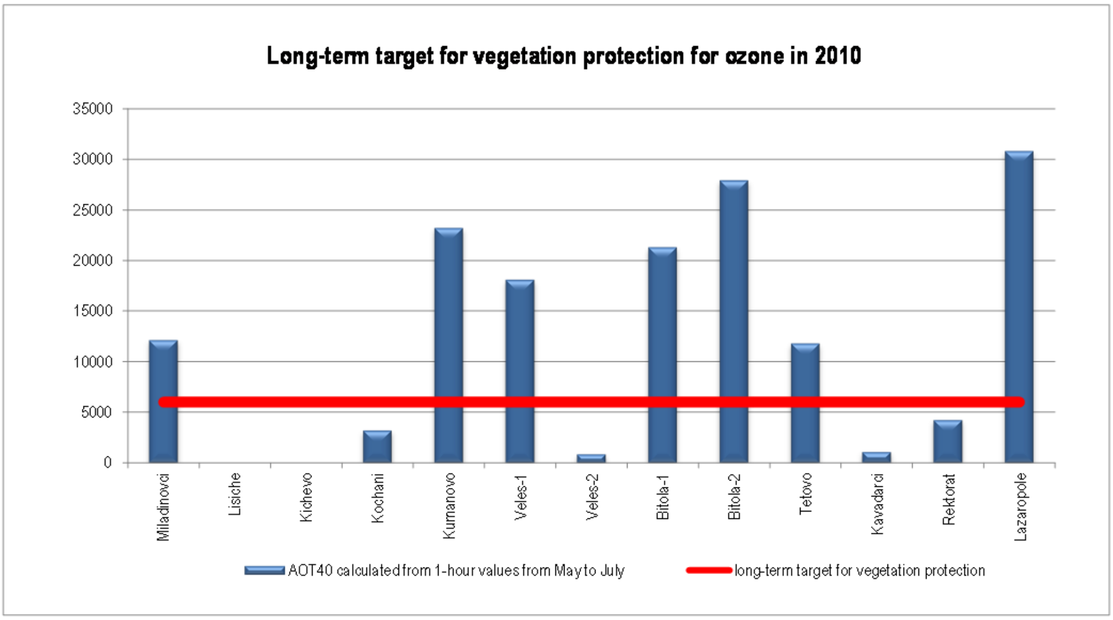


Diagram 25 Long-term target for vegetation protection for ozone in 2010

Long-term target for vegetation protection was exceeded in the measuring points Miladinovci, Kumanovo, Veles-1, Bitola-1, Bitola-2, Tetovo and Lazaropole.

AOT40 expressed in ($\mu g/m^3$ x hours) means the sum of the difference between hourly concentrations higher than 80 $\mu g/m^3$ (= 40-th parts of billion) and 80 $\mu g/m^3$ during the analyzed period May-July.

Hourly values measured every day in the period between 8:00 in the morning and 20:00 hours in the evening by Central European time when the solar radiation is strongest are taken into account. Exceedings of long-term targets for ozone on most of the measuring points in the course of 2010 in our country were due to its geographical position in the southern part of Europe characterized with high number of sunny days during summer period.

Exceeding of information threshold (180 μg/m^3) was recorded only in Lazaropole in the summer period, while alert threshold was not exceeded in any measuring station during 2010.

4.6 Assessment of the quality of the air in the Republic of Macedonia

On the basis of data on emissions in 2004 contained in the Cadastre of the Republic of Macedonia and data on emissions from CORINAIR Inventory from 2005, as well as data on the quality of air for the period 2004-2006 generated by the SAAQMS, Preliminary Assessment of the Quality of the Air was prepared in the frames of the Twinning Project "Improvement of the Quality of the Air" [10]. As part of this assessment, zones and agglomerations in the Republic of Macedonia have been established. Air quality assessment was made with regard to the following pollutants: SO_2, NO_x, CO, O_3 and suspended particles sized up to 10 micrometers. Suspended particles up to 2.5 micrometers in size have not been taken into consideration, due to the lack of sufficient number of data. Namely, measurement of these particles commenced on two measuring stations in Skopje, in September 2011. Based on the completed assessment, it was proposed to establish two zones – Eastern and Western Zones, and Skopje agglomeration. Zoning is shown on the next figure.

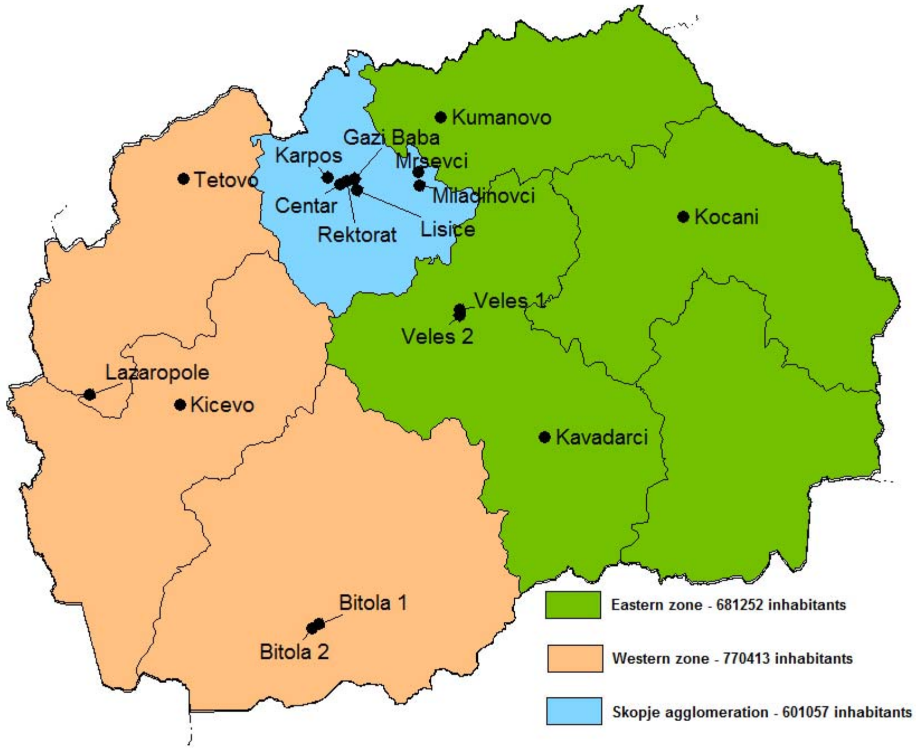


Figure 3 Zones and agglomerations in the Republic of Macedonia

As it can be seen on the Figure, boundaries of Skopje Agglomeration correspond with the boundaries of Skopje region. Western zone is composed of Southwestern, Polog and Pelagonia statistical regions, and Eastern one of Vardar, Northeastern and Eastern statistical regions.

As the preparation of this assessment relied on data on the concentrations of the mentioned pollutants for a period of three years, while the requirements of both EU Directives and national legislation [11] are that the assessment of the quality of the air for the pollutants relies on data from a five year period, a review of the Preliminary Air Quality Assessment was made. The Review of the Preliminary Air Quality Assessment [12] considering the established zones was carried out in the frames of the Twinning Project "Strengthening of the capacity on central and local levels in environmental management in the area of air quality", as a follow-up of the previous Twinning Project. Apart from the main pollutants, this report also analyzed the following heavy metals: arsenic, nickel, cadmium and lead.

The following data was taken into account in the process of the assessment review:

- data on the concentrations of pollutants for the period 2005-2010;
- data on the heavy metals: arsenic, nickel, cadmium and lead measured in the period January-August 2006 by use of low volume sampling devices (source: MEPP);
- data on heavy metals lead and cadmium for the period 2006-2010 (source: PHI);
- data on air emissions for 2009 (Cadastre of polluters and pollutants in the Republic of Macedonia);
- data on pollutant emissions for the period 2001-2009;
- data on completed air quality modeling with regard to nitrogen oxides through application of CAR-FMI model and sulphur dioxide and nitrogen oxides by application of UDM-FMI model.

Nevertheless, it should be pointed out that there is certain degree of uncertainty related to all types of data. Namely, the main uncertainty associated with data obtained by measurements result from irregular calibration of instruments, irregular supply of spare parts necessary to repair the measuring instruments, as well as from the fact that no regular consecutive data correction is made in accordance with the conducted calibration.

With reference to emission data, uncertainties derive from the fact that emission inventories are incomplete and instead of national, "default" emission factors taken from the EMEP CORINAIR Guidelines are applied for most of the sectors. At the same time, it is necessary to improve data coverage, especially for emissions from the traffic and wood combustion in households.

Uncertainty of data from modeling results from uncertainty of input data, especially concerning low quality and insufficient coverage of meteorological input data used in calculations.

Determination of the quality of air for the main polluting substances in the defined zones relies the most on data on the quality of the air produced by the automatic measuring stations, while emission data and data from modeling are used as auxiliary resources.

By comparing data on the main pollutants produced by the automatic measuring stations for the period 2005-2009 with the limit values and thresholds of assessment specified in the Rulebook on criteria, methods and procedures for ambient air quality assessment [11], the regimes of air quality assessment have been established in the Eastern and Western zone and Skopje agglomeration.

Table11 Regimes* of assessment in the zones and Skopje agglomeration

	SO_2	NO_2	PM_{10}	CO	O_2
Skopje agglomeration	1	1	1	1	1
Eastern zone	1	1	1	1	1
Western zone	2	2	1	1	1

*Regime 1: Concentrations higher than the upper assessment threshold – Fixed measurements that may be supplemented by modeling techniques and/or indicative measurements are applied in air quality assessment.

Regime 2: Concentrations lower than the upper assessment threshold, but higher than the lower assessment threshold. Combination of fixed measurements and modeling techniques and/or indicative measurements is applied in air quality assessment

Based on regimes defined for each zone, the minimum number of stations per pollutant has been defined in the following Table in accordance with the Rulebook on the methodology for ambient air quality monitoring [13].

Table12 Minimum number of measuring stations per zone/agglomeration

	Inhabitants	**SO_2**		**NO_2**	**NOx**	**PM_{10}**	**CO**	**O_3**	
		health	ecosystem	health	ecosystem			health	ecosystem
Skopje agglomeration	578 144	2	0	2	0	3	2	2	0
Eastern zone	680 596	2	0	2	0	3	2	2	0
Western zone	763 807	1	1	1	1	4	3	2	1
	Total	5	1	5	1	10	7	6	1

The Table below shows the current number of measuring stations per zone/agglomeration.

Table13 Current number of measuring stations per zone/agglomeration

	Inhabitants	**SO_2**		**NO_2**	**NOx**	**PM_{10}**	**CO**	**O_3**	
		health	ecosystem	health	ecosystem			health	ecosystem
Skopje agglomeration	578 144	6	0	7	0	7	7	5	0
Eastern zone	680 596	5	0	5	0	5	5	5	0
Western zone	763 807	4	1	4	1	5	4	4	1
	Total	15	1	16	1	17	16	14	1

If we compare the tables, we may conclude that the minimum requirements concerning the number of stations have been met in both zones and Skopje agglomeration. However, further expansion of the network is needed by appropriate type of stations, namely:

- Skopje agglomeration: 3 stations should be located in suburban areas to measure ozone;
- Eastern zone: 1 station located in suburban area to measure ozone;
- Western zone: 1 urban background station should be established to measure solid particles and 1 to measure carbon monoxide.

With regard to heavy metals (Cd, As, Ni, Pb), analysis of the quality of air was made in relation to target values and thresholds of assessment as specified in the Directive on heavy metals, and in relation to limit value and thresholds of assessment for lead as specified in the Rulebook on criteria, methods and procedures for ambient air quality assessment [11]. It concluded that there was no exceeding of the limit value and thresholds of assessment for lead at any measuring point. Target value for arsenic has been exceeded in Jegunovce, and upper assessment threshold has been exceeded in Kavadarci. Concentrations of nickel in Kavadarci are above the target value, while upper assessment threshold has been exceeded in Skopje and Veles. With regard to cadmium, upper assessment threshold has been exceeded in Kavadarci, while the lower assessment threshold in Skopje and Veles. Here, we should underline again that data obtained on measured concentrations of heavy metals date from 2006 and does not reflect the current status of the quality of the air with regard to these pollutants. The conducted analysis indicated that there was insufficient data to complete the zoning of the territory of the Republic of Macedonia for heavy metals (data coverage is lower than 14%), but the results obtained suggest that the monitoring of these pollutants in PM10 fraction should continue.

4.7 Assessment of the air quality impact on human health

4.7.1 Methodology

Methodology for integrated environmental zoning is an instrument for solving problems in complex situations of existing technological facilities. Complex situations assume existence of higher number of pollutions or various types of environmental burdens. Such integrated approach to zoning of micro and macro urban sites is intended to offer establishment of a balance between existing and expected environmental burden and required functional structure of the site. Under such conditions, it is also necessary to assess the health risk for the workers and for the local population, both in direct and indirect terms through threats for all environmental media (water, air, ground).

According to the World Health Organization (WHO), the burden of diseases the causes of which also involve air pollution of more than 2.000 000 premature death cases in the world is a consequence of urban air pollution or exposure to polluted inside air. More than half of this burden occurs in developing countries like Macedonia. Burden of environmental diseases quantifies diseases caused by environmental risks.

Burden with environmental diseases can be expressed through death cases, incidence in DALY (Disability Adjusted Life Years). Here, this measure is a combination of burden due to death and disability in an index. Use of such an index allows for comparison of the burden of different environmental risk factors with other risk factors or diseases. According to the 2007 Study of the WHO, the burden of diseases that can be associated with environmental health risks has been assessed at 15 % of the total disease burden in the country. According to WHO's estimate, the air pollution in the Republic of Macedonia is responsible as attributive risk for additional deaths of 300 persons or 0.8 DALY per 1000/inhabitants/year, while indoor air pollution is associated with death of less than 100 persons or 0.2 DALY per 1000/inhabitants/year.

The most frequent diseases in the country, cardio-vascular diseases, cancer, respiratory system diseases, injuries and undefined sympthoms have many causes that are interrelated, including genetics, condition status of people (through diet, exercise, etc.) and environmental conditions they are exposed to. Consequently, the establishment of the cause-effect relationship is rather difficult, especially where environmental impact on health is postponed or product of high number, maybe small, environmental factors in co-action. Further more, there is severe lack of data and information on exposure, effects and biological models connecting such factors.

PHI and the 10 regional Public Health Centres are the key sources of resources for environmental risks detection and management in the country.

4.7.2 Monitoring and analysis of health risk

The estimate of health effects is carried out on the basis of the monitoring of certain pollutants in ambient air by the EU limit values and guideline values of WHO – World Health Organization (Table14).

Table14 Limit values/target values of EU for public health protection and WHO guideline values for air quality

Pollutant	Period of monitoring	EU µg/m^3	WHO µg/m^3
Sulphur dioxide SO_2	20 minutes		500
	1-hour average	350 Not to be exceeded> 24 times per year	
	24-hour average	125 Not to be exceeded> 4 times per year	20

Pollutant	Period of monitoring	EU µg/m³	WHO µg/m³
Nitrogen dioxide NO_2	20 minutes		
	1- hour average	200 Not to be exceeded> 18 times per year	200
	24-hour average		
	1-year average	40	40
Particulate matters PM_{10}	1-hour average		
	24-hour average	50 Not to be exceeded > 36 times per year	
	1- year average	40	
$PM_{2,5}$	24-hour average		
	1- year average	25	
Carbon monoxide CO	20 minutes		
	1-hour average		30000
	8-hour average	10000	10000
	24-hour average		
Ozone O_3	20 minutes		
	1-hour average		
	8-hour average	120 target value Not to be exceeded > 25 times over 3- year period	100
	24-hour average		
Benzene C_6H_6	20 minutes		
	24-hour average		
	1-година просек	5	
Lead Pb	20 minutes		
	24-hour average		
	3-month average		
	1- year average	0.5	0,5
Benzo(a)pyrene	1- year average	0.001	

On the basis of delivered findings on recorded concentrations of pollutants in the air in Skopje and Veles, categorization of pollution on annual level in different urban zones was completed in accordance with internationally specified norms and WHO.

PM_{10} with a diameter of 10 micrometers are the most frequently mentioned indicators of air pollution with potential effect on human health owed primarily to their diameter allowing them to reach the deepest paths in the lungs, but also to their specific chemical composition which depends on the source of pollution (this concerns particles with a diameter of 2.5 micrometers- $PM_{2.5}$ measured in the Republic of Macedonia as of 2011).

The annual limit value for PM_{10} at all measuring points in the country has been exceeded, which indicates the fact that the air is severely polluted with these particles and thus human health is affected thereby.

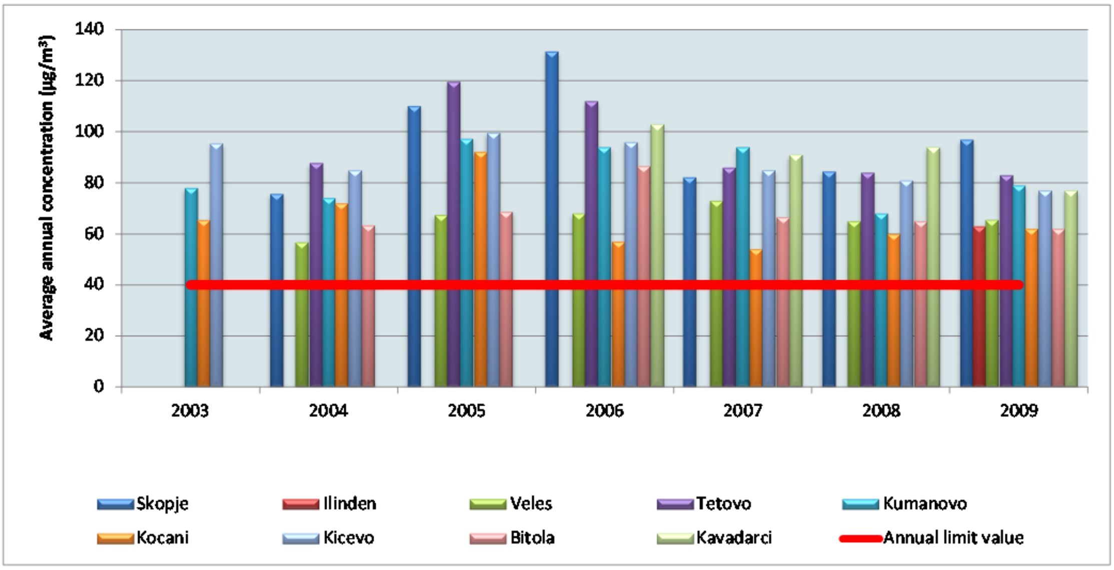


Diagram 26 Average annual concentrations of PM_{10} at the measuring points in the Republic of Macedonia in the period 2003-2009

Although we lack data on the concentrations of $PM_{2.5}$ their assumed concentration is in the range 0.4-0.6 x PM_{10}, which in our case indicates that these concentrations are within health risk range.

By application of specific software developed by WHO (AirQ 2.2.3), many countries survey the health effect of these particles, as well as ozone and NO_2. In order to assess the short-term effects of the potentially reduced concentration of particles, it is compared with standardized mortality rates of all causes, as well as the number of disease rates of cardiovascular and respiratory diseases, while for the purpose of assessing long-term effects, the years of lost life (YLL) resulting from mortality of all causes for cardiovascular and lung cancer of the population in a given region are calculated. Estimates include the calculated Relative risk deriving from completed epidemiological studies in several European cities (APHEA Study).

It is considered that the background level of PM_{10} in European cities is 8-10 micrograms, while each increase of PM_{10} by 10 micrograms leads to increase in the rate of general mortality by 0.6-1.5 %. Detected concentrations of PM_{10} in the country (almost twice above the permissible annual level) give grounds for annoyingly high impact on general and specific mortality rates. In any case, upon installation and application of this software (AirQ 2.2.3) and modification of the current health statistics, these estimates could be also made by our environmental health services in future thus assisting in authentic detection of the relative risk for our area and setting the short and the long-term targets for action. Sufficient motive is the information contained in the APHEA Study that reduction of the annual concentrations of $PM_{2,5}$ to 15 micrograms/m^3 will lead to extension of life expectancy of urban inhabitants by 1 month to 2 years at an average.

4.7.3 Assessment of health risk of the air pollution with PM_{10} in Skopje 2010

The assessment of the health risk has been made on the basis of the monitoring of certain polutants in ambient air according to the limit values of the EU and guideline values of the WHO – World Health Organization.

Pollutant	**Period of monitoring**	**ЕУ** **µg/m^3**	**WHO** **µg/m^3**

Solid particles PM_{10}	24-hour average	50 Not to be exceeded > 36 times per year	

In Skopje, in 2010, the number of days above the permissible limit value was 261. According to the results obtained at the measuring points (3) in Skopje, the average value was 64 μg/m^3 (adjusted by adjustment factor of 0.7 for summer months).

Table15 Daily average values, standard deviation and 5th and 9th percentile for the pollutant PM_{10} for Skopje in 2010 (values are adjusted by adjustment factor)*

Pollutant	Daily average value (μg/m^3)	Standard deviation	5th percentile	95th percentile
		(μg/m^3)	(μg/m^3)	(μg/m^3)
PM_{10} (daily average)	64	36	21	140

* adjustment factor

PM adjustment factor (winter)	1.0
PM adjustment factor (summer)	0.7

Table 16 Annual average values and mortality rates and admission to hospital per 100.000 for Skopje in 2010

Health condition	ICD9	ICD10	Age	Number	Annual rate per 100.000
Total mortality without injuries and violations	< 800	A00-R99	all	4503	847
Hospitalization for cardiological diseases	390-429	I00-I52	all	6106	1149
Hospitalization for respiratory diseases	460-519	J00-J99	15-64	4.923	926
Hospitalization for respiratory diseases	460-519	J00-J99	>65	1.227	231
Hospitalization for respiratory diseases	460-519	J00-J99	all	8630	1624

In the world, urban air pollution contributes to attributive risk of 7.865 (in a thousand) DALYs (Disability Adjusted Life Years), according to WHO, 2000. Also according to the estimates of the World Health Organization concerning the burden of environmental diseases, 0.8 of all DALY/1000 deaths result from urban air pollution with PM_{10} in theRepublic of Macedonia or around 300 deceased.

According to our estimates, in 2010, out of 4602 deceased persons in Skopje (without violent death), 110 persons died directly as a consequence of the increased air pollution with PM_{10}, as attributive risk, while out of 8630 persons hospitalized for respiratory diseases in 2010, 420 patients were consequence of increased air pollution with PM_{10}.

Also in Skopje, out of 6106 persons hospitalized for cardiovascular diseases in 2010, 80 patients were consequence of increased air pollution with PM_{10}.

Table 17 Potential benefit of the reduction of daily PM_{10} level on the total mortality (without external causes)

Scenario	**Annual number of avoided death cases**	**Annual number of avoided death cases per 100.000**
Reduction by 5 μg/m^3	13	3
Reduction by 20 μg/m^3	117	22

Table18 Potential benefit of the reduction of daily PM_{10} level on hospitalization

	Hospitalization for respiratory diseases		**Hospitalization for cardiological diseases**	
Scenario	**Annual number of avoided cases**	**Annual number of avoided cases per 100.000**	**Annual number of avoided cases**	**Annual number of avoided cases per 100.000**
Reduction by 5 μg/m^3	48	9	18	3
Reduction by 20 μg/m^3	420	79	159	30

Estimates have been made of the burden reduction through air pollution reduction at annual level under two scenarios: reduction by 5 μg/m^3 and 20 μg/m^3.

Potential benefit of the reduction of daily PM_{10} level on the total mortality (without external causes) under the first scenario would be 13 annual number of avoided death cases, and under the second scenario - 117.

Potential benefit of the reduction of daily PM_{10} level on hospitalization for respiratory diseases under the first scenario would be 48 annual number of avoided death cases from respiratory diseases, and 18 from cardiovascular diseases, while under the second scenario – 420 avoided death cases from respiratory diseases, and 159 from cardiovascular diseases.

5. Analysis of the impact of pollutants from different sectors on ambient air quality

The following sectors had the greatest contributions to the total emission of pollutants for the period 2001 – 2009: energy, industry, transport, agriculture and waste, and impacts of each of them are presented in the forthcoming chapters.

5.1 Energy

Energy infrastructure of the Republic of Macedonia enables exploitation of domestic primary energy, import and export of primary energy, processing of primary energy and production of final energy, transport and distribution of energy. Energy infrastructure of the Republic of Macedonia consists of the sectors for coal, oil and oil derivatives, natural gas, electric power sector and sector for heat production [17].

Energy sector in Macedonia makes the gretest contribution to environmental pollution because almost 90% of the primary energy is generated from fossil fuels, mostly lignite and crude oil. Thus, this sector contributes more than 70% to the total emission of greenhouse gases, and similar contribution to local pollution. Projections for greenhouse gas emissions under the scenario for electric power system development based only on coal indicate average annual growth rate of 3.6% in the period 2008-2020, while if environmentally mitigated scenarios are considered (introduction of co-generation gas plants, reduction of electricity consumption and increased use of renewable energy sources), the average annual growth rate in the period 2008-2020 will fall at 1.4% [17].

The text below will put the main accent on electric power sector, because it contributes the highest percentage to ambient air pollution and total emissions of greenhouse gases emission in the Republic of Macedonia.

The main function of the electric power system (EPS) of Macedonia is electricity production, supply, transmission and distribution.

Management of EPS of Macedonia is performed by four entities, namely:

- Electric power plants of Macedonia, AD ELEM, state owned, joint stock company for electricity production and supply,
- Macedonian electricity transmission system operator AD MEPSO, state owned, operator of electric power transmission system of Macedonia – joint stock company for electricity transmission and management of electric power system of Macedonia,
- Distribution company EVN Macedonia AD, and
- AD TPP Negotino, state owned, joint stock company for electricity production.

Electric power plants of Macedonia, AD ELEM [18]. The main activity of Electric power plants of Macedonia is electricity production and supply to tariff consumers. Within its structure, Electric power plants of Macedonia include large hydro power plants and termal power plants based on lignite. Table19 shows the main parameters of thermal power plants on lignite in the Republic of Macedonia, managed by Electric power plants of Macedonia.

Table19 Main characteristics of thermal power plants in Macedonia

TPP	Number of aggregates	Designed capacity [MW]	Year of putting into operation
Bitola 1	1	225	1982
Bitola 2	1	225	1984
Bitola 3	1	225	1988
Oslomej	1	125	1980

TPP	Number of aggregates	Designed capacity [MW]	Year of putting into operation
Total	4	800	

Table 20 shows the main parameters of hydro power plants in the Republic of Macedonia, managed by Electric power plants of Macedonia.

Table 20 Main characteristics of hydro power plants in Macedonia

HPP	Basin	Number of aggregates	Designed capacity [MW]	Year of putting into operation
Vrutok	Mavrovo	4	150	1957/1973
Tikvesh	Crna Reka	4	114	1968/1981
Globochica	Crn Drim	2	42	1965
Shpilje	Crn Drim	3	84	1969
Kozjak	Treska	2	80	2004
Raven	Mavrovo	3	19.2	1959/1973
Vrben	Mavrovo	2	12.8	1959
Total		20	502	

The portfolio of Electric power plants of Macedonia includes two small hydro power plants with total designed capacity of 0.34 MW, i.e. SHPP Modrich with 0.15 MW and SHPP Oslomej with 0.19 MW.

Macedonian electricity transmission system operator AD MEPSO [19]. The main activity of the Macedonian electricity transmission system operator is electricity transmission and management of electric power system of the Republic of Macedonia. The structure of the Macedonian electricity transmission system operator also includes dispatching system. Transmission network of the Macedonian electricity transmission system operator consists of long distance transmission lines with a volatage level of 400, 220, 110 and 35 [kV].

EVN Macedonia AD [17]. The main activity of EVN Macedonia AD is electricity distribution, management of distribution system and supply to tariff consumers. EVN Macedonia AD possesses distribution network with a voltage level of 110, 35, 20, 10 and 0.4 [kV].

EVN Macedonia AD has 11 small hydro power plants, too.

Table 21 shows the main parameters of small hydro power plants owned by EVN Macedonia AD.

Table 21 Main characteristics of small hydro power plants in the Republic of Macedonia

SHPP	Designed capacity [MW]
Sapunchica*	2.9

SHPP	Designed capacity [MW]
Kalimanci*	13.8
Zrnovci*	1.4
Doshnica*	4.1
Pesochani*	2.7
Matka*	9.6
Pena*	2.5
Babuna	0.7
Belica	0.3
Turija	2.2
Popova Shapka	4.8
Total	45

* seven of the small hydro power plants owned by EVN Macedonia AD are in the ROT (**R**evitalize, **O**perate and**T**ransfer) programme. The programme envisages that the Czeck Company Hydropol revitalizes, operates and transfers them to the management of EVN Macedonia AD in 2012.

AD TPP Negotino. The only thermal power plant in Macedonia based on crude oil, Negotino, was put into operation in 1978, and has operated as independent entity since 2006. This production facility operates on crude oil and railway transport infrastructure exists for this purpose. Designed capacity of this facility is 210 MW, with a possibility to operate with 1 or 2 boilers. At present, it is used as so called cold reserve.

Electricity production. The greatest electricity producer in the Republic of Macedonia is Electric Power Plants of Macedonia, the designed capacity of which is presented in Table19 and Table 20; furthermore, another electricity producer is EVN Macedonia AD through its 11 small hydro power plants, the designed capacity of which is presented in Table 21, private initiatives, gas cogeneration plants KOGEL with designed capacity of 30.4MW and TE-TO with designed capacity of 220 MW, small hydro power plants with designed capacity of 3.7 MW and photovolatic power plants with designed capacity of 1.5 MW. Electricity production in the Republic of Macedonia in the period from 1996 to 2010 is presented in diagrams below [20, 21, 22,23].

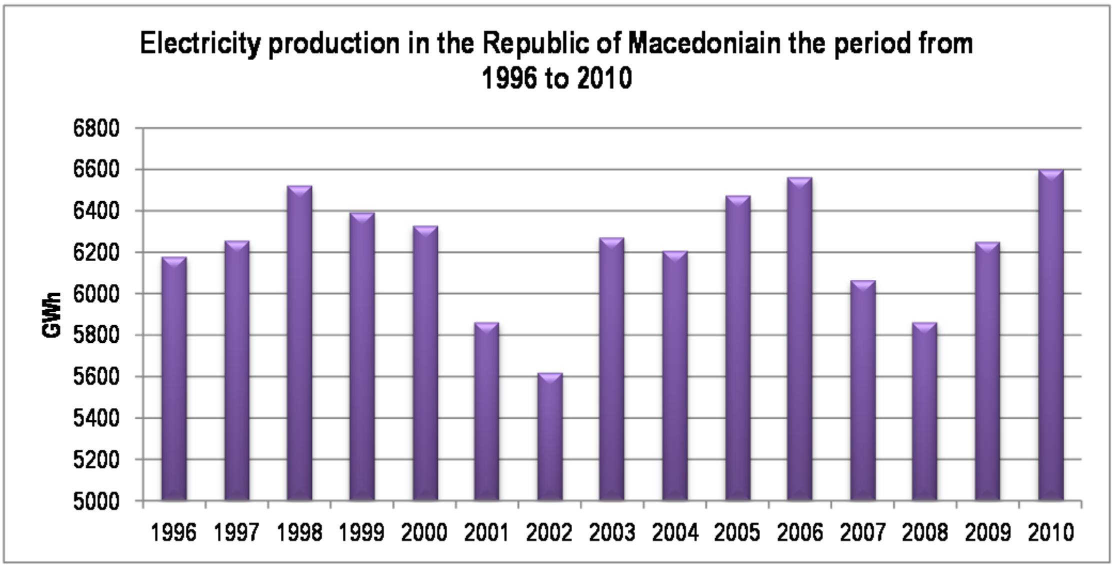


Diagram 27 Overview of electricity production in the Republic of Macedonia in the period from 1996 to 2010

Electricity consumption. Electricity consumers in the Republic of Macedonia are divided into two groups, namely: tariff (price of electricity is set by the Regulatory Commission for Energy of the Republic of Macedonia) and qualified consumers (buying electricity liberally on the market). Table 22 below shows electricity consumption in the Republic of Macedonia in the period from 1996 to 2010[20, 21, 22,23].

Table 22 Electricity consumption in the Republic of Macedonia in the period from 1996 to 2010

Consumption by year							
1996	1997	1998	1999	2000	2001	2002	2003
6276[GWh]	6414[GWh]	6626[GWh]	6658[GWh]	6620[GWh]	6323[GWh]	6392[GWh]	7226[GWh]
Consumption by year							
2004	2005	2006	2007	2008	2009	2010	
7384[GWh]	8074[GWh]	8377[GWh]	8467[GWh]	8643[GWh]	7796[GWh]	8329[GWh]	

System balance. Diagram 28 below shows the balance of the system, i.e. electricity consumption and production in the Republic of Macedonia in the period from 1996 to 2010[20, 21, 22,23].

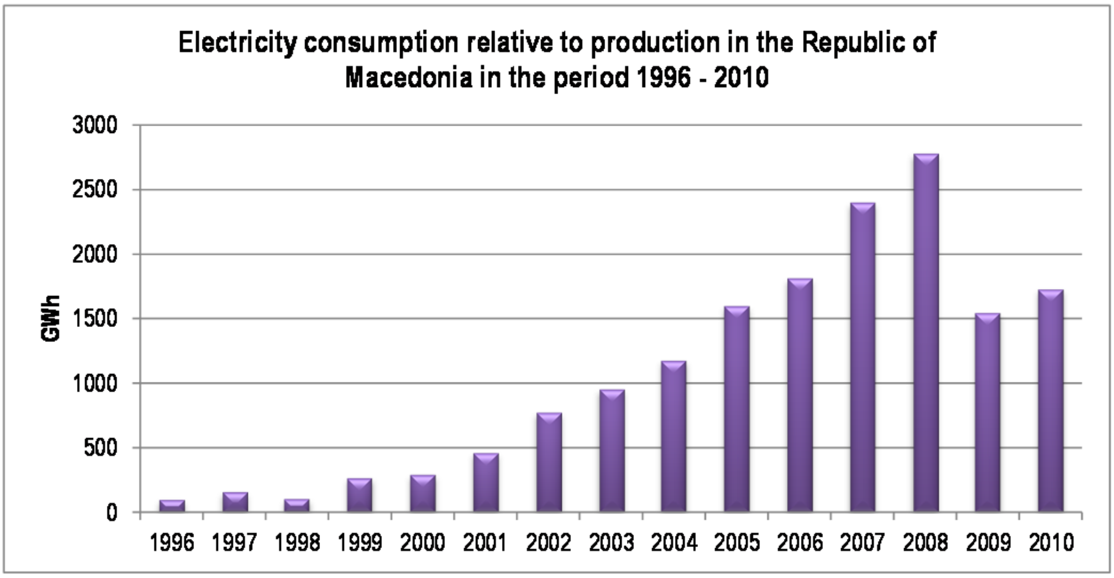


Diagram 28 Graphical overview of electricity consumption relative to production in the Republic of Macedonia in the period 1996 - 2010

Consumption of primary energy by energy resource. Diagram 29 shows primary energy consumption by energy resource in the period from 2002 to 2007 [17].

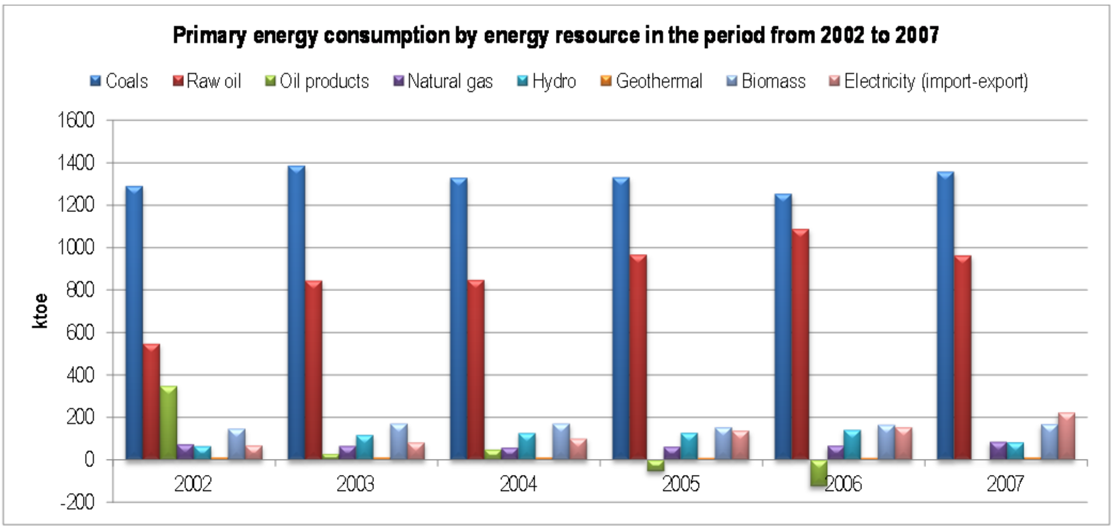


Diagram 29 Graphical overview of primary energy consumption by energy resource in the period from 2002 to 2007

Consumption of final energy by energy resource. Diagram 30 below shows final energy consumption by energy resource in the period 2001 to 2006 [17].

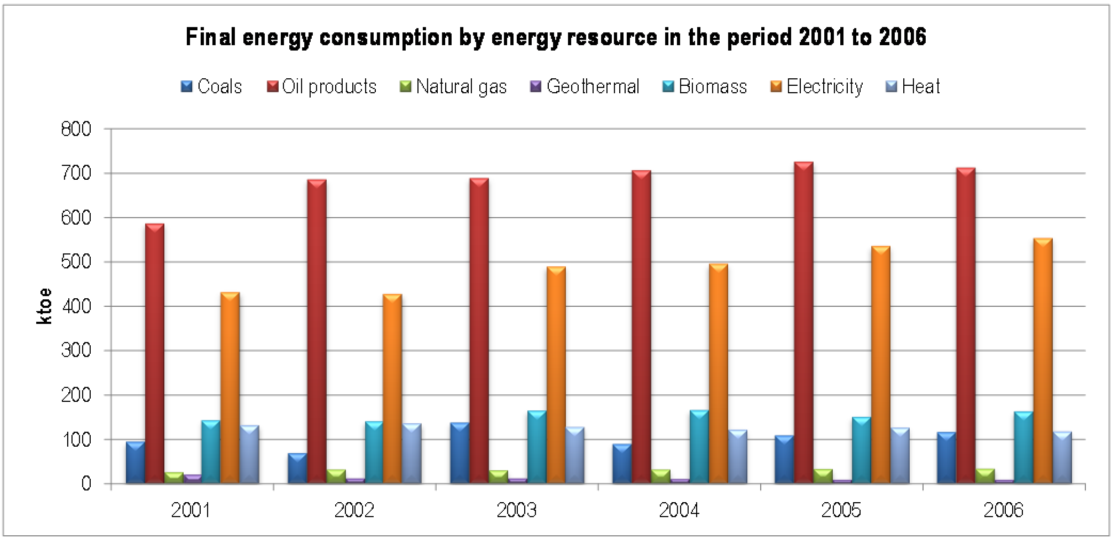


Diagram 30 Final energy consumption by energy resource in the period 2001 to 2006

Note: Consumption of final energy is actually the part of primary input energy which upon energy transformations by appropriate energy technologies serves as final useful energy in individual sectors.

Demand for primary energy by 2020 by energy resource. Table below shows the demand for primary energy by 2020 by energy resource.The Table refers to the baseline scenario of the Strategy for Energy Development in the Republic of Macedonia [17].

Table 23 Overview of the demand for primary energy by 2020 by energy resource by year

	Demand for primary energy by 2020 by energy resource by year									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coals	1369[ktoe]	1399[ktoe]	1417[ktoe]	1314[ktoe]	1326[ktoe]	1318[ktoe]	1326[ktoe]	1346[ktoe]	1624[ktoe]	1653[ktoe]
Oil and biofuels	1170[ktoe]	1225[ktoe]	1285[ktoe]	1169[ktoe]	1223[ktoe]	1249[ktoe]	1296[ktoe]	1231[ktoe]	1292[ktoe]	1343[ktoe]
Natural gas	427[ktoe]	435[ktoe]	444[ktoe]	753[ktoe]	766[ktoe]	760[ktoe]	769[ktoe]	797[ktoe]	648[ktoe]	674[ktoe]
Biomass	225[ktoe]	228[ktoe]	231[ktoe]	234[ktoe]	236[ktoe]	241[ktoe]	245[ktoe]	250[ktoe]	254[ktoe]	259[ktoe]
Hydro	136[ktoe]	136[ktoe]	136[ktoe]	136[ktoe]	152[ktoe]	186[ktoe]	208[ktoe]	208[ktoe]	237[ktoe]	241[ktoe]
Geothermal	13[ktoe]	13[ktoe]	14[ktoe]	15[ktoe]	16[ktoe]	18[ktoe]	20[ktoe]	22[ktoe]	23[ktoe]	24[ktoe]
Solar	1[ktoe]	2[ktoe]	3[ktoe]	3[ktoe]	4[ktoe]	4[ktoe]	5[ktoe]	6[ktoe]	6[ktoe]	7[ktoe]
Wind	1[ktoe]	2[ktoe]	3[ktoe]	3[ktoe]	4[ktoe]	4[ktoe]	5[ktoe]	6[ktoe]	6[ktoe]	7[ktoe]
Electricity	26[ktoe]	35[ktoe]	46[ktoe]	2[ktoe]	2[ktoe]	2[ktoe]	3[ktoe]	5[ktoe]	0 [ktoe]	0 [ktoe]
TOTAL	3368[ktoe]	3475[ktoe]	3579[ktoe]	3629[ktoe]	3729[ktoe]	3782[ktoe]	3877[ktoe]	3871[ktoe]	4090[ktoe]	4208[ktoe]

Demand for FINAL energy by 2020 by energy resource. Table below shows the demand for FINAL energy by 2020 by energy resource.The Table refers to the baseline scenario of the Strategy for Energy Development in the Republic of Macedonia [17].

Table 24 Overview of the demand for final energy by 2020 by energy resource

	Demand for final energy by 2020 by energy resource by year									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity	675[ktoe]	697[ktoe]	719[ktoe]	739[ktoe]	761[ktoe]	782[ktoe]	803[ktoe]	823[ktoe]	844[ktoe]	865[ktoe]
Heat	121[ktoe]	123[ktoe]	125[ktoe]	127[ktoe]	129[ktoe]	131[ktoe]	134[ktoe]	136[ktoe]	138[ktoe]	140[ktoe]
Oil derivatives and biofuels	751[ktoe]	787[ktoe]	825[ktoe]	862[ktoe]	901[ktoe]	941[ktoe]	981[ktoe]	1021[ktoe]	1063[ktoe]	1103[ktoe]
Natural gas	42[ktoe]	45[ktoe]	50[ktoe]	54[ktoe]	59[ktoe]	65[ktoe]	73[ktoe]	81[ktoe]	89[ktoe]	98[ktoe]
Coal	102[ktoe]	119[ktoe]	123[ktoe]	126[ktoe]	130[ktoe]	133[ktoe]	137[ktoe]	140[ktoe]	144[ktoe]	147[ktoe]
Biomass	222[ktoe]	223[ktoe]	225[ktoe]	227[ktoe]	228[ktoe]	230[ktoe]	231[ktoe]	233[ktoe]	234[ktoe]	236[ktoe]
Geothermal	11[ktoe]	11[ktoe]	12[ktoe]	13[ktoe]	14[ktoe]	17[ktoe]	19[ktoe]	20[ktoe]	21[ktoe]	22[ktoe]
Solar	1,4[ktoe]	1,6[ktoe]	1,9[ktoe]	2,2[ktoe]	2,6[ktoe]	3,1[ktoe]	3,5[ktoe]	4,0[ktoe]	4,6[ktoe]	5,2[ktoe]
TOTAL	1925,4[ktoe]	2006,6[ktoe]	2080,9[ktoe]	2150,2[ktoe]	2224,6[ktoe]	2302,1[ktoe]	2381,5[ktoe]	2458,0[ktoe]	2537,6[ktoe]	2616,2[ktoe]

Emissions From energy sector

Energy sector (electricity and heat production), owing to combustion processes, is the biggest source of pollutants emission into the air, especially SO_2, NO_x and CO. Quantities of emissions from energy sector for SO_2, NO_x,CO, NMVOC, NH_3 and TSP on annual level for the period 2001-2009 are shown in Table 25.

Table 25 Total emissions of pollutants from energy sector for the period 2001 - 2009

Energy	2001	2002	2003	2004	2005	2006	2007	2008	2009
SO_2 (кt)	97.83	97.53	108.57	99.37	99.20	99.20	98.54	112.20	111.24
NOx (кt)	17.21	17.61	19.59	17.34	17.73	17.73	18.06	19.92	19.92
VOC (кt)	0	0	0	5.41	5.37	5.32	5.29	5.54	5.52
TSP (кt)	0	0	14.08	7.41	7.95	7.45	10.00	10.37	10.37
CO (кt)	7.30	7.20	34.31	42.37	2.71	44.40	43.78	43.79	43.84

The analysis of the values of total emissions by pollutant in energy sector for the period 2001 – 2009 leads to the conclusion that there is a trend of continuous growth, which is due to expanded scope of work in combustion plants during the analyzed period. This sector also includes boilers for administrative and residential buildings heating, combustion in thermal power plants, central heating plants and process of oil distillation.

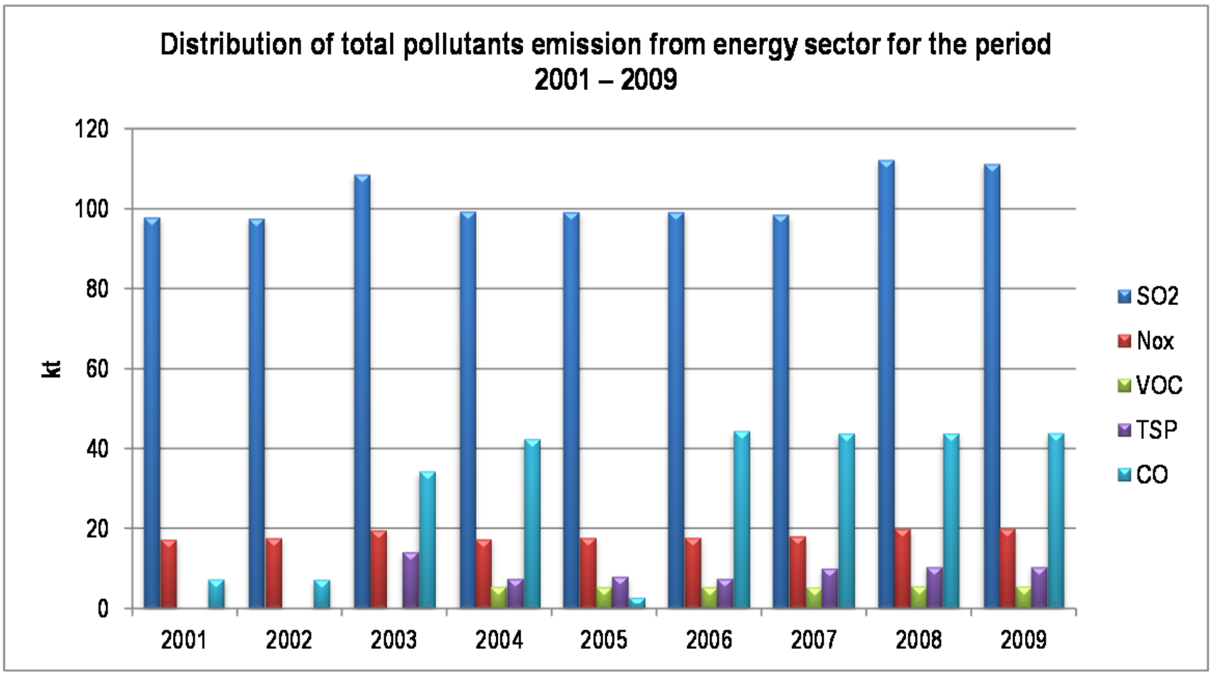


Diagram 31 Distribution of total pollutants emission from energy sector for the period 2001 – 2009

Energy sector has the greatest share in total emissions of sulphur dioxide from all sectors: emissions of SO_2 are in the range of 72 % in 2001 to 99 % in 2009; emissions of NO_x originating only from energy sector are almost 60 % for the analyzed period, while 21 % of the total emissions of volatile organic compounds comes from this sector.

5.2 Industry

Industry plays important role in the development of the overall Macedonian economy, securing its stability, having direct influence on employment growth, enhancement of export and social welfare of the population.

The important role of the industry in Macedonia is also reflected in its share in the structure of the total GDP (Table 26) ranging around 21% in the period 2002-2007, including three industrial sectors (mining, manufacturing industry, electricity supply) and construction. In 2009, mining sector recorded growth with a share of 1%, manufacturing industry of 14.1%, and the electricity, gas and water supply sector - 3.7%.

Table 26 Share of industry in the total GDP 2002-2007 [3]

Industrial sectors	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
	Share of sector in the structure of GDP (%)					
Mining and stone excavation	0.4	0.4	0.4	0.5	0.5	0.7
Manufacturing industry	15.5	15.8	15.0	15.5	16.3	18.4
Electricity, gas and water supply	4.7	4.2	3.5	3.3	3.3	2.7
Construction	5.2	5.2	5.3	5.3	5.5	5.7

In the frames of manufacturing industry, metal processing and metal products, production of foodstuffs, beverages and tobacco, production of textile and textile products, etc., are the most prominent. Manufacturing industry employed ¼ of the total number of employed persons in 2007 (113 000 of the total number of 434 000 employees), and textile industry employs the highest number of persons (44 000) within manufacturing industry.

Share of sectors in the total number of commercial entities in 2009 was as follows: a) commercial entities 0.1% in mining sector; b) commercial entities 11.6% in manufacturing industry; c) commercial entities 0.2% in the sector for electricity, gas and water supply.

In the total number of commercial entities, the highest portion consists of small and medium size enterprises (99.81%), with this share amounting 99.5% in manufacturing industry, and another important fact is that small and medium size enterprises employed 79% of the total number of employees in 2009.

The most prominent industrial branches in the Republic of Macedonia with biggest and most important impact on the environment, including also the quality of the air through emission of pollutants, are presented in Table 27, reflecting representation of metallurgy, energy transformation, construction, production of food, beverages and other foodstuffs, electric power industry and wood and paper manufacturing in almost all regions.

Table 27 Represented industrial branches in the Republic of Macedonia by region [7]

Type of industry	Vardar	Eastern	Southwestern	Southeastern	Pelagonia	Polog	Northeastern	Skopje
Production of food and beverages	X	X		X	X	X	X	X
Metallurgy	X	X	X	X	X	X	X	X
Textile industry	X	X		X	X	X		
Food and vegetables processing				X				
Production of bread and baked products	X	X	X		X	X	X	X
Electric power industry	X	X	X	X	X			X

Type of industry	Vardar	Eastern	Southwestern	Southeastern	Pelagonia	Polog	Northeastern	Skopje
Tobacco processing	X	X			X			X
Metal processing				X				
Oil derivatives				X				X
Chemical and pharmaceutical industry				X				X
Construction	X	X	X	X	X	X	X	X
Energy	X		X		X			X
Wood and paper processing	X	X	X	X				X
Agricultural and livestock products	X							
Meat processing industry	X							X
gardening	X							
Forestry		X						
Horticulture		X						

There are obvious differences between large industrial facilities existing since 1950s, the equipment of which is obsolete and operate with energy inefficient technologies, lacking reuse of energy and water (steam) in the process and small and medium size industrial facilities equipped with technology of later date and including technological solutions for better and more efficient combustion of fuel, reuse of heat in the process and treatment of gases prior to their release into the air. It is a positive fact that the owners of large industrial facilities are also aware of the need for investment in and improvement of technological process that will contribute to fulfillment of environmental standards, protection and safety at work, improved and more competitive product, and on the other side financial benefits through lower input of energy, water and raw materials in the process and in the price of the final product. On the other side, large industrial facilities have teams dealing with environmental monitoring, identification of aspects that need to be improved in accordance with the legal requirements and best international practices, take care of the implementation of proposed measures, report regularly to MEPP on the status of media and communicate the public and cooperate with local communities and non-governmental organizations.

Technological processes conducted in industrial facilities in Macedonia, together with the transport of raw materials and finished products to clients, as well as use of natural resources (land, energy, water) have direct impacts of pollution and make pressure on all environmental media, and not only on the quality of air through emission of pollutants. Combustion of energy resource (type and quality of fuel used in technological process, e.g. content of sulphur, management of combustion process), transportation vehicles used by industrial facilities (quality of fuel they use, specification of engines with regard to exhaust gas emissions, driving regime, etc.), emissions resulting from chemical processes performed within the technological process, emissions occurring upon the storage of industrial waste in site or out of the site, as well as emissions from the storage of primary or auxiliary materials (fugitive emissions) are the main sources of polluting substances in the air from an industrial facility.

Table 28 shows total emission of pollutants from the sector Industry for the period 2001 – 2009.

Table 28 Total emission of pollutants from the sector Industry for the period 2001 – 2009

Industry	2001	2002	2003	2004	2005	2006	2007	2008	2009
SO_2 (кt)	38.20	67.85	40.76	0.36	0.36	0.36	0.21	0.30	0.02
NOx (кt)	0.50	5.60	5.91	4.93	4.96	4.96	2.68	4.63	0.48
VOC (кt)	-	-	-	10.01	9.47	9.46	9.47	9.96	9.95
TSP (кt)	-	-	2.08	22.28	20.45	22.45	13.56	16.76	0.59
CO (кt)	21.50	26.80	27.90	9.55	9.59	9.57	5.37	8.38	0.74

There is notable increase in pollutant emissions originating from industrial sector by 2002, followed by constant falling of the values of all pollutants upon 2003 as a result of the closure (terminated operation) of high number of industrial facilities in the Republic of Macedonia in the analyzed period.

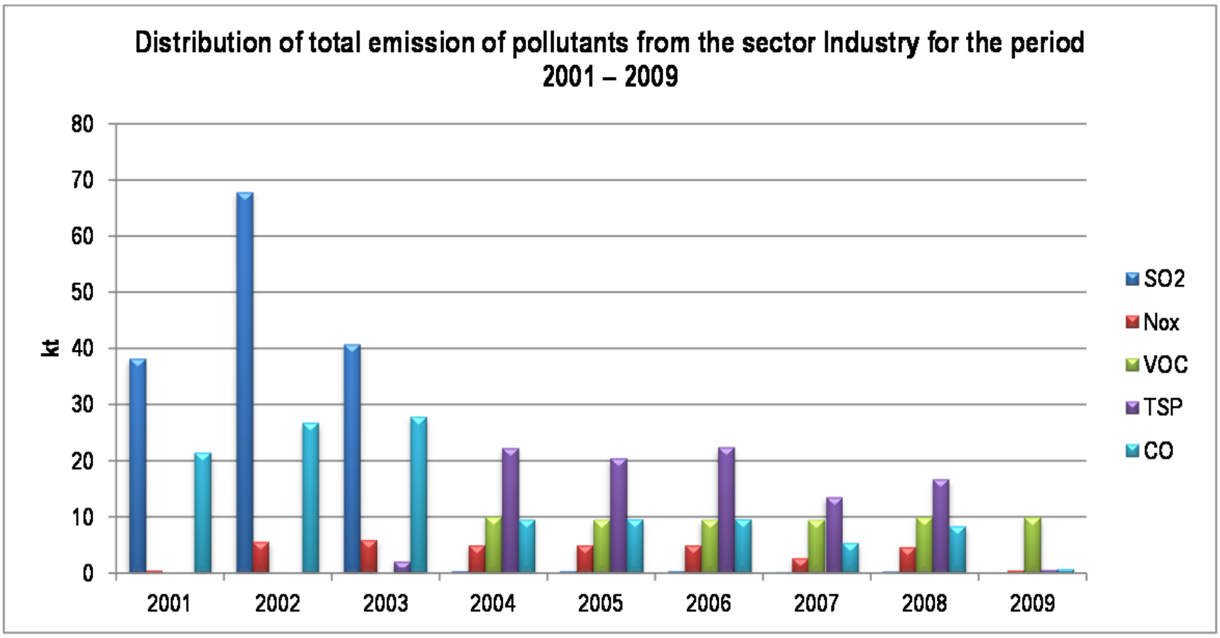


Diagram 32 Distribution of total emission of pollutants from the sector Industry for the period 2001 – 2009

Industrial sector contributes around 28% to the total annual emissions of sulphur dioxide from all sectors, 14 % to the total annual emissions of nitrogen oxides, 38% to the annual emissions of volatile organic compounds and around 60% to the generation of solid particles emissions at annual level.

Mining operations of excavation, transport and disposal, open queries and coal stores, mining, primary preparation of chopping and classification, as well as disposal of flotation slag are the most important sources of fugitive emission of suspended particles, carbon monoxide and methane. Total annual emissions of these pollutants are presented in Table 29. Mines are located in Northeastern, Skopje, Eastern and Pelagonia regions (“Toranica – Indos Minerals”, “SASA – Makedonska Kamenica”, “Suvodol – Novaci”, “Zletovo – Probishtip”, “Buchim – Radovish”, etc.)

Table 29 Fugitive emission from mining operations in the mines in Macedonia (2008) [7]

Source of fugitive emissions	Pollutant (kt/year)		
	SPM	CO	CH_4
Coal mines	2.637	1.161	11.570
Mines for metal ore exploitation	15.296		
Mines for industrial minerals exploitation	2.076		
Mines for stone aggregate exploitation	6.719		
Total	26.727	1.161	11.570

Emissions of volatile organic compounds, according to the Cadastre of polluters and pollutants in the air for 2008 [7] originating from transport, unloading and storage of oil and oil derivatives on annual level are presented in Table 30. In Macedonia, the main producer of oil derivatives is OKTA Refinery, which has large reservoirs' park for oil and oil derivatives within its production site and several petrol stations, mostly in Skopje and its surrounding. AD Makpetrol is the main importer and distributor of oil derivatives and has high number of petrol stations and large storage area in the settlements Ilinden and Miladinovci. There are around 300 petrol stations in the Republic of Macedonia. Low share in total emissions originates from smaller distributors of fuels possessing several petrol stations each, but without their own reservoirs' area.

Table 30 Total emissions of volatile organic compounds from oil and oil derivatives storage and delivery

Activity	Emissions of NMVOC (kt/year)
Storage and loading in dispatching station in OKTA Refinery	0.015
Transport and depots	0.055
Unloading and storage in petrol stations and delivery of fuel to vehicles	0.355
Total	0.425

Total quantities of volatile organic compound emissions for 2008 are presented in the Table below, under the SNAP categorization.

Table 31 Emissions of NMVOC for 2008 by SNAP sectors (kt)

	SNAP 1	SNAP 2	SNAP 3	SNAP 4	SNAP 5	SNAP 6	SNAP 7	SNAP 8	Total
2008	1.76	3.51	0.27	0.95	0.42	9.01	10.83	1.08	27.83

It can be noted that the highest proportional share of emission originates from road transport (SNAP 7) and use of solvents and other products (SNAP 6) contributing to the total quantity of VOCs for 2008 39% and 32%, respectively. The lowest share in total emission for 2008 for VOCs belongs to the sector of combustion processes in industrial production and this amounted 1%.

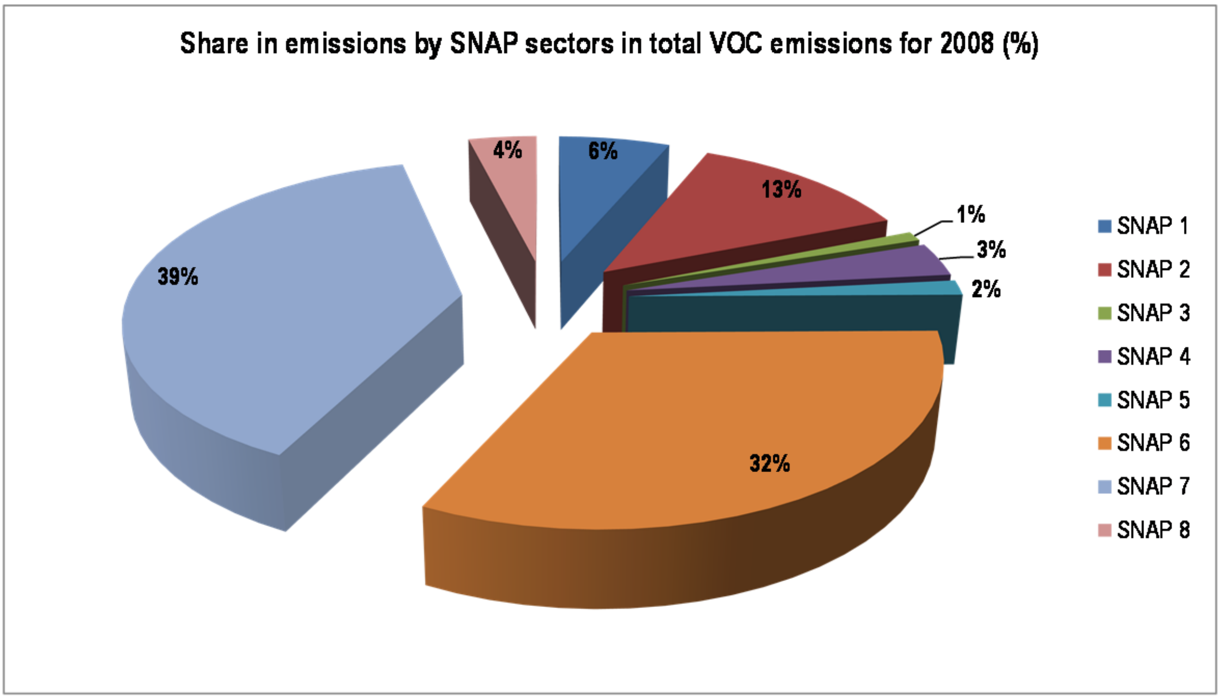


Diagram 33 Share in emissions by SNAP sectors in total VOC emissions for 2008 (%)

As far as industrial plants and emissions of volatile organic compounds are concerned, this plan analyzes emissions originating from chemical industry, industry for organic substances manufacturing, metal industry, food industry, industry for beer, wine and alcoholic beverages production, industrial processes using dyes, processes of cleaning and degreasing, printing and chemical products manufacturing and combustion plants used in production industry.

In 2007, in the frames of the Project "EAR/MEPP Strengthening of environmental management" (2006-2007), initial inventory of around 300 small and medium size enterprises which in their production use solvents, dyes, coatings, lacquers and other volatile organic compounds was completed.

Emissions of heavy metals in the air in the Republic of Macedonia originate primarily from stationary sources belonging to the sectors of energy, mining, metal processing, pharmacy, food processing, textile industry and construction materials manufacturing.

In 2011, "Report on the measurement and analysis of heavy metals from stationary sources" [30] was prepared in accordance with Annex II to the Protocol on heavy metals. Total quantities of heavy metals in identified installations which by their technological processes release heavy metals into the air for 2011 are presented in Table 32.

Table 32 Total emission of heavy metals in Macedonia (2011)

Total emission of heavy metals (kt/year) in 2011	Lead	Cadmium	Mercury	Arsenic	Nickel
	0.0023	0.00019	0.00021	0.001	0.0047

Industry also contributes to emissions of polycyclic aromatic hydrocarbons (PAHs), though the biggest source is heating of households with wood and coal, transport and production of coke and anodes and aluminum. These industries are not represented in Macedonia and presence of certain PAH compounds in air samples is due to transport.

Preliminary inventory of PCB (polychlorinated biphenyls) containing equipment was completed in 2009 and the following industrial sectors were identified to include such equipment: a) Electric power industry – EVN, MEPSO, ELEM, b) Metal industry (Makstil, Skopski Leguri, FENI, Jugohrom – Ferrou-alloys), c) Mines (SASA, Silika – Gostivar, Zletovo – Probishtip, Toranica – Kriva Palanka, Buchim - Radovish, d) Chemical industry (OHIS – Skopje, OKTA Refinery, etc. Digital inventory also contains the weight of oil in transformers, condensers and used oil in barrels (closed systems).

Table 33 Total quantity of identified PCBs under the completed inventory [14]

Quantity of identified PCBs in equipment	Total weight (kg)
Transformers	357.500
Condensers	29.700
Used oil in barrels	16.000
Total	403.200

Graphical overview of each equipment in the total one identified during the completed inventory is presented on Diagram 34.

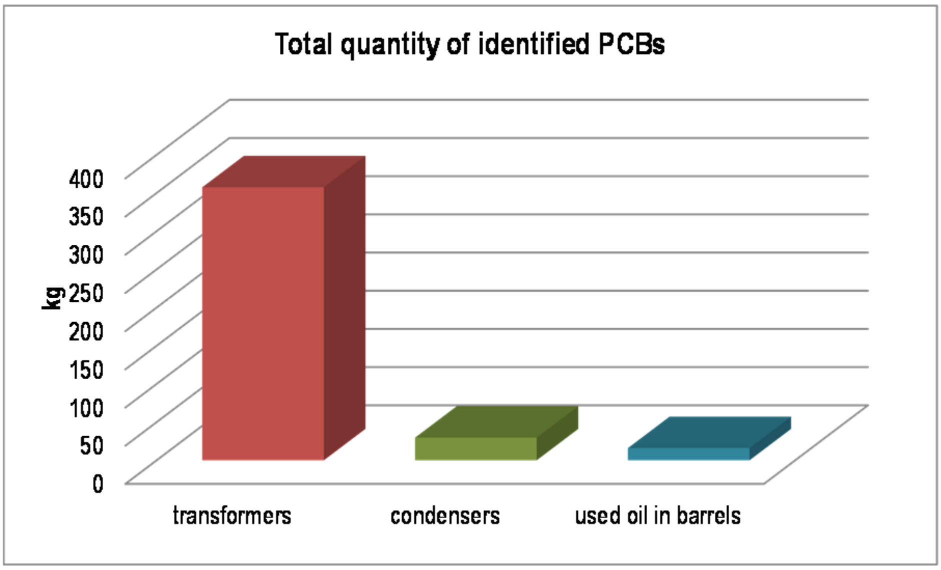


Diagram 34 Total quantity of identified PCBs

Also, quantities of hydraulic PCB containing oil that is still used in mining have been identified. Share of industrial branches in the total quantity of used hydraulic oil is presented on Diagram 35, where the greatest share belongs to metallurgy, followed by energy supply, construction industry, agriculture, electric power industry and transport.

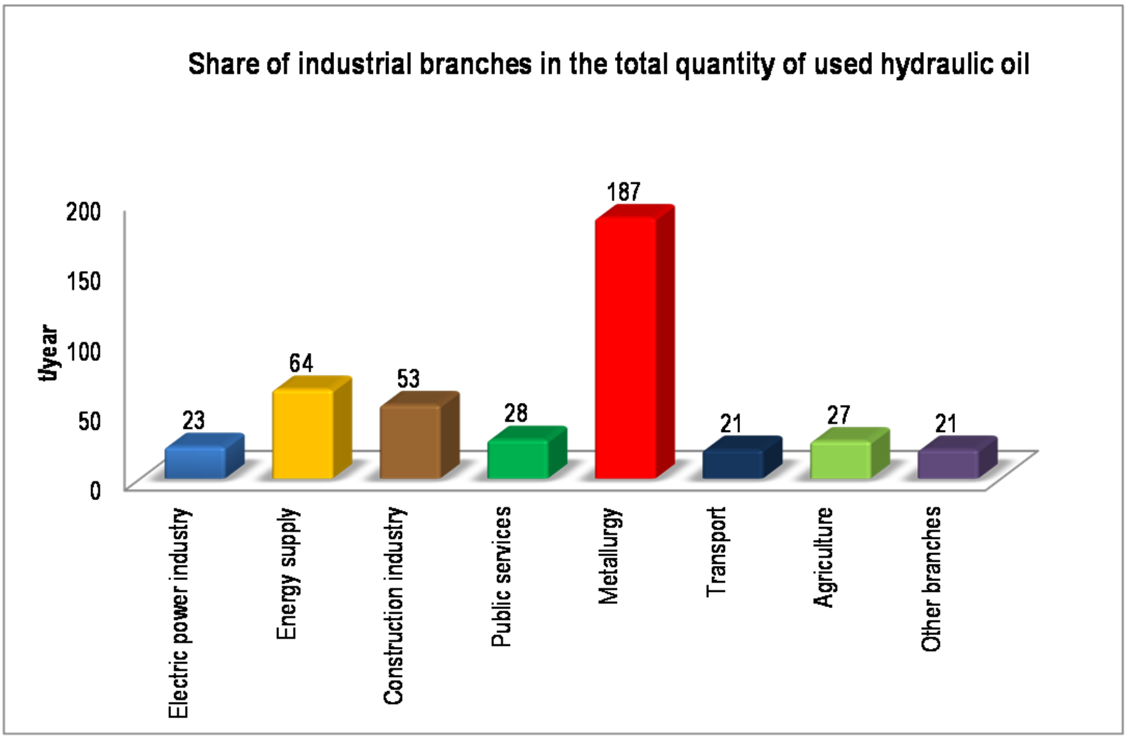


Diagram 35 Share of industrial branches in the total quantity of used hydraulic oil

5.3 Consumption of fuel

The highest proportion of pollutants emission originates from fuels combustion. The emission is also in direct correlation with the type, quality and consumption of fuel used in individual sectors and activities.

Around 400 commercial entities distributed in all eight planning regions have been identified as the biggest consumers of fuels. Quantities, type and distribution of the fuel consumption for all stationary sources (industrial, production and combustion processes and administrative institutions), presented in the Cadastre of pollutants and polluters in the air prepared in 2009 by MEPP are shown in Table 34.

Table 34 Consumption of fuels by planning regions and distribution by fuel type [7]

Region	Total annual consumption of fuel [t/year]	Fuel consumption [t/year]				
		Gas	Wood	Coal	Crude oil	Oil
Vardar	135.028.50	110.00	3.209.00	4.395.00	117.561.00	9.752.50
Eastern	35.590.20	1.907.60	9.673.00	1.117.00	11.100.00	11.792.60
Southwestern	1.176.602.70	246.20	1.587.50	1.158.760.00	4.684.50	11.324.50
Southeastern	47.384.84	1.249.00	15.523.50	55.00	24.218.00	6.339.34
Pelagonia	6.597.665.01	487.50	1.286.00	6.566.582.00	18.455.00	10.854.51
Polog	96.856.54		360.50	82.655.00	6.653.00	7.188.04
Northeastern	13.305.00	1.600.00	1.373.50		6.665.00	3.666.50
Skopje	1.664.725.40	1.374.501.00	1.446.20	1.417.00	241.744.00	45.617.20

Total	9.767.158.19	1.380.101.30	34.459.20	7.814.981.00	431.080.50	106.535.19

Share of different fuel types in each of the eight planning regions is presented on Diagrams below:

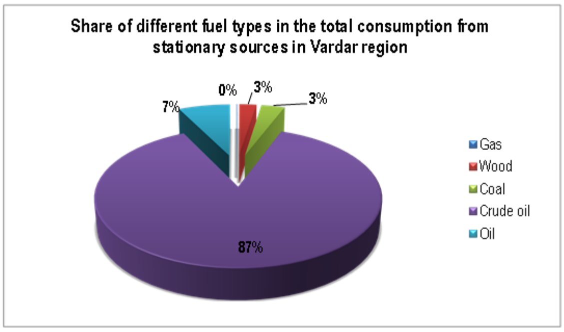


Diagram 36 Share of different fuel types in the total consumption from stationary sources in Vardar region

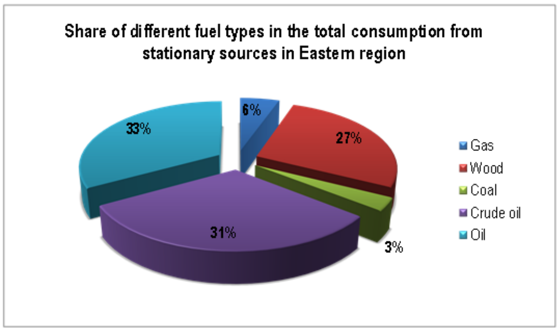


Diagram 37 Share of different fuel types in the total consumption from stationary sources in Eastern region

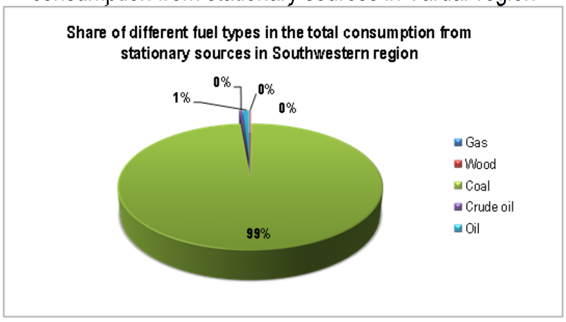


Diagram 38 Share of different fuel types in the total consumption from stationary sources in Southwestern region

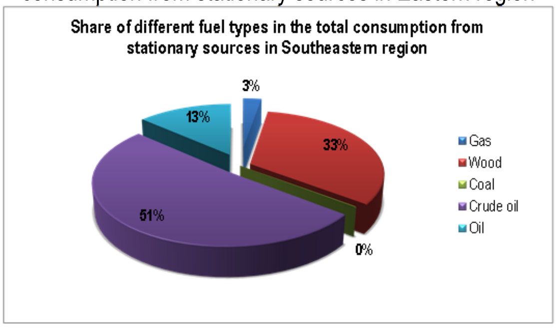


Diagram 39 Share of different fuel types in the total consumption from stationary sources in Southeastern region

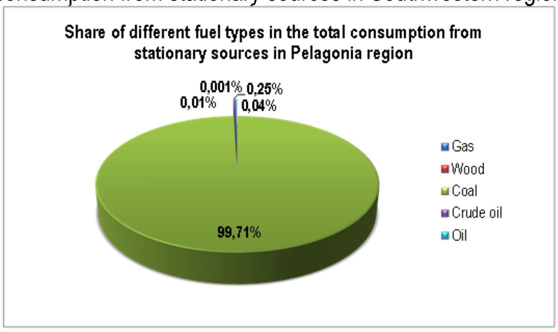


Diagram 40 Share of different fuel types in the total consumption from stationary sources in Pelagonia region

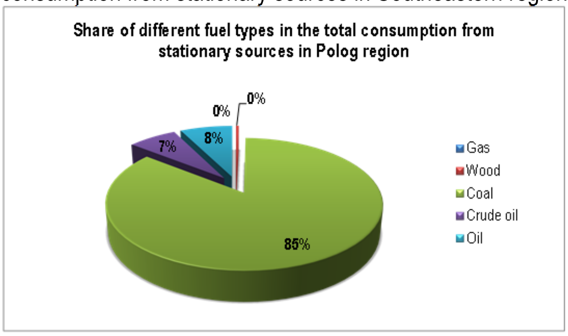


Diagram 41 Share of different fuel types in the total consumption from stationary sources in Polog region

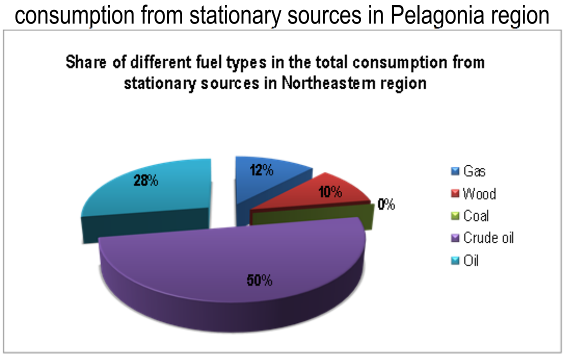


Diagram 42 Share of different fuel types in the total consumption from stationary sources in Northeastern region

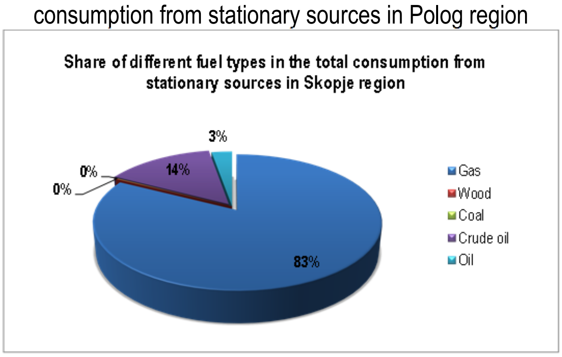


Diagram 43 Share of different fuel types in the total consumption from stationary sources in Skopje region

Share of different fuel types in the total annual consumption for 2009 is presented on Diagram 44.

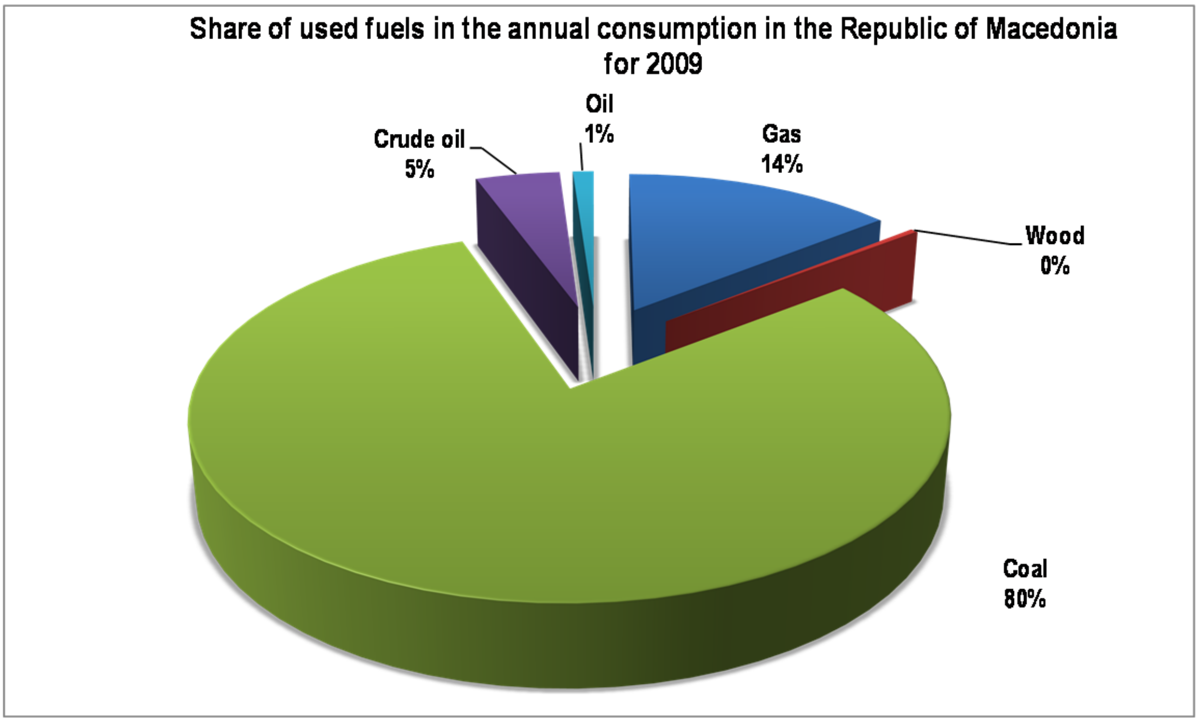


Diagram 44 Share of used fuels in the annual consumption in the Republic of Macedonia for 2009

The highest share in the total annual consumption of fuels belongs to coal (80%) and crude oil (7%). This is due to electricity production (REK Bitola, REK Oslomej), metallurgy ("FENI Industry", "Jugohrom Ferroalloys", "Makstil", "Skopski Leguri"), oil industry ("OKTA Refinery"), heat production ("AD Toplifikacija"), construction ("Cement plant USJE", "Tondah - Vinica", "BOMEKS - Pehchevo", "IGM Vratnica", "IGM-Elenica"), production of food and beverages, chemical and pharmaceutical industry and wood and paper processing. Crude oil remains the most represented energy source in production industrial facilities, while natural gas is the most represented in Skopje planning region (97%) because of the spread of gasification network only in Skopje (Industrial zone Bunardzik, "AD Brewery – Skopje", "AD Evropa - Skopje", "AD Alkaloid", "Makstil", "Gas plant TE-TO (AD Toplifikacija)", "Archelormital", "Skopski Leguri" and other smaller industrial facilities in food processing sector. Use of oil (extra light fuel) is almost evenly represented in all regions and all sectors with the greatest share of small and medium size enterprises operating in food processing sector, textile industry, meat processing industry, production of agricultural products, tobacco production.

Quality of fuels has improved significantly during the last 5 years in line with the EU policies concerning restriction of polluting substances in fuel and currently the crude oil, which is most used in production processes, has sulphur content of 1 % (former content was up to 3.5%), while the content of sulphur in extra light fuel has dropped by 10 times (from concentration of 10 000 ppm to 1000 ppm). This has been enabled through investment in OKTA Refinery – Skopje, by introduction of new technological plants (desulfurization), improvement of the choice of raw oil and modification of old with modern catalysts in the process of crude oil and extra light fuel production. Quality of fuels is analyzed in accredited laboratories for testing by internationally recognized methods in the area of oil derivatives (Makpetrol Laboratory and OKTA Laboratory).

5.4 Transport

Transport is sector with great share in environmental pollution, with especially degrading effects in urban environments. Depending on the development of motorization in a country, air pollution from the traffic can reach even 60% of the total pollution. The main emission sources in urban areas are passenger vehicles, i.e. internal combustion engines (ICE) installed in different means of transportation. Regardless of the extent of combustion, ICEs release pollutants which pose potential hazard to the environment and human health, and at the same time affect the safety of the transport.

Today, three types of ICEs are used in the world. The most frequently used engines are the four-wheel drive engines where ignition is done by electric sparkle (Oto engines). These engines are used in passenger cars and light freight vehicles. Also, four-wheel and two-wheel engines where ignition of mixture is conducted by self-ignition under compression, are frequently used. These are the so called diesel engines used for drive of larger freight vehicles, buses, locomotives and ships. The third type of ICEs is the turbo jet engines of aircrafts.

Since the middle of the last century, photochemical smoke was recorded and this motivated car producers to undertake measures for reduction of the harmful emission of exhaust gases from ICE installed in cars. Efforts made by experts towards reduction of harmful substances in exhaust gases produced positive results, and thus release of carbon which used to amount 567 grams per car in 1960 at an average has dropped by more than 65 %.

Given the fact that our society as a whole rests on the principle that "each person should possess vehicle and use it frequently", it is logical that the traffic is the most developed in major cities where the air is the most polluted as well. It is well known that 1 liter petrol produces around 10 m^2 harmful gases which have negative impacts on human organisms. Overview of environmental effects of ICEs is presented on Diagram 45.

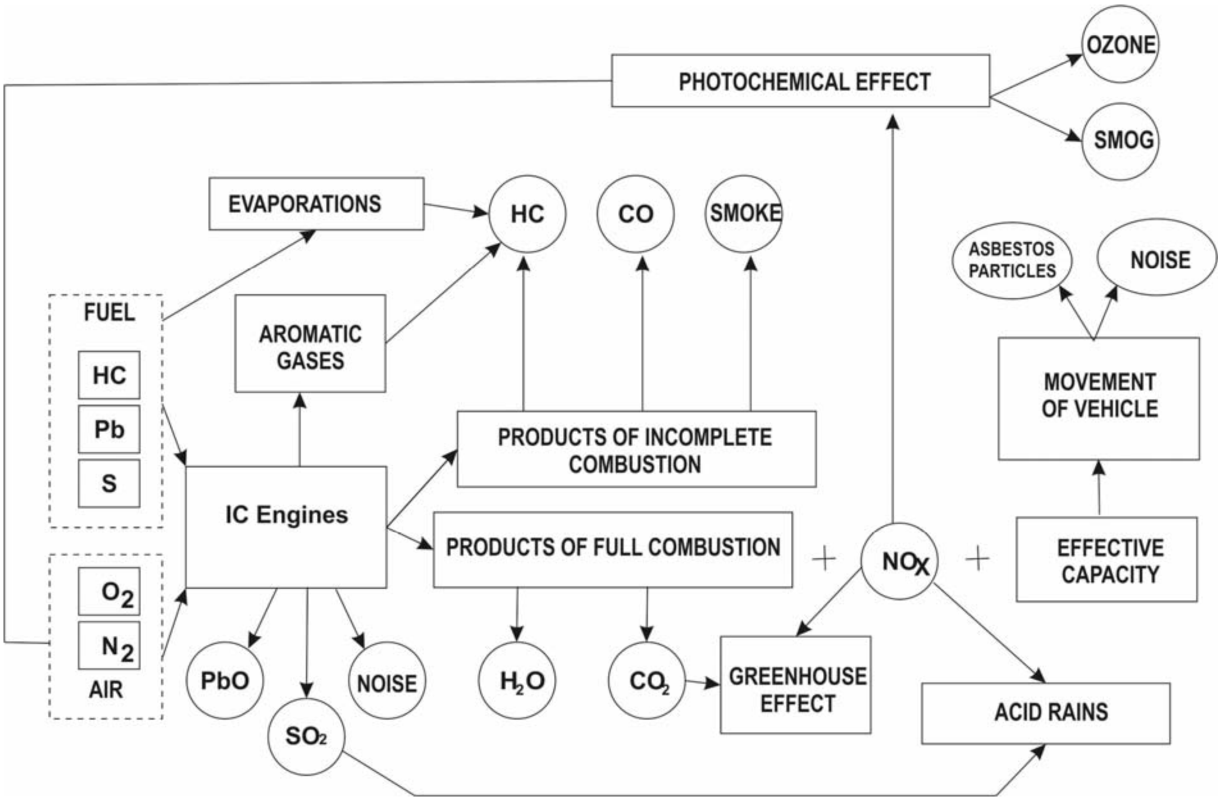


Diagram 45 Environmental effects of ICEs

Air pollution from vehicles originates from several outlets, the main portion of which , 95 – 99%, belongs to exhaust gases, while the rest originates from cardplayer, carburetor and fuel tank.

Exhaust gases from internal combustion engines solely contain around 280 pollutants. According to their chemical composition and effects on human organism, exhaust and cardplayer gases can be divided into several groups.

The group of non-toxic components comprises: nitrogen – N_2, oxygen – O_2, hydrogen – H_2, water steam – H_2O and carbon dioxide – CO, and the group of toxic components includes: carbon monoxide – CO, nitrogen oxides – NO_x, uncombusted hydrocarbons – C_nH_m, aldehydes – RCHO and solid particles.

Primary polluting substances from motor vehicles exhaust gases include: carbon monoxide, nitrogen oxides, sulphur dioxide, uncombusted hydrocarbons and solid particles. These primary polluting substances are subjected to photochemical reactions in atmosphere, resulting in creation of secondary polluting substances.

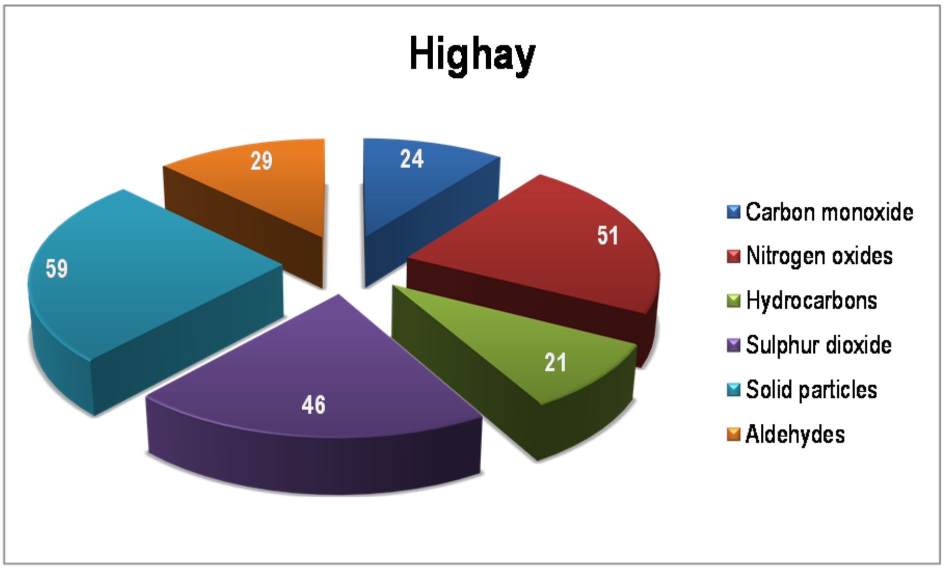
During the combustion of fuels containing certain percentage of sulphur, sulphur dioxide (SO_2) and hydrosulphur (H_2S) occur. Cancerogenic polycyclic aromatic hydrocarbons form separate group, and benzopyrene is the most active among them according to its cancerogenic effects.

Emission of lead and lead compounds from motor vehicles using petrol is of particular significance. Lead in a form of organic compounds (most frequently tetratethyllead – TEO and tetramethyllead – TMO), is added as additive to petrol to improve the antidetontation properties, and it is released into the atmosphere via exhaust gases. Leaded petrols have been phased-out from use in the Republic of Macedonia, but the additives MTBE, bensol and aromates are used instead and these cause releases of pure benzene and other toxic compounds into the atmosphere. Identification and effects of these polluting substances require indicative measurements to be followed by introduction of limit values.

Distribution of the type of emissions depends on the conditions under which the traffic is carried out (urban environment or highway), and it is presented in Table 35 based on investigations carried out in EU.

Table 35 Distribution of motor vehicles depending on traffic conditions (%)

Pollutant	Urban environment	Highway
Carbon monoxide	54	24
Nitrogen oxides	24	51
Hydrocarbons	60	21
Sulphur dioxide	31	46
Solid particles	17	59
Aldehydes	51	29



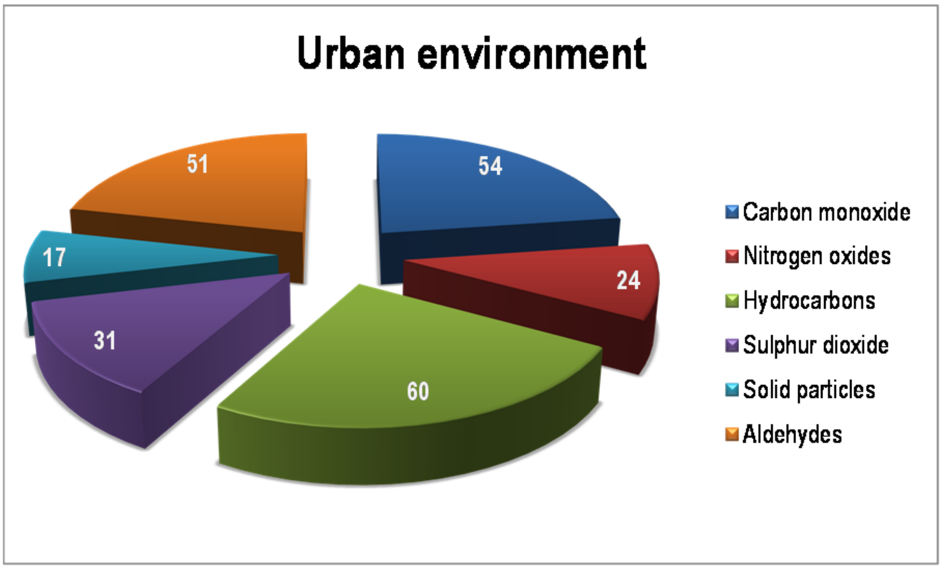


Diagram 46 Graphical overview of the distribution of emissions from motor vehicles depending on traffic conditions (%)

Problems of air pollution are more prominent in urban environments. The state of traffic systems in our cities is specific because it does not comply with the main principles which are closely related to environmental modalities of modern cities to a great extent. Namely, traffic systems have influence on the mobility and traffic connectivity of certain parts of the city, because reduction in the speed of motor vehicles driving through urban streets cause higher consumption of motor fuel and this further causes release of higher quantity of polluting substances.

Air pollution from vehicles depends on the type and the number of motor vehicles. The number of registered motor vehicles in the Republic of Macedoniain the period 2006-2009 is presented in Table 36 and Diagram 47(Statistical Yearbook of the Republic of Macedoniafor 2011 [4]).

Table 36 Number of registered motor vehicles in the Republic of Macedonia 2006 – 2009

Vehicle type	2006	2007	2008	2009
motorcycles	3432	4437	8626	9097
passenger cars	242287	248774	263112	282196
Buses	2220	2284	2270	2454
freight cars	13545	12981	13325	14160
special tractive vehicles	12169	13577	15555	17874
tractors and operational vehicles	584	569	756	1194
trailing vehicles	4627	4600	4850	5388
total	278864	287222	308494	332363

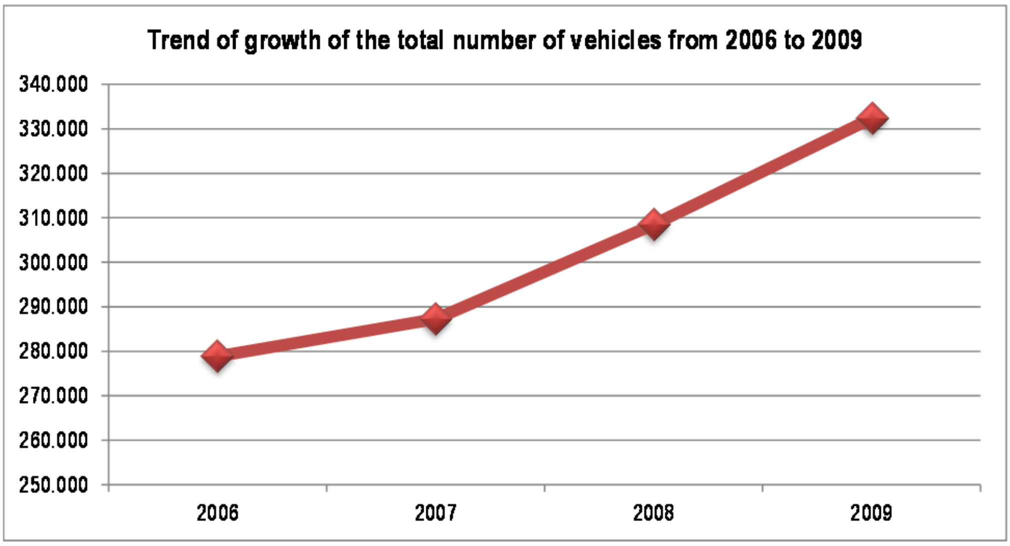


Diagram 47 Trend of growth of the total number of vehicles from 2006 to 2009

Consumption of liquid fuels in the period 2007 to 2009 is presented in Table 37.

Table 37 Sale of liquid fuels in the Republic of Macedonia in the period 2007 – 2009 (in thousand tons = 10^3tons)

Year	2007	2008	2009
Motor petrols	114	121	123
Diesel fuels	234	266	267
Extra light	191	96	109
TNG	60	57	59
Jet fuel	6	6	1.6
Aircraft petrol	0.085	0.149	/

Most of the motor petrols sold in the Republic of Macedonia are used in the transport sector, in light passenger cars.

Almost 80% of diesel fuels sold in Macedonia are used in transport sector, in heavy freight vehicles and buses.

Railway transport in the Republic of Macedonia drives on diesel fuel and electricity. Consumption of diesel fuels (*t/year*) in the railway transport is presented on the next Diagram:

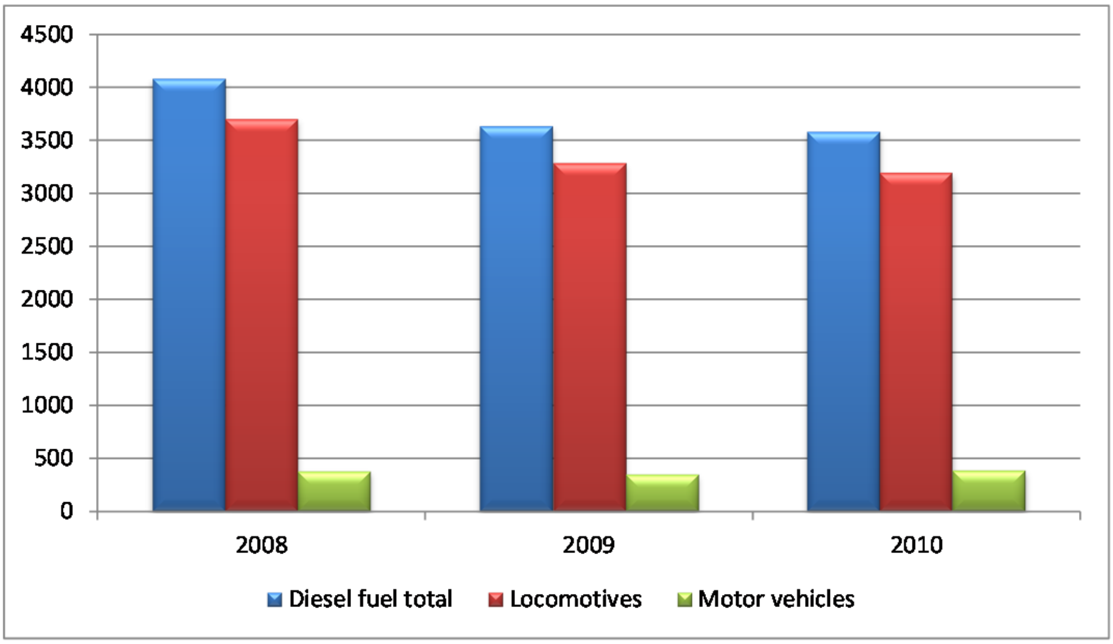


Diagram 48 Consumption of diesel fuels (*t/year*) in the railway transport

Total quantities of pollutant emissions from sector SNAP 07 (Road transport) and 08 (other mobile sources) in the period 2001 to 2009 are presented in Table 38.

Table 38 Total emissions of pollutants from the sector Transport for the period 2001 - 2009

Transport	2001	2002	2003	2004	2005	2006	2007	2008	2009
SO_2 (кt)	0.50	0.50	1.00	1.02	1.07	1.07	1.33	1.07	1.07
NOx (кt)	11.30	11.30	22.00	11.27	11.87	11.87	14.27	12.07	12.07
VOC (кt)	-	-	-	9.79	9.96	9.97	11.15	11.91	11.78
TSP (кt)	-	-	-	0.22	0.24	0.24	0.30	0.26	0.26
CO (кt)	47.30	47.30	76.30	42.95	43.73	43.50	48.77	45.66	45.67

Diagram 49 shows the total emissions of pollutants from the sector Transport for the period 2001 – 2009, reflecting a trend of growth in emissions for all substances, with specific accent on CO and NO_x.

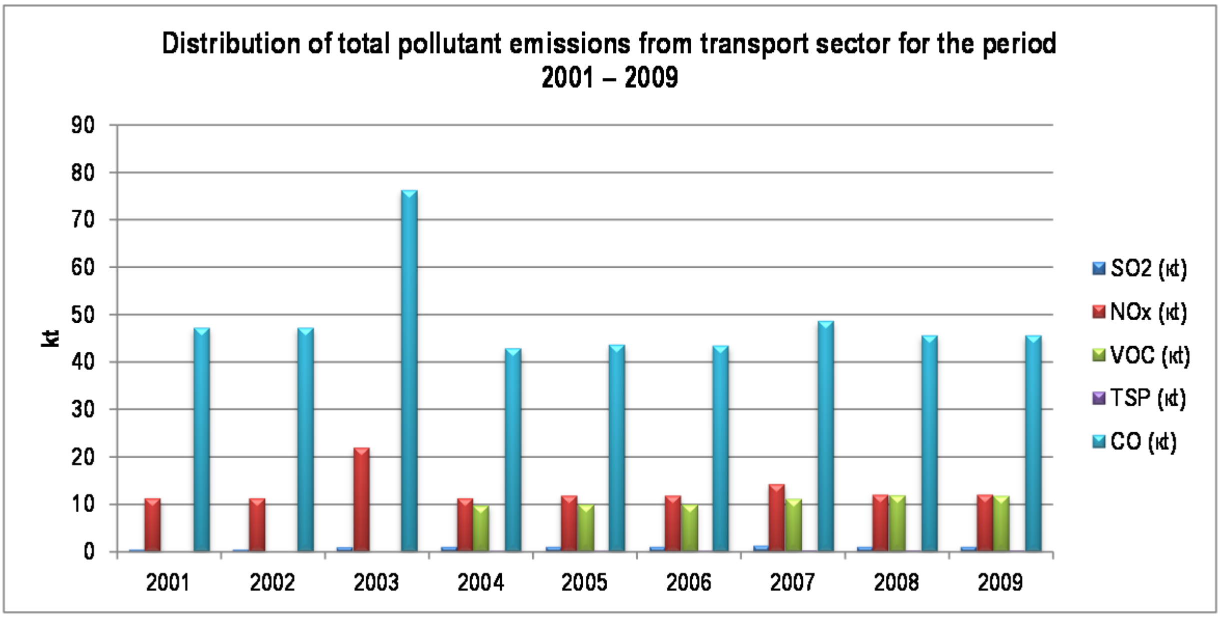


Diagram 49 Distribution of total pollutant emissions from transport sector for the period 2001 – 2009

Within the total annual emissions from all sectors on national level, the highest share of the transport sector occurred with the emissions of NO_x (32 % - 47 %) for the period 2001 – 2009, the share of the sector in volatile organic compounds ranged from 38 % in 2004 to 43 % in 2009, while the share in SO_2 emissions ranged between 0.37 % and 1.33 %.

Contribution of different types of transport by vehicle types to the total emission generated from the transport sector in the period 2001 – 2009 is presented on Diagram 50. The Diagram shows that passenger transport which includes passenger vehicles, light freight vehicles, mopeds and motorcycles contribute 92% to the generation of total emissions of all pollutants originating from transport sector, while other mobile sources including railway transport, international air and road transport, contribute 8% to the generation of the total emission.

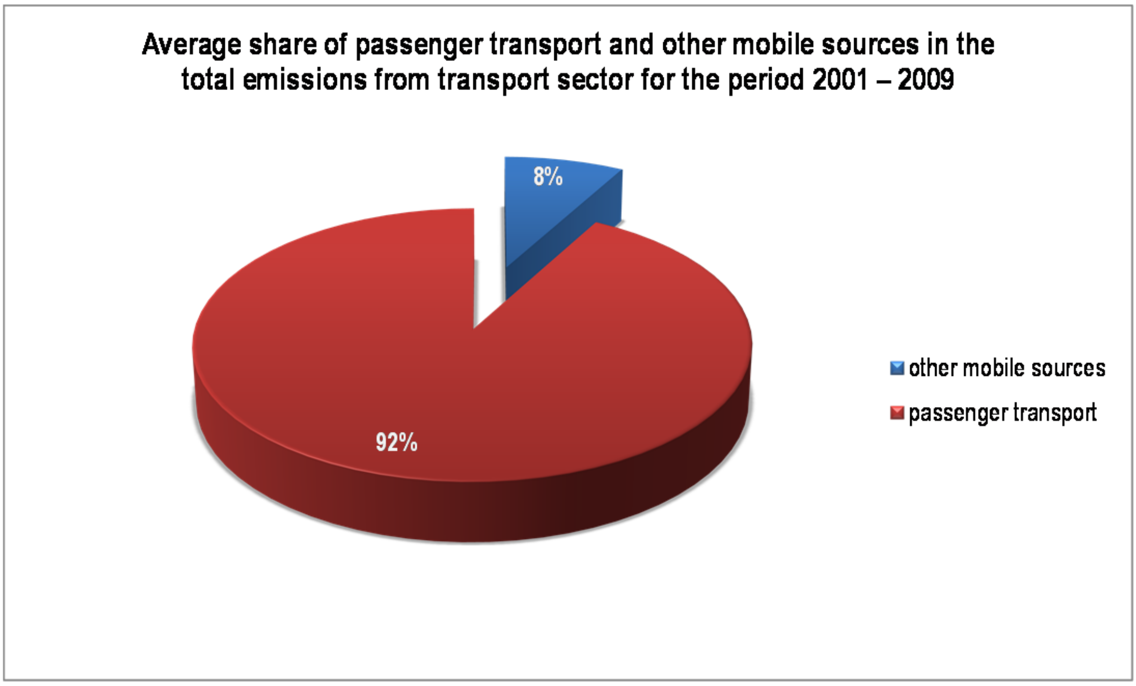


Diagram 50 Average share of passenger transport and other mobile sources in the total emissions from transport sector for the period 2001 – 2009

Depending on the level of the Republic of Macedonia's development, implementation of strategic documents in the area of transport and economic power of its citizens, two scenarios are possible for vehicle fleet development in the Republic of Macedonia.

Under the optimistic scenario for the growth of the number of vehicles using modern technologies with low level of harmful emissions of pollutants in the air or vehicles with zero emission, in the period 2011 – 2016, the number of vehicles will grow with annual rate of 0.5% on annual basis or 1.700 vehicles per year at an average to reach a growth of 8.500 vehicles, i.e. 2.5% of the vehicle fleet.

Pessimistic scenario envisages lower growth in vehicle fleet, with increase in the total number of vehicles by 3.700 vehicles in 2016.

The estimate of the growth rate for the total number of vehicles in the period 2011 – 2016 should be made taking into account the data of MOI which indicate increase in the overall vehicle fleet in the Republic of Macedonia by used vehicles produced between 2000 and 2005 by 16%, in the period between 2010 and 2011 under the influence of the amended legislation on import and registration of used vehicles from abroad. In the course of the next five years, the growth of overall vehicle fleet in the country is expected to rise by 2% at annual level, i.e. 8.000 vehicles per year during the next five years.

It has to be underlined that vehicles in the transport sector recorded in the Statistical Yearbook are registered in the MOI, but there is also high number of non-registered vehicles occurring as active participants in the transport. There are two categories of non-registered vehicles: vehicles that have failed to comply with the technical check and have thus not been registered (yet, they have remained active participants in the transport) and vehicles that are registered, but their users avoid the obligation to pay damages caused on third persons. There is no accurate data in the MOI on the number of non-registered vehicles, but it has been deemed to be in the range of 20 - 30 %. This condition is also a result of the high number of vehicles that are not in proper operational condition and stay parked on parking places or at depots, while they have not been regularly checked out from the registry (which has not been published for 20 years). For this exact reason, it has been estimated that the number of non-registered vehicles is in the range between 20 and 30%. Yet, this figure seems to be too high, as the number of vehicles used in the Republic of Macedonia under the current registry of the MOI is around 390 000 vehicles, and it is deemed that 5 % of these have not fulfilled the obligation for annual re-registration of the vehicle.

5.5 Agriculture

Agricultural sector is the main source category for ammonia emissions. Namely, 99% of the total national emissions of NH_3 originate from agricultural sector, and the trend in the quantities of ammonia emissions is shown on Diagram 12 in chapter 4.2. Also, agricultural sector is second in size source of greenhouse gas emissions, namely: CH_4, N_2O and CO_2. Greenhouse gas emissions from agricultural sector contribute 8-15% to the total emission and consist of methane (CH_4) and dinitrogen oxide (N_2O) which originate from the following sources: enteric fermentations of domestic animals, emissions from fertilizers management with regard to organic and nitrogen compounds, emissions from rice fields, direct emissions from agricultural soils, as well as indirect emissions of nitrogen used in agriculture and emissions from agricultural residues burning.

Apart from the lack of relevant statistical data or data of the Ministry of Agriculture, Forestry and Water Economy, calculations of emissions from this sector were made in the frames of the Second National Communication of the Republic of Macedonia to the United Nations Framework Convention on Climate Change.

Emissions of CO_2-eq from agriculture by subsectors for 2002 are shown on Diagram 51, which indicates clearly that the main sources of emissions in agricultural sector are enteric fermentation with 51% and agricultural soils with 34%, and emissions from rice fields and fertilizers management contribute less. Diagram 52 shows contributions of individual greenhouse gas emissions in the overall emissions of CO_2-eq in agricultural sector.

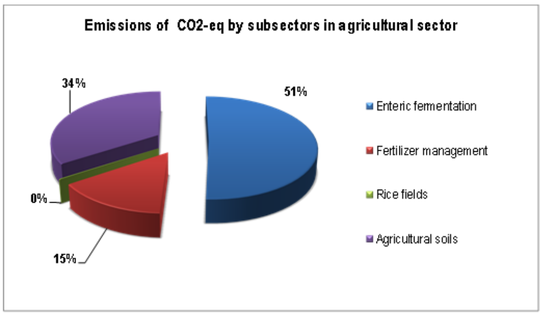


Diagram 51 Emissions of CO_2-eq by subsectors in agricultural sector for 2002

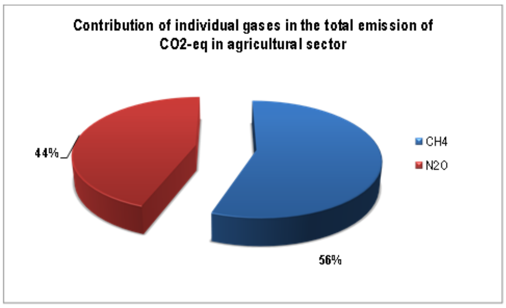


Diagram 52 Contribution of individual gases to the total emissions of CO_2-eq in agricultural sector for 2002

The amount of quantitative data concerning environmental issues related to agriculture in the Republic of Macedonia is low. Namely, there is no data on the use of fertilizers at farm level, emissions of methane and ammonia (greenhouse effect causing substances) originating from inadequate storage and use of manure and fertilizers of animal origin in regions with high number of livestock breeding farms, have not been analyzed in detail. At present, there is no agro-environmental policy in the Republic of Macedonia and the only ongoing activity is the scheme for organic production managed by the MAFWE.

Furthermore, there has been no regulated limitation of ammonia emissions resulting from the use of solid carbamide based fertilizers.

In the frames of the Programme for use of the funds from the EU Pre-accession Instrument for rural development for the period 2007-2013 (IPARD Programme), investments have been planned towards introduction of a system for cattle housing cleaning and keeping manure till its application on agricultural areas. Investments for introduction of the system for cleaning and manure keeping and handling are subject to co-financing.

IPARD Programme enables introduction of appropriate measures for agriculture and rural development support, in order to improve competitiveness of agricultural production and agriculture and food processing sectors through their harmonization with the EU standards and achievement of sustainable environmental and socio-economic development of rural areas. IPARD support for cattle and poultry breeding includes projects for:

1. Investments in agricultural properties to restructure and upgrade to the level of EU standards;
2. Investments in agricultural products processing and marketing, to restructure and upgrade to the level of EU standards;
3. Rural economy diversification and development.

Reconstruction of existing and establishment of new facilities for cattle and poultry breeding and fattening, to include activities related to:

- Materials for construction of animal manure depots and tanks for manure collection, collectors and platforms,
- Equipment for manure handling and storage, including mechanization for manure cleaning and handling.

Measures for ammonia emission reduction have been defined by way of applying the best available techniques, as regulated in the Law on Environment, Chapter on IPPC. Due to the lack of national document on the best available techniques, the EU Best Available Techniques are used as good agricultural practices and these have been elaborated in detail in the National Plan for Reduction of Emissions of Certain Pollutants in the Republic of Macedonia with emission projections for the period 2010 to 2020 (NERP).

5.6 Waste

Waste is one of the air polluters resulting from inadequate waste storage and treatment involving processes like self-burning or other chemical reactions releasing pollutants into the air. Most of the waste is disposed of at legal and non-compliant or so called illegal landfills. The rate of waste recycling in the Republic of Macedonia is very low. Consequently, impact of landfills on environment and thus on human health is great, because they release pollutants, including greenhouse gases (methane), organic micro pollutants (dioxins and furans), volatile heavy metals and leakage from landfills drained in soils and ground waters, and it may contain toxic substances.

Several ongoing activities are aimed at reducing the quantities of waste, its recycling and application of safety standards in waste landfilling.

Primary goal of the Republic of Macedonia is to establish system for adequate management of all waste types, in order to reduce pollution of environmental media and areas through observation of the principles for waste generation reduction, recycling, reuse and use as energy resource prior to its final removal.

The Ministry of Environment and Physical Planning establishes and maintains the unique Cadastre of Environment as integral part of the Environmental Information System. Among others, it includes the Cadastre of waste generators. This Cadastre contains data on waste generation and treatment, i.e. collection, selection, treatment, recovery, storage and removal of hazardous and non-hazardous waste by legal and natural persons that are obliged to report data for the purpose of establishing and maintaining the relevant cadastre in accordance with the regulations. According to the Cadastre of waste generators produced in 2008 and 2009, legal and natural persons or around 1000 business entities in the Republic of Macedonia reported overall generated waste in an amount of 19.659.638.99 tons and 1.003.003,65 m^3. Among these quantities of waste, including waste from industry, together with the waste from excavation and chemical processing of mineral resources, waste from agriculture, as well as commercial waste, total of 11.509.354.86 tons and 616.385.03 m^3 was reported as own disposal by business entities, 988.072.96 tons and 66.134.69 m^3 as temporarily stored and 380.585.36 tons and 162.161.35 m^3 of waste for further treatment. This value presented as shares in the total generated industrial waste is 2.14%. Waste transferred to other persons, i.e. business entities was reported in a quantity of 6.746.518.11 tons and 156.600.1 m^3.

From among all pollutants released during inadequate waste disposal, certain data exists on the emissions of greenhouse gases presented in the Second National Communication of the Republic of Macedonia to the UN Framework Convention on Climate Change [2].

Emissions of greenhouse gases in this sector consist of methane (CH_4) and dinitrogen oxide (N_2O) released in the process of waste decomposition under anaerobic conditions. According to the Inventory of greenhouse gas emissions, the share of waste sector in the total greenhouse gas emissions ranges between 5.5 and 7.0 %. The main sources of emissions in this sector are grouped in the following three subsectors: municipal solid waste, wastewater treatment (household and industrial wastewaters) and sewerage waste.

The share of individual sectors and pollutants in waste sector is presented in diagrams below.

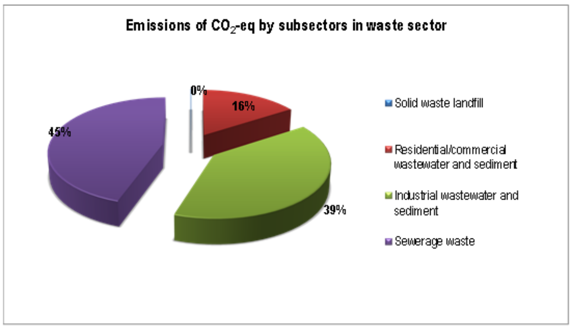


Diagram 53 Emissions of CO_2-eq by subsectors in waste sector for 2002

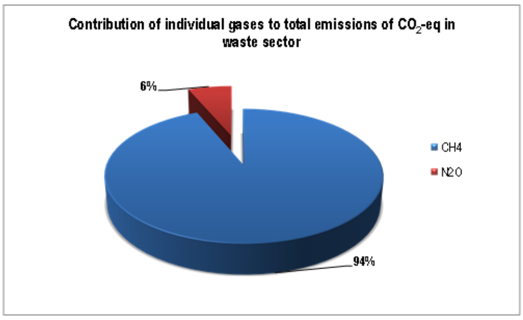


Diagram 54 Contribution of individual gases to the total CO_2-eq emissions in waste sector for 2002

Taking into account that major part of emissions originate from waste disposed of at solid waste landfills (around 90% of the total greenhouse gas emissions from waste sector), analyses for reduction will be made mainly for this subsector.

In order to reduce greenhouse gas emissions from waste decomposition, technology has been adopted for collection and combustion of methane, so that methane from landfill gas is transformed into CO_2.

There are plans for construction of managed solid waste landfills in Macedonia that will increase emission of methane from waste sector. Increase in methane emissions can also be expected from the introduction of plants for treatment of household/commercial and industrial wastewaters.

5.7 Acidification and eutrophication

Combustion of fossil fuels and agricultural activities are the most significant human activities causing effects of environment acidification and eutrophication, as well as increased presence of ground level ozone through emissions of sulphur dioxide (SO_2), emissions of nitrogen oxides (NO_x) and emissions of volatile organic compounds (VOCs) and ammonia (NH_3). They lead to critical levels of pollutants and critical burdening of ecosystems.

Critical burdening means quantitative estimate of exposure to one or more pollutants below which no significant harmful effects occur on specified sensitive elements in the environment, while critical levels indicate concentrations of pollutants in the atmosphere which if exceeded can produce direct unfavourable effects on man, plants, ecosystems and materials.

Critical burdens of acidification in the Republic of Macedonia have not been elaborated at all, though there is data that could be used in the model recommended for their establishment.

Ozone is pollutant the critical levels of which are determined in order to protect plants and they are expressed as cumulative exposure through the threshold for ozone concentration of 40 ppb. The levels of ground ozone relative to short and long-term targets are presented in chapter 4.5 of this document.

The extents of eutrophication, acidification and ground ozone are presented through indicators observing the trends in emissions from anthropogenic sources of acidifying substances, i.e. processes of air acidification.

The shares of the three most important sectors – energy, industry and transport in the total emission of acidifying substances are shown in Table 39. Energy sector has the highest share of 79.61% in the total emission of acidifying substances in the air. Industrial processes have significant share in total emission contributing 11.24 % at an average, while transport contributed 9.15 % to the total emission in the period 2001 – 2009.

Table 39 Total emission of acidifying substances by SNAP sectors (kt/year)

Sector	2001	2002	2003	2004	2005	2006	2007	2008	2009
Energy	115.04	115.14	128.16	116.71	116.93	116.93	116.00	132.12	131.16
Industry	38.70	73.45	46.67	5.29	5.32	5.32	2.89	4.93	0.50
Transport	11.80	11.80	23.00	12.29	12.94	12.94	15.60	13.14	13.14
Total	165.54	200.39	197.83	134.29	135.19	135.19	135.09	150.19	144.8

The analysis of data in Table 40 concerning total emission of acidifying substances indicates trend of decrease in the values for SO_2 after 2002 and slight increase after 2008. Low quality of fuels used in electricity production, transport and industrial production processes are the main sources of SO_2 emissions. Emissions of NO_x in the analyzed period 2001 – 2009 are variable, i.e. there were slight oscillations after 2003.

Table 40 Total emission of acidifying substances SO_2 and NO_x (kt/year)

Substance	2001	2002	2003	2004	2005	2006	2007	2008	2009
SO_2	136.53	165.88	150.33	100.79	100.63	100.63	100.08	113.57	112.33
NO_x	29.01	34.51	47.5	33.54	34.56	34.56	35.01	36.62	32.47
Total	165.54	200.39	197.83	134.29	135.19	135.19	135.09	150.19	144.8

The trends of acidifying substances emission in the air (SO_2 and NO_x) for the period 2001 – 2009 are presented on Diagram 55 which shows a varying trend from 2002 to 2009. Emissions of SO_2 recorded rapid reduction from 2002 to 2004, followed by three years of stagnation, and then slightly increased again as of 2007. Emissions of NOx noted slight increase from 2001 to 2003, then reduced and maintained approximately the same value by 2009. The trend of reduction in SO_2 and NO_x emissions also means reduction in the quantities of acidifying substances. The reduction resulted from non-operation of certain large sources of pollution in the Republic of Macedonia.

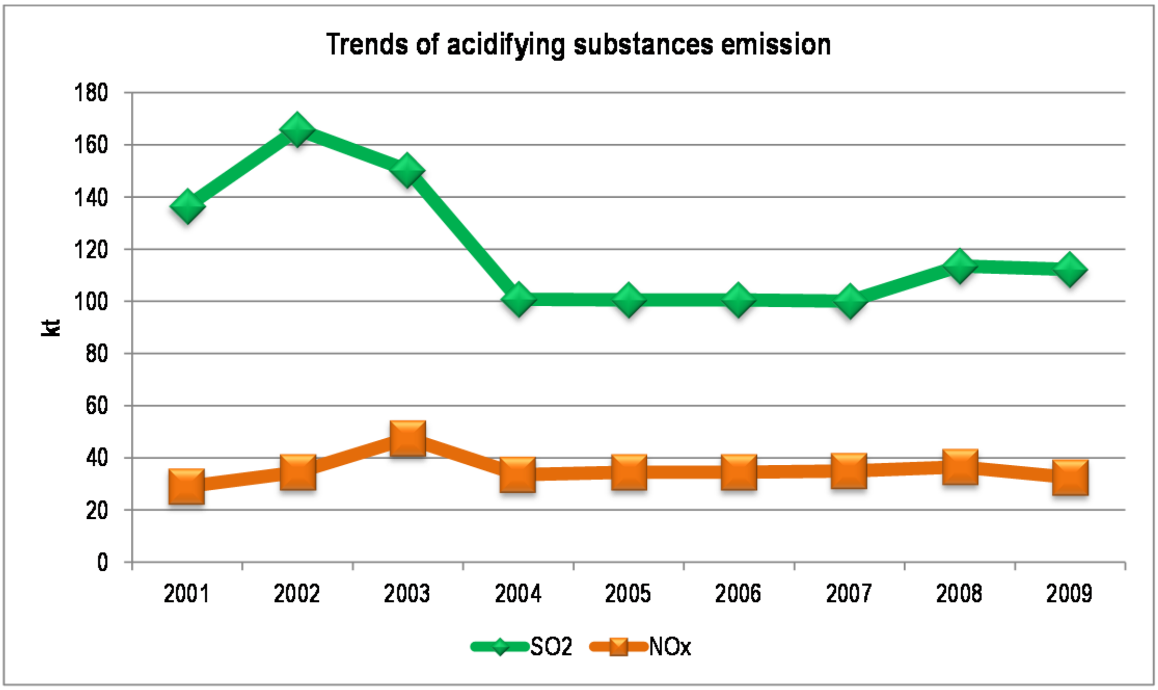


Diagram 55 Graphical overview of acidifying substances emission by year

Detailed overview of SO_2 and NO_x emissions in the period 2001 – 2009 by SNAP sectors is presented in Table 41, which leads to the conclusion that the values of SO_2 and NO_x emissions in the period 2001 – 2009 by SNAP sectors were of variable nature.

Achievement of the goals for reduction of emissions of acidifying substances that cause degradation of environment, materials and negative effect on human health requires adoption of all planning documents in accordance with the National Programme for Approximation with the EU Acquis.

Table 41 Total emissions of SO_2 and NO_x in kt by SNAP sectors

Year	2001		2002		2003		2004		2005		2006		2007		2008		2009	
Sector	SO_2	NOx	SO_2	NOx	SO_2	NOx	SO_2	NOx	SO_2	NOx	SO_2	NOx	SO_2	NOx	SO_2	NOx	SO_2	NOx
Energy	97.83	17.21	97.53	17.61	108.57	19.59	99.37	17.34	99.20	17.73	99.20	17.73	98.54	18.06	112.20	19.92	111.24	19.92
Industry	38.20	0.50	67.85	5.60	40.76	5.91	0.36	4.93	0.36	4.96	0.36	4.96	0.21	2.68	0.30	4.63	0.02	0.48
Transport	0.50	11.30	0.50	11.30	1.00	22.0	1.02	11.27	1.07	11.87	1.07	11.87	1.33	14.27	1.07	12.07	1.07	12.07
Total	136.53	29.01	165.88	34.51	150.33	47.5	100.75	33.54	100.63	34.56	100.63	34.56	100.08	35.01	113.57	36.62	112.33	32.47

6. Climate change

During the last decades, climate change has been one of the most important issues faced by global community in the 21st century. The main reason for climate change is increased concentration of greenhouse gas (GHGs) emission resulting from human activities, such as: combustion of fossil fuels, deforestation and increased emission of methane. The issue of climate change and the right to a healthy environment are subjects of many legal, strategic, planning and programme documents at national level, but also multilateral agreements and policies.

Republic of Macedonia ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1997 and its Kyoto Protocol in 2004. The Ministry of Environment and Physical Planning is designated national authority responsible to coordinate the activities of implementation of the United Nations Framework Convention on Climate Change and Kyoto Protocol. As a party to the United Nations Framework Convention on Climate Change and non-Annex I country, which in absolute terms is not major GHG emitter, it observes the Convention principle for common but differentiated responsibilities for stabilization of atmospheric concentrations of greenhouse gases. This commitment has been extended by the Republic of Macedonia at several levels: strategic, legislative, institutional, technical and certainly through cooperation on bilateral, regional and global levels.

At this moment, Macedonia is in a rather specific position – we are Non-Annex I Party to Kyoto Protocol and at the same time candidate country for EU membership. These facts assume that Macedonia is not obliged to reduce emissions and may apply for funding of energy related projects assuring clean development (under the Clean Development Mechanism of the Kyoto Protocol).

The Clean Development Mechanism is defined in Article 12 of the Kyoto Protocol. It provides for countries that belong to Annex I Parties to invest in projects through which greenhouse gas emissions are reduced and contribute to the sustainable development of non-Annex I parties. The Clean Development Mechanism is the only flexible mechanism accessible to the Republic of Macedonia under the Kyoto Protocol.

In order to utilize the possibilities of the Clean Development Mechanism, in February 2007, the Government of the Republic of Macedonia adopted the *National Strategy for the Clean Development Mechanism*, for the first commitment period 2008-2012 in accordance with the Kyoto Protocol. Also, the Government provided all necessary preconditions for proper functioning of this mechanism, such as: it designated the Ministry of Environment and Physical Planning as responsible body of the state administration for coordination of activities related to the implementation of projects under this mechanism (so called DNA-designated national authority). By way of amendment of the Law on Environment, specific article for this mechanism was introduced. In the context of the bilateral cooperation in the area of climate change and Kyoto Protocol, the Ministry of Environment and Physical Planning has signed Memoranda for Cooperation with the Italian and Slovenian Ministries of Environment, as well as with the United Nations Development Programme (UNDP) on carbon funding. Opportunities for carbon financing are also highlighted in the Draft National Strategy for Investment.

The First National Communication on Climate Change was adopted by the Government of the Republic of Macedonia and submitted to the Secretariat of UNFCCC in 2003, and the Second National Communication in 2008. The *Second National Communication on Climate Change* presents the state of the country with regard to greenhouse gas emissions (Inventory of greenhouse gases), and at the same time offers a framework defining the measures of the country towards climate change mitigation and adaptation.

Preparation of the Third National Communication on Climate Change started in April 2012. Under this Communication, new inventory of greenhouse gases will be elaborated for the period 2003-2009, and at the same time all analyses conducted under the previous communication will be reviewed. The report will be finalized by the end of 2013 and it will incorporate a new national action plan on climate change.

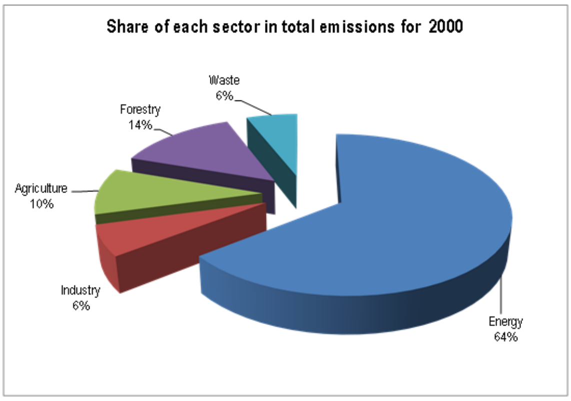
The issue of climate change is addressed as one of the global issues in the Law on Environment, which establishes the legal basis for the preparation of the National communications on climate change and plans for their mitigation and adaptation to it. Specific article on clean development mechanism has been introduced to specify the responsibilities of the MEPP in the implementation of coordination activities of projects based on the clean development mechanism under the Kyoto Protocol.

National indicators of climate change have been developed, while the State of the Environment Report 2010 incorporated analysis of this issue 2010.

6.1 Analysis of greenhouse gas emissions in the Republic of Macedonia

The Inventory of greenhouse gases of the Republic of Macedonia was prepared for the period 1999-2002 (with 2000 taken as baseline year) and covered the following sectors: energy, industrial processes, agriculture, change in land use and forestry, waste and for the first time solvents and use of other products. The Inventory gases include the six direct greenhouse gases - CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, as well as the following indirect greenhouse gases: CO, NOx, SOx and NMVOCs. Total emission of CO_2-eq in the Republic of Macedonia for the period 1990-2002 ranged from 11.9 to 14,4 $MtCO_2$-eq. Emission for 2000 amounted 14.318 $ktCO_2$-eq, or 7.16 t CO_2-eq per capita. The main polluter is the energy sector contributing around 70% to total emission. The second in size polluter is the agricultural sector with around 10-15%, while each of the remaining sectors contributes less of 10%. The only exception was the forestry sector in 2000, when it contributed around 14% to the total emission as a result of the high number of forest fires. Around 75-80% of equivalent emissions are direct emissions of CO_2 from fuels combustion, 12-14% are emissions of CH_4, 5-9% emissions of N_2O and around 2% emissions of CO.

Diagram 56 presents contribution of individual sectors and greenhouse gases to the overall emission of CO_2-eq for the baseline year (2000).



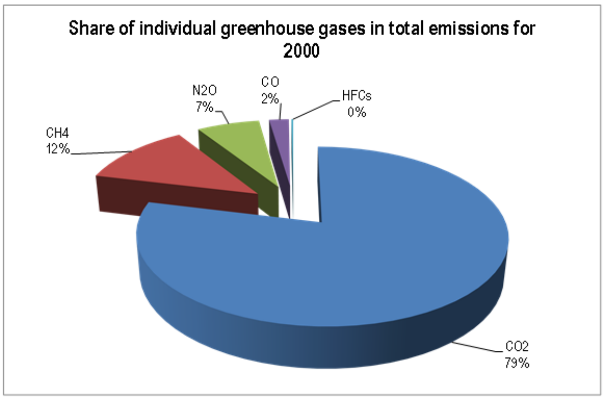


Diagram 56 Share of each sector and individual greenhouse gases in the total emission for 2000

The most important among the key sources of emission in the Republic of Macedonia is the sector of energy transformations (51.3%), where the overall emission originates practically from thermal power plants based on lignite. Other key sources which are far behind energy transformations, include: road transport (7.4%), solid waste disposal (6%), enteric fermentation (4.4%), agricultural soils (2.9%), cement production (2.9%) and production industries and construction (2.9%). Uncertainty of emissions from energy sector has been estimated at 8.45%, while with regard to the main key source – energy transformations – it has been assessed at 10.75% (which is within the permissible range, considering the uncertainties of input data). In general, significant progress has been achieved both in the process of inventory taking (strengthened capacity of the team, improved communication with the sources of data and other stakeholders, promotion of quality assurance and quality control procedures, documentation and archiving, regional cooperation), and in obtained results (reliable series of greenhouse gas emissions). Under the Second National Communication on Climate Change, the conducted analysis covered the following sectors – electric energy, industrial energy transformations and heating, transport, waste and agriculture. Several development scenarios were defined for each sector for the period 2008 to 2025 – baseline scenario and mitigation scenarios involving appropriate measures/practices/projects/interventions for emission abatement. Optimum year of implementation has been determined for most of the measures, using the requirements for maximum reduction of emission and minimum cost as optimizing criteria.

In line with the projected growth of the national economy, electricity consumption will grow constantly at the assumed annual rate of 3.5% during the first ten years and 3% during the seconds ten years of the analyzed period. The goal of the planning in electric energy system is to cover the demand for electricity, taking into consideration production capacity of existing plants (including also the reserves of energy resources) and realistic possibilities for new production facilities development.

The baseline scenario is based on thermal power plants using domestic lignite. The following thermal power plants have been listed as candidates for new facilities: “Mariovo” – with designed capacity of 209 MW, fourth block of “Bitola“ – with the same capacity of 209 MW, new thermal power plant “Negotino” at the same location as the existing one – with 300 MW (they would be supplied with lignite from the newly established mine in the vicinity).

The First mitigation scenario rests on the alternative for use of the capacity of the gas pipeline for electricity production in two gas plants for combined heat and power production (CHP). One of those is the gas based power plant in Skopje (TETO) with designed capacity of 234 MW, and the other is the gas based power plant (CHP) with designed capacity of 300 MW with a location that has not been defined yet, and those would replace the thermal power plants that are candidates under the baseline scenario and operate on lignite (“Mariovo” and “Negotino”).

The Second mitigation scenario, besides gas based power plants, also proposes reduction in electricity demand by 2000 GWh, resulting from the liberalization of electricity market for major industrial consumers.

This scenario further assumes that at the end of the analyzed period (in 2025), the cumulative effect of increased use of renewable energy sources (small hydro power plants, wind farms and biomass based plants) for electricity production will reach annual production of 180 GWh. In the applied model for planning in the electric power system, this effect has been incorporated through introduction of a small hydro power plant with a capacity of 25 MW and annual production of 45 GWh every fourth year (2010, 2014, 2018 and 2022).

All three development scenarios assume operation of the existing thermal power plants “Bitola“ (3 x 225 MW) and “Oslomej” (1 x 109 MW) and existing large hydro power plants throughout the whole analyzed period. Also, all there scenarios include the same large hydro power plants as candidates for construction: “Boshkov Most”, “Chebren” and “Galishte”. The scenarios have been developed by application of the software package WASP, which provides meeting the demand for electricity with minimum emission of greenhouse gases and minimum overall costs (investment costs, costs for fuel and maintenance).

Baseline scenarios in all other sectors are based on the assumptions of the respective sectoral strategies, though the analysis has been limited due to lack of development plans in each of the sectors, other relevant studies and relevant data (historical and current). Reduction of greenhouse gas emissions (mitigation scenarios) in other sectors would be achieved by improved energy efficiency in industrial sector and households, promotion of sustainable development, application of systems for methane collection and combustion at landfills, introduction of systems for biogas collection and combustion on pig farms and other measures.

Evaluation of scenarios from environmental point of view (detailed calculations of greenhouse gas emissions and local polluters) has been made by application of the software package "LEAP". According to the projections for greenhouse gases as presented in the Table – there will be significant increase in greenhouse gas emissions in 2025 compared to values broadcasted for 2008 (in absolute terms, around 9.900 ktCO$_2$-eq, or around 71% in relative terms), if the usual practices are applied without imposing the requirement for emissions reduction (baseline scenario).

Situation would be improved if development paths include measures for emission reduction. Thus, the first mitigation scenario leads to increase by 46% in 2025 compared to emissions in 2008, or absolute difference of 6.400 ktCO$_2$-eq. This increase in total emission is further reduced to 32% (absolute difference of 4.000 ktCO$_2$-eq), if development paths follow the second mitigation scenario.

Table 42 Total emission of greenhouse gases at the beginning and at the end of the analyzed period

	Total greenhouse gas emissions in 2008 (ktCO$_2$-eq)	Total greenhouse gas emissions in 2025 (ktCO$_2$-eq)
Baseline scenario	14.040	23.947
First mitigation scenario	13.904	20.348
Second mitigation scenario	12.645	16.713

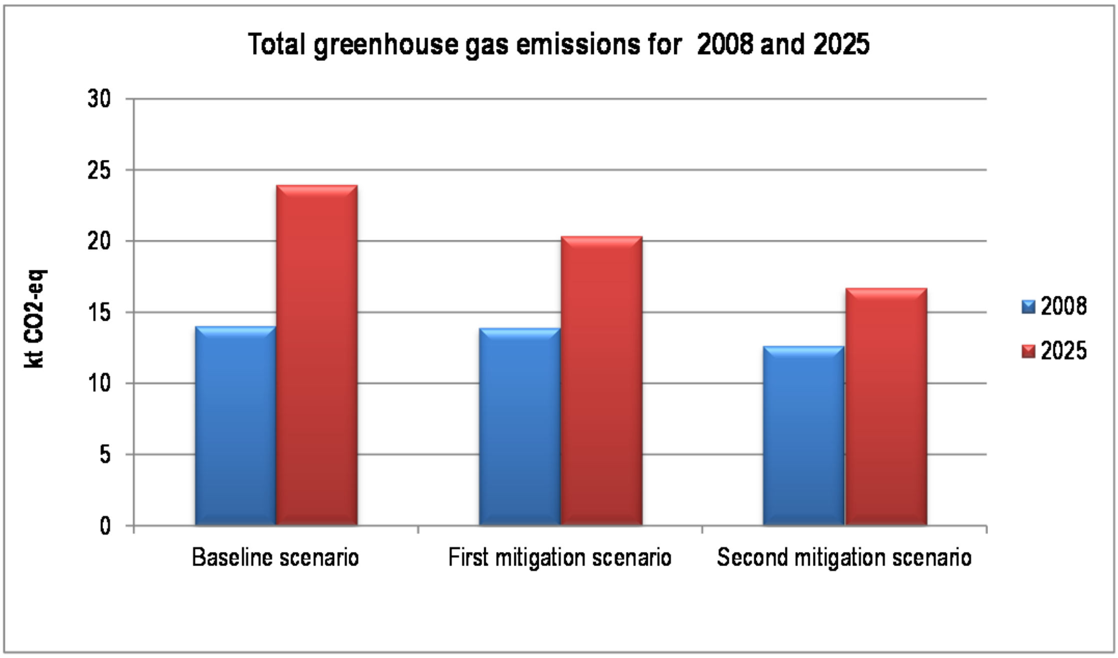


Diagram 57 Total greenhouse gas emissions for 2008 and 2025

The highest achievement in mitigation scenarios is related to electric power sector. Namely, the relative increase of emissions in this sector is limited to 14% under the second mitigation scenario as a result of the introduction of gas plants with combined production, reduced consumption of electricity for the value of large consumers and increased use of renewable energy sources. The analysis of climate change mitigation has been finalized with the National Action Plan for climate change mitigation, which contains measures / activities / projects / interventions in each sector for greenhouse gas emissions reduction. In wider terms, the national Action Plan also includes country specific instruments, that will enable implementation of the proposed direct measures (economic and fiscal instruments; regulations and standards; voluntary agreements; information and public awareness; research and development).

In principle, “indirect” actions of the National Action Plan provide integration and implementation of climate change mitigation measures in all other relevant national policies (for energy, industry, transport, agriculture, forestry, waste management). This will certainly enable implementation of direct measures / activities / projects / interventions proposed under mitigation scenarios in the frames of this study.

7. Measures for ambient air protection and improvement

Taking into consideration the main sources of pollutants emission and air quality monitoring, it is necessary to define measures to contribute to emissions reduction in efficient and sustainable manner and promote the quality of living in the Republic of Macedonia.

The adoption of new laws and bylaws transposing the requirements and the standards of the EU environmental law is the first step, that has already been taken towards prevention, avoidance and reduction of risks for different pollutants emission.

Production industrial capacities which in their operation involve significant use of natural resources and land and have negative impacts on environmental media, are obliged to acquire IPPC environmental permit in accordance with the legal requirements for IPPC, defining the conditions for the installation's operation in terms of use of the best available techniques and/or technologies, limit values for pollutants emissions into all environmental media, management of different fractions of industrial and other waste types, chemicals storage and handling, monitoring and reporting on the state of emissions, sources of emissions and undertaken measures. Installation should analyze all sources of emissions – point and fugitive, into all environmental media (air, ground and surface waters, soil) and annoyance and hazards occurring in the areas of environment, such as: odours, dust, noise and vibrations and identify and analyze the monitoring and sampling points, methods and frequency of sampling and testing by internationally recognized method. So far, around 400 industrial facilities have been identified in the Republic of Macedonia (IPPC permitting terminology uses the term "installations") which are obliged to prepare application in order to acquire IPPC permit (IPPC A type for large in capacity installations with more significant potential negative impact on environment and IPPC B type of permit to be acquired by smaller size facilities and yet with potential significant negative impact on environment). A-integrated adjustment permits with adjustment plans fall under the competence of MEPP; by the end of 2007 all 127 applications were submitted, and 28 IPPC permits and adjustment permits with adjustment plans have been issued so far. B-integrated permits are under the responsibility of the Local Self-Government Units (LSGUs). These processes of IPPC permitting are still underway.

Large Combustion Installations having input thermal capacity of more than 50 MW are obliged to undertake measures for reduction of the emissions of SO_2 , NO_x and dust, as well as to acquire IPPC permit for operation, taking also into account efficient use of fuel, type of fuel they use, emissions into water, minimization of waste generation, etc. They actually pose the strongest pressure on the quality of air because they contribute more than 80% to the total emission of pollutants in the air.

Under the Decree determining combustion plants to undertake measures for ambient air protection, installations with a capacity above 50 MW are obliged to prepare a Plan for undertaking measures for air protection, in which they will define the actions for emission reduction and timeframe for fulfillment by the respective installation. It should be underlined that each LCP prepares separate plan for reduction. The plans prepared by the LCPs are part of the overall plan of LCPs at the level of the Republic of Macedonia.

The Plan for undertaking measures for air protection contains the basic data on the installation, such as general data, quantities of emission on annual level, contribution to the national emission ceilings, type of fuel, capacity of the installation, number of operational hours, annual emissions of SO_2, NO_x and TSP, emissions of SO_2 before and after the commencement of desulphurization, rate of desulphurization and total annual flow. The Plan also contains measures for emission reduction, such as substitute of fuel, change in and improvement of the management of burning and combustion processes, introduction of new devices for emission reduction, schedule of the plan implementation, estimate of financial resources for the implementation, cost-benefit analysis, etc.

The number of LCPs identified at the level of the Republic of Macedonia is 15, with designed capacity of more than 50 MW, obliged to prepare a Plan for undertaking measures for air protection and these are also included in the Programme for gradual reduction of emissions in the air at the level of the Republic of Macedonia.

Regular monitoring of emissions and reporting to competent authorities are legal obligations, but voluntary tools that can be used are of equal importance, including introduction of environmental management systems (EMAS, ISO 14 001 series of standards), cleaner production, life cycle analysis, etc.

Tables below present measures that are general and sectoral in nature, i.e. measures for air quality monitoring and assessment, measures for air emissions reduction from industrial sector, measures for reduction of air emissions from transport sector, measures for reduction of air emissions from agricultural sector and measures for human health protection.

7.1 General measures

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1.	Implementation of measures defined in strategic documents listed in chapter 3.4	MEPP and other relevant institutions	Continuous (in line with the adopted timeframe)	Monitoring of implemented measures/actions/projects, review of detailed action plans and preparation of new one for the next year, with priority actions
2.	Adoption of national Best Available Techniques - BATs	MEPP / Committee for BATs	Continuous	
3.	Strengthening of the capacity of MEPP and LSGUs in IPPC permitting and elaborates aimed at proposing use of new technological and technical solutions – BATs in processes	MEPP	Continuous organization of trainings and enhancement of knowledge in the area of IPPC/new EU trends, industrial policies relative to environment, etc.	Project to be designed and applied before donor community
4.	Upgrading and regular upgrading of the Cadastre of environmental media with sufficient scale of data	MEPP/Division for cadastres and modeling	Continuous	
5.	Introduction of IPPC databases in line with the PRTR system	MEPP/ Division for cadastres and modeling	2013	Project assisting the country in the introduction of the PRTR system is underway
6.	Support to manufacturing SMEs in the preparation of projects for CIP-Eco innovations. EU Programme (trainings, practical consultant assistance in the preparation of applications)	Ministry of Economy/MEPP Consulting companies/Economic Chamber of the Republic of Macedonia and other associations of SMEs/industrial clusters	Continuous	Information posting on the web site of the Ministry of Economy/MEPP
7.	Cooperation with projects providing crediting lines environmental standards improvement and promotion to industrial facilities	Ministry of Economy/MEPP Consulting companies/Economic Chamber of the Republic of Macedonia and other associations of SMEs/ industrial clusters	Continuous	Regular meetings/distribution of promotion material
8.	Promotion of voluntary tools for	MEPP/Ministry of Economy	Continuous	

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
	environment improvement (eco-label, ISO 14 001, EMAS, cleaner production concept, etc.) and financial support (co-financing) for their implementation and maintenance			
9.	Strengthening of the capacity of the administration of LSGUs in SEA procedure implementation	MEPP/ALSGU	2013	Project to be designed and applied before donor community
10	Protection against usurpation of green areas and enlargement of green areas in urban areas	LSGUs	Continuous	

7.2 Priority measures deriving from air quality assessment

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1.	Extension of the State monitoring network by 3 stations for ozone measuring in suburban areas in Skopje region agglomeration	MEPP		Financial resources should be provided from the Budget or other sources
2.	Extension of the State monitoring network by 1 station for ozone measuring in suburban area in the Eastern zone	MEPP	2015	
3.	Extension of the State monitoring network by 1 urban background station to measure carbon monoxide and PM10 in the Western zone	MEPP	2015	
4,	Establishment of monitoring of PM2.5 in 1/3 of the stations, while 2/3 of the stations should perform monitoring of PM10	MEPP	From 2013	Replacement of the heads of analyzers in some of the existing stations and procurement of new analyzers to measure PM2.5
5	Carrying out additional measuring campaigns for the purpose of air quality assessment with regard to heavy metals in a fraction of PM10	MEPP	From 2013	Financial resources and staff should be secured
6	Procurement of mobile ambient air quality monitoring station	MEPP		Financial resources should be provided from the Budget or other sources

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
7.	Regular maintenance of the State ambient air quality monitoring network	MEPP	Continuous	Regular supply of spare parts, gases for calibration, materials necessary for heavy metals analysis, etc.
8.	Accreditation of the calibration laboratory	MEPP	2014	Financial resources and staff should be secured
9.	Continuous application of quality assurance and quality control (QA/QC) system on the operation of the State ambient air quality monitoring network	MEPP	Continuous	
10.	Improvement of the inventory of air emission by all sectors and activities and pollutants, including GHG gases, by EMEP/CORINAIR and IPCC methodologies	MEPP	Continuous	Financial resources should be provided from the Budget or other sources
11	Introduction of national emission factors for all sectors and activities and pollutants, including GHG gases	MEPP	2013	
12.	Use of dispersion models for air quality assessment in urban areas	MEPP	Continuous	
13.	Regular maintenance of meteorological stations	HMA	Continuous	Regular supply of spare parts, calibration of instruments
14.	Strengthening of administrative capacity for ambient air quality monitoring	MEPP	2012	
15	Establishment of local air quality monitoring networks by LSGUs	LSGUs		
16.	Preparation of Plans for air quality improvement by individual zones and agglomerations	ALSGU/MEPP	2014	These plans should be prepared in the course of the next two years in line with the assessment of the quality of air in zones and agglomerations where limit values have been found to be exceeded.

7.3 Measures for air emissions reduction in the area of energy

No.	Definition of measure	Timeframe	Activity	Comment
1.	Preparation of planning documents for air emission reduction	2014	Definition of actions for reduction of pollutants quantities	Law on Ambient Air Quality Decree determining LCPs to undertake measures for air protection

No.	Definition of measure	Timeframe	Activity	Comment
2.	Monitoring of air emissions and quality by large combustion plants	2014		Law on Ambient Air Quality
3.	Use of desulphurization equipment (scrubbers)	2020	Elimination of sulphur prior to its final release in the atmosphere in accordance with the requirements of LCP Directive 2001/81/EC	Law on Ambient Air Quality Decree determining LCPs to undertake measures for air protection Rulebook on ELV Plan for undertaking measures for air protection by LCPs Introduction of best available techniques
4.	Application of catalytic converters to reduce NO_x emissions	2020	Reduction of NOx emissions in accordance with the requirements of LCP Directive 2001/81/EC	Law on Ambient Air Quality Decree determining LCPs to undertake measures for air protection Rulebook on ELV Plan for undertaking measures for air protection by LCPs Introduction of best available techniques
5.	Use of electrostatic precipitators to reduce emissions of suspended particles		Reduction of suspended particles emission in accordance with the requirements of LCP Directive 2001/81/EC	Law on Ambient Air Quality Decree determining LCPs to undertake measures for air protection Rulebook on ELV Plan for undertaking measures for air protection by LCPs Introduction of best available techniques
6.	Adding of biomass in coal combustion as partial substitute for the fuel	2020	Reduction of the quantities of pollutants emission	Plan for undertaking measures for air protection by LCPs
7.	Substitute and reduction of crude oil and diesel with biofuel and firing fuel	2020	Reduction of the quantities of pollutants emission	Plan for undertaking measures for air protection by LCPs
8.	Higher rate of utilization of biomass and biogas as energy resources		Reduction of the quantities of pollutants emission	
9.	Use and increase in share of natural gas in all sectors, especially in households,		Reduction of the quantities of pollutants emission	

No.	Definition of measure	Timeframe	Activity	Comment
	industry and in heat production			
10.	Increase in the rate of renewable energy sources use		Achievement of energy efficiency	Reduction of harmful effects on environment and fuels causing higher pollution and reduction in greenhouse gas emissions. The necessary secondary legislation should be adopted
11.	Provision of energy efficiency in energy production, transmission and use	2020	Reduction of net consumption of final energy by 20 %	Introduction of higher rate of energy utilization
			Supply of energy from renewable sources in an amount of 20 %	Inclusion of renewable energy sources in production and energy utilization. Construction of facilities for energy production from RES
			Reduction of pollutants emission into the air by 20 %.	This is in line with greenhouse gases reduction by 20% and to that end energy efficient systems should be used in both energy production and consumption
12.	Application of energy efficiency in residential sector		Investments in residential sector by given time and financial schedule	25% of the investments are expected in the sector for increased use of energy from renewable sources, for new boilers for individual central heating, new highly efficient furnaces for fire wood
			Improvement of energy efficiency in urban areas	Signing of Memorandum of Understanding for energy efficiency by Mayors' network
13.	Application of energy efficiency in commercial and service sectors		Higher growth rate can be expected in hotel management as significant energy consumer	Energy consumption in this sector consists mostly of electricity with a share of 43 % in the consumption and oil derivatives (heating oil, so called D2 fuel and TNG) with almost 42 %
14.	Efficient use of energy in industrial sector		Improvement and reconstruction of production processes, equipment and systems for process control.	Introduction of the system of integrated pollution prevention and control (IPPC) and integrated environmental permits Introduction of best available techniques-BATs Clean Development Mechanism - CDM
15.	Energy savings in transport sector		More intensive use of public transport with less environmental pollution, improvement of the quality of fuel, as well as placement of biofuels on the market	

Projects in the area of energy for pollutant emissions reduction

No.	Definition of measure	Timeframe	Activity	Comment
Completed projects				
1.	Modernization of subsidiary Energetika (Energy), A.D. ELEM	2009	Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 30MW. Increase of electricity production from domestic sources and reduction of electricity import by around 160GWh per year. Increase of thermal power production by around 200GWh per year. Significant reduction of pollution by use of natural gas in production process.	Co-generation regime has been introduced and turbo-generators produce combined electricity and heat. Natural gas is used as driving fuel instead of crude oil that used to be used for heat production only. Own investment of 3.5 million EUR.
2.	Project TE-TO Construction of plant for combined electricity and heat production in Skopje	2011	Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 220MW. Increase of electricity production from domestic sources and reduction of electricity import by around 1850GWh per year. Increase of thermal power production by around 350GWh per year. Significant reduction of pollution by use of natural gas in production process.	Electric power system of the Republic of Macedonia has obtained new, contemporary and technologically modern production facility owned by Sintezgroup from Moscow, Russia and AD Toplifikacija from Skopje, with ownership structure of 70% to 30% to the benefit of Sintezgroup from Moscow, Russia. Implementation of the whole project was 167 million EUR worth, 70% of which was credit based indebt in LBB Bank from Germany and 30% own funds. Production process uses natural gas as driving fuel.
3.	Project KOGEL. Construction of plant for combined electricity and heat production in Skopje	2009	Increase of electricity production from domestic sources and reduction of electricity import by around 30,4MW. Increase of electricity production from domestic sources and reduction of electricity import by 150 to 220GWh per year. Increase of thermal power production by around 30 to	

No.	Definition of measure	Timeframe	Activity	Comment
			70GWh per year. Significant reduction of pollution by use of natural gas in production process.	
Current projects				
4.	Modernization of REK Bitola.	2014	Extension of operational lifetime of REK Bitola by additional 120 000 operational hours. Increase of designed capacity of REK Bitola by additional 8.32 MW per block or around 25MW in total. Increase of electricity production from domestic sources and reduction of electricity import by around 160-200GWh per year. Reduction of environmental pollution by 134688t/ per year less CO_2, 258t/ per year less NOx.	The whole process of modernization of REK Bitola is planned for implementation in two phases. The first phase includes modernization and automation of turbo aggregates (turbines and generators) of the three blocks. The second phase includes modernization and automation of boiler of the three blocks. A.D. ELEM's own investment in an amount of 55.9 million EUR
5.	Rehabilitation of six hydro-power plants	2013	Increase of designed capacity of the six hydro power plants by additional 18.31MW. Increase of electricity production from domestic sources and reduction of electricity import by around 50GWh per year. Reduction of environmental pollution by 45750t/ per year less CO_2, 88t/ per year less NOx. Increase of energy efficiency and use of renewable energy sources for electricity production.	This project involves rehabilitation of six hydro power plants owned by A.D. ELEM, namely: HPP Globochica, HPP Tikvesh, HPP Vrutok, HPP Raven, HPP Vrben and HPP Shpilje. The first phase of this project was completed in the period 1998 to 2005, and the implementation of the second phase expected to be completed by 2013 is underway. A.D. ELEM's own investment in an amount of 31.88 million EUR.
Planned projects				
6.	Construction of wind power plants park - Bogdanci	2013	Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 50MW. Increase of electricity production from domestic sources	This project is divided into two phases. The first phase of the implementation will have wind turbines installed with a capacity of 37MW, and wind turbines with a capacity of

No.	Definition of measure	Timeframe	Activity	Comment
			and reduction of electricity import by around 100GWh per year. Reduction of environmental pollution by 91500t/per year less CO_2, 173t/per year less NOx. Increase of energy efficiency and use of renewable energy sources for electricity production.	13MW will be installed in additionally in the second phase. Total investment for the implementation of this project is 55.5 million EUR.
7.	Project Lukovo Pole	2016	Increase of electricity production from domestic sources and reduction of electricity import by around 159GWh per year. Reduction of environmental pollution by 145485t/per year less CO_2, 275t/per year less NO_x. Increase of energy efficiency and use of renewable energy sources for electricity production.	This Project assumes construction of new accumulation Lukovo Pole, construction of water supply canal in a length of around 20 km – by intake of the Korab's waters and construction of small hydro power plant Crn Kamen. Total investment for Lukovo Pole development has been estimated at 62 million EUR.
8.	Project Boshkov Most	2016	Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 68MW. Increase of electricity production from domestic sources and reduction of electricity import by around 120GWh per year. Reduction of environmental pollution by 109800t/per year less CO_2, 207t/per year less NOx. Increase of energy efficiency and use of renewable energy sources for electricity production.	This Project assumes construction of new accumulation Boshkov Most. The total investment for its implementation has been assessed at 86 million EUR.
9.	Project solar power plant in the mine Suvodol near Bitola		Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 50MW. Increase of electricity production from domestic sources and reduction of electricity import by around 104GWh per year.	This Project assumes construction of new solar power plant. By early 2013, Feasibility Study on solar power plant development will be elaborated. The development of the solar power plant will

No.	Definition of measure	Timeframe	Activity	Comment
			Reduction of environmental pollution by 94000t/per year less CO_2, 179t/per year less NOx. Increase of energy efficiency and use of renewable energy sources for electricity production.	cost up to 225 million EUR.
10.	Project small hydro power plants		Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 250MW. Increase of electricity production from domestic sources and reduction of electricity import by around 1200GWh per year. Reduction of environmental pollution by 1098000t/per year less CO_2, 4296t/per year less NOx. Increase of energy efficiency and use of renewable energy sources for electricity production. Direct so called "Greenfield" investment.	This project assumes construction of 400 small power plants throughout the territory of the Republic of Macedonia Investments have been estimated at 62 million EUR.
11.	Project Chebren and Galishte		Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 530MW. Increase of electricity production from domestic sources and reduction of electricity import by around 1100GWh per year. Reduction of environmental pollution by 1006500t/per year less CO_2, 3938t/per year less NOx. Increase of energy efficiency and use of renewable energy sources for electricity production. Direct so called "Greenfield" investment.	This project assumes selection of a company – concessionaire which will together with A.D. ELEM construct the hydro power plants Chebren and Galishte. The total investment has been estimated at around 700 million EUR.
12.	Project Sv.Petka	2012	Increase of designed capacity of electricity production plants in the Republic of Macedonia by around 36.4MW. Increase of electricity production from domestic sources and reduction of electricity import by around 66GWh per	This project assumes construction of a new hydro power plant. HPP Sv. Petka (former Matka 2) on the river of Treska. Total investment amounts around 68 million

No.	Definition of measure	Timeframe	Activity	Comment
			year. Reduction of environmental pollution by 59654t/per year less CO_2, 114t/ per year less NOx. Increase of energy efficiency and use of renewable energy sources for electricity production.	EUR.

7.4 Measures for reduction of air emissions from industrial sector

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1.	Promotion of the Industrial Policy of the Republic of Macedonia and annual Programme before industrial facilities (SMEs) towards maximum possible efficient resources utilization	Ministry of Economy/MEPP	Immediately upon the adoption of the annual programme (every year)	Organization of open day for the Programme presentation
2.	Continuous implementation of the system for integrated pollution prevention and control for installations operation	MEPP, LSGUs, Installation	2013	Deadline for compliance and environmental permit acquiring is 2014
3.	Inspection supervision over the application of measures proposed for air protection by installations	State Environmental Inspectorate	Continuous	
4.	Performance of air quality and emission monitoring by industrial sector	Installations	Continuous	
5.	Implementation of investments proposed in the adjustment plan for BAT/emission limit values achievement	Installations	Continuous by 2014	
6.	Maintenance of regular information fora with industry to discuss topics in the area of air protection	MEPP Consulting companies	Continuous	

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
7.	Training of industrial facilities for elaboration of risk assessment for environmental liability (establishment of national methodology)	MEPP Installations Consulting companies	2012/2013	Project to be designed and implemented together with operators
8.	Training of industrial facilities for elaboration of measures and Emergency Plan (in case of industrial accident involving dangerous substances)	MEPP Installations Consulting companies	2012/2013	Project to be designed and implemented together with operators

7.5 Measures for reduction of air emissions from transport sector

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1.	Development of laws and bylaws to regulate the use of natural gas and equipment for vehicles driving on natural gas in the transport sector of the Republic of Macedonia	ME	2013	
2.	Development of laws and bylaws to regulate the use of biofuels in the transport sector of the Republic of Macedonia	ME	2013	
3.	Renewal of vehicle fleet		Continuous	
4.	Improvement of the quality of liquid fuel	ME	Continuous	
5.	Inventory of exhaust gases from large polluters (buses and trunks)	MEPP	2014	Development of cadastre for direct measurement of emission of the pollution caused by buses and trunks
6.	Monitoring of the status of degradation of exhaust gases from large polluters 9buses and trunks)	MEPP	2014	Strengthening of administrative capacity of the MEPP
7.	Promotion of the use of gas fuels of the types of natural gas and propane butane in transport	MEPP, ME, NGO sector, companies	2013	
8.	Promotion of the use of biofuels from domestic raw materials in the transport	MEPP, ME, NGO sector	2013	Increase of public awareness of the benefits from intensive application of biofuels from domestic raw materials
9.	Introduction of organized transport in urban areas and major	LSGUs,		

	companies	companies		
10.	Intensification of public transport	LSGUs, companies	Continuous	
11.	Intensification of the use of alternative transport (e.g. bicycles)	LSGUs		
12.	Introduction of vehicles with zero emission of harmful gases	MEPP, ME, MTC		Vehicle on electric drive or new technologies with zero emission

7.6 Measures for reduction of air emissions from agricultural sector

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1.	Management of organic manure from agricultural properties in accordance with EU standards for environment protection	MAFWE	Continuous	Code on good agricultural and hygiene practice (Official Gazette of RM no. 112/10) Guide on achievement of the principles of good agricultural and hygiene practice (Official Gazette of RM no. 138/10) Practical brochure on Waste Management by the standards of good agricultural practice and technical instruction on products for plant protection and agricultural waste Rulebook on the rules of good agricultural practice in fertilizers use (Official Gazette of RM no. 68/11)
2.	Mineral fertilizers management	MAFWE	Continuous	
3.	Sustainable cattle management and breeding	MAFWE	2020	Law on Livestock Breeding (Official Gazette of RM no. 7/2008 and 116/2010) Rulebook on the scale of genetic reserves, as well as the manner and procedure of reserves provision and maintenance (Official Gazette of RM no. 151/2010) Rulebook on the manner of trading in native breeds and/or lines, the form and the content of the application for recognition of new native breeds and or lines and the form, content and manner of register keeping (Official Gazette of RM no. 151/2010) Rulebook on the manner of performing monitoring of biological diversity in

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
				livestock breeding (Official Gazette of RM no. 151/2010) Rulebook on detailed conditions for performing individual public service of biological diversity conservation in livestock breeding and preservation of cattle genetic reserves (Official Gazette of RM no. 151/2010) Programme for biological diversity in livestock breeding (Official Gazette of RM no. 144/2010) Common Plan for Livestock Breeding (CBCBP) for the period 2011-2020, (Official Gazette of RM no. 43/2011)
4.	Reduction in methane emissions from enteric fermentation	MAFWE Individual farmers	2020	Increase of productivity per head, adjustment of nutrition to minimize bacterial activity in tripe, by additives in fodder, antibiotics, vaccinations, etc.
6	Investments in increase of economic value of forests	MAFWE		Law on Agriculture and Rural Development, Article 71 IPARD support for RES use
7.	Education (of experts/farmers/ decision makers on the application of measures / technologies for greenhouse gas emissions reduction in agriculture	MAFWE Agency for agriculture development Educational institutions	Continuous	Through the Project Agroeconomy – 1 October 2010 - 31 December 2012 (see Comment on measure 8)
8.	Modernization of technological processes towards procurement of equipment for milk and meat processing			IPARD support for RES use
9.	Implementation of project “Agroenergy”	Centre for sustainable agricultural practices promotion and	1 October 2010 - 31 December 2012	Project funded by SIDA, with the support of the Ministry of Agriculture, Forestry and Water Economy, Ministry of Economy, Ministry of Environment and Physical Planning, Ministry of Local Self-Government, Faculty of Agricultural Science and Food, Federation of Farmers of the Republic of Macedonia, ALSGU

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
		rural development		

7.7 Measures for reduction of air emissions from waste sector

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1	Minimization of waste generation	Industrial facilities / Public Utilities/ Citizens	Continuous	
2.	Waste recycling, reuse and recovery as energy source prior to its final disposal	Authorized waste collectors and companies for recycling and treatment/ Industrial facilities	Continuous	
3.	Storage of waste on adequately equipped landfills	MEPP/ Public Utilities		Construction of regional landfills
4.	Introduction of systems for collection of gases released from landfills	MEPP/LSGUs/ Public Enterprises for landfill management		Technical upgrading of landfills is required
5.	Reduction of methane and dinitrogen oxide emissions	MEPP/LSGUs	Continuous	
6.	Increase of public awareness to prevent uncontrolled waste burning	MEPP/LSGUs/NGOs	Continuous	Public involvement is necessary to change the awareness of the harmfulness of uncontrolled waste burning

7.8 Measures for reduction of air emissions from acidification and eutrophication

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1.	Establishment of monitoring system	MEPP/MAFWE	2014	Collection and verification of current data on acidification,

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
	for the processes of acidification and eutrophication and ground level ozone;			eutrophication and ground level ozone.
2.	Monitoring of the quality of precipitations – rain waters	HMA		Expansion of the network of measuring points, because it is conducted at one measuring point in the country
3.	Identification of acid sediments in the soils in the Republic of Macedonia;	MAFWE /Instutute of agriculture		
4.	Establishment of critical levels of loading	MEPP/ MAFWE	2014	Emission of acidifying and eutrophication causing substances is compared with levels
5.	Preparation and implementation of a strategy for reduction of unwanted effects of acidification, eutrophication and photochemical pollution.	MEPP/ MAFWE		Project should be proposed to fulfill this activity
6	Establishment of monitoring of the status of forests concerning the impacts of acidification	MAFWE		
7.	Calculation and mapping of critical loads pollutants causing acidification, eutrophication and rise in the concentration of ground level ozone for the Republic of Macedonia on air, forests, soils and waters	MEPP, MAFWE, Universities in the Republic of Macedonia		Project should be proposed to fulfill this activity
8.	Action Plans in case of increase in critical loads for the purpose of their reduction	MEPP, MAFWE	From 2012	

7.9 Measures for human health protection

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
1.	Detection of human health risks related to impact of polluted air	MH	Continuous	Planned in the budget of PHI and PHC through the Programme for public health, though without

	Definition of measure	Responsible institution	Timeframe for implementation	Comment
				specification of costs for this task only
2.	Establishment of targeted environmental health indicators to assess health risks for children from polluted air	PHI and PHC	2013	Involvement of pilot studies of WHO
3.	Application of modeling in health risk assessment	MEPP, PHI		
4.	Adoption of the National Children's Environmental Health Action Plan	MH and Government of the Republic of Macedonia	2012	Upon adoption, the Government will have to allocate budget targeted to the implementation of actions specified in the Plan
5.	Establishment of specific unit – Office for environmental health, to include Centre for health risks assessment	MH	2013	
6.	Strengthening of the capacities of public health institutes	MH	2013-2015	Human and technical resources existing in public health institutes, dealing with assessment of environmental health risks have to be upgraded and strengthened and trained in modern techniques for risks assessment and provision of evidence of this, with particular accent on industrial hot-spots management
7.	Procurement of modern technique for detection of environmental health risks related to air pollution	MEPP and/or MH	2013	Bio monitoring, as well as the necessity for routine assessment of the linkage between pollution with PM2.5 and PM10 and certain diseases or causes for death through specific software solutions
8.	Additional epidemiological investigation of air pollution effects on human health	PHI, PHC	2012-2013	Application of EU funds (FP7, etc.)

8. Estimates of financial resources required for air emissions reduction

The analysis for reduction and projections of the quantities of emissions for the pollutants sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia, measures for their reduction, estimate of financial resources for emission reduction are presented in the National Programme for Gradual Reduction of missions of Certain Pollutants at the Level of the Republic of Macedonia[29]. The estimate of financial resources required to reduce emissions in the air of the pollutants sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia is presented in the forth coming chapters.

8.1 Experiences of Macedonia as a developing country

In conditions of transition towards a new economic system and relatively new management ambient in our country, the issue of environmental threat seems to be neglected in a way. The low level of development of the Macedonian economy, high internal and external deficit, labour-capital disbalance, structural distortions, etc., are only few of the problems that have seemed to be more acute in Macedonia compared to the issue of environment pollution. Their impact was decisive in its temporary establishment on the margins of scientific interest. It seems that the presence of the 'critical mass' of environmental pollution provided the key feedback that has prevented its full desertion and thus the settlement of this issue occurs as an important precondition for the future development of Macedonia.

The 'critical mass' of pollution in Macedonia in early 1990s exactly, in correlation with the transition to a new economic ambient, posed the need for environmental profiling of the future development of the country. If we concede under the burden of the problems brought in by the transition to a market economy, in terms of possible "reservation" of the settlement of pollution for some future better times, we will loose irrevocably the possibility for exercising environmentally acceptable civilization trend. In such case, continuity in use of natural resources below their positive price with irreversible consequences of deepened discrepancy between economic and environmental indicators, is unavoidable. Neglecting the environmental dimension in this case occurs with all of its intensity: poor society with strongly polluted environment.

For more than twenty years, Republic of Macedonia has coped with major environmental challenges. Falling down of the former socialist system threw out to the surface the real problems regarding the quality of the environment. Implementation of economic reforms has had additional contribution to the settlement of part of the inherited problems related to environment protection. In this context, the following issues deserve particular attention:

- Reduction of the control on prices (as well as subsidies), especially on the example of the prices of fuels. This led to initial increase in the costs of production, resulting in the need for production processes adjustment (resource saving), restructuring towards more efficient production and orientation to resource use less intensive sectors.
- Establishment of hard budgetary constraints for a relatively short period of time made the climate in economy more severe. These constraints made the managers of the companies improve the efficiency of production processes, reduce the residues stream and improve the management of resources.
- Privatization of the former socially (state) owned capital and at least for the time being scarce foreign direct investments have contributed to the promotion of corporative governance, efficiency and profitability, as well as access to the necessary financial resources for renewal of the technology used in the past, which was obsolete, inefficient and pollution intensive.
- Trade liberalization and market liberalization contributed to greater exposure of enterprises at market requirements not only with regard to the application of modern knowledge in management, but also in terms of current practices of coping with environmental problems, as well as access to cleaner technologies markets.

Upon the transitional process pass by, another reason for environmental pollution reduction is the establishment of modern legislation in this relevant area, gradual steps towards implementation of effective protection policies and increased investments with ecological prefix.

8.2 Use of economic instruments in environment protection

The great advantage of economic instruments is in the incorporation of the environmental pollution issues directly in the context of the developments on the market. Efficiency of economic instruments is due to the flexibility they offer to polluters, which is much greater than the corresponding one that would be enabled by other related instruments of environmental policy. In this context, possibilities for saving depend on:

- variant based possibility for technological and consumption modifications;
- cost sensitivity of producers or consumers;
- difference in marginal costs of different options (possibilities).

Compensations (taxes) for environmental pollution are collected directly from polluters. Thus, they represent application of the polluter pays principle (PPP). On the other side, these instruments augment public revenues and it is therefore important to determine whether their primary goal is to create revenues or exercise the tasks of environmental protection.

The policy of environmental protection is important for the efficient functioning of economic instruments. High number of such instruments has been applied for a while in developed countries. Despite this, such policy has been traditionally marked by command and control approach in the countries of OECD. From the beginning of the transition towards market oriented economy, there have been great expectations for expansion of the role of economic instruments in environmental policy. The experience with their use has been so far slightly different than the one in developed countries.

The criterion for economic efficiency requires uniform rates of pollution load to correspond with the limits of environmental pollution that are related to normal pollution. For most of the compensations, the average difference in the rates for different polluters is usually related to the difference in polluting toxins that damage the environment.

Monitoring of the impact and the performance of economic instruments is often part of the formal legislation and not included as part of the activities of the regular administration. Yet, it is more difficult to gather information on environment than on the necessary financial flows.

Compensations for preservation of the quality of the environment have been accepted in post-socialist countries and adapted to the new conditions that have occurred in political and economic development. Generally, greater attention has been paid to instruments contributing to the state revenues enhancement, though in some cases alternative economic instruments able to address certain problem have been ignored efficiently and effectively, including here compensations for environmental protection which are inclined to the course of their growing revenue potential. Emission compensations and fines for non-adherence to standards are applied to highest extent, while production compensations have been established as from recently.

As far as the application of the system of integrated pollution prevention and control (IPPC) through integrated environmental permitting is concerned, we may conclude that the potential for their application has already been recognized, but their application is in its initial stage.

8.3 Overview, analysis and scenario of socio-economic indicators (GDP) as baseline for the impact of economy on ambient air quality.

Gross domestic product is the basic measure of economic activity in a country, measuring the value of the total final products produced in the country for a period of one year. The text below gives short description and analysis of GDP trend from 2000 to 2009 (see Table 43).

Table 43 GDP trend from 2000 to 2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
GDP (% of growth)	4.5	-4.5	0.9	2.8	4.6	4.4	5.0	6.1	5.0	- 0.9
GDP per capita (EUR)	1.921	1.886	1.978	2.081	2.185	2.363	2.564	2.919	3.283	3.253

Source: State Statistical Office of the Republic of Macedonia, National Bank of the Republic of Macedonia.

Continuous trend of economic growth in the Republic of Macedonia, with its peak in 2000 (with real GDP growth of 4.5%) was terminated in 2001. Deteriorated safety in the country and aggravated operational conditions induced reduction of the overall economic activity and weakening of macroeconomic performances.

Nevertheless, macroeconomic policy implemented in the Republic of Macedonia in 2002 contributed to economy consolidation, improvement of macroeconomic performances and continuation of structural reforms resulting in GDP real growth rate of 0.9. In this way, the national economy returned to the zone of positive real growth rates of GDP.

Positive trend in GDP real growth rates of the Macedonian economy continued in the period 2003 to 2008 as well, reaching historically highest rate of real growth in 2007 (GDP real growth rate of 6.1%). However, in 2008, instead of continuation of the trend of significant GDP growth, lower real growth was achieved compared to 2007 (GDP growth of 5% in 2008), resulting from the occurrence of the world financial crisis.

The wave of stresses in global finances in September 2008 also meant deepening of economic crisis in developed economies and significant decline in external demand for Macedonian export, with articulated effects in the last months of the year.

Negative effects of the global financial and economic crisis on the national economy caused reduction in domestic economic activity in 2009. The first effects were visible even in the last quarter of 2008 with slowing down in the annual growth, while in the course of 2009 GDP experienced real drop of 0.9%. Negative achievements were notable from the beginning of the year, and the economy recorded its strongest fall during the third quarter, while the first positive annual changes were recorded during the last quarter of 2009. Yet, the positive fact was that Macedonian economy in 2009 proved to be relatively more resistant compared to other economies in the world, where the fall in economic activity was significantly bigger (NBRM: Annual Reports, 2000-2009).

Similar trend was also noted with GDP developments per capita (see Table 43).

In absence of adequate reliable quantitative methods for macroeconomic broadcasting and planning of future development of the national economy, projections of future GDP growth rates have been based on the following information: projections of the Ministry of Finance presented in the Pre-Accession Economic Programme 2012-2014, as well as projections for the future growth of neighbouring economies (important commercial partners) and projections for the growth in EU Member States. According to these assumptions, GDP growth in 2015 and 2020 could reach 6%, and 7%, respectively (Table 44).

Table 44 GDP achieved in 2010 and GDP projected for 2015 and 2020

	2010	2015	2020
GDP (% of growth)	1.8	6.0	7.0

Source: State Statistical Office of the Republic of Macedonia, own projections

Macroeconomic projection at medium and long run is further aggravated by the great uncertainty in global economic trends, which to a great extent derive from events related to debt crisis in the Euro-zone, i.e. high uncertainty related to duration and depth of debt crisis. Thus, further aggravation of economic conditions in the Euro-zone would result in bigger slowing down of external demand, reduction in export and production in the country and vice-versa.

The main factors that can contribute significantly to the future development of Macedonian economy (mainly related to the rate of achievement of EU integration) include:

- *Faster economic growth through improved competitiveness.* The Republic of Macedonia should proceed with the implementation of sound macroeconomic policies, measures for improvement of business climate and status of infrastructure, as well as increased investments in education, including also university level of education.
- *Achievement of inclusive growth through strengthened opportunities for employment and social welfare.* Permanent improvements of active policies are required on labour market, as well as for the programmes for social welfare and aid.
- *Green growth through sustainable use of resources.* Investments in clean and efficient energy are necessary, as well as greater support to analysis development, in order to design and implement measures of the economic policy towards achievement of the green growth and mitigation of the effects of climate change on the national economy.

8.4 Estimate of financial resources required to reduce pollutants emission for sulphur dioxide, nitrogen oxides, volatile organic pollutants and ammonia

The estimate of financial aspects, measures and activities for harmful emissions reduction takes the quantification of measures differentiated by their financial cost-effectiveness as starting point. In this context, distinction is made between measures requiring low, medium or high level of costs necessary for their implementation. Nevertheless, the basic characteristic under our circumstances is the shortage of financial resources to implement the appropriate measures. This is further burdened by often inadequate communication between individual ministries and state authorities, which creates administrative barriers. Finally, "there are many cases where the main constraints are the lack of expertise and opposition to new technologies, including also the low level of awareness of and interest in their application, even for settling vital energy problems... In some of the measures, serious constraints are also posed by the different interests of the stakeholders, because there is high number of independent decision-makers whose goals are difficult to adjust." Convergence of different interests of decision makers under market conditions can be accomplished through development of appropriate economic strategy. Only in that way, we may expect change in the behavior of the stakeholders, but also change in the criteria by which they are led in the process of deciding on issues related to energy or harmful gases emission.

Projection of financial resources (costs) for emission reduction is based on the RAINS model, developed by IIASA. Within this model, time horizon of 15-20 years is taken into consideration. Projection of costs, i.e. financial expenditures is certainly very difficult and complex task, given the fact that technological changes (that cannot be foreseen), changes in the structure of economy and its individual sectors (industry, transport, etc.), as well as changes in the structure of individual energy resources consumption occur meantime. Therefore, long-term economic prognoses are most often limited to aggregated level of economic activity (national economy), and rarely at sector level. Projections of costs concern the level of the entire economy for individual harmful gases. On one side, uncertainties that may derive from the changes individual sectors are made relative on one side, but this level of aggregation does not allow sufficient level of relevance of the prognosis itself, on the other. Anyhow, estimates of the total sums of costs for harmful gases reduction are presented at the level of the national economy and should as such serve as momentum for further investigations.

The main intention of the costs evaluation is to identify the values of resources that need to be allocated by the society for harmful emissions reduction. "In practice, these values are approximated through estimate of costs at production level, and not through prices faced by consumers… Of course, there will be certain transfers of money that will have impact on the distribution of income or competitiveness of the entity, but these phenomena should be exempted from analysis. Also, any kind of taxes added to production costs should be ignored similarly as transfers." [29]"

In the frames of the model, the applied methodology divides parameters into general and country specific. General parameters refer to interest rate (i.e. discount factor), while specific data to certain type of technology (life cycle, depreciation rate, maintenance costs, etc.). In this context, the amount of costs is determined on the basis of present prices (in some cases, on the bases of data for 2010), using discount factor of 6%. Thus, the value of costs in individual tables does not refer to the current value, but is given by the value for the year it refers to.

Country specific parameters refer to average size and depreciation of installations in a given sector, prices of electricity and labour on the respective national market, prices of material input in the specific country, etc. Also, "…all indirect costs, like effects on the prices of energy resources, trade balance, employment and benefits obtained as a result of reduced damage on ecosystems, are exempted from the evaluation."

We made comparative analysis of energy consumption relative to GDP or so called energy intensity indicator relative to one of the countries in the region – Republic of Croatia.

Based on the above, Republic of Macedonia belongs to the group of high energy intensive countries, i.e. high energy consumption. The first decade of the 21st century has been characterized by falling trend in energy intensity at global level, which is due to "increased efficiency in the use of energy, increased substitution of costly fuels and use of more cost-effective and renewable energy sources". Industry in Macedonia is responsible for 33.8% of final energy consumption, and at the same time it contributes around 20 % to GDP generation. This reflects the high energy intensity in industrial sector, which is higher than the average. Nevertheless, "comparison of the situation in Macedonian industry with other European countries indicates energy intensity in this sector and the fact that Macedonia has insignificantly better performance than the average of the countries that are not members of OECD."

Namely, in 2003 Macedonia recorded energy consumption relative to GDP (TPES/per 000 US$ PPP, i.e. ton oil equivalent) of 0.20. On the other side, consumption of total energy per capita in Macedonia (2004) was 1.282 kg toe (ton oil equivalent). As far as consumption of electricity per capita is concerned, in Macedonia, in 2004 it was 2.799 kwh per capita. Namely, 31.7% of the total energy consumption in Macedonia is attributed to industry, followed by households and road transport with 30.6% and 21.9% respectively.

Taking all the above into account, the required amount of financial resources for reduction of a ton of harmful emissions can be taken by a certain dose of reservation.

8.4.1. Estimate of financial resources for implementation of measures and activities for sulphur dioxide emissions reduction

The estimate of costs for SO_2 emissions reduction under the three scenarios is based on present prices (more specifically, on data for 2010), by use of discount factor of 6%. There is no distinction made in the amount of unit cost per kt SO_2, between individual scenarios. Relatively high amount of costs for 2020 derives from high potential for reduction (obtained as a result of differences in emissions projected for 2015 and 2020) on one side, and as a result of use of assumed interest (discount) factor, on the other. Their settlement to present value (PV) would make relative the amount of the cost for the value of the discount factor conformed with time interval (5 or 10 years).

Table 45 Total cost for SO_2 emissions reduction

Year	2005	2010	Reduction potential ($SO_{2\ 2010}$-$SO_{2\ 2015}$)	Cost (financial resources) – ($SO_{2\ 2010}$-$SO_{2\ 2015}$) – in mil.EUR	2015	Reduction potential ($SO_{2\ 2015}$-$SO_{2\ 2020}$)	Cost (financial resources) – ($SO_{2\ 2015}$-$SO_{2\ 2020}$) - in mil.EUR	2020	National emission ceiling
SO_2 [kt] – OC		115.1383	-15.1301	-	130.2684	31.06077	1266.3	99.21763	130
SO_2 [kt] – CM		114.7563	-12.9408	-	127.6971	43.07589	1919.3	84.62121	130
SO_2 [kt] – Model	99.72	112.85	19.26	381.4	93.59	78.37	3195.2	15.22	130

8.4.2. Estimate of financial resources for implementation of measures and activities for nitrogen oxide emissions reduction

The estimate of financial resources required for nitrogen oxide emissions reduction takes into account the key sectors by SNAP methodology that have greatest contributions to the total emission of nitrogen oxides. Specificity of NOx emissions in Macedonia is reflected in the fact that they are to the greatest extent a result of fossil fuels combustion for electricity production in coal fired thermal power plants (REK Bitola and REK Oslomej), as well as emissions from the combustion of liquid fuels for heat production and processes in industry.

As far as transport sector is concerned, the starting point is the fact that in the middle of the previous decade, the number of passenger motor vehicles in Macedonia was around 124 vehicles per 1000 inhabitants (the share of passenger in the total number of motor vehicles was around 80-90%), while under the baseline scenario the rate of motorization in 2020 should reach the level of around 260 vehicles per 1000 inhabitants.

Projection of costs has been made again by use of RAINS model and Nitrogen oxides emission abatement cost curves settled within it. The estimate of total costs refers to 2010 while taking into account the current legislation as starting point. This assumes ranking of all options for emission control that are available, according to their cost effectiveness. Initial emissions and control costs include measures that have been already covered by the current legislation. Cost curves analyze the remained potential for emission control.

Through this approach, several abatement cost curves have been obtained, fed by specific parameters for Macedonia, namely: both for stationary sources of emission and mobile sources of emissions (such that use petrol or diesel fuel). Taking the aggregation of emissions projected under the three scenarios as starting basis, use of the three curves was not adequate and thus the curve for stationary sources was basically used. Results obtained are presented in Table 46.

Table 46 Total cost for NOx emissions reduction

Year	2005	2010	Reduction potential (NOx 2010-NOx 2015)	Cost (financial resources) – (NOx 2010-NOx 2015) – in mil.EUR	2015	Reduction potential (NOx 2015-NOx 2020)	Cost (financial resources) – (NOx 2015-NOx 2020) - in mil.EUR	2020	National emission ceiling
NO_x [kt] – OC		33.27	-4.37	-	37.64	8.97	48.19	28.67	39
NO_x [kt] – CM		33.16	-0.54	-	33.7	9.9	53.19	23.8	39
NO_x [kt] - Model	31.93	33.85	5.46	21.92	28.39	7.55	40.56	20.84	39

The estimate of the total costs for NOx emission reduction will be more complete if we take into account current and planned projects in energy sector, by which NOx emissions are reduced and generate reductions in carbon dioxide as additional effect. Based on current and planned project, total NOx for the period 2010 to 2014 will be reduced by 9.528 kt, while the planned amount of investments reaches the sum of 1.346.280.000 EUR (under the current prices).

8.4.3. Estimate of financial resources for implementation of measures and activities for volatile organic compound emissions reduction

Projection of the required financial resources for volatile organic compound emissions reduction is very complex task given the fact that projected emissions are presented in general, and not as broken down amounts. Thus, the estimates can only be indirect. "Implementation of directives on large combustion plants, IPPC, waste incineration, volatile organic compounds, quality of fuels, non-road vehicles, etc., will result in emissions reduction. However, it is not certain whether this reduction associated with the future growth will be sufficient to achieve the future emission ceilings or other reduction activities will need to be implemented as well... The estimated capital and operational costs for this sector are subject to significant uncertainties."

As far as the costs for the IPPC system implementation are concerned, those have been estimated at approximately 572 million EUR in investments and 39 million EUR annual operational costs to be covered by industry (investment and operational costs for the systems for mitigation of harmful effects of processes), Ministry of Environment and Physical Planning and Units of the local self-government (costs for training, administrative costs and costs for the employees). On the other side, strengthened management of the quality of environment, ambient air in this case, requires "...overall costs, capital of almost 8 million EUR and operational gradually growing costs of almost 8.4 million EUR per year. These seem to be relatively low, but this results from the fact that most of the technical measures that will improve the quality of the air in the Republic of Macedonia are attributed to the sector Industrial pollution control, especially Large Combustion Plants Directive and IPPC Directive. These costs are lower than the real ones, because financial resources required implementing the measures for emission reductions in other sectors and smaller size industrial facilities could not be taken fully into account [31].

8.4.4. Estimate of financial resources for implementation of measures and activities for ammonia emissions reduction

The estimate of the financial resources (costs) for ammonia emissions reduction is based on parameters contained in the RAINS ammonia module. [20] Specific function of costs derived in the context of the given model relates to 2010. Based on it, the estimates of the required resources have been made. No distinction is made between baseline scenario and scenario with use of models. Simply, the estimate of costs has been left to generate the difference in the level of costs.

Table 47 Total cost for ammonia emissions reduction

Year	2005	2010	Reduction potential (NH_3 $_{2010}$- NH_3 $_{2015}$)	Cost (financial resources) – (NH_3 $_{2010}$- NH_3 $_{2015}$) – in mil.EUR	2015	Reduction potential (NH_3 $_{2015}$- NH_3 $_{2020}$)	Cost (financial resources) – (NH_3 $_{2015}$- NH_3 $_{2020}$) - in mil.EUR	2020	National emission ceiling
NH_3 [kt] – OC		9.87	-0.37	-	10.24	0.99	17.65	9.25	17
NH_3 [kt] – Model	8.5	8.94	-0.19	-	9.13	0.19	3.39	8.94	17

Data presented in Table 47 lead to the conclusion that the absolute amount of financial resources for the application of ammonia reduction measures in the period from 2015 to 2020 is by far lower than the amounts required to reduce the emissions of SO_2 and NOx. The relevance of projected amounts is further supported by two relevant examples. Namely, total investments in six pig farms (in Veles, Shtip, Vinica, Sv.Nikole, Berovo and Tetovo) for reduction of harmful emissions of gases in the period 2010-2012 have been estimated at 1.097.200 US$, with parallel operational costs of 117.600 US$ at annual level. At the same time, total investments in nine landfills (in Skopje-Drisla, Veles, Shtip, Vinica, Strumica, Gostivar, Kumanovo, Bitola and Kochani) to reduce harmful gas emissions in the period 2009-2014 were estimated at 3.760.806 US$, with parallel operational costs of around 452.000 US$ on annual level.

Nevertheless, the analysis of costs for ammonia emissions reduction involves the fact that there are still many uncertainties in the case of Macedonia. Namely, in Macedonia, "emissions of methane and ammonia have not been analyzed in detail... where those originate from inadequate storage and use of manure and fertilizers of animal origin in regions with significant number of livestock breeding farms". On the top of this, in our country, "there is no continuous process of environmental monitoring and consequently there is shortage of relevant environmental data related to agriculture (soil, water, biodiversity, ecological areas). There is certainly lack of data on agriculture at the level of farm as well (introduction of FADN – Farm accounting data network is in its initial phase of establishment). This situation narrows to a certain degree the field of research freedom, though this does not jeopardize the feasibility of projected costs.

8.4.5. Projections of emissions of sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia under individual scenarios per capita

The analysis of the estimated overall emissions of individual harmful matters will attain additional relevance if estimates of emissions are presented per capita, i.e. disaggregated with the estimates of the total population in Macedonia for specific years. On 31.12.2010, the total number of registered population in Macedonia was 2.057.284 inhabitants. Projections of the total number of inhabitants in 2015 and 2020 are 2.026.551 and 2.022.092 inhabitants, respectively.

Projected emissions per capita are presented below, expressed in kilograms.

Table 48 Projected emissions of sulphur dioxide under the three scenarios per capita (in kg)

Year	2010	2015	2020	National emission ceiling per capita		
				2010	2015	2020
SO_2 [kg] - OC	55.97	64.28	49.07	63.19	64.15	64.29
SO_2 [kg] - CM	55.78	65.01	41.85			
SO_2 [kg] - Model	54.85	46.18	7.53			

Table 49 Projected emissions of nitrogen oxides under the three scenarios per capita (in kg)

Year	2010	2015	2020	National emission ceiling per capita		
				2010	2015	2020
NO_x [kg] - OC	16.17	18.57	14.18	18.96	19.24	19.29
NO_x [kg] - CM	16.12	16.63	11.77			
NO_x [kg] - Model	16.45	14.01	10.31			

Table 50 Projected emissions of volatile organic compounds under the three scenarios per capita (in kg)

Year	2010	2015	2020	National emission ceiling per capita		
				2010	2015	2020
VOC [kg] - OC	13.79	15.91	18.13	14.58	14.80	14.84
VOC [kg] - CM	13.74	15.40	15.66			
VOC [kg] – Model	9.71	8.28	7.56			

Table 51 Projected emissions of ammonia under the three scenarios per capita (in kg)

Year	2010	2015	2020	National emission ceiling per capita

				2010	2015	2020
NH_3 [kg] - OC	4.80	5.05	4.57	8.26	8.39	8.41
NH_3 [kg] - Model	4.34	4.50	4.42			

Conclusions

The National Plan for Ambient Air Protection has been prepared in accordance with the adopted and implemented strategic planning documents which analyze economic activities in the Republic of Macedonia and their impact on the quality of ambient air through analysis of emissions from stationary and mobile sources.

Combustion of fossil fuels for electricity production in thermal power plants fired on coal (REK Bitola and REK Oslomej) which lack desulphurization plants, central heating plants and production industry, construction, iron and steel, is the reason for the generation of around 99% of the total annual emission of SO_2 . In the coming period (2011-2015) total emissions of SO_2 at annual level are expected to increase up to 130 kilo tons, and reduction will be achieved by 2020 resulting from the application of the planned measures in energy sector.

The key sectors with highest contribution to nitrogen oxides emission are the sector of public energy (production of electricity and heat) represented by 37.2%, processes of production industry and construction, iron and steel with 11.3% and transport with 26.5%. In the coming period (2011-2020), no exceeding of the emission ceiling of 39 kilo tons nitrogen oxides at annual level is expected.

Emissions of volatile organic compounds (VOCs) originate from mobile sources (combustion and evaporatrion of fuels) contributing 39.6% to the total emission, 27.4 % from evaporations in printing industry,15% from household related sources, 6.2 % from evaporations in heat production and around 11.8% from other sources. In the course of the next ten years, increase is expected in emissions of volatile organic compounds by 29.2%, while the first mitigation scenario assumes increase in the quantities of VOCs by 12 % for the same period, thus exceeding the emission ceiling of 30 kilo tons at annual level.

In agricultural sector, ammonia emissions in the air are mainly from enteric fermentation in cattle breeding (milky cows breeding 44.4% and other cattle 21.1%, pigs 14.4%, laying hens 11.7% and sheep and horses 7.5%.) and agricultural soils. High emission of ammonia has been broadcasted for the next five years, and then decrease is expected and there will be no exceeding of emission ceiling of 17 kilo tons at annual level.

Introduction of measures for reduction of emissions from stationary sources is certainly neither easy (due to technological changes and best available techniques that should be applied), nor can be achieved in a short period because of the high costs and the required highly qualified labour trained to operate sophisticated technology and even more important improvement of environmental standards and quality of air is a cost of the economic real sector which has already felt the global economic crisis for several years now. Nevertheless, the global trends of environment friendly and socially responsible companies attributing high attention to the protection and safety of workers at work, protection and improvement of environment and thus positive attitude towards community, force companies to invest in improved standards.

Generally, investment in environmental standards improvement and promotion of protection and safety of workers at work, is still a cost for the owners of industrial facilities. Owners should permanently follow the opportunities for co-financing offered by EU (grants in the frames of CIP Programme and EU/Eco innovations, CIP-EIP-Eco-innovation First Application and Market Replication Projects, intended for introduction of new technologies, products, processes or services that will contribute to the protection of the environment or more efficient use of natural resources, thus improving the environmental performances of industrial facility. The EBRD credit line which is ongoing, enables use of favourable credits for investments in small and medium size enterprises (by awarding grant of 20% of the amount of the investment) by which they will achieve compliance of national with the EU environmental standards, standards for safety and protection at work and product quality. Investments include procurement of equipment (filters for treatment emissions into the air and other media, replacement of old and energy inefficient equipment/technological line by more efficient one that will consume less raw materials, generate less waste and use energy and water in efficient manner.

All these possibilities need to be promoted and industrial facilities should take maximum part in their utilization towards improved environmental performances and social responsibility towards employees and community in general. Further more, utilization of the funds of the IPARD Programme should be proposed, as it is intended for agriculture development through application of good agricultural practices and will have indirect impact on air emission reduction.

Regular monitoring of pollutant emissions from stationary and mobile sources and reporting to the authorities responsible for environment protection and air quality improvement, continuous monitoring of the quality of air, introduction of measures for air pollution prevention and reduction of negative impacts on the environment from air emissions and observation of the health risk related to deteriorated quality of the air, are major challenges for all stakeholders towards transparent and cooperative management of the environment and securing of economic development that will include the goals of air quality protection in the earliest possible phase.

The National Plan for Ambient Air Protection of the Republic of Macedonia shall enter into force within eight days from the day of its publishing in the Official Gazette of the Republic of Macedonia.

No. ____________adopted on

______________, Skopje

President of the Government of the Republic of Macedonia

Nikola Gruevski, MSci

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