

5.12.2016

AIR QUALITY IMPROVEMENT PLAN FOR SKOPJE AGGLOMERATION

Further strengthening the capacities for effective implementation of the acquis in the field of air quality
This project is funded by the European Union

ABSTRACT

This air quality improvement plan was prepared in order to provide a strategy for the air quality improvement in the Skopje agglomeration, which includes the municipalities of City of Skopje (Aerodrom, Butel, Centar, Cair, Gazi Baba, Gjorce Petrov, Karpos, Kisela Voda, Saraj and Suto Orizari) and the rural municipalities Aracinovo, Cucer-Sandevo, Ilinden, Petrovec, Sopiste, Studenicani and Zelenikovo. As part of the plan an air quality assessment was carried out for all the pollutants regulated by the national legislation. The emission study carried out shows the prevalent role of domestic heating and traffic and some stationary sources (industrial sector) especially for the total emission of nitrogen oxides and particulate matter.

The air quality assessment was carried out with the air quality information available from seven air quality monitoring stations in Skopje agglomeration. The study shows that the most critical pollutant in the Skopje agglomeration is the particulate matter: PM_{10} concentrations exceed both the daily and annual limit value and $PM_{2.5}$ concentrations exceed the annual limit value all over the region. Nitrogen dioxide (NO_2) and benzene levels show local exceedances of the limit values in the central parts of the City of Skopje. Also the limit value of carbon monoxide (CO) has been exceeded in the inner parts of the city. The indicative measurements carried out for benzo(a)pyrene and heavy metals (lead, nickel, cadmium, arsenic) show an exceedance of target value for benzo(a)pyrene, whereas no exceedances were recorded for heavy metals. The long-term target value for ozone (O_3) is exceeded in the whole area.

Concerning PM_{10}, it is obvious that the secondary PM_{10} has great significance in total PM_{10} concentrations. For this reason and due the exceedance of the ozone target value, the air quality improvement measures must include actions to reduce emission of the precursors of secondary PM_{10} and ozone, i.e. nitrogen oxides, sulphur dioxide, volatile organic compounds and ammonia emissions.

According to the result of the emission inventory and the air quality assessments, a strategy for the air quality improvement is proposed. A set of possible measures were defined in order to reduce the emissions and their impact on air quality. These measures are classified in short-term and long term-measures. The short-term measures should be adopted as soon as possible in order to decrease the concentrations of the most critical pollutants. The long-term measures needs more time to be implemented due to the need of significant funding and planning. The short-term measures in the plan are prepared mainly for the years 2017-2022 and the medium or long-term measures mainly for years 2017-2027. The plan should be reviewed each five years.

The air quality improvement plan for Skopje agglomeration was prepared with the support of the EU funded Twinning project ‘Further strengthening the capacities for effective implementation of the acquis in the field of air quality’.

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1 INTRODUCTION

This plan aims at reduction of pollution and improving the air quality in the Skopje agglomeration. The plan is prepared in accordance to articles 23 and 26 of the Law on Ambient Air Quality. Air quality improvement plans should be developed for those zones and agglomerations where the levels of pollutants in ambient air exceed limit or target values set for pollutant concentrations.

For this plan an assessment of NO_2, SO_2, CO, O_3, PM_{10}, $PM_{2.5}$, benzene, benzo(a)pyrene and heavy metal concentrations was prepared based on the measurement data of years 2010-2015 from seven measurement stations in the Skopje region. The assessment was carried out using the air quality criteria defined in the national legislation: the limit and target values and the information and alert thresholds (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 No. 50/05, 4/13).

The measures to improve local air quality in the Skopje agglomeration presented in this plan are based on the emission study of different pollutants in each main emission sector and air quality assessment covering the years 2010-2015. These measures should be adopted progressively in the next 5-10 years. The measures are divided in to categories based emission sector. Part of the measures can be put into force fairly quickly and without significant additional resources and funding. The impact of these measures is not expected to be very significant but nevertheless they are important so that some progress in air quality improvement will be taken and seen at the local level in a short period of time.

The implementation of most of the measures to significantly decrease the emissions and the concentration of the critical pollutants will take longer period of time and need further planning and guaranteed funding. Implementation of these measures is expected to take several years and require political commitment at the local level. The measures developed at the local level will also have to be supported by the measures designed in the national level. The implementation of the measures will be followed and developed at local level with the coordination of the Ministry of Environment and Physical Planning (MEPP). The plan and the included measures should be reviewed in 5 years period.

2 GENERAL INFORMATION

2.1 Characterization of the Skopje agglomeration and its population

The Skopje agglomeration, which is one of the three zones for air quality assessment in the country, consists of the City of Skopje and the surrounding municipalities of Aracinovo, Cucer-Sandevo, Ilinden, Petrovec, Sopiste, Studenicana and Zelenikovo (Figure 1). The city itself is divided into 10 separate municipalities.

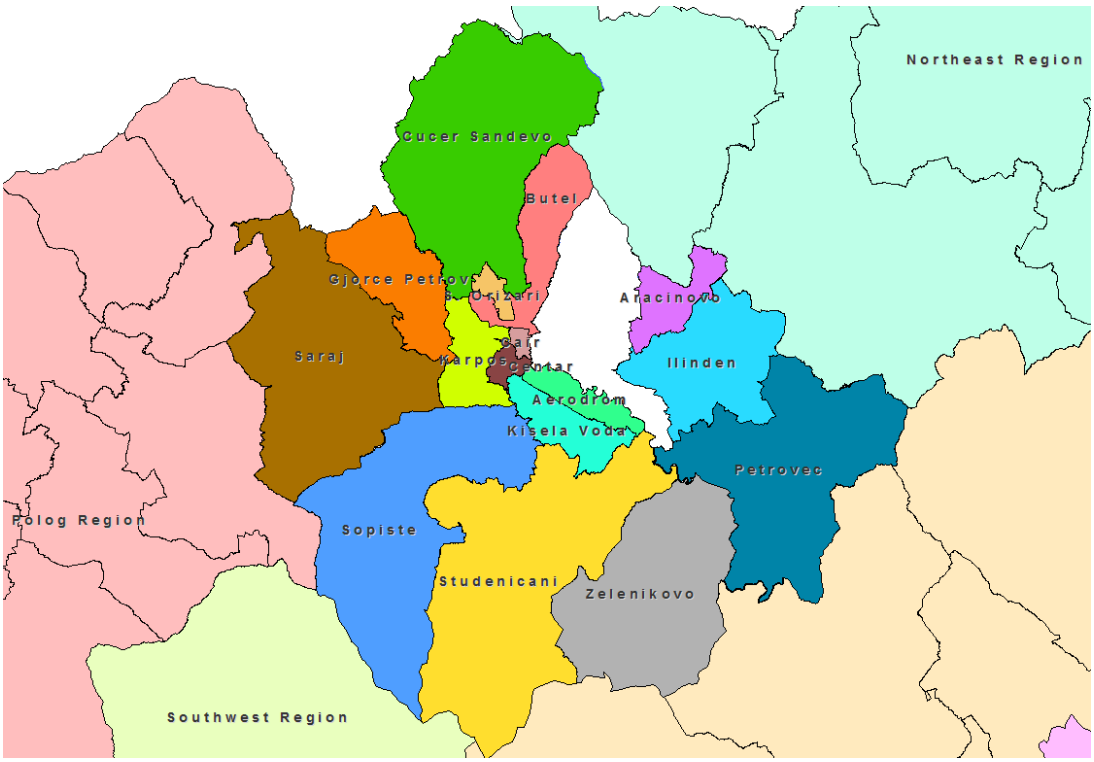


Figure 1. Skopje agglomeration municipalities.

The City of Skopje is the capital of the country and with significant business and industrial activities. The total population of the area is approximately 580 000 according to the last official census in 2002, while according to the assessment by the State statistical office in June 2015 the total population was 619 279 (Table 1).Total number of dwellings in the area is approximately 165 000 (according to the 2002 statistics).

Table 1. Population in the Skopje agglomeration (data from 2002 census).

Municipality	Population (2002)	Number of households (2002)	Population (assessment 2015)
City of Skopje	**506 926**	**146 566**	**544 086***
Suto Orizari	22 017	5 102	---------
Saraj	35 408	7 972	40 587
Butel	36 154	10 056	---------
Gjorce Petrov	41 634	11 886	42 379
Centar	45 412	15 355	---------
Kisela Voda	57 236	17 577	---------
Karpos	59 666	19 680	60 625
Chair	64 773	17 107	---------
Aerodrom	72 009	21 495	---------
Gazi Baba	72 617	20 336	76 636
Other municipalities			
Aracinovo	11 597	2 267	13 505
Cucer-Sandevo	8 493	3 925	9 891
Ilinden	15 894	4 298	16 836
Petrovec	8 255	2 087	9 018
Sopiste	5 656	1 510	---------
Studenicani	17 246	3 570	21 200
Zelenikovo	4 077	1 014	4 743
Total	**578 144**	**165 237**	**619 279**

* Data for the municipalities Aerodrom, Butel, Kisela Voda, Centar, Cair, Suto Orizari and Sopiste are included in City of Skopje

2.2 Topography and climate

Skopje agglomeration is located in the center of the Balkan Peninsula. The City of Skopje is built in the Skopje valley, oriented on a west-east axis, along the course of the Vardar River. The valley is approximately 2,000 km wide and is limited by several mountain ranges to the North and South. These ranges limit the urban expansion of Skopje, which spreads along the Vardar and the Serava, a small river which comes from the North.

Skopje is approximately 245 m above sea level and covers an area of 571 km^2. The urbanized area covers 337 km^2.

The Skopje valley is bordered in the west with the Sar Mountains, in the south with the Jakupica range, in the east with the hills belonging to the Osogovo range, and in the north with the Skopska Crna Gora. Mount Vodno, the highest point inside the city limits, is 1066 m high and is a part of the Jakupice range. Although Skopje is built on the foot of Mount Vodno, the urban area is mostly flat. It comprises several minor hills, generally covered with woods and parks, such as Gazi Baba hill (325 m), Zajcev Rid (327 m), the foothills of Mount Vodno (lowest between 350 and 400 m high).

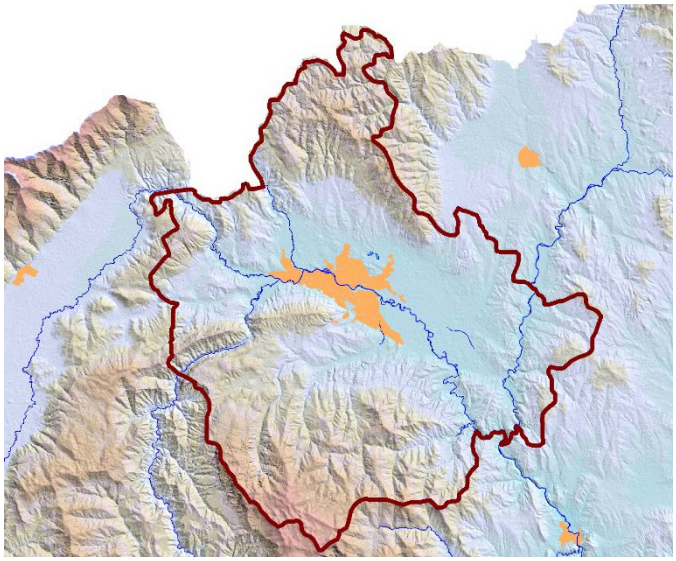


Figure 2. Topography of the Skopje region.

The climate in Skopje is usually classified as continental sub-Mediterranean or even hot continental climate. The summers are long, hot and humid, while the winters are short and relatively cold. Snowfalls are common in the winter period, but heavy snow accumulation is rare and the snow cover lasts only for a few days.

In summer, temperatures often reach over 30°C and sometimes over 40°C. The hottest months are July and August with average temperature over 20 °C. In spring and autumn, the temperatures range from 15 to 24°C. In winter, the day temperatures are approximately 6 °C, but at nights they often fall below 0°C and sometimes below −10°C. The coldest months are January and December when averaged temperatures are only few degrees above zero. Monthly averaged temperatures in 2012-2015 are shown in Figure 3.

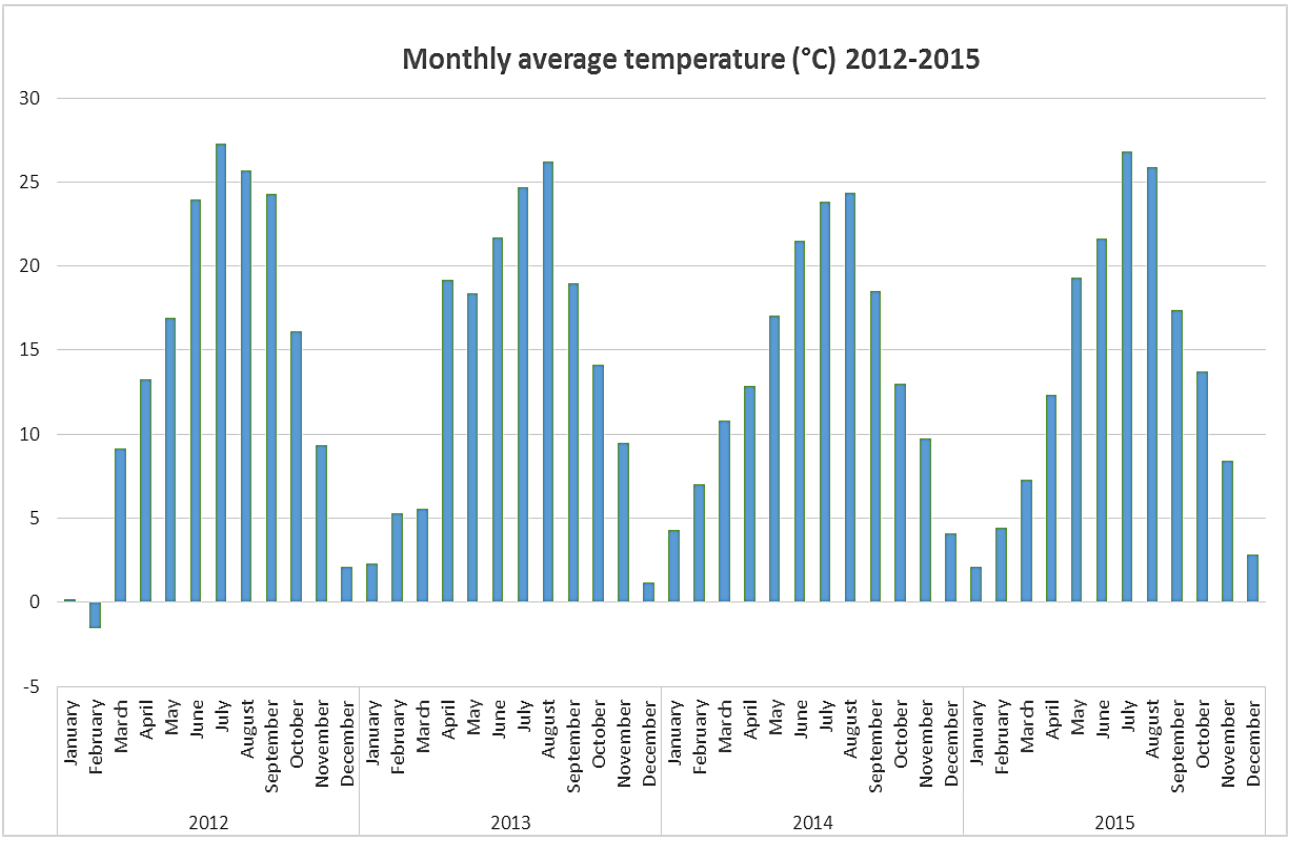


Figure 3. Monthly averaged temperature in Skopje 2012-2015.

Precipitation is relatively low due to the pronounced rain shadow of the Prokletije Mountains to the northwest, precipitation being only a quarter of what is received on the Adriatic Sea coast at the same latitude. Averaged annual precipitation is 388 mm (in the four-year period). Driest months are usually August and July. The precipitation is heaviest usually from October to December and from April to June. Monthly precipitation sums in 2012-2015 are shown in Figure 4. Total duration of sunshine in the Skopje valley is about 2 100 h/year.

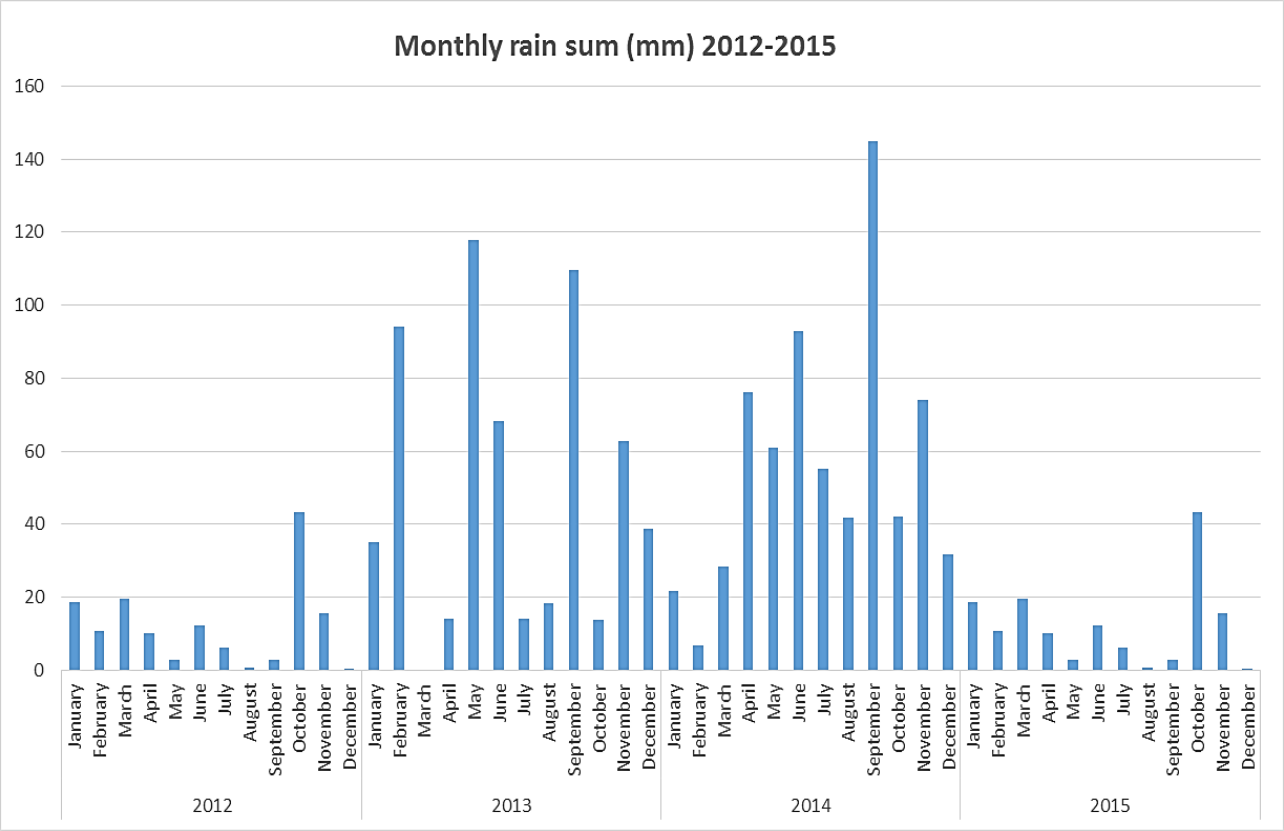


Figure 4. Monthly rainfall in Skopje in 2012-2015.

According to the meteorological observations from Zajcev Rid weather station in 2015 the most frequent wind directions are west and northwest. The wind speed and direction are represented as wind rose in Figure 5. Wind rose represents as percentages (%) the average wind sectors (from where the wind is blowing) and the average wind speed (m/s) as percentages (%) of each sector.

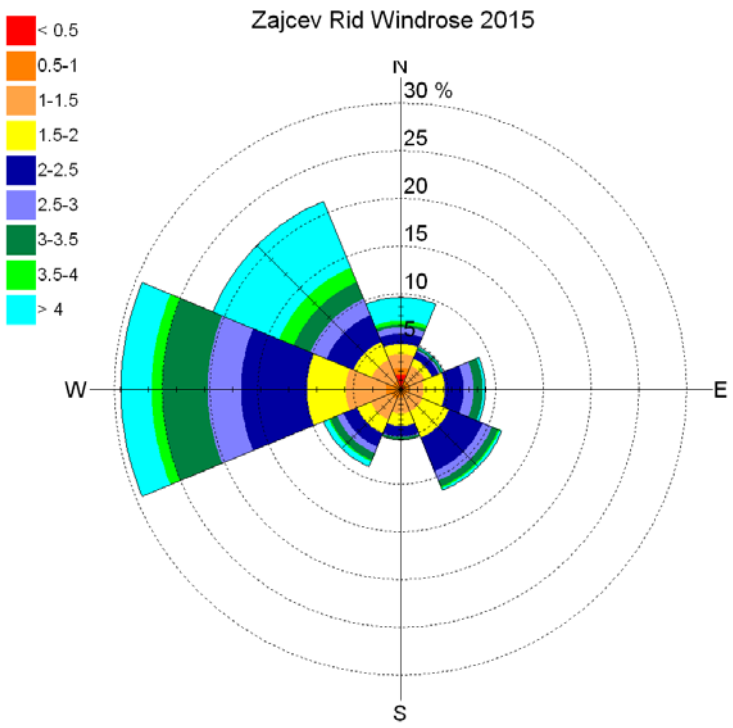


Figure 5. Wind rose representing the average wind speed and direction in Skopje during 2015.

It can be estimated that the meteorology has very significant contribution to the occurrence of air pollution in Skopje. During the winter period very high concentrations of air pollution are measured. The high concentrations are observed during stable atmospheric conditions, with emitted substances accumulating into the valley. During these periods there is reduced circulation in the atmosphere due to prolonged period with weak winds, very little rain and occurrence of temperature inversion.

2.3 Urban morphology and industries

The urban morphology of Skopje was deeply impacted by the 1963 earthquake which destroyed 80% of the city and by the reconstruction that followed. For instance, neighbourhoods were rebuilt in such a way that the demographic density remains low to limit the impact of potential future earthquakes. The south bank of the Vardar River generally comprises high-rise tower blocks, including the vast Karpos neighbourhood which was built in the 1970s west of the centre. Towards the east, the new municipality of Aerodom was planned in the 1980s to house 80,000 inhabitants on the site of the old airport. Between Karpos and Aerodrom lies the city centre.

Outside of the urban area, the City of Skopje encompasses number of small settlements. Some of them are becoming suburbs, such as Singelikj, located on the road to Belgrade, which has more than 23,000 inhabitants, and Dracevo which has almost 20,000 inhabitants. Other large settlements are located north of the city, such as Radisani, with 9,000 inhabitants, whereas smaller villages can be found on the Mount Vodno or in Saraj municipality, which is the most rural of the ten municipalities that form the City of Skopje. Some localities located outside the city limits are also becoming suburbs, particularly in Ilinden and Petrovec municipality. They benefit from the presence of major roads, railways and the airport located in Petrovec.

The Skopje region industry is dominated by production of food and beverages (bread, baked products, and meat), textile industry, printing and metal processing. Most of the industrial areas are

located in Gazi Baba municipality, on the major routes and rail lines to Belgrade and Thessaloniki. Notably, the Arcelor Mittal and Makstil steel plants are located there, and also the Skopje Brewery. Other industrial zones are located between Aerodrom and Kisela Voda, along the railway to Greece. These zones comprise Alkaloid Skopje (pharmaceuticals), Rade Končar (electrical supplies), Imperial Tobacco and Ohis (fertilizers). Two special economic zones also exist, around the airport and the Okta refinery.

2.4 Traffic networks

Both on the northern and western side of the river Vardar are located the major roads M3 and M4 leading from south to north and from east to west. A ring-road is located further away north from the central city area. Major road on northern side of the river Vardar is 1482 Bulevar Aleksandar Makedonski and on the southern side 470 Boris Trajkovski. Total length of roads in the Skopje region is 919 km and in the City of Skopje 533 km.

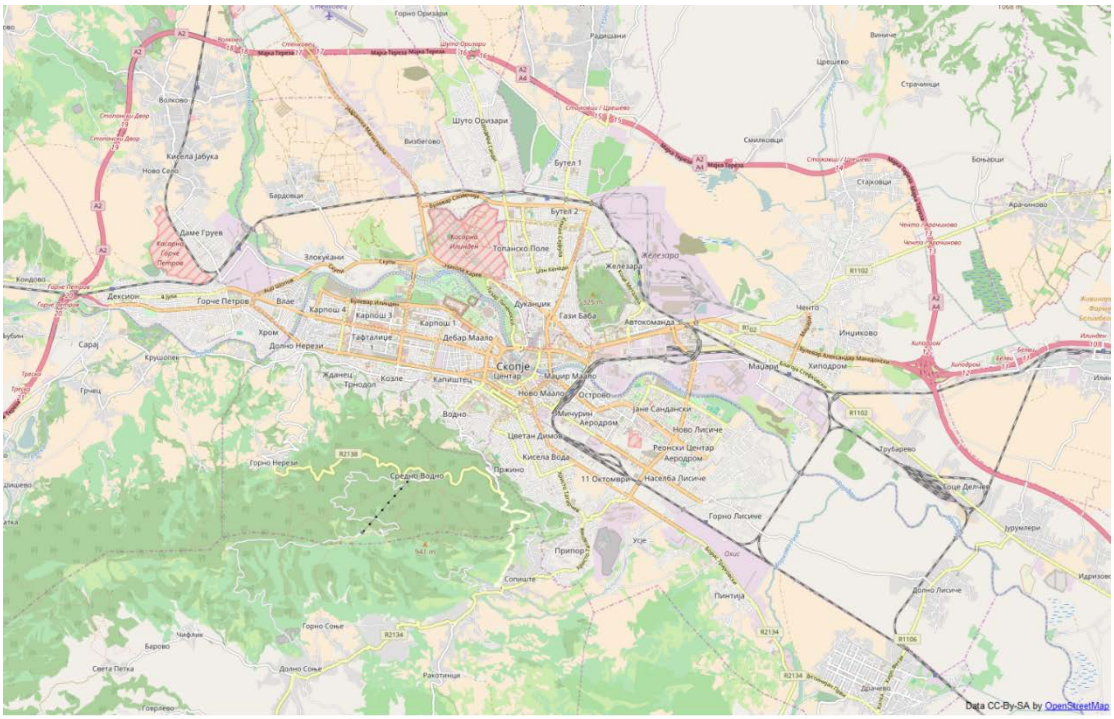


Figure 6. Street map of the City of Skopje.

The number vehicles registered in Skopje was 161 474 in 2014. Table 2 presents the shares of different types of vehicles of all registered vehicles in Skopje and division of the car fleet to euro classes.

Table 2. Shares of different types of vehicles of all registered vehicles in Skopje and division of the car fleet to euro classes (Ministry of Interior, 2014).

Share of different types of vehicles		Share of vehicles in euro classes	
Passenger cars (petrol)	56.6%	Euro 0 (-1992)	11%
Passenger cars (diesel)	29.2%	Euro 1 (1993 - 1996)	15%
Passenger cars (other)	1.9%	Euro 2 (1997 - 2000)	24%
Light duty vehicles (petrol)	2.4%	Euro 3 (2001 - 2004)	17%
Light duty vehicles (diesel)	4.4%	Euro 4 (2005 - 2010)	26%
Heavy duty vehicles	2.7%	Euro 5 (2011 - 2014)	7%
Buses	0.7%		
Motorcycles	2.1%		
Total number of vehicles	**161 474**		

International rail lines go from Skopje north to Belgrade, south to Thessaloniki and west to Pristina.

Skopje has a bus network managed by the city and operated by three companies. A new network for small buses started to operate in June 2014, not to replace but to decrease the number of big buses in the city centre. A tram network has long been planned in Skopje and the idea was first proposed in the 1980s, but so far the plan has not been put into practice.

2.5 Energy infrastructure

Electric power consumed in the Skopje region is supplied by the national power network. Local electric power generation is negligible.

City of Skopje has a city gas pipeline network of about 19 km, which distributes gas to the industry and energy sector. The capacity of the network is 70 000 m^3/h.

Central parts of the City of Skopje are covered by the heating network with a total length of 170 km. The heat is produced by 5 heating plants (hot water capacities of 295 MW, 230 MW, 100 MW, 70 MW and 28 MW). Over 33 % of the households (about 51 000 households) in Skopje are connected to the network. About 4 % of the households have their own boiler and 63 % are heated by other means.

3 LEGISLATIVE FRAMEWORK

3.1 Air quality legislation

Ministry of Environment and Physical Planning (MEPP) prepared the framework Law on Ambient Air Quality in accordance with the Framework Directive 96/62/EC on ambient air quality assessment and management. The Decree on limit values for levels and types of pollutants in ambient air and alert thresholds, terms for achievement of limit values, limit value margins of tolerance, target values and long term targets, has been prepared in accordance with Law on Ambient Air, taking into consideration the Framework Directive and the daughter directives. The Law and the Decree were updated with the provisions and details stipulated in the Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (so called CAFÉ Directive) and Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air. Until now, 16 bylaws have been prepared in accordance with the EU regulations and this process is still on-going.

3.1.1 Air quality criteria

The legislation defines the limit and target values, long-term objectives and alert and information thresholds for pollutants in ambient air (Table 3). Limit and target values for SO_2, NO_2, CO, PM_{10}, $PM_{2.5}$, O_3, benzene, PAHs and certain heavy metal concentrations are defined for protection of human health. The alert threshold is a concentration level beyond which there is a risk to human health from brief exposure for the population as a whole and at which immediate steps are to be taken to improve air quality. The legislation defines alert thresholds for SO_2 and NO_2 concentrations and alert and information thresholds for ozone concentrations. Draft proposal exists for the information and alert thresholds for PM_{10} concentrations.

Table 3. Air quality limit values, target values, long-term objectives, information and alert threshold values for the protection of human health

	Limit or target value			Long term objective	Information and alert thresholds	
Pollutant	**Averaging period**	**Value**	**Maximum number of allowed occurrences**	**Value**	**Period**	**Threshold value**
SO_2	Hour Day	350 µg/m^3 125 µg/m^3	24 3		3 hours	500 µg/m^3**
NO_2	Hour Year	200 µg/m^3 40 µg/m^3	18 0		3 hours	400 µg/m^3**
Benzene (C_6H_6)	Year	5 µg/m^3	0			
CO	Maximum daily 8-hour mean	10 mg/m^3	0			
PM_{10}	Day Year	50 µg/m^3 40 µg/m^3	35 0		2 days 2 days	150 µg/m^3* 200 µg/m^3 with margin of tolerance of 50 µg/m^3 (25%) from the day of enforcement, with equal annual percentage reduction each 12 months to reach 0 % by 1 January 2022** (draft proposals at the moment)
$PM_{2.5}$	Year	25 µg/m^3	0			
Pb	Year	0.5 µg/m^3	0			
As	Year	6 ng/m^3	0			
Cd	Year	5 ng/m^3	0			
Ni	Year	20 ng/m^3	0			
BaP	Year	1 ng/m^3	0			
O_3	Maximum daily 8-hour mean averaged over 3 years	120 µg/m^3	25	120 µg/m^3	1 hour 3 hours	180 µg/m^3* 240 µg/m^3**

* information threshold, ** alert threshold

3.1.2 Air quality plans and programs

Air quality improvement plans should be developed to ensure that concentrations of air pollutants will not exceed the air quality standards (limit values, target values, alert thresholds) when they have to be met. In accordance with the Law on Ambient Air Quality the following documents shall be prepared for the planning of air quality protection:

1. National level
    - National plan for ambient air protection;
    - National programme for gradual reduction of the emission quantities from certain types of pollutants.
2. Local level
    - Plan for improvement of the ambient air quality;
    - Short-term action plan for ambient air protection.

Plans for improvement of ambient air quality should be prepared for the municipalities where the levels of pollutants in ambient air exceed any limit or target value.

In municipalities, where there is a risk that the levels of pollutants in ambient air will exceed one or more of the alert thresholds, short term action plan should be prepared indicating the measures to be taken in the short term in order to reduce the risk or duration of such an exceedance.

The content of the air quality plan should be in accordance with the provisions prescribed in the Rulebook on detailed content and manner of preparation of the plan for ambient air quality improvement.

3.2 Emission legislation

The regulation of permitted emission levels of pollutants in stationary emission sources is based on the Law on Ambient Air Quality (Article 13). Detailed emission limit values for different pollutants from different processes and enterprises are given in the Rulebook on the limit values for the permissible levels of emissions and types of pollutants in the exhaust gases and vapours emitted in the air from stationary sources (Official Gazette no. 141/10). The Rulebook refers to all identified (existing) industrial and energy production installations, and certain agricultural processes. Guidelines have been prepared for the adequate implementation of the rulebook. The guidelines are directed preliminarily at industrial operators, but also to inspectors dealing with control of emissions from stationary sources, and authorities giving A and B permits to operators.

4 CONNECTION TO OTHER PROGRAMS AND STRETEGIES

4.1 National plan for the ambient air quality protection

National plan for the ambient air quality protection has been adopted for the whole country in 2012. It identifies and describes the measures for emission reduction and improvement of ambient air quality. For each measure the responsible institution and deadline for its implementation were defined. The national plan is adopted by the Government upon proposal of the Ministry of Environment and Physical Planning and with the consent of the Ministry of Health and the Ministry of Economy, and is referring to the period 2013-2018.

The national plan includes 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.

The national plan has numerous measures that have impacts at local level and support the local level activities to improve air quality. In many cases these national measures may even be primary measures in air quality improvement, since the air quality problems in the country are rather national and regional in origin than only local.

4.2 National program for gradual reduction of the emission

National emission reduction program in accordance with the EU Directive for National Emission Ceilings has been adopted by the Government in 2012. It specifies the measures for reducing pollutants in relation to the upper limits – ceilings for emissions and the projections for reducing the quantities of pollutant emissions on annual level until 2020.

The terms for preparing the programme for gradual reduction of the emission quantities of sulphur dioxide, nitrogen oxides, ammonia, volatile organic compounds, total suspended particles, and carbon monoxide are specified in Article 27-b of the Law on Ambient Air Quality.

The programme covers period 2012-2020 and is in accordance with all relevant documents in energy sector listed in the next subchapter.

4.3 Other planning documents

The plans mentioned above are in relation with the following strategic documents which have been adopted nationally:

- Third national communication on climate change;
- Strategy for energy development up to year 2030;
- Strategy to promote energy efficiency up to year 2020;
- Strategy for using renewable energy sources up to year 2020;
- National strategy and national plan for waste management;
- National strategy for transport.

This plan will be in-line with the all strategic documents of the country.

The City of Skopje has adopted in 2011 the second local environmental action plan (LEAP 2). The plan includes numerous measures and actions that are planned to improve local air quality. The objectives cover traffic, stationary sources, domestic heating and improvement of energy efficiency. It also includes measures that are related to better emission inventories and cadastres and more versatile air quality monitoring. The actions listed in the plan however are quite general in terms.

The City of Skopje has adopted in 2011 the sustainable urban mobility plan. The plan includes recommendations for sustainable transport system for the City of Skopje. The recommendations and measures cover:

- Coordinated urban planning and traffic planning;
- Public transport development;
- Pacifying traffic;
- Transport and parking;
- Urban freight transport.

5 EMISSIONS IN THE SKOPJE AGGLOMERATION

The knowledge of the main emission sources in Skopje agglomeration and their contribution to the total amount of emissions is fundamental in order to define the set of measures to be included in this document.

The emission estimation includes the following most important sectors:

- Energy production;
- Industry;
- Traffic;
- Domestic heating;
- Waste management;
- Construction sites;
- Agriculture.

The information concerning the emissions from energy plants and industry related to each pollutant is retrieved from the stack measurements (emission measurements), made according to the emission permits.

The emission estimation from the other sectors is performed using a top-down approach. To this aim, according to the EEA emission estimation Guidebook[1], one or more activity indicators are defined for each emission sector. Most of the information concerning the activity data can be retrieved from the local or the national statistics properly scaled to the area of interest. For some certain pollutants the activity data are multiplied by emission factors included in the Guidebook in order to estimate the related emission. The main reference for this chapter is the document “Skopje Region Assessment of the main emission sources”, where all the calculations made for the emission estimation are reported in detail.

5.1 Emission inventory

5.1.1 Energy production

Electric power consumed in the Skopje region is supplied by the national power network. There are several heating plants located in Skopje connected to the district heating system in the urban city centre. Heat energy produced in those plants covers approximately 30% of the total heating need in the City of Skopje. The heat energy plants currently active in Skopje are listed in Table 4.

[1]EEA Guidebook 2013 - June 2014 review http://www.eea.europa.eu/publications/emep-eeaguidebook-2013/

Table 4. List of energy plants located in Skopje.

Plant	Power capacity
TE-TO AD Skopje	230 MW
AD ELEM Energetika, Skopje	100 MW
Balkan Energy - Toplana ISTOK	295 MW
Balkan Energy - Toplana ZAPAD	70 MW
Balkan Energy - Toplana 11 Oktomvri	28 MW
KOGEL	26.5 MW (thermal) 31 MW (electrical)

According to the measurements performed in the plants in 2014, the emission related to energy and heat production in the City of Skopje are listed in Table 5. The progressive substitution of heavy oil with natural gas as main fuel for the district heating during the last few years and introduction of low NOx burners in the heating plants led to a significant decrease of the emissions in the atmosphere related to this sector.

Table 5. Total emissions from heat and energy production sector

	Pollutants (in t/year)			
Heat and Energy Production Sector	TSP	SOx	NOx	CO
Total emissions	4	8	182	10

5.1.2 Industry

The main industrial infrastructures in Skopje Region include ferrous and non-ferrous metal processing plants, chemical factories, cement processing plant, asphalt factory, refinery, and food and beverages companies.

A cadastre with the information about the main emission point sources in the City of Skopje was developed by the Ministry of Environment and Physical Planning. Periodic emission measurements are required from all the main installation under the A and B permits, in order to update the cadastre data. The information concerning the emission measurements referred to the 2014 year was used to estimate the emissions from industrial production sector. The list of significant emitting plants located in Skopje is included in Table 6.

Table 6. Industrial installations with significant emissions in Skopje.

Name of Company	Industry type
Makstil	Iron and steel
Arcelor Mittal	Iron and steel
RZ Institut	Non-ferrous metal
Dzoson Meti	Chemical
Alkaloid	Chemical
Cementarnica USJE	Cement
OKTA rafinerija	Oil refining
JP Ulici i patista	Road paving with asphalt
Rade Koncar	Electrical supplies
Duropack	Packaging production
Pivara	Food and beverages
Imperial Tobako	Tobacco

According to the measurements performed in the plants in 2014, the emissions related to the industrial production in the City of Skopje are listed in Table 7.

Table 7. Total emissions from industrial production sector in Skopje.

	Pollutants (in t/year)			
Industrial Production Sector	TSP	SOx	NOx	CO
Total emission	25	159	1528	2816

5.1.3 Road traffic

According to the EEA emission estimation guidebook, the classification of vehicles is the following:

- Passenger Cars;
- Light Duty Vehicles;
- Heavy Duty Vehicles;
- Buses;
- Motorcycles.

For PM_{10}, the emissions from traffic sector include also the non-exhaust fraction, due to vehicle tyre and brake wear and road surface wear.

The information related to the vehicles fleet for Skopje region (for 2014) was retrieved from the State Statistical Office and Ministry of Interior. The real circulating fleet in Skopje is probably composed also by vehicles from other areas of the country and the vehicles registered in Skopje are circulating outside the city. Nevertheless, the registry data for the City of Skopje is considered a good approximation of the real circulating fleet.

According to the data available for the 2014 from the Ministry of Interior there are 161 474 vehicles registered in the Skopje Region. The chart in Figure 8 shows the composition of the fleet by categories of vehicles, whereas the chart in Figure 9 shows the classification of each vehicles category by Euro standard classes.

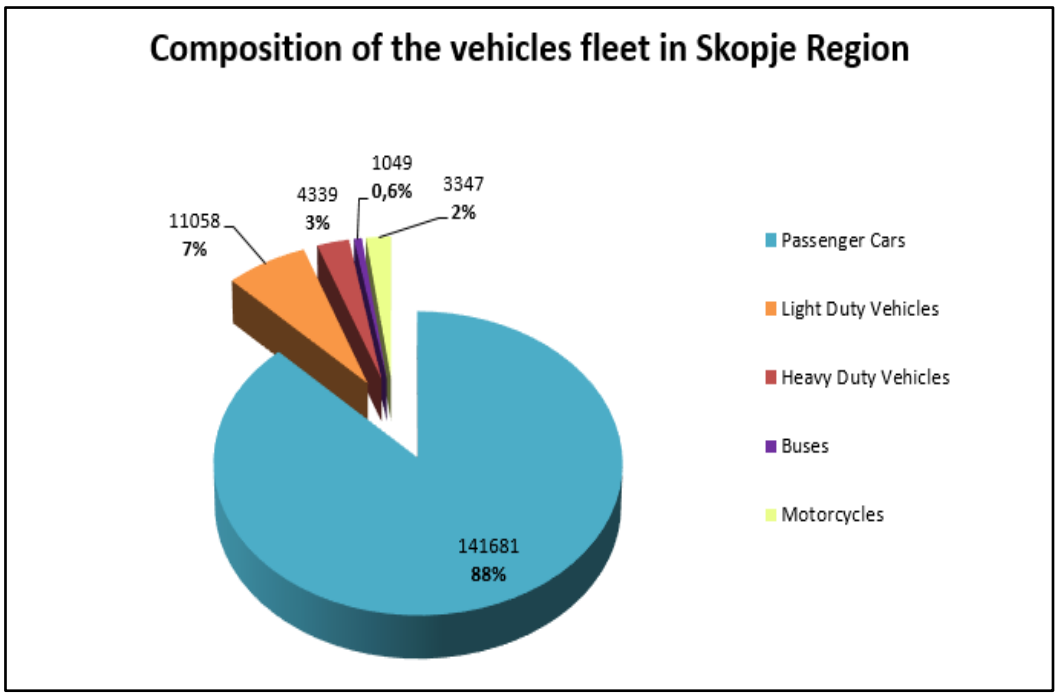
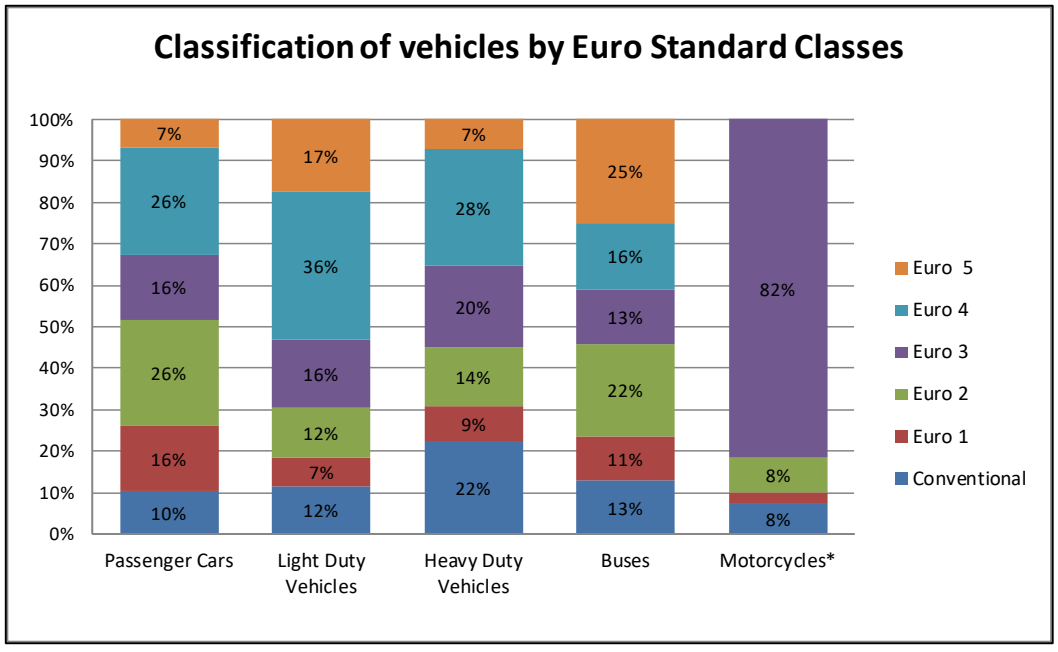


Figure 7. Composition of the vehicle fleet in Skopje Region with amount and percentage of vehicles classified by categories.



*According to the Euro Standards the motorcycles are classified from conventional to Euro 3. Euro 4 and Euro 5 classes are not defined yet.

Figure 8. Classification of vehicles by euro standard classes.

According to the Figure 7 the circulating fleet in Skopje is composed mainly by passenger cars (88%), whereas the duty vehicles represent approximately 10% of the fleet. Figure 8 shows that except for the light duty vehicles and motorcycles, at least 40% of the vehicles are classified as conventional, Euro 1 or Euro 2, which are the most significant in affecting the atmospheric emissions. The light duty vehicles is the category with the highest percentage of new vehicles; on the contrary 31% of the heavy duty vehicles are very old, classified as conventional or Euro 1. The motorcycles category,

classified differently from the other ones (Euro 4 and Euro 5 standards are not regulated yet), is composed mainly by Euro 3 vehicles, considered relatively environmental friendly. Concerning the PM_{10}, the oldest classes of vehicles (conventional, Euro 1 and Euro 2) contribute to almost 70% to the total emissions from passenger vehicles. For CO and NO_x, the conventional technology class represents the most polluting class.

Most of the passenger vehicles in the City of Skopje are fuelled with gasoline (65%). Approximately 30% of the passenger cars use diesel. Only a very minor part of the fleet is fueled by LPG (2%). Concerning the light duty vehicles, 63% are diesel fuelled and about 37% are fuelled by gasoline. Concerning heavy duty vehicles, about 80% are diesel fuelled, while the remaining 20% is fuelled by gasoline.

According to the data calculated for each class of vehicles, the total amount of emissions for the road traffic sector is summarized in Table 8.

Table 8. Total emissions from road transport sector.

	Pollutants (in t/year)					
Road transport sector	**CO**	**NH_3**	**NMVOC**	**NO_x**	**PM (exhaust + non-exhaust)**	**SO_2**
Passenger Cars	3166	37	309	572	43	197
Light Duty Vehicles	270	2	27	105	12	21
Heavy Duty Vehicles	805	0	83	294	13	30
Buses	137	0	34	577	25	16
Motorcycles	50	0	11	2	0	2
Total emission	4428	39	464	1549	93	265

Concerning the calculation of total emissions from traffic sector, the estimation of the mileage covered per year in urban area may entail some degree of uncertainty, since no referenced data are officially available at local level, except for the buses. Nevertheless the magnitude of the mileage amount estimated for each category of vehicles in Skopje Region is comparable with information retrieved in other areas of Europe.

5.1.4 Domestic heating

According to the report “Energy Consumption in Households in 2014”, released by the State Statistical Office, in Skopje Region there are 161 841 households: most of them (approximately 83%) were built before 1991. Figure 18 shows the distribution of fuels used in the household primary heating system.

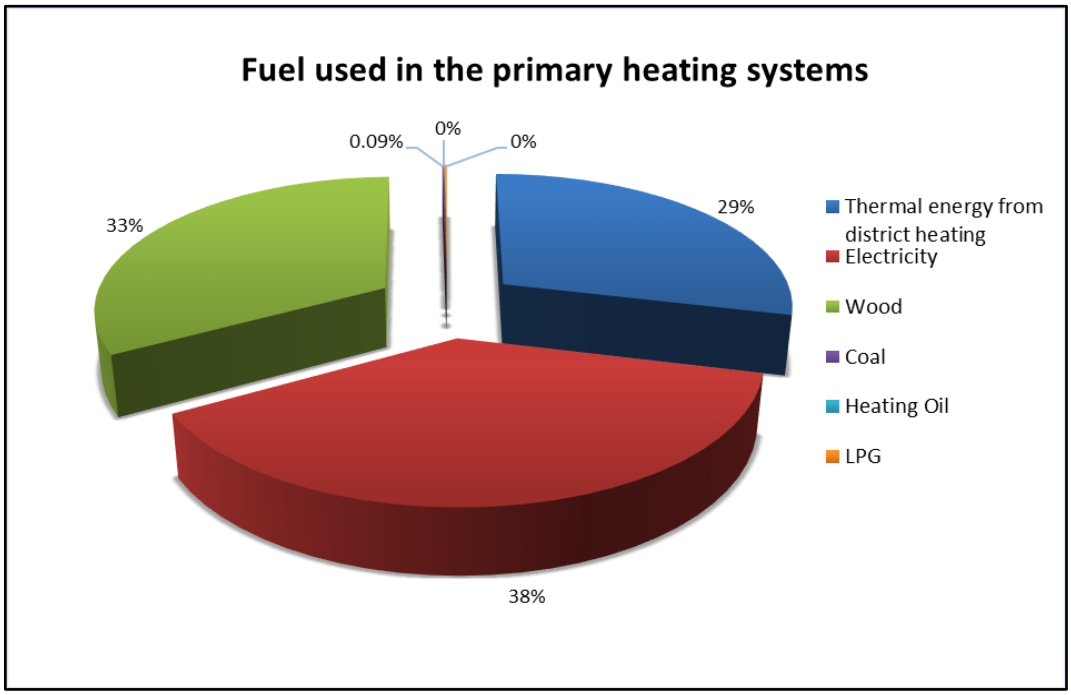


Figure 9. Type of fuel used in household primary heating system.

According to the chart, 38% of households use electricity in the primary heating systems (air conditioning systems with inverters, electric stoves, electric panels, etc.) and 29% of households are connected to the district heating system. Moreover, wood is also very common, used in 33% of the households. According to the statistics, the utilization of new generation wood fuels (pellets, briquettes, etc.) is still very low (less than 2% of the total biomass consumption), whereas the most popular type of wood format is log. The map in Figure 10 shows the percentage share of wood consumption among the municipalities in the Skopje Region. The municipalities with higher consumption of wood are Suto Orizari and Butel with approximately 9%, Gazi Baba with 11%, and Kisela Voda with more than 15% of the total consumption of wood in the region.

The emissions from the domestic heating were estimated using the information of the annual fuel consumption in Skopje area and emission factors from the EEA Guidebook 2013 (small combustion residential plants).

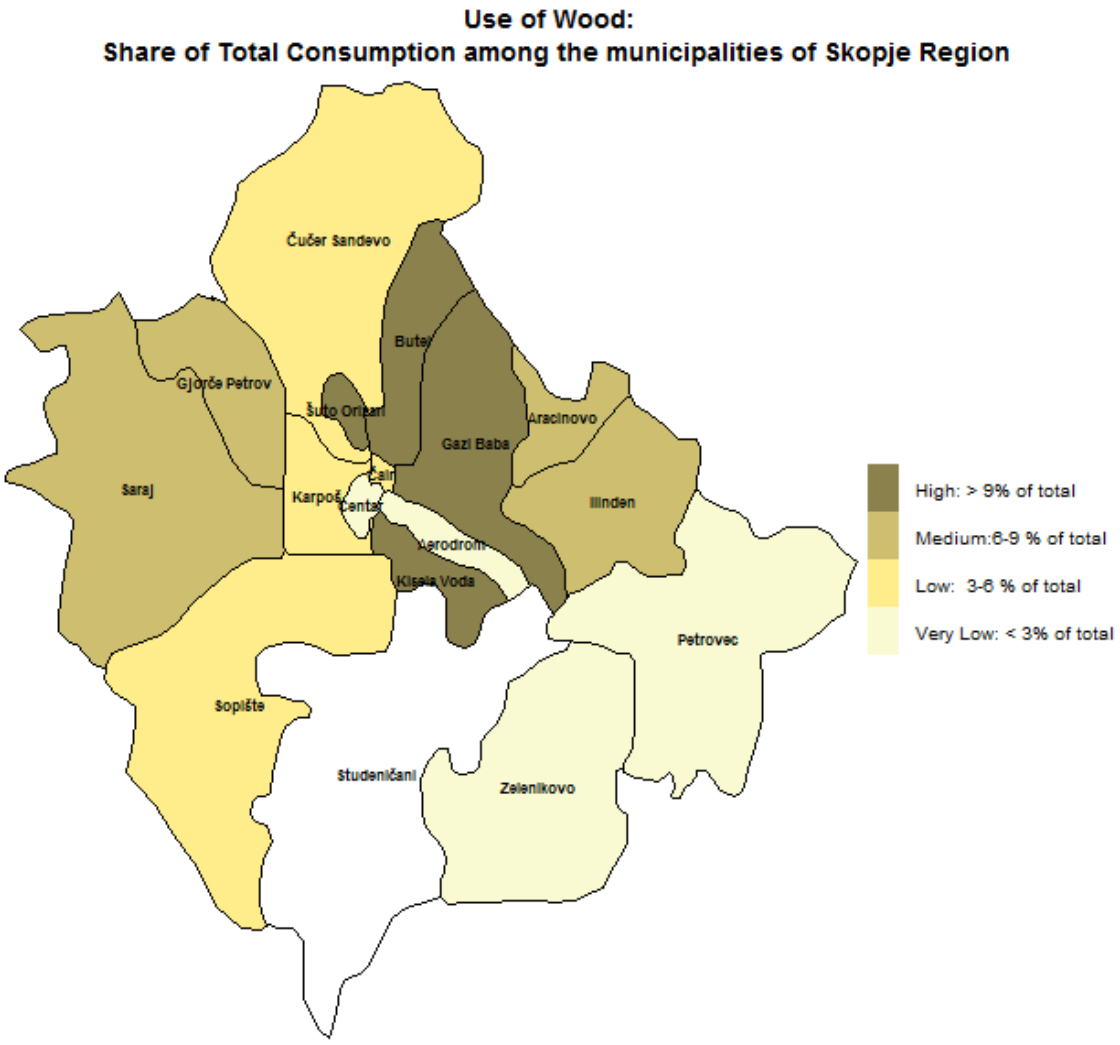


Figure 10. Use of Wood: Share of total consumption among the municipalities of the City of Skopje (data not available for the municipality of Studenicani).

The emission calculated in this paragraph do not include the electric energy consumption or the district heating related energy, because they are already included in the “energy production sector” paragraph. According to the report “Energy Consumption in Households in 2014”, the following fuels contribute to the emission from the domestic heating sector.

Table 9. Annual fuel consumption for the domestic heating in Skopje Region.

Fuel	Annual consumption of fuels	
wood	234978	m^3
coal	1275	t
heating oil	754	t
LPG	525 466	kg

The total amount of estimated emissions for the domestic heating sector is summarized in Table 10. It can be observed that about 99% of the total emission from households heating is related to the wood burning.

Table 10. Total emissions from domestic heating sector.

	Pollutants (in t/year)					
Domestic heating sector	CO	NH_3	NM VOC	NO_x	SO_x	PM
Biomass	10 247	179	1 537	128	28	2 049
Coal	39	0	4	1	8	4
LPG	0	na	0	1	2	0
Heavy oil, liquid oil	2	0	0	2	2	0
TOTAL	10 289	179	1 541	132	41	2 053

5.1.5 Waste management

Emissions related to the waste management activities refer mainly to the waste incineration and waste disposal. Both the emissions were estimated using the basic approach included in the EEA Guidebook 2013 for the medical waste incineration and the solid waste disposal activities.

According to MEPP (Yearly report on processed environmental data) 153 732 tons of municipal solid waste were disposed in landfill during the 2014. According to data received by the operator Drisla approximately 711 tons of medical waste were incinerated. The estimated emissions related to these activities are listed in Table 11.

Table 11. Total emissions from waste management sector

Waste management	Pollutants (in t/year)				
Type of treatment	CO	NM VOC	NOx	PM	SOx
Waste incineration	0.1	0.5	1.6	12.1	0.4
Waste disposal	na	239.8	na	0.1	na
TOTAL	0.1	240.3	1.6	12.2	0.4

5.1.6 Construction sites

The emissions from construction sites (for particulate matter) were estimated according to the basic approach included in the EEA Guidebook 2013. According to the report “Construction in the Republic of Macedonia 2010-2014”, released by the State Statistical Office, in Skopje Region there were built approximately 168 866 m^2 of dwellings during 2014. There is no precise data concerning the other classes of constructions (commercial buildings etc.), but for first approximation, the information of dwelling construction sites is useful to represent the magnitude of the construction related PM_{10} emissions.

The estimated emission related to these activities are listed in Table 12.

Table 12. Total emissions from construction sites.

	Pollutants (in t/year)
Construction sector	PM_{10}
Construction sites	27
TOTAL	27

5.1.7 Agriculture

This paragraph estimates emissions from agriculture practices, especially concerning the manure management, including animal husbandry and emissions following application of manure to land, and use of artificial fertilizers.

The information of the number of animals bred in 2014 was retrieved from the document “Livestock”, prepared by the State Statistical Office. The emission related to use of artificial fertilizers is estimated according to the basic approach included in the EEA Guidebook 2013. According to the document “Field crops, orchards and vineyards”, prepared by the State Statistical Office and the report “Annual report on the quality of environment”, in Skopje Region there are 80 598 ha of arable soil, and an estimated amount (scaled from national statistics) of about 84 tonnes of nitrogen used as a fertilizer. The total emission related to agricultural activities are listed in Table 13.

Table 13. Total emissions from agricultural activities.

	Pollutants (in t/year)			
Agriculture	NH3	NMVOC	NOx	PM
Manure management	809	346	5	50
Use of fertilizers	6	69	2	na
TOTAL	815	416	7	50

5.2 Total emissions in the Skopje agglomeration

According to the present emission assessment study performed for Skopje region (reference year 2014), the total emissions estimated for CO, NH_3, NMVOC, NO_x, SO_x, PM_{10}, classified by emission sectors, are listed in Table 14. The same results are presented in the following figures.

Table 14. Emission of total estimations classified by sector for the Skopje agglomeration (reference year 2014).

	Emission estimation (in t/year)					
Sources	CO	NH_3	NMVOC	NO_x	SO_x	PM
Traffic	4 428	39	464	1 549	265	93
Industrial production	2 816	na	na	1 528	159	25
Energy plants	10	na	na	182	8	4
Domestic heating	10 289	179	1 541	132	41	2 053
Waste management	0	na	240	2	0	12
Agriculture activities	na	815	416	7	na	50
Construction sites	0	na	0	0	0	27
TOTAL	**17 543**	**1 033**	**2 661**	**3 400**	**473**	**2 264**

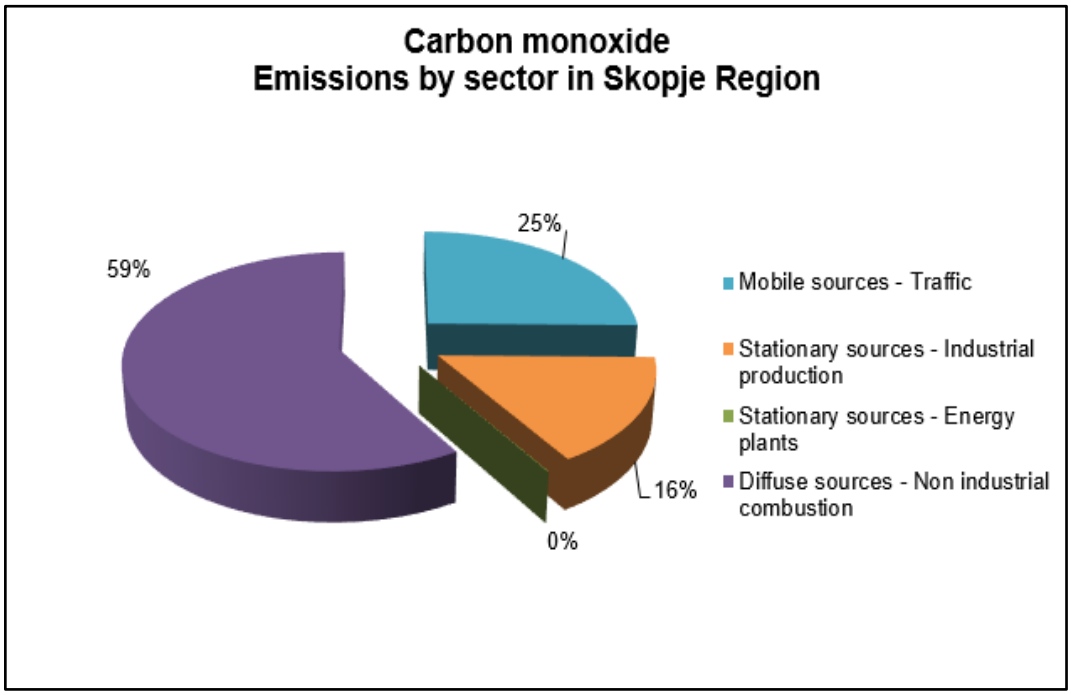


Figure 11. CO emissions by sector in Skopje Region.

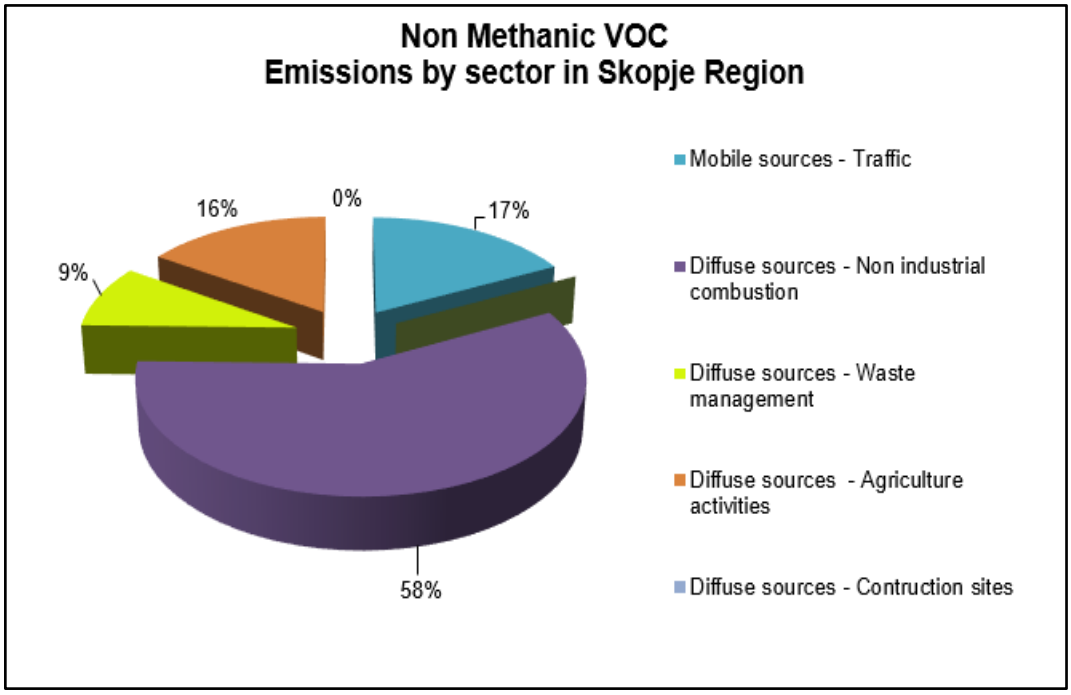


Figure 12. NMVOC emissions by sector in Skopje Region.

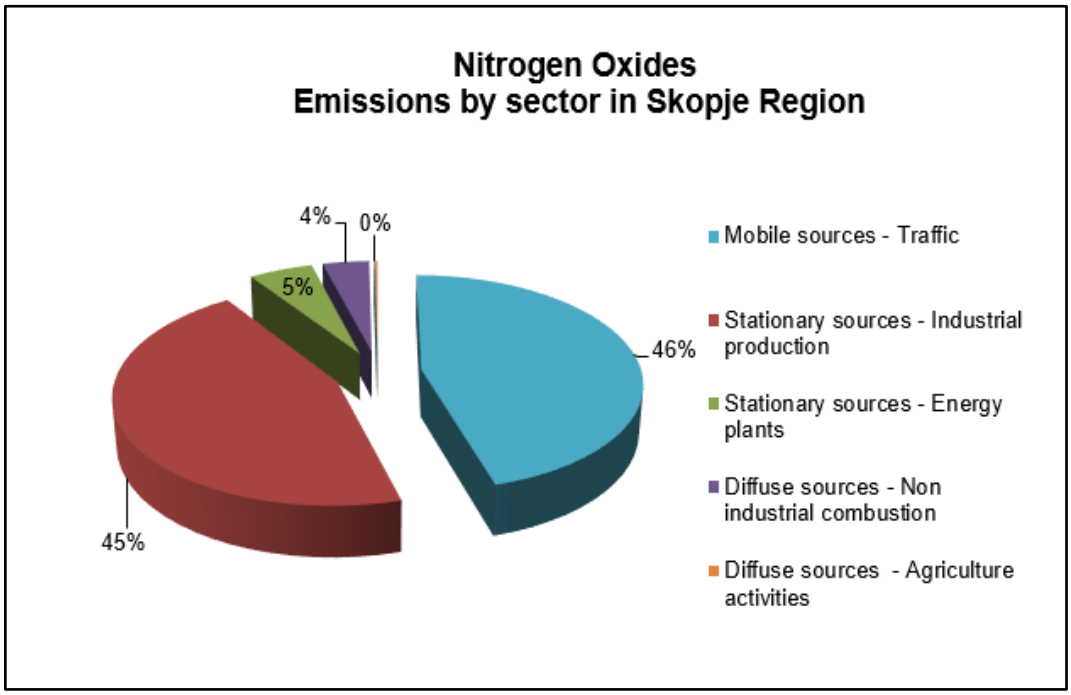


Figure 13. NO_x emissions by sector in Skopje Region.

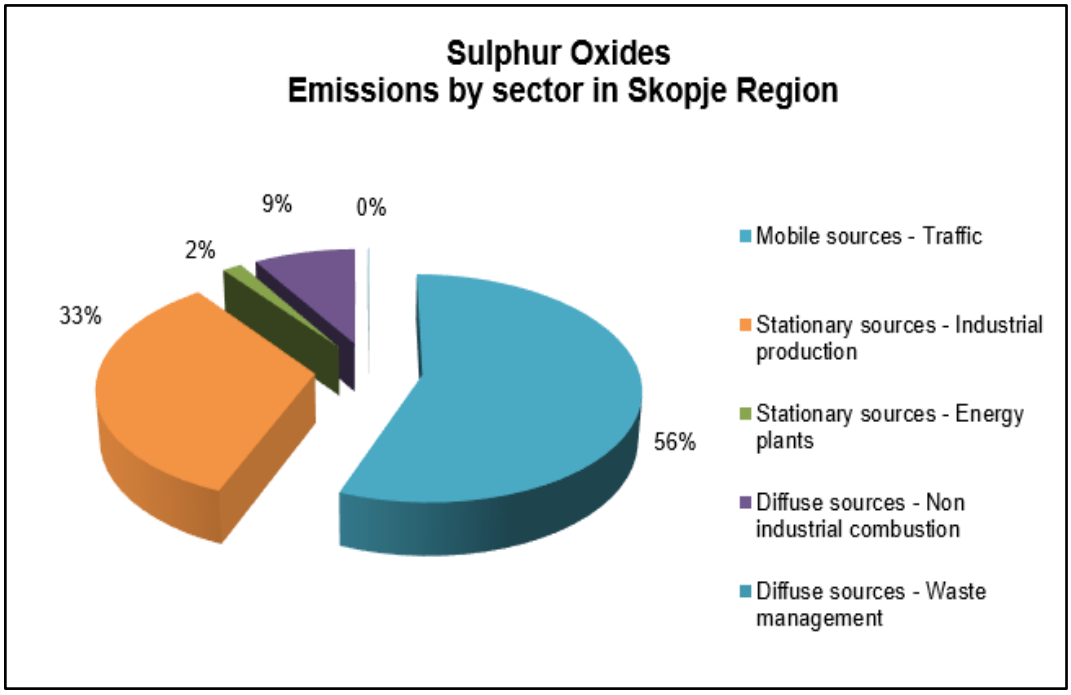


Figure 14. SO_x emissions by sector in Skopje Region.

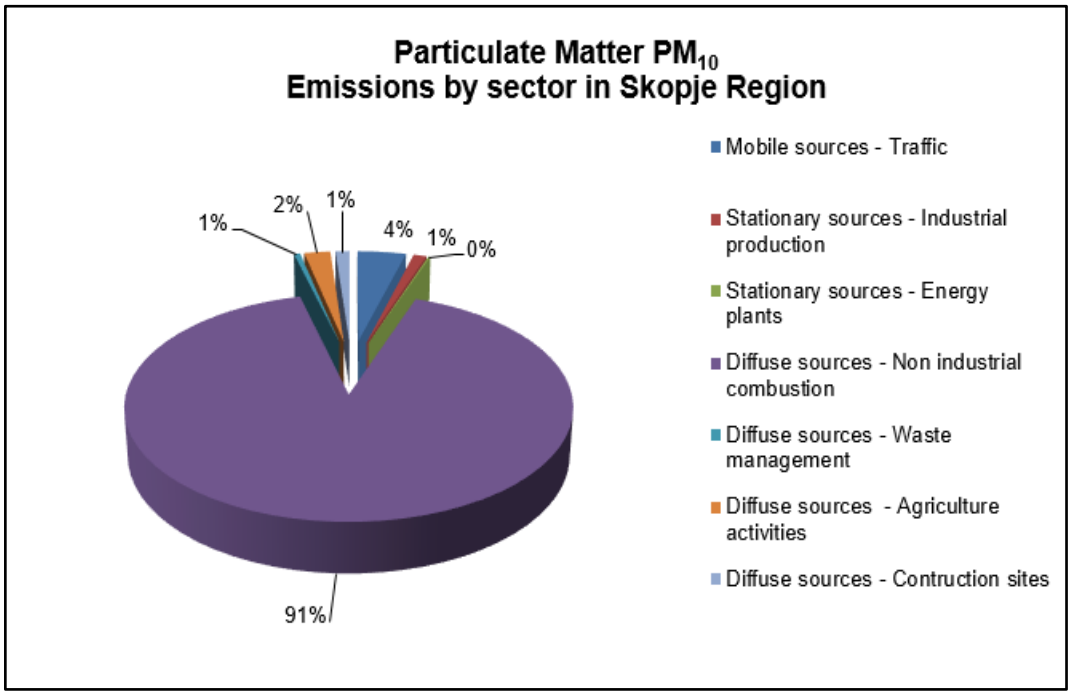


Figure 15. PM_{10} emissions by sector in Skopje Region.

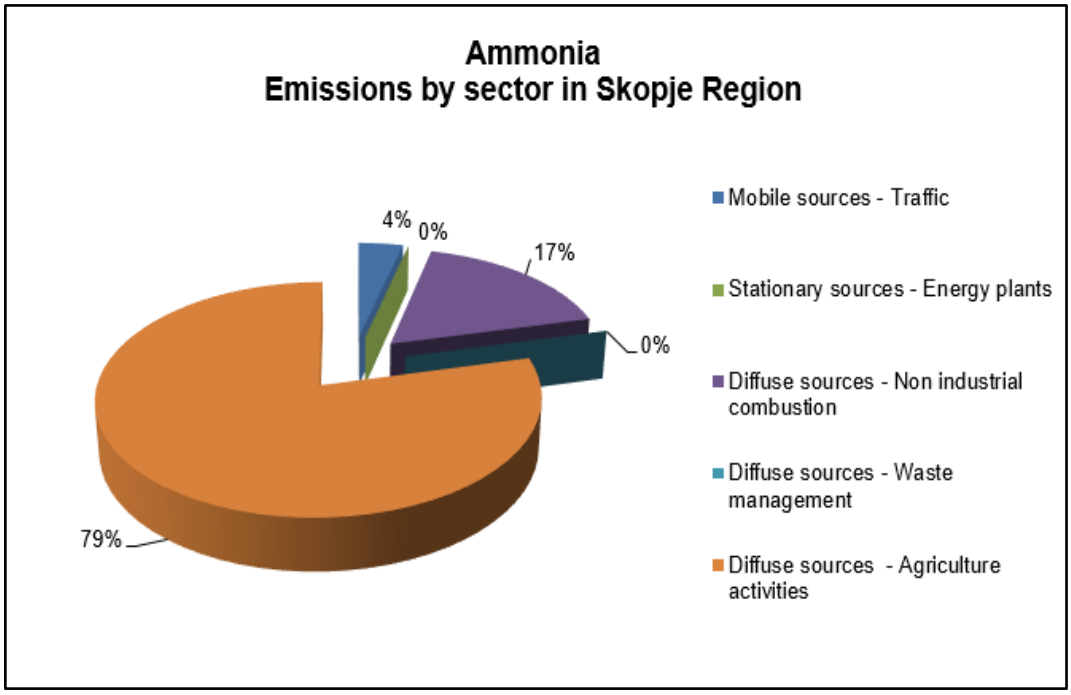


Figure 16. NH_3 emissions by sector in Skopje Region.

The main emission sources for **carbon monoxide** in Skopje region are non-industrial combustion sector (59%), the road transport (25%) and the industrial processes (16%), whereas the contribution of the other sectors is negligible.

The main emission sources for **non-methane volatile organic compounds** in Skopje region are non-industrial combustion sector (58%), the road transport (17%), the agricultural activities (16%) and the waste management processes (9%) whereas the contribution of the other sectors is

negligible. However emissions from the industrial sector may be underestimated due to the lack of activity data on local level.

The main emission sources for **nitrogen oxides** in Skopje region are road transport (46%) and the industrial production (45%), with minor contribution from energy production (5%) and the non-industrial combustion (4%) sectors.

The main emission sources for **sulphur oxides** in Skopje region are the road transport (56%) and the industrial production (33%), with minor contribution from the non-industrial combustion (9%) and the energy production (2%) sectors.

Very clearly prevalent emission source for **particulate matter** in Skopje region is non-industrial combustion (domestic heating) with 91% of the total emissions. Other sources have a small contribution to the total emissions.

The main emission source for **ammonia** in Skopje region is agricultural sector (79%), with minor contribution from non-industrial combustion (17%) and road transport (4%) sectors.

The assumptions made for the traffic sector have uncertainty related to urban mileage per year covered by vehicles for which there is no accurate data as well as categorization of vehicles per Euro class which has been done according to the production year, not based on actual measured emissions. The particulate emissions from construction sites are underestimated, due to the lack of information of the construction and demolition of buildings. These uncertainty do not affect significantly the general emission situation.

6 SOURCE APPORTIONMENT STUDY FOR PARTICULATE MATTER

The contribution of different emission sources to the concentrations measured in Karpos station in Skopje was estimated with Positive Matrix Factorization (PMF) Model. Particulate matter, SO_2, NO_2, CO, O_3, heavy metals and PAH concentrations measured during the period of August 2015-February 2016 were used in the assessment.

The study shows prominent contribution of biomass burning to $PM_{2.5}$ and PM_{10} concentrations in Karpos. The biomass burning originating from domestic heating contributes to 32-36% of the particulate matter concentrations (graphs below). Other important sources of particulate matter concentrations are traffic with 16-19%, soil including road dust with 19-20% and industry with 18% of the particulate matter concentrations.

The location of the monitoring station in Karpos represent a residential area which is not significantly and solely affected by any single emission source. Therefore it can be estimated that the concentrations measured in this location are similar to which majority of people living in Skopje are exposed to. However, the concentrations and the source contribution can be different in other areas for example close to major roads or where a large number of houses are using wood as heating source. Nevertheless the result indicate that the air quality improvement measures in local level in Skopje should be directed to domestic heating and traffic sectors.

Due to very limited dataset (heavy metal and PAH concentration data was available only for six months period) the results of the PMF modelling should be considered as indicative. To improve the results of the source apportionment studies, longer time-series of reliable air quality monitoring data should be utilized.

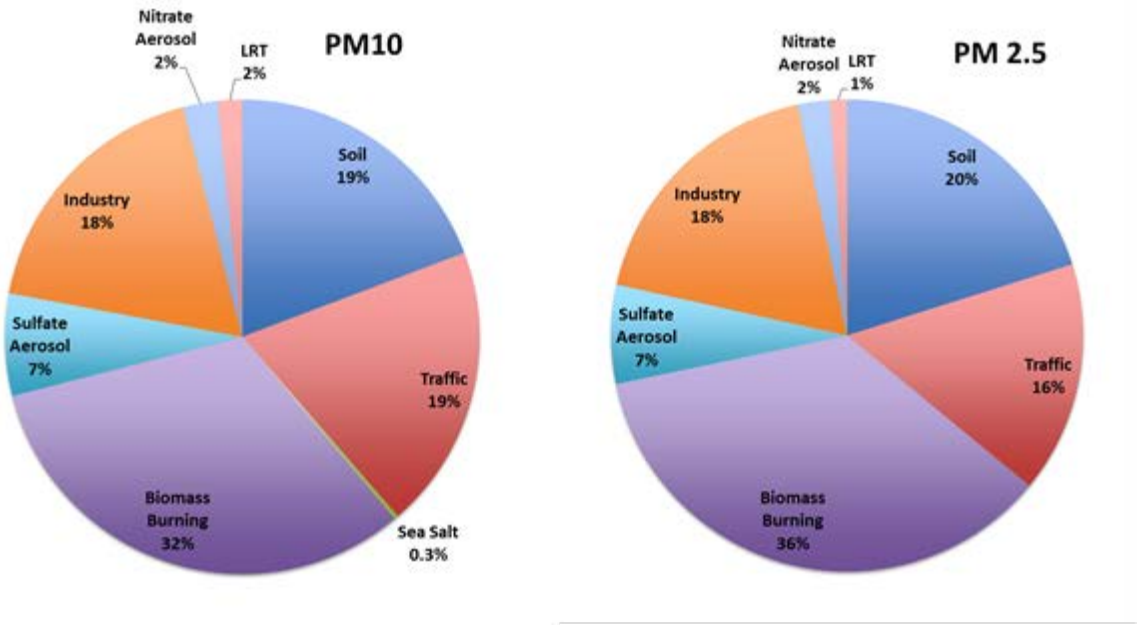


Figure 17. Contribution of different emission source sectors to PM_{10} and $PM_{2.5}$ concentrations in Karpos urban background station.

7 AIR QUALITY ASSESSMENT FOR THE SKOPJE AGGLOMERATION

7.1 The process of establishing zones and agglomerations

Two zones and one agglomeration for the basic pollutants SO_2, CO, NO_2, NOx, PM_{10} and O_3 have been established on the territory of the country.

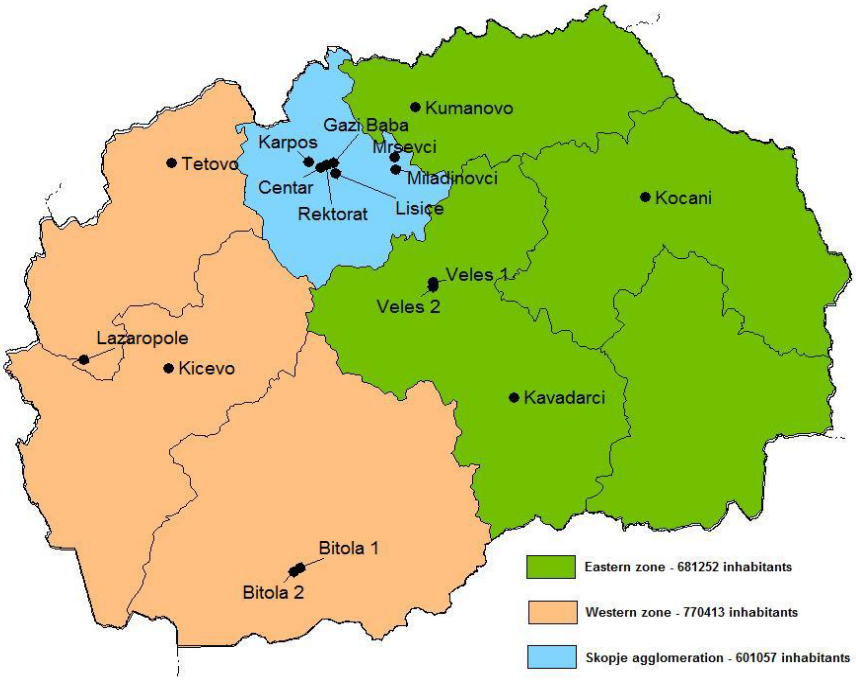


Figure 18. Classification of zones and agglomerations and situation of air quality measurement stations.

The zones are defined as: Western zone (South-west, Polog and Pelagonija statistical region), Eastern zone (North-east, South-east, Vardar and East statistical region) and Skopje agglomeration (Skopje statistical region).

Table 15. Basic data per zone (data have been taken from the publication "Regions in Republic of Macedonia", from 2016)

Zones/agglomeration	Statistical regions	Number of population	Area / km^2	Population density
Eastern zone	Vardar	686 003	13 183	52.04
	East			
	North East			
	South East			
Western zone	Pelagonija	770 944	10 476	73.59
	Polog			
	South West			
Skopje agglomeration	Skopje	619 279	1 718	360.46

7.2 Air quality network at national and local level

7.2.1 General

According to the Law on ambient air quality, for air quality monitoring on the territory of the country, the Government established national ambient air quality monitoring network. This network is managed by the MEPP. It consists of 17 air quality monitoring stations, connected with the air quality database located in the MEPP with GPRS connection. In the frame of the network there is a calibration laboratory for regular maintenance and calibration of the instruments. Five of the stations are located in Skopje (Karpos, Centar, Lisice, Rektorat and Gazi Baba) and two in municipality of Ilinden (Miladinovci and Mresevci). The monitoring stations Gazi Baba and Lisice have been operational since 1998, the station Rektorat since April 2004 and stations Karpos and Centar since September 2011. The monitoring stations from municipality Ilinden which were relocated from the Skopje city area, have been functional since 2008. For the purpose monitoring of the ambient air quality in settlements and industrial areas, the City of Skopje, have had one monitoring station of their own measuring SO_2, NO_2, CO and PM_{10} on Makedonija Street in the years 2011-2012. The station is not in operation at the moment.

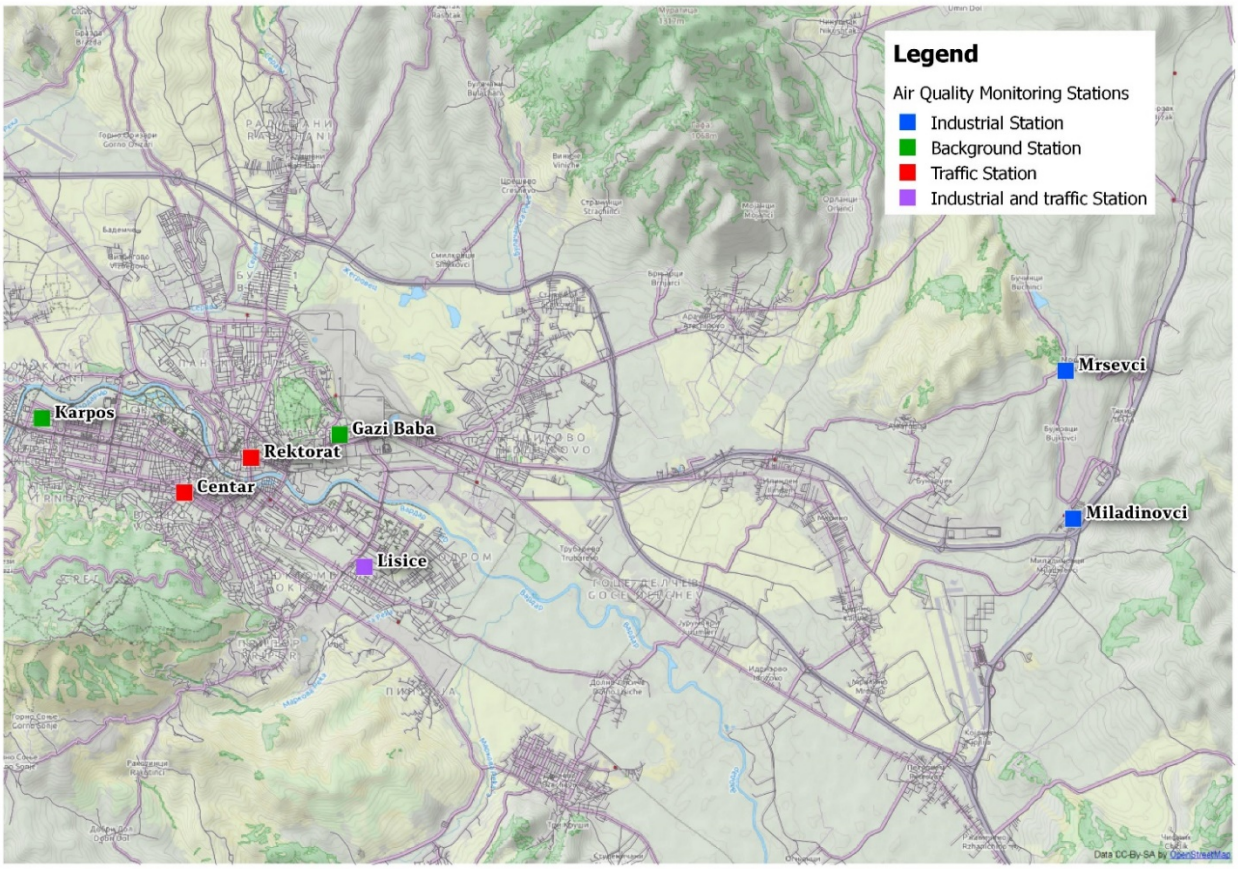


Figure 19. The air quality monitoring stations in the Skopje agglomeration.

7.2.2 Karpos monitoring station (Skopje)

Karpos station is positioned in a school yard in the middle of an urban residential area in the western part of Skopje. The nearest low-speed residential roads are 20–120 m away and major boulevards are located approximately 250 m away. This urban background station represents the overall city background concentrations. Measured components are: O_3, NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, benzene, toluene and xylene. Also meteorological parameters are monitored.

Figure 20. Karpos monitoring station.

7.2.3 Centar monitoring station (Skopje)

Centar is an urban traffic station in Skopje centre. The station is located approximately 15 m from a frequently trafficked road and approximately 20 m from a minor intersection. The nearest traffic emission sources are located on the south-eastern side of the station. There is a major intersection on the north-eastern side at a distance of 100 m. This station represents a city center area with high impact of traffic emissions. Measured components are: O_3, NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, benzene, toluene and xylene. Also meteorological parameters are monitored.

Figure 21. Centar monitoring station.

7.2.4 Lisice monitoring station (Skopje)

Lisice site is located in the south-western part of Skopje in an area representing both industrial and residential areas. The station is positioned close to a major intersection: the distance to the nearest street is 45 m and to the intersection 70 m. A cement factory is located 1.2 km in the south-west direction of the station and a quarry at a distance of 1.8 km. Measured components are: O_3, NO_2, SO_2, CO and PM_{10}. Also meteorological parameters are monitored.

Figure 22. Lisice monitoring station.

7.2.5 Rektorat monitoring station (Skopje)

Rektorat site is located near a major intersection in the center of Skopje. This urban traffic site represents area with high impact from traffic emissions. Measured components are: O_3, NO_2, CO, PM_{10}, benzene, toluene and xylene. Also meteorological parameters are monitored.

Figure 23. Rektorat monitoring station.

7.2.6 Gaza Baba monitoring station (Skopje)

Gazi Baba site is located on a hill in the north-western part of Skopje near the university buildings. There is a parking lot at the distance of 20 m. In the district of Zelezara, north-west of the station, there are metallurgy industries at a distance of 2 km. The distance to the main road (Boulevard Alexander of Macedon) is 300 m and the distance to the nearest residential houses is approximately 100 m. This suburban background station represents the overall city background concentrations influenced by the integrated contribution from all sources. Measured components are: NO_2, SO_2, CO and PM_{10}. Also meteorological parameters are monitored.

Figure 24. Gazi Baba monitoring station.

7.2.7 Miladinovci monitoring station (Ilinden)

Miladinovci is a station in the municipality of Ilinden, approximately 15 km east of Skopje. The station monitors the air quality effects of the OKTA refinery. The station is located in a small village approximately 0.5 km south of the refinery. The factory area is large and the point source emissions (stacks) are located approximately 2 km from the station, however fugitive emissions (from oil tanks) may also be released closer to the station. The motorway M1/E75 passes 200 m east of the station. Measured components are: O_3, NO_2, SO_2, CO, PM_{10}, benzene, toluene and xylene. Also meteorological parameters are monitored.

Figure 25. Miladinovci monitoring station.

7.2.8 Mrsevci monitoring station (Ilinden)

Mrsevci is a station in the municipality of Ilinden which is positioned approximately 15 km east of Skopje. The station monitors the air quality effects of the OKTA refinery. The station is located in a small village approximately 0.5 km north of the refinery. The factory area is wide-ranging and the point source emissions (stacks) are located approximately 1.2 km away from the station. The distance to the motorway M1/E75 is 1.7 km. Measured components are: NO_2, SO_2, CO and PM_{10}. Also meteorological parameters are monitored.

Figure 26. Mrsevci monitoring station

7.3 Air quality in Skopje agglomeration

The air quality assessment for Skopje agglomeration has been made according to the Decree on limit and target values for levels and type of pollutants in the ambient air, alert and information thresholds; dead-lines for achieving limit and target values for specific substances; margins of tolerance for limit value and target value and long term objectives for specific pollutants. The assessment is based on the measurement data available from years 2010-2015. For some periods and years the data coverage has been too low so that all values comparable to the limit and target values have not been able to be calculated.

7.3.1 Sulphur Dioxide (SO_2)

According to the current national legislation, sulphur dioxide concentration (SO_2) is regulated by two limit values and one alert threshold for protection of human health. Moreover a critical level for the protection of vegetation is included in the legislation.

The daily limit value for SO_2 is set at 125 µg/m^3, not to be exceeded more than 3 times a calendar year. The following chart shows the 4th highest daily value for each year, which must be smaller than the limit value. The values in charts show clearly that the daily limit value for SO_2 is fulfilled in Skopje agglomeration.

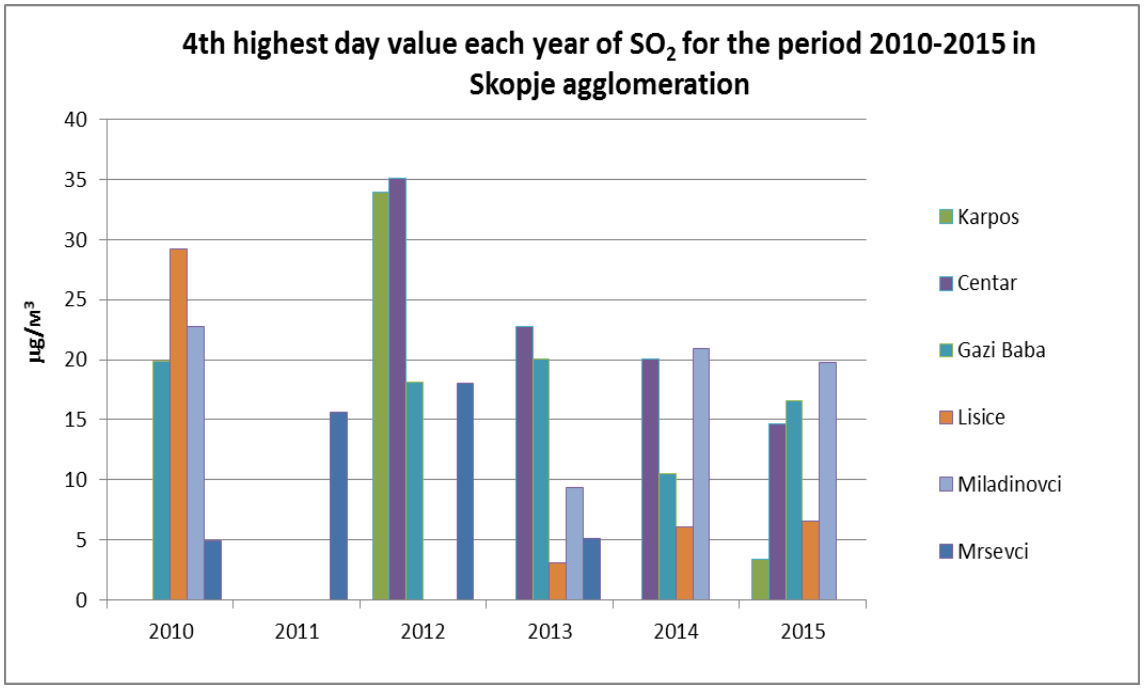


Figure 27. Assessment of the SO_2 daily limit value (125 µg/m^3) exceedance in Skopje agglomeration.

The hourly limit value for SO_2 is set at 350 µg/m^3, not to be exceeded more than 24 times a calendar year. The following chart shows the 25^h highest hourly value for each year, which must be smaller than the limit value. The values in charts show clearly that the hourly limit value for SO_2 is fulfilled in Skopje agglomeration.

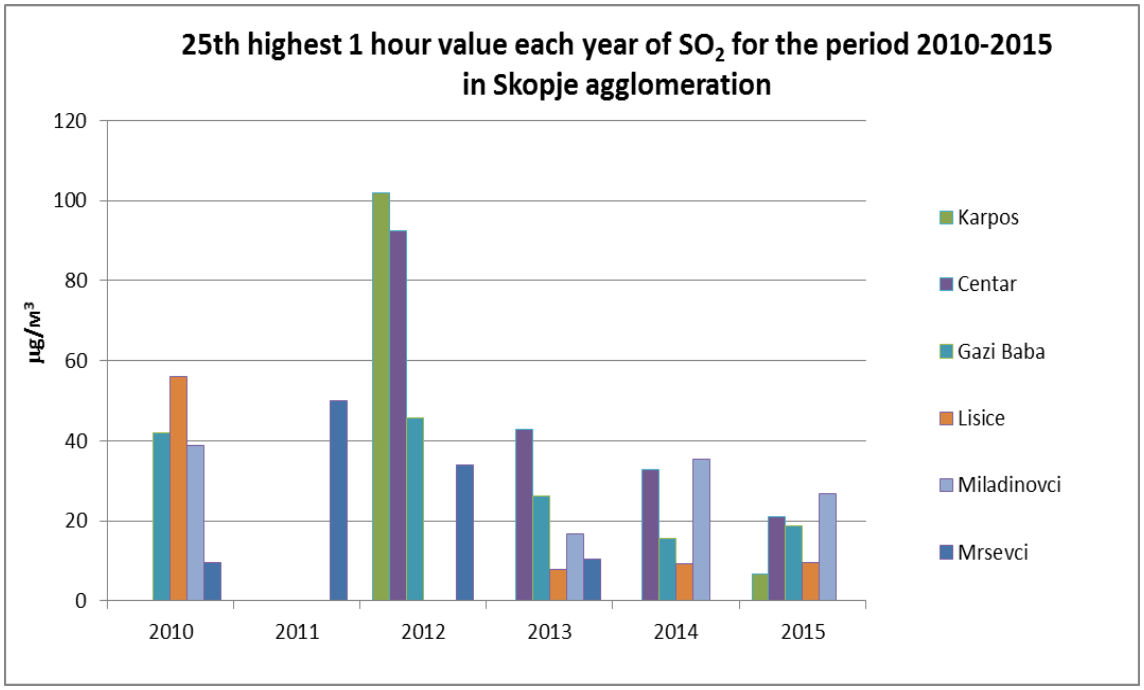


Figure 28. Assessment of the SO_2 hourly limit value (350 µg/m^3) exceedance in Skopje agglomeration.

The alarm threshold is set at 500 µg/m^3 as hourly value, and represents the threshold a level beyond which there is a risk to human health from brief exposure for the population. No exceedances of the alarm thresholds were recorded in Skopje agglomeration during the last 5 years.

Legislation includes also for SO_2 a critical level (CL), set at 20 µg/m^3, as annual average and winter average, to be both respected in order to protect the vegetation.

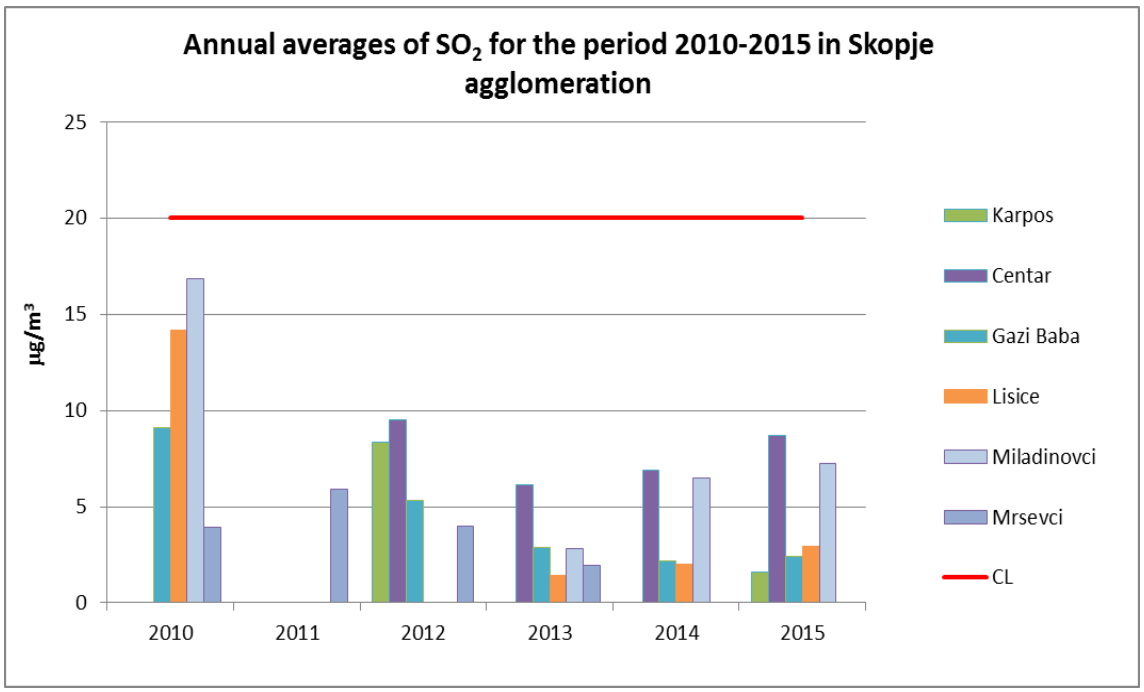


Figure 29. Assessment of the SO_2 annual critical level (20 µg/m^3).

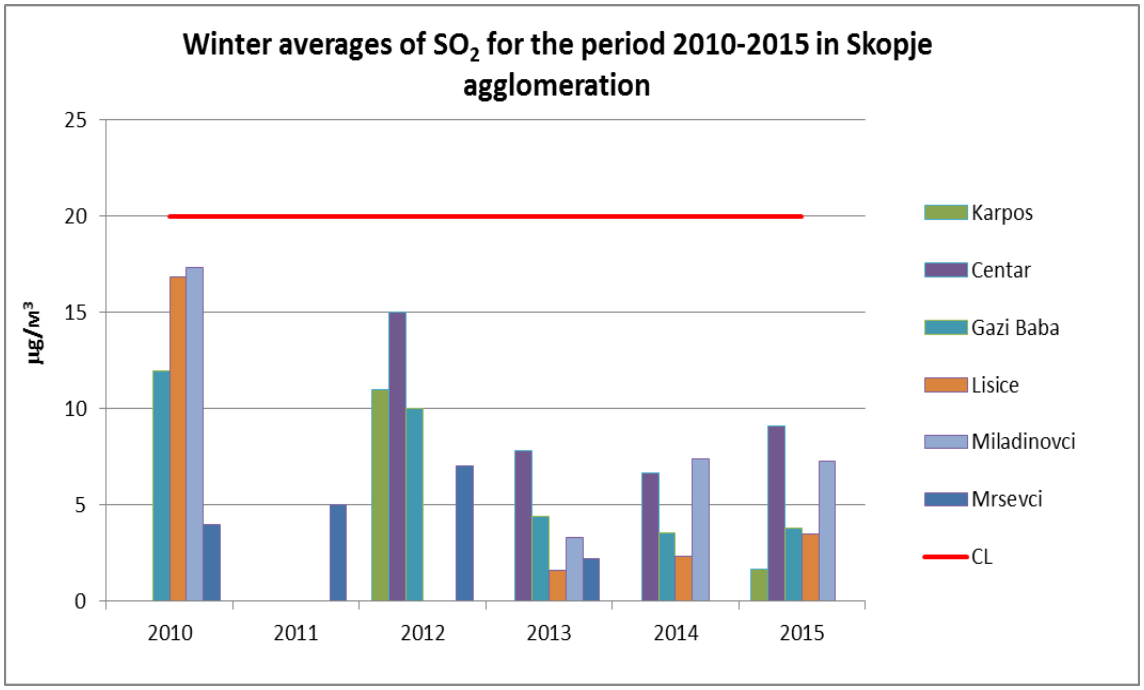


Figure 30. Assessment of the SO_2 winter critical level (20 µg/m^3).

According to the charts above, the critical level for both the annual and the winter period is fulfilled in all the stations located in Skopje agglomeration.

7.3.2 Nitrogen Oxides (NO_x)

According to the current national legislation, nitrogen dioxide concentration (NO_2) is regulated by two limit values and one alert threshold for protection of human health. Moreover, a critical level for the protection of vegetation is included in the legislation concerning the total nitrogen oxides (NO_x).

The hourly limit value for NO_2 is set at 200 µg/m^3, not to be exceeded more than 18 times a calendar year. The following chart shows the 19th highest hourly value for each year, which must be smaller than the limit value. The values in charts show that the limit value was exceeded in Lisice in 2011, and was close to the limit value in Centar in 2012.

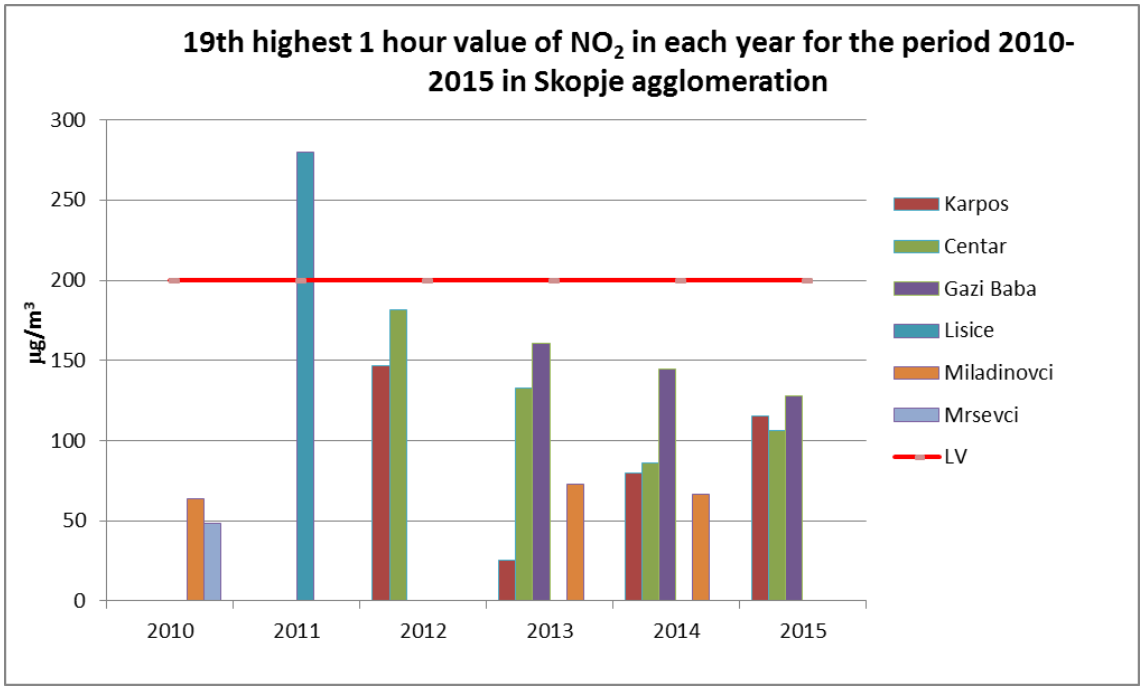


Figure 31. Assessment of the NO_2 hourly limit value (200 µg/m^3) exceedance in Skopje agglomeration.

The annual limit value for NO_2 is set at 40 µg/m^3. The following chart shows two exceedances of the limit value, in Lisice in 2011 and in Centar in 2012.

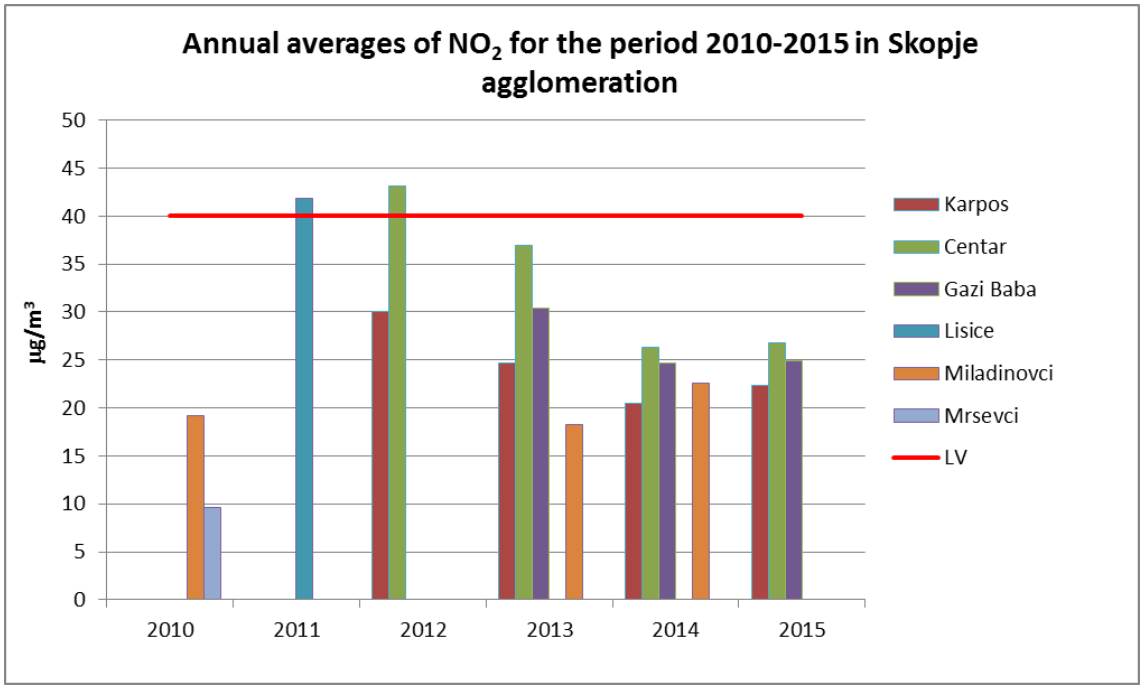


Figure 32. Assessment of the NO_2 annual average limit value (40 µg/m^3).

The alarm threshold for NO_2 is set at 400 µg/m^3 as hourly value, and represents the threshold a level beyond which there is a risk to human health from brief exposure for the population. Several 1 hour exceedances of the alarm threshold were recorded during the 2013-2014 period, in particular:

- 4 exceedances in Gazi Baba station in 2013;
- 17 exceedances in Karpos station in 2013;

- 7 exceedances in Miladinovci station in 2014.

No exceedances of the alarm threshold were recorded in 2015.

Legislation includes also for NO_x (total nitrogen oxides) a critical level, set at 30 µg/m^3, as annual average, to be respected in order to protect the vegetation.

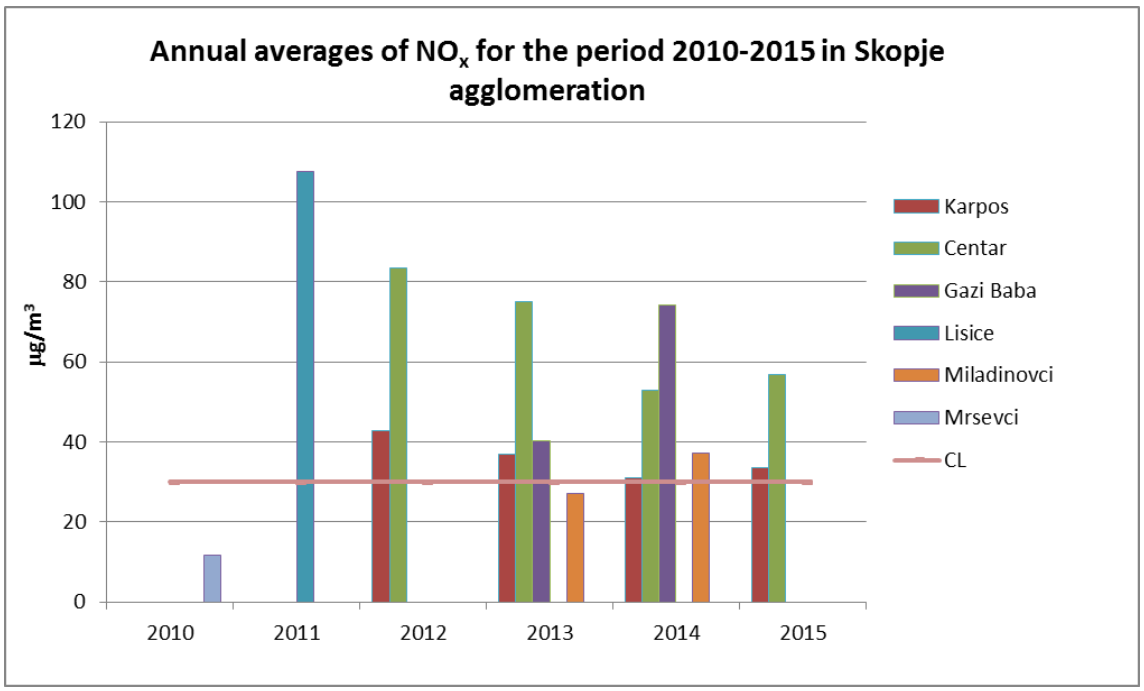


Figure 33. Assessment of the NOx annual critical level (30 µg/m^3).

The NOx critical level is exceeded in most of the stations located in Skopje agglomeration in the 2010-2015 period.

The situation concerning nitrogen oxides in Skopje agglomeration shows many critical points, since all the legislation standards are exceeded in one or more years. For this reason nitrogen oxides, and in particular nitrogen dioxide, are considered as target pollutants and an appropriate set of measures should be adopted to reduce progressively their concentrations in the atmosphere.

7.3.3 Suspended particles with size up to 10 micrometers (PM_{10})

According to the current national legislation, PM_{10} concentration is regulated by two limit values for protection of human health.

The annual limit value for PM_{10} is set at 40 µg/m^3 as annual average. The following chart shows that concentrations in all the stations in Skopje agglomeration exceeded constantly this limit value during the 2010-2015 period. Moreover the averages are significantly higher than the limit value, showing an extremely critical situation in the area of study.

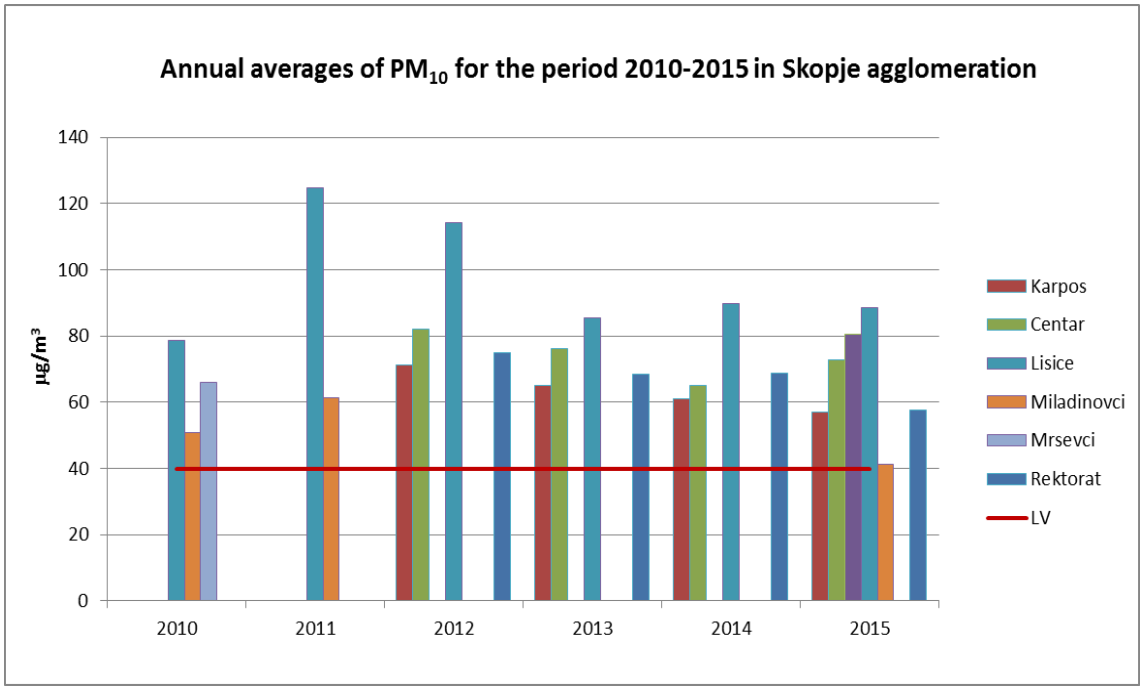


Figure 34. Assessment of the PM_{10} annual average limit value (40 µg/m³).

The daily limit value for PM_{10} is set at 50 µg/m³, not to be exceeded more than 35 times a calendar year. The Figure 35 shows the number of exceedances of the daily value for each year. The values in charts above show clearly that the daily limit value for PM_{10} is widely exceeded in Skopje agglomeration.

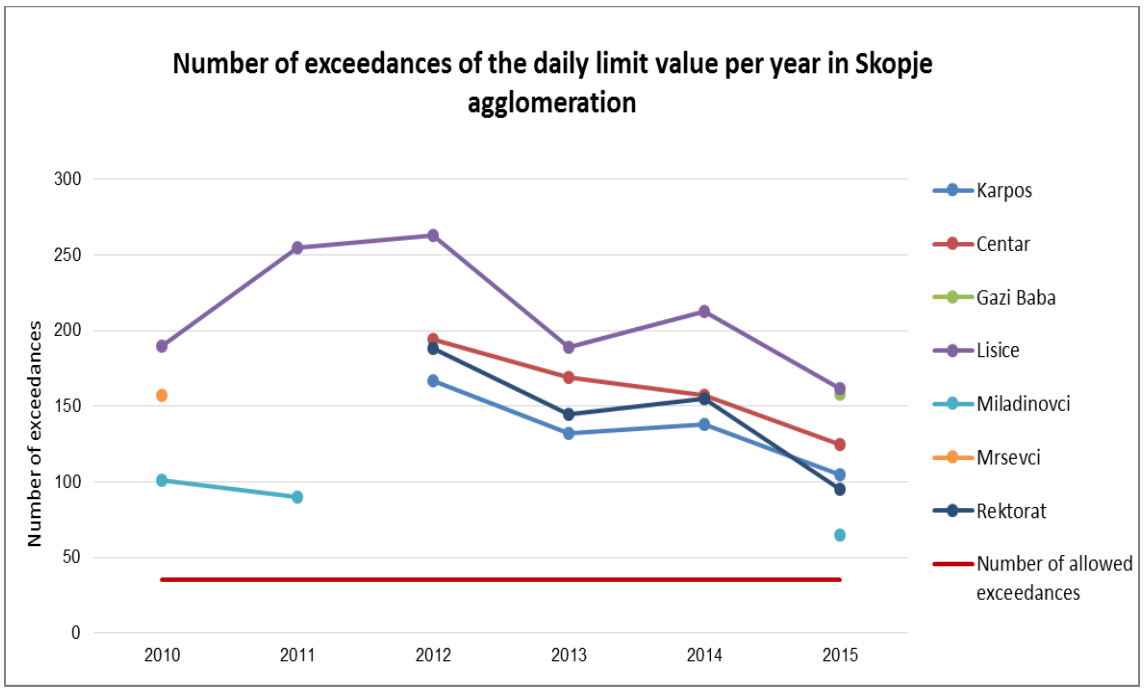


Figure 35. Number of exceedances of PM_{10} daily limit value (50 µg/m³).

Moreover a deeper analysis was carried out assessing the 36th highest daily average recorded by the station for each year. The 36th highest daily average should be under the daily limit value to respect the legislation standards. According to the data in the following chart, the 36th highest daily

averages are significantly higher than the daily limit value for all the stations, pointing out that most of the days of exceedance are characterized by a very high concentration of PM_{10}, very far from the legislation standard in Skopje agglomeration.

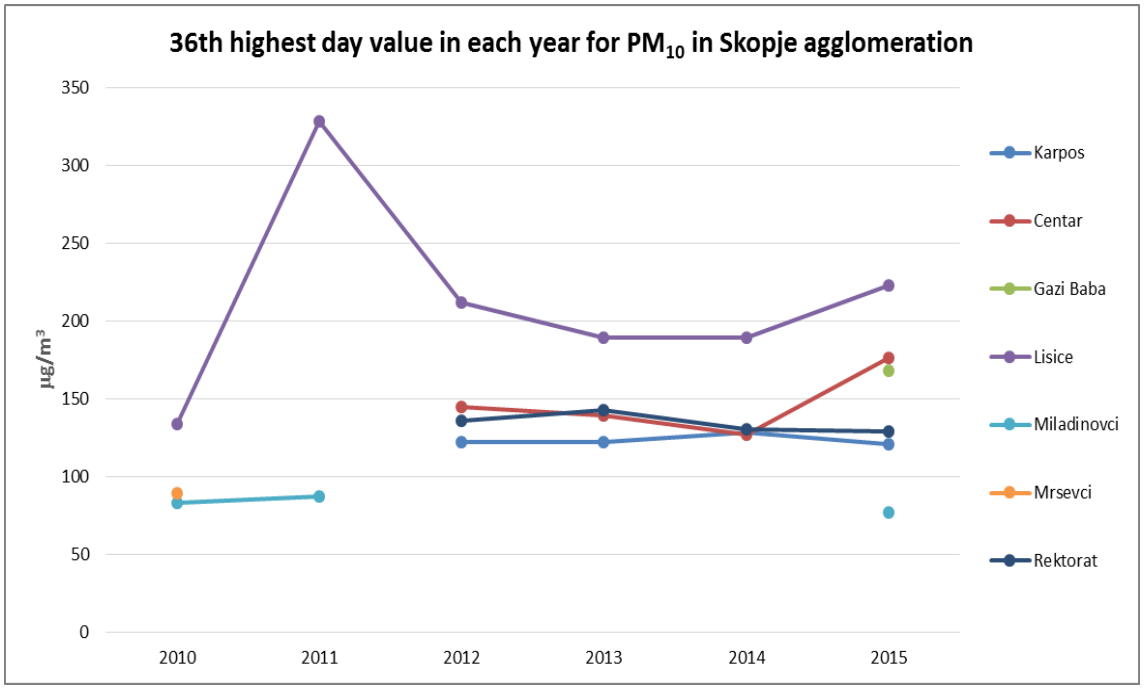


Figure 36. Assessment of PM_{10} daily limit value (50 µg/m³) exceedance in Skopje agglomeration.

7.3.4 Suspended particles with size up to 2.5 micrometers ($PM_{2.5}$)

According to the current national legislation, $PM_{2.5}$ concentrations is regulated by a limit value for the protection of human health, set at 25 µg/m³ as annual average. The measurements for $PM_{2.5}$ in Skopje agglomeration are available since 2012 (two stations, Karpos and Centrar). In Karpos monitoring station during 2013-2014 the $PM_{2.5}$ measurements do not fulfil the minimum data coverage requested by legislation, and therefore reliable annual average concentrations are not available.

As shown for the PM_{10}, also the $PM_{2.5}$ situation in Skopje agglomeration is critical, with the annual averages that exceeds constantly the limit value in both the stations considered. This information strengthens the result of the assessment carried out for PM_{10}, and shows a very critical situation in Skopje agglomeration concerning the general levels of particulate matter.

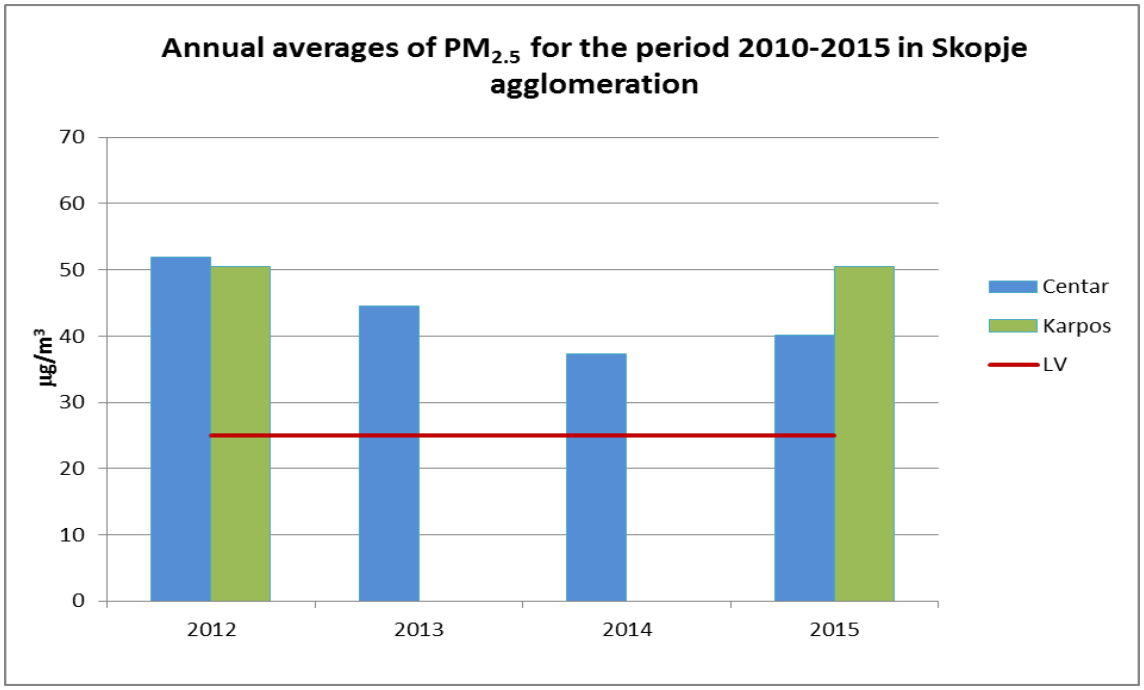


Figure 37. Assessment of the $PM_{2.5}$ annual average limit value (25 µg/m^3)

7.3.5 Ozone (O_3)

According to the current national legislation, O_3 concentration is regulated by one target value for protection of human health and by two thresholds.

The target value for O_3 is set at 120 µg/m^3, expressed as maximum daily eight-hour mean, not to be exceeded on more than 25 days per calendar year averaged over three years. The following chart shows for the 2013-2015 period that limit value was not exceeded.

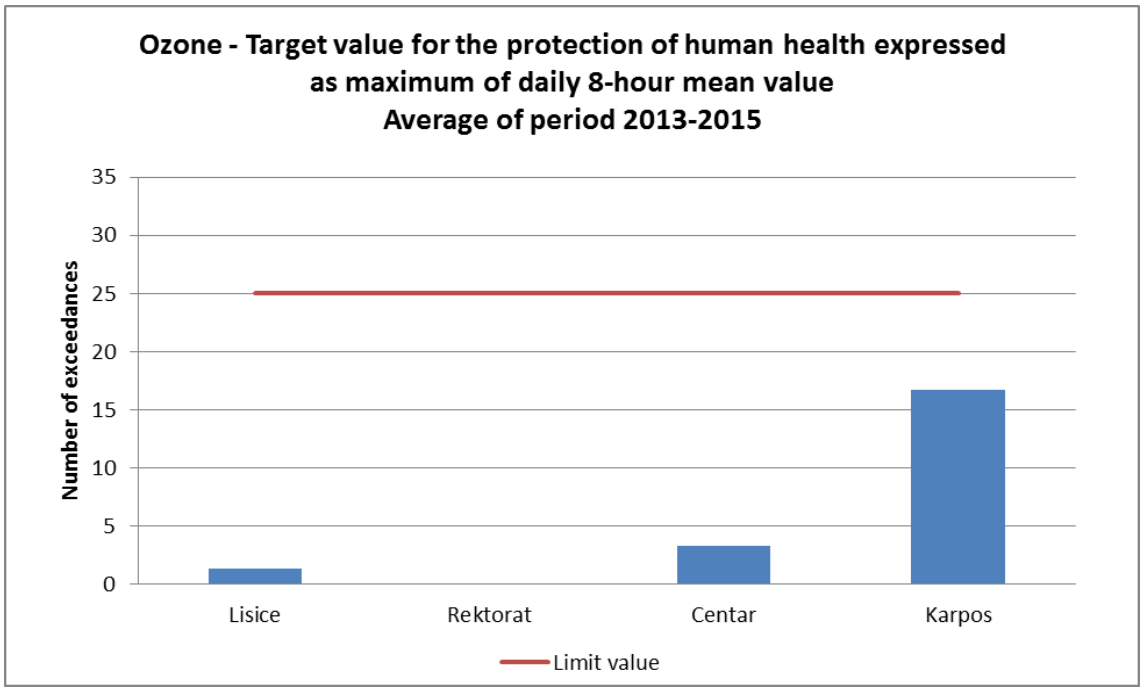


Figure 38. Assessment of the O_3 target value for the protection of human health (120 µg/m^3).

The alert threshold is set at 240 µg/m^3 as hourly average. The alert threshold represents the level beyond which there is a risk to human health from brief exposure for the population as a whole. No exceedances of alert threshold were recorded in Skopje in the last 3 years.

The information threshold is set at 180 µg/m^3 as hourly average. The information threshold represents the level beyond which there is a risk to human health from brief exposure for particularly sensitive sections of the population. No exceedances of information threshold were recorded in Skopje in the last 3 years.

Finally the long term objective for the protection of human health (120 µg/m^3 as maximum daily eight-hour mean, not to be exceeded during the year), is exceeded in all the stations, except Rektorat.

According to the data, the O_3 assessment shows a low level of criticality in the Skopje agglomeration. However, due to the concentrations recorded especially during the summer periods, ozone should be considered as potentially critical in the area of study.

7.3.6 Carbon monoxide (CO)

According to the current national legislation the carbon monoxide concentrations are regulated by one limit value, calculated as maximum of the daily 8 hour averages and set at 10 mg/m^3. For the period 2012-2015, the measurements carried out in Skopje agglomeration show that the limit value is exceeded constantly in Lisice station, while Centar, Karpos and Gazi Baba recorded values close to the limit value at least in 2013.

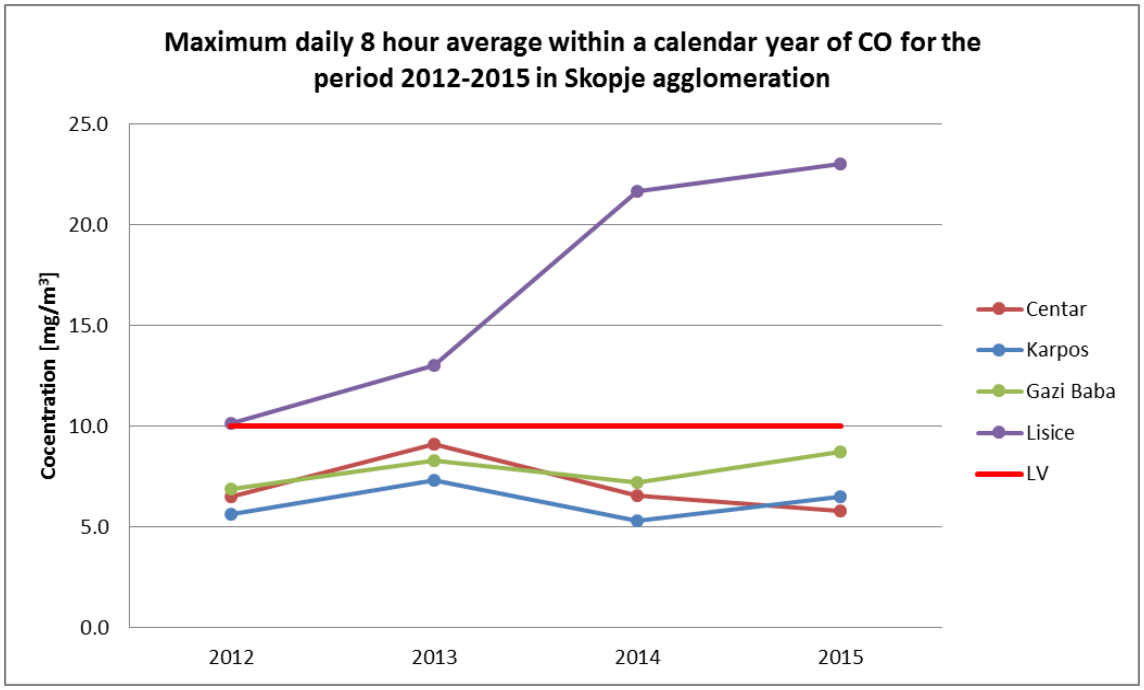


Figure 39. Assessment of the CO limit value (10 mg/m^3).

According to the measurement data, carbon monoxide should be considered as critical in Skopje agglomeration.

7.3.7 Benzene

According to the current national legislation, benzene concentration is regulated by a limit value for the protection of human health, set at 5 µg/m^3, as annual average.

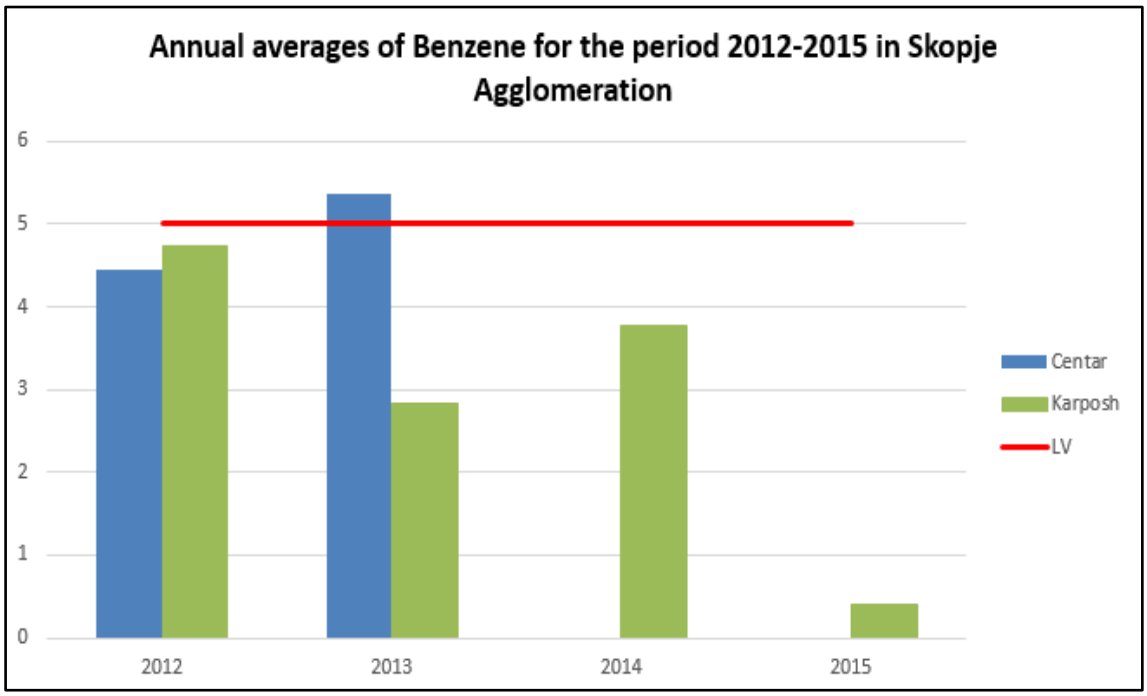


Figure 40. Assessment of the benzene annual average limit value (5 µg/m^3)

The measurements for benzene in Skopje agglomeration are available only since 2012, for the stations of Karpos (2012-2014) and Centar (2012-2013). No measurements are available for 2015. The limit value for benzene was exceeded in Centar station in 2013, while in 2012 both the stations recorded values very close to the 5 µg/m^3. For this reason, benzene is considered as critical for the air pollution in Skopje agglomeration.

7.3.8 Benzo(a)pyrene and heavy metals

For estimation of the concentration levels of benzo(a)pyrene, lead and other metals regulated by the legislation an indicative measurement campaign was performed in Karpos from August 2015 to January 2016, with daily samples collected every third day. The results of these preliminary measurements are listed in the following.

Concerning lead, arsenic, nickel and cadmium, the results of the campaign are included in table 16.

Table 16. Heavy metals – results of the indicative measurements performed in 2015-2016.

Concentration (ng/m^3)	Arsenic	Nickel	Cadmium	Lead*
Minimum	0.2	0.4	0.1	0.5
Maximum	14.0	20.4	40	116.4
Average	1.8	11.4	0.9	11.4
Target/Limit Values (as annual average)	6	20	5	500

***** Lead is regulated by a limit value (500 ng/m^3) calculated as annual average

Due to the adequate coverage of the campaign (6 months, equally divided between the summer and the winter season), a preliminary comparison between the average values and the target/limit values was performed. According to the data, all the regulated heavy metals are significantly under the respective target/limit values, with no evidence of possible critical situations, at least in the background zone of the Skopje agglomeration.

Concerning benzo(a)pyrene (B(a)P), identified by legislation as a main marker for the polycyclic aromatic hydrocarbons, the results of the campaign are included in Table 17.

Table 17. Benzo(a)pyrene – results of the indicative measurements performed in 2015-2016.

Concentration (ng/m^3)	Minimum	Maximum	**Average**	**Target Value**
Benzo(a)pyrene	0.1	18.9	**5.3**	**1**

Due to the adequate coverage of the campaign (6 months, equally divided between the summer and the winter season), a preliminary comparison between the average measured concentration and target value is performed. The benzo(a)pyrene levels show a significant seasonal trend, with minimum concentrations during the summer period and high concentrations during the wintertime. The average value is meaningfully higher than the target value, identifying benzo(a)pyrene likely as a critical pollutant.

Benzo(a)pyrene concentrations are connected to the wood combustion practices that according to the conclusions of the emission assessment, are commonly used in domestic heating during the wintertime in Skopje agglomeration. The figure 41 shows the variation of the B(a)P concentration compared to the daily average temperature in Karpos station. A significant raise of B(a)P level can be recognized when the temperature decreases. This can be related to the use of biomass for heating, especially during the coldest months.

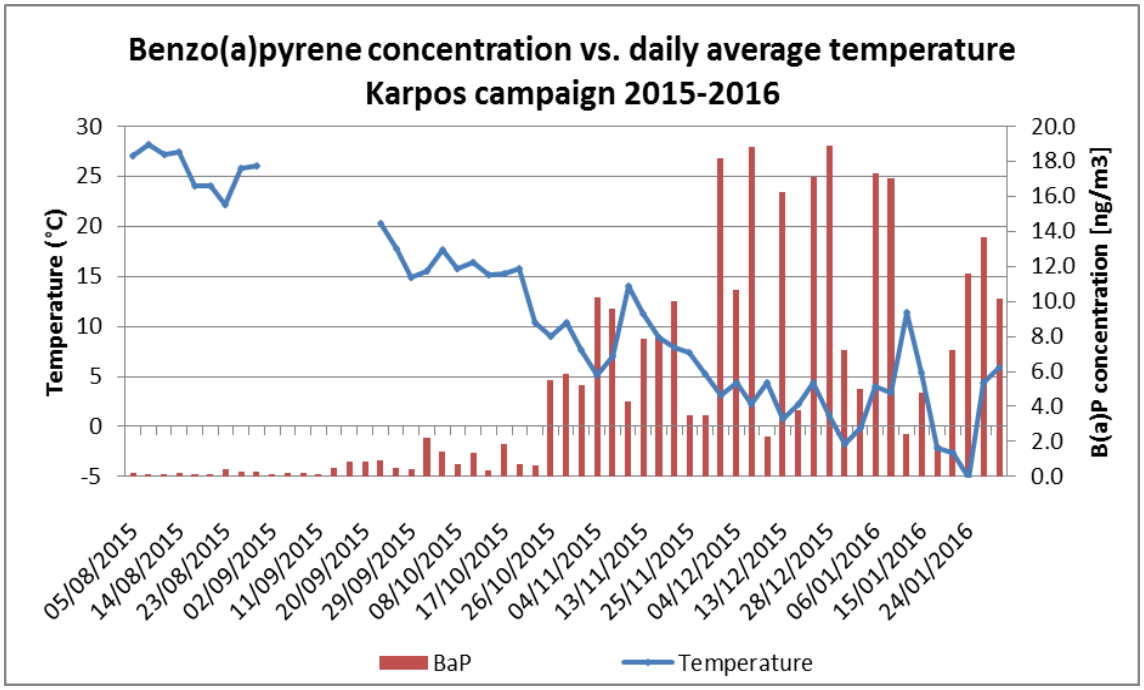


Figure 41. Comparison between temperature and benzo(a)pyrene concentrations.

7.4 Results of dispersion model calculations

The dispersion of nitrogen dioxide emissions from road traffic and major installations for City of Skopje have been preliminary calculated using data for traffic flow, car fleet, emissions from stationary sources and 2015 meteorological observation data.

According to the model calculations the NO_2 concentrations exceed the annual limit value (40 µg/m^3) in the vicinity of major roads and crossroads. In residential areas the annual concentrations are below the limit value.

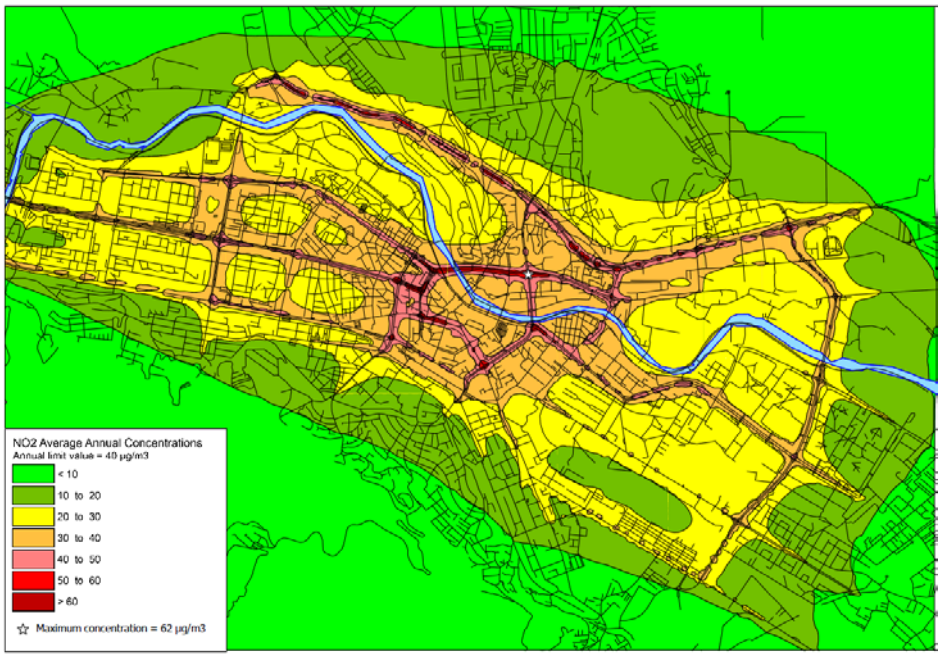


Figure 42. Annual average concentrations of NO_2 from road traffic in Skopje calculated with dispersion model

Emissions from seven stationary sources including heating plants, cement factory and metal industries have been included in the calculations for energy production and industry.

According to the dispersion modelling calculations, the maximum annual NO_2 concentration caused by the stationary sources was 0.2 µg/m^3. The impact of the stationary sources is minor and significantly less than from the road traffic due to emissions being released in the air in a height of 18-65 meters (depending on the installation). The emissions disperse and dilute in the atmosphere and as a consequence the ground level concentrations are low despite of the higher amount of emissions than from the road traffic.

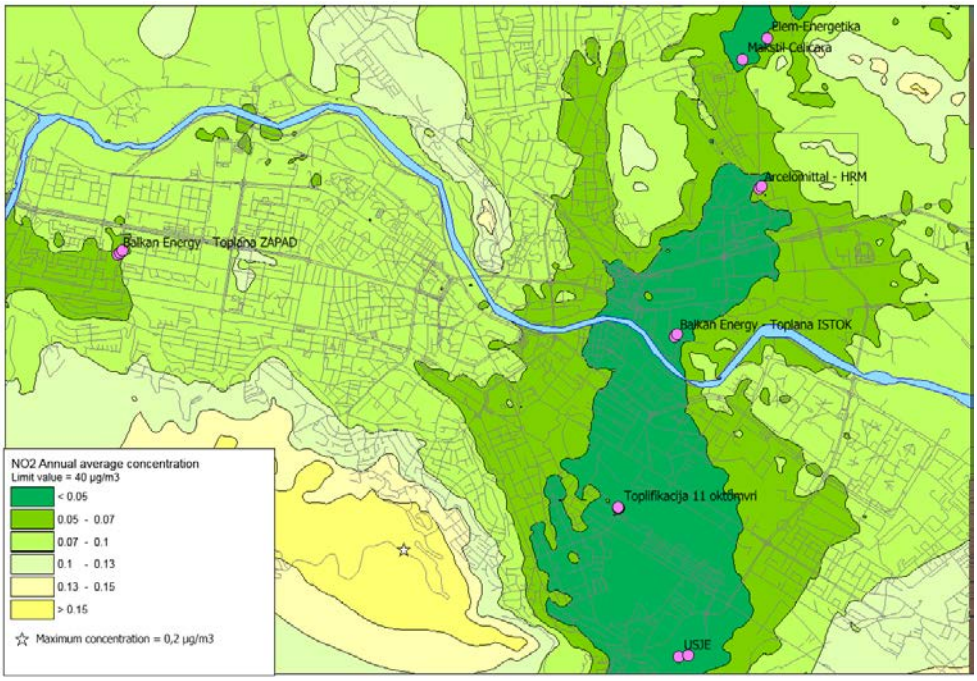


Figure 43. Annual average concentrations of NO_2 from industrial and energy production installations in Skopje calculated with dispersion model.

The model calculation results should be compared to measured concentrations to estimate the reliability of the modelling results. For the year 2015 there is not available reliable NO_2 measurement data from the monitoring stations in Skopje due to malfunction of the instruments and poor time coverage. However, as during the previous years the annual average NO_2 concentrations have exceeded the limit value in traffic stations, it can be estimated that the modelling results are reasonably reliable. The modelling calculations should be repeated when reliable NO_2 monitoring data becomes available in Skopje.

8 HEALTH IMPACTS OF AIR POLLUTANTS

The knowledge on the health effects caused by the exposure to different pollutants in the air is continuously increasing due to the research studies, and rising interest and awareness of the health aspect of pollutants in the air. Even relatively low concentrations of the pollutants can cause health effects especially for the vulnerable groups. Therefore, improved air quality can reduce the exposure to the pollutants in air and the negative health effect caused by pollutants. Table 19 presents the main health effects of different pollutants.

Table 19. Main health effects of different air pollutants.

Pollutant	Health effects
Particulate matter (PM)	Can cause or aggravate cardiovascular and lung diseases, heart attracts and arrhythmias. Can cause cancer. May lead to atherosclerosis, adverse birth outcomes and childhood respiratory diseases. The outcome may be premature death.
Ozone (O_3)	Can decrease lung function. Can aggravate asthma and lung diseases. Can lead to premature mortality.
Nitrogen dioxide (NO_2)	Increased cardiovascular and respiratory mortality and respiratory morbidity.
Sulphur dioxide (SO_2)	Aggravates asthma and can reduce lung function and inflame respiratory tract. Can cause headaches, general discomfort and anxiety.
PAHs, especially benzo(a)pyrene	Carcinogenic
Carbon monoxide (CO)	May lead to heart diseases and damage to nervous system. Can cause headache and fatigue.
Arsenic (As)	Carcinogenic. May cause lung cancer.
Cadmium (Cd)	Carcinogenic
Lead (Pb)	Can affect almost every organ and system, especially the nervous and cardiovascular systems. May have adverse cognitive effects in children and lead to increased blood pressure in adults.
Mercury (Hg)	Can affect the liver, kidneys and digestive and respiratory systems. May affect also the central nervous system.
Nickel (Ni)	Carcinogenic
Benzene (C_6H_6)	Carcinogenic

Particulates attribute the most severe health risk from air pollutants. A threshold for particulate concentrations below which no damage to health is observed has not been identified. The effects of PM on health occur at levels of exposure currently being experienced by most urban and rural populations in both developed and developing countries. Both short-term and long-term exposure for the particulates can cause health effects. The health effects of PM are caused after inhaling the particles. Depending on their size, particles can penetrate into lungs and blood streams causing adverse effects in the respiratory, cardiovascular, immune and neural systems. The smaller is the particles the deeper they penetrate into the lungs. Particulates mortality effects are clearly associated by the $PM_{2.5}$ fraction, which typically presents 40–80 % of the PM_{10} concentration in Europe. The mortality in cities with high levels of pollution exceeds that observed in relatively cleaner cities by 15–20%. Even in the EU, average life expectancy is 8.6 months lower due to exposure to the $PM_{2.5}$ produced by human activities.

9 CONCLUSION OF THE AIR QUALITY SITUATION IN THE SKOPJE AGGOMERATION

The air quality assessment for NO_2, SO_2, CO, O_3, PM_{10}, $PM_{2.5}$, benzene, benzo(a)pyrene and heavy metals was carried out using the limit/target values defined in the national legislation. The assessment is based on the five year data from 2010 to 2015. For heavy metals and benzo(a)pyrene the assessment was based on 6 month measurement campaign carried out in 2015-2016. The results of the air quality analysis are summarized in table 20.

Table 20. Overall air quality assessment of the Skopje agglomeration.

Pollutant	Air quality criteria		Centar	Gazi Baba	Karpos	Lisice	Rektorat	Miladinovci	Mrsevci
NO_2	**Alert threshold**	400 μg/m^3, 3 consecutive hours							
	Hourly limit value	200 μg/m^3, not to be exceeded more than 18 times per year							
	Annual limit value	40 μg/m^3							
SO_2	**Alert threshold**	500 μg/m^3, 3 consecutive hours							
	Hourly limit value	350 μg/m^3, not to be exceeded more than 24 times per year							
	Daily limit value	125 μg/m^3, not to be exceeded more than 3 times per year							
CO	**Limit value**	10 mg/m^3, maximum daily 8th hours mean							
O_3	**Information threshold**	180 μg/m^3, 3 consecutive hours							
	Alert threshold	240 μg/m^3, 3 consecutive hours							
	Target value	120 μg/m^3 maximum daily 8th hour mean not to be exceeded more than 25 days per calendar year (averaged over three years)							
	Long term objective	120 μg/m^3 maximum daily 8th hour mean							
PM_{10}	**Daily limit value**	50 μg/m^3, not to be exceeded more than 35 times per year							
	Annual limit value	40 μg/m^3							
$PM_{2.5}$	**Annual limit value**	25 μg/m^3							
Benzene	**Annual limit value**	5 μg/m^3							
PAH	**Annual target value**	B(a)P - 1 ng/m^3							
Lead	**Annual limit value**	0.5 μg/m^3							
Heavy metals	**Annual target value**	As - 6 ng/m^3; Cd - 5 ng/m^3; Ni - 20 ng/m^3							

	Limit/objective not exceeded		Risk of exceedance
	Limit/objective exceeded		Data not available/not measured

Assessment of the critical pollutants in the ambient air of the Skopje agglomeration includes some uncertainties, which are linked to uncertainties in air quality measurement data. In air quality measurement data there are lacks in data representativeness: there is no data available for certain periods of time due to malfunctioning of equipment or poor data quality. For some important pollutants there is very little data. This concerns especially $PM_{2.5}$, benzene, benzo(a)pyrene and heavy metals.

It can be observed that the most critical pollutant in the Skopje agglomeration is the suspended particulate matter. PM_{10} concentrations exceed both the daily and annual limit value in all measurement stations, where there is data available. There is limited data available concerning the $PM_{2.5}$ concentrations in Skopje. Nevertheless based on the available data it can be assessed that there is a significant contribution of the $PM_{2.5}$ fraction to the total PM_{10}, and therefore an integrated policy is needed for both the PM_{10} and $PM_{2.5}$. $PM_{2.5}$ is an important pollutant from the health perspective, since the most significant health effects caused by air pollution are connected to $PM_{2.5}$.

The secondary PM_{10} and $PM_{2.5}$, formed from SO_2, NO_x, NH_3 and VOCs, have great significance in total PM_{10} and $PM_{2.5}$ concentrations, especially during the summer time. Therefore not all of the measured PM_{10} and $PM_{2.5}$ originates from local primary emission sources.

Ozone concentrations are relatively high in most of the monitoring locations and there is a possibility that the information and alarm thresholds for ozone exceed at certain periods. Especially the long term objective of ozone has been exceeded during the last years. High concentrations of ozone have adverse health effects and also cause damage to vegetation and crops.

NO_2 concentrations have exceeded the limit values in 2011 and 2012 in locations, where traffic has the most influence, i.e. Licise and Centar. In Licise also the limit value for CO has exceeded. Dispersion model calculations indicate that NO_2 concentrations could exceed the limit values even more widely in the vicinity of major roads and crossroads in the city center.

For the pollutants for which there is only very limited amount of data available (benzene, lead, arsenic, nickel and cadmium and benzo(a)pyrene), the indicative measurements carried out in 2015-2016 show that benzo(a)pyrene concentrations exceed the target value, and should be considered as critical. The measurements of heavy metals did not show any exceedance of the relevant target values.

No exceedance of limit values are recorded for sulphur dioxide during the previous five years. Therefore SO_2 is not classified critical in the Skopje region.

The air quality measurements made in the Skopje region indicate that the concentrations of the pollutants may differ somewhat between the stations. This indicates that in some parts of the city air quality may be affected by different emission sources. On the other hand especially concerning PM, when the concentrations are high, they are usually high at the same time in all the monitoring stations, indicating that the cause for the situation is common for the whole region.

In air quality in the Skopje agglomeration there is a clear seasonal trend, especially in PM concentrations: the PM_{10} and $PM_{2.5}$ concentrations are very high during the heating season from October to April. This is most probably connected to the increased emissions from heating during that period but also due to the adverse weather conditions and the prevailing topography of the region. At times during, the winter the pollutants emitted into the atmosphere stay in the valley and do not disperse into surrounding countryside.

For $PM_{2.5}$, PM_{10} and O_3 concentrations are affected also to some extent by the long-range transport of the pollutants. The share of the long-range transport for the prevailing concentrations has not been able to be assessed in this report.

The emission calculations and source apportionment study show that for the PM_{10} and $PM_{2.5}$ concentrations the prevailing emission sector is the domestic heating. The domestic wood burning is responsible for almost all (90%) of the primary PM emissions in Skopje. The emission amounts do not directly translate to equal amount of pollution in the air, as the formation of the pollutant

concentrations is influenced by the height and location of the emission release. According to the source apportionment study, the wood burning contributes to approximately 30 % of the particulate concentrations in the location of the Karpos monitoring station. However, the contribution can vary between different parts of the city, for example in areas where majority of the houses use wood for heating, the contribution is likely to be higher.

After the domestic heating the second most important emission sector in Skopje is the road traffic. It is possible that in the emission inventory the traffic sector is somewhat underestimated, as there exists evidence that the emissions in real circumstances from traffic are higher than the calculations based on the emission factors of Euro-classes show. Traffic has the most influence on air quality during the summer time, when also some exceedances of PM_{10} limit value have been measured. Source apportionment study for particulate matter concentrations show that also dust from soil, streets and pavements have importance and the so-called street dust may have a role for the high concentrations of PM_{10} especially during the dry periods.

The industrial energy production installations are estimated not to have a significant impact on air quality, partially due to the limited amount of large installations in Skopje and secondly due to improved emission control in some installations (for example ceasing the use of heavy fuel oil in heating plants). In addition, the emission release height affects the ground concentrations as the emissions disperse and dilute in the atmosphere and as a consequence cause low ground level concentrations.

Concerning the photochemically formed secondary PM_{10} and $PM_{2.5}$, the NO_x, SO_2, VOC and NH_3 emissions have a key role in the particulate formation. For this reason also those emissions have to be taken into account, when considering the measures to the decrease the PM_{10} and $PM_{2.5}$ concentrations.

Overall conclusion of the air pollution situation in the Skopje agglomeration

- The most characteristic feature for the air quality in the Skopje region is the very high concentrations of PM_{10} and $PM_{2.5}$ and very significant variation of the concentrations between winter and summer seasons. Emission calculations and source apportionment study show that major part of the primary PM emissions originate from wood burning in households.
- However to reduce the PM_{10}, $PM_{2.5}$ and also the NO_2 concentrations the traffic emission must be taken into account. Traffic emissions affect the local air quality mostly during the summer time and in the city center, where there traffic is the most frequent.
- To reduce the formation of secondary PM and O_3, also emissions of NO_x, SO_2, VOC and NH_3 need to be reduced in all main emission sectors.
- The prevailing pollutant concentrations are not strictly and solely related to the amounts of emissions. Local meteorological and topographic conditions have a strong influence on local air quality and on its variation between winter and summer seasons. In addition the emissions height and location of the emissions source have an effect on how concentrations differ geographically and in time.

10 POLICIES AND MEASURES TO IMPROVE AIR QUALITY IN THE SKOPJE AGGLOMERATION

10.1 Objectives of the plan

The overall objective of this plan is to improve the air quality in the Skopje agglomeration so that human health and the environment are protected according to the air quality legislation.

The main objective of the plan is to reduce the very high PM_{10} and $PM_{2.5}$ concentrations, but also NO_2 concentrations especially in the city center. In the Skopje region also O_3 concentration are high, but due to the secondary nature of this pollutant, the local measures are not so efficient to reduce the O_3 concentrations.

10.2 Measures to improve the air quality

10.2.1 General

The measures to improve the local air quality in Skopje region which are presented here are based on the emission inventories and air quality data assessment. According to the severe situation of the air pollution related to the high concentrations of particulate matter in Skopje agglomeration and significant contribution from domestic heating, the plan includes measures for the reduction of emissions from wood burning. This reduction could be achieved with measures related to renewal of the old stoves used for heating and restrictions for wood burning. Also information measures aiming for better maintenance and use of the wood combustion units are of importance together with energy saving actions.

Because of the importance of the secondary PM_{10} and $PM_{2.5}$ the measures for PM concentration reduction also include actions to reduce emission of the precursors of secondary PM_{10}, i.e. NO_x, SO_2, VOC and NH_3 emissions. Since ozone is also a secondary pollutant in the atmosphere, the measures to decrease secondary PM formation also affect ozone concentrations.

In addition to the domestic heating an important emission sector is traffic, which contributes primarily to NO_2 concentrations and to lesser extent to PM_{10} and $PM_{2.5}$ concentrations and therefore is addressed by number of emission reduction measures for road traffic.

Industry and energy production sectors can have a local effect for PM_{10} concentrations and contribute to the part of the NO_x, SO_2 and VOC emissions. For the industrial sector, efforts have been made to implement the requirements of the Law on environment and sub-legislation acts for IPPC. Application of the IPPC regulations together with best available techniques (BAT) and proper regular maintenance of the installations should be effective in the long-run to reduce the emissions. Transposition of the new Industrial Emission Directive and new emission limit values for medium and small energy production plants will decrease the emissions in the long-run from the present level. For the emissions from industry (A and B permits) the national air quality legislation and environmental permits are the most efficient way to decrease the air quality impacts. For those reasons industry is not so widely covered with the measures of this plan.

The plan also covers measures related to waste management, which directly and indirectly have influence on local air quality.

Most of the measures are presented in a general level and need more detailed planning, when starting the implementation. In addition, the costs, responsible authorities and time-frame for implementation of the different measures must be defined in more detail when the measures are designed in detail. The implementation of most of the measures to decrease the emissions and concentrations of the critical pollutants are expected to take a long period of time. The detailed air quality impacts, i.e. decrease in concentrations, of the listed measures were not possible to be assessed with the presently available information. This would have required development of real emission scenarios for each sector including model calculations based on the scenarios. The expected air quality impacts of the implemented measures should however be assessed whenever possible.

10.2.2 Description of the measures

The main target sectors for the measures included in the plan are:

- Domestic heating;
- Traffic;
- Industry;
- Waste management;
- Energy production and use.

In addition to the measures that are strictly related to the emission sectors mentioned above in the plan there are also measures that are related to:

- Information to the public;
- Administrative policies.

In general it would be favourable and cost-effective if the measures for local air quality improvement are as much as possible related to other policies which the local administration are promoting. Especially energy, climate, traffic and public transport policies are the ones that have a close relation to air quality and emission to air. In addition urban planning has a major role in the long run and gives possibilities to decrease the emissions. The need for air quality improvement, especially for reduction of PM_{10} and $PM_{2.5}$ concentrations, is significant to protect the human health. However, it is clear that it is not possible to improve the situation very quickly, in the next few years, without making systematic changes in the key polluting sectors. The measures needed must be drastic and systematic, before the concentrations are decreased below the limit values. Some of the measures may be expensive.

For the high O_3 concentrations it is not possible to decrease the concentrations just by local or even by national measures, due to the nature of the O_3 origin. It depends very much on the regional and international measures, how the O_3 concentrations will change in the future. The probability that target values of O_3 will be exceeded in the near future, even if the local emissions will decrease widely, is very high.

Many of the measures will affect emissions and concentrations of several pollutants at the same time, which is favourable also from the economic point of view.

The possible measures to improve air quality in the Skopje region by local level activities are listed in the Annex 1. The measures are summarized as follows:

<u>Measures for domestic heating</u>

1. Domestic heating at the moment has the most significant influence on air quality at the local level in Skopje. Especially burning of wood and waste materials cause large part of the PM emissions. In the long-term substituting the use of wood with district heating, gas or other heating forms would have a strong impact on the PM emissions. In the short-term it would be possible to decrease PM emissions from domestic heating by correct use of the stoves and fuel, performing chimney sweeping activities and increasing the checking of the solid fuel heating systems.

Measures for energy use and energy production

2. Increasing the energy efficiency in general in all sectors and especially in the public buildings and private houses is necessary. This can include changes in lightning, thermal insulation and heating systems as well as regulations related to energy efficiency. Increasing energy efficiency is vital for existing buildings (renovation) and when constructing new buildings.
3. Changes in energy production and heating of the houses may play a major role in decreasing the emissions. Expanding the district heating network in Skopje would decrease the emissions from heating and make heating more energy efficient. Also establishing a primary and secondary gas supply network for households and commercial sector may have the same effect. Adoption and promotion of new energy forms like solar, geothermal, wind and hydro power are favourable in the medium and long-term. Increasing the use of renewable biofuels in heating is acceptable only in bigger heating units with advanced emission control. Improved fuel quality standards decrease emissions, but are mainly applicable at the national level.

Measures for traffic

4. Road traffic emissions have local effect especially in the central parts of Skopje. There are numerous different possibilities to decrease the traffic emissions, but many of them require major investments to traffic network or infrastructure (re-routing traffic, new connections, and road tolls) and are effective only in the medium and long-term. There are also measures that can be adopted fairly quickly, but their effect on traffic emissions may not be very significant, like lowering the speed limits. Creation of low emission zones (LEZ) or zones, where heavy duty vehicles are forbidden have been successful in many European cities. Reduction of traffic congestion in general in advantageous also for emission reduction. At the local level there are also possibilities to promote the use of vehicles with low or even zero emissions.
5. Freight transport in the city area with old and heavy vehicles may have a significant role in the total emissions caused by traffic. There are possibilities to organize the transport so that emissions are minimized: time-tables for freight delivering, effective signing and providing maps of designated routes to all companies in the city, distribution centres etc.
6. With local parking policy it is possible to some extent also to restrict traffic. Parking policy and parking charges have been used widely in European cities to regulate traffic in the city centres.
7. Promotion of public transport in general and promotion of more environmental friendly public transport is a common measure very widely used to decrease traffic volumes in cities. In modern high-quality public transport important aspects are e.g. travelling times, tariff policy, routes, network, exchange connections, information system, and implementation of e-ticket and smart ticketing. Introduction of city rail traffic is expensive at the local level but it is

possible to set minimum emission standards for the buses and taxis and substitute old vehicles with modern ones or install filters in the public transport buses.

8. Together with promotion of public transport, walking and cycling in the city area are commonly promoted. This means expanding pedestrian and bicycle network, removal of urban barriers, establishing safe bicycle parking systems and establishment of new pedestrian zones where supply of goods will only be conducted by low emission/electric vehicles (traffic calmed routes).

Measures for industry and waste management

9. Emissions from industry and energy production plants are mainly regulated by the national legislation and environmental permits for the enterprises. The supervision of the plants is the responsibility of the national or local environmental administration. At the local level it is possible to promote new emission prevention techniques (BATs) by granting subsidies and by voluntary agreements (e.g. eco-label, ISO 14 001, EMAS, cleaner production concept).

10. Better waste management may decrease emissions to air from landfills and prevent illegal burning of waste materials. Energy recovery from incineration of municipal waste and recovery of biogas from organic fraction of municipal waste are methods also to prevent emissions to air.

Measures for city and traffic planning

11. In general level city planning including also traffic planning are in the long-term important when preventing air pollution together with other harmful environmental impacts such as noise. Air quality assessment should be part of the city planning processes in the future.

Measures for diffuse emissions

12. To prevent diffusive PM emissions it is possible to adopt better and more intense street cleaning techniques and intensification of street cleaning and to convert the winter maintenance fleet to wet salt technology. Dust control at construction and demolition sites can be regulated by local level requirements.

Measures to increase public awareness

13. Measures that are easy and fast to implement are different kinds of information measures aiming to raise public awareness and to change public behaviour to more environmentally friendly. Informative campaigns could cover issues like energy efficiency, waste burning, cycling, walking, car-free days etc. Better and advanced real time air quality information provision to the public is important. It is also important to improve information concerning the health effects that poor air quality may cause.

14. Local air quality and the reasons behind the poor air quality are important to be widely understood in the local administration. Air quality assessments (e.g. with dispersion modelling) should be made in all the major planning processes, which may affect significantly the air quality. Although the air quality monitoring is done by MEPP, it is also possible at the local level to arrange measurement campaigns. However when arranging local measurements, it has to be taken into account that there are enough resources and knowledge at the local level to guarantee that the measurements fulfil all the QA/QC requirements.

10.3 Review of the plan

Periodic check of the implementation of the measures should be done regularly at the local level with the MEPP supervision. The coordination between local and central level administration is recommended in order to check the effectiveness of the measures adopted and to assess the impact of each action undertaken for the air pollution improvement. Moreover, the exchange of information between the local and the central level is fundamental also in order to synchronize the measures at local and national level.

For this purpose, briefings between MEPP and the local administration are recommended, for instance every year, in order to point out how the activities are affecting the air quality. During these meetings the following information should be shared:

- Overall situation concerning the planned activities reported by the local staff;
- Existence of possible problems, related to the implementation of the measures, due to different reasons (economic, logistic, social, etc.);
- Opinion of the local experts concerning the measures in progress and their effectiveness at the local level;
- Future actions planned;
- Implementation of measures at central level (e.g. emissions reduction, update of the emission inventories, results of modelling studies, analysis of the air quality datasets).

The results of the briefings should be taken into account in order to solve in the short time minor problems related to the measures and to prepare the plan review. According to the characteristics of the present plan, a first review of the document is strongly recommended in a relatively short period of time (after two years). During this period, it should be possible to gain further information concerning the importance of different emission sources in the Skopje region. According to this more detailed information an improved assessment process could be made in order to define an updated set of structural measures to be adopted in the medium-long period for the air pollution improvement.

The plan review process could be structured in the following steps:

Update of air quality data and emission information: This activity concerns the chapters 5 and 7 of the present plan, with possible modifications in chapter 9. The role of MEPP in the information update process is fundamental. Concerning the emissions, a comparison between the original situation and the future situation is recommended.

Reconsidering of the possible measures to be implemented: This activity is extremely important and joint work between local and central experts is strongly recommended. In the measures reconsidering process the following aspects should be taken into account:

- Conclusions gained by the first reviewing activity (assessment of the air quality situation, identification of the most critical pollutants, definition of the main emission sources, definition of the main intervention sectors);
- Assessment of the effectiveness of the measures. The experience gained during the 2017-2018 period will be very valuable in order to assess the role of the measures adopted to improve the air quality. The opinion of the local administration in the Skopje region will be essential in order to evaluate the real contribution of each measure, its social and economic impact and the related benefits;
- Coordination of the national and local measures. The reviewed local plan should be coordinated with the National programme for emission reduction and National plan for the

ambient air quality protection. The local air quality plan should represent a sort of conformation of the national guidelines for the air quality improvement at the local level. The coordination between national and local scale measures is a basic requirement in order to reduce effectively the critical pollutants like PM and ozone.

Review of the key measures to be adopted: this final step should be made taking into account all the conclusions collected in the previous steps. The key measures should be defined (or confirmed if already adopted in the original plan) according to the emission targets, estimated effectiveness, funds needed for the implementation etc. Especially for the local measures the role of the local administration in the definition the measures is essential. Moreover each measure should be described in a dedicated table as made in the present document. The information of the responsible authority, the implementation time, the estimated costs and air quality benefits should be included in the tables.

After the first review of the plan, an ordinary check of the activities is strongly recommended every 6 months and the plan should be in force for 5 years before starting a new reviewing process.

11 CONCLUSIONS AND RECOMMENDATIONS

Local air quality improvement plan is a document, which describes the targets for air quality improvement in a region or a city. The targets are the basis for local measures to improve air quality and decrease emissions of the major pollutants. The plan is primarily based on assessment of local air quality and major emission sectors. The plan may be considered as a strategy for the air quality improvement, but to be effective the resources and political support to implement the measures included in the plan should be safeguarded.

This plan for improvement of air quality in the Skopje agglomeration is based on the assessment of available air quality data and emissions in the region. As described in the plan the assessment of local air quality and emissions include uncertainties, which have to be taken into account when implementing the plan and the measures. It also should be noted that the national programs and targets for air quality improvement will have an effect on local air quality and support the measures described here.

As soon as the knowledge of the air quality situation and emissions and effectiveness of the different measures increase, the local administration should be prepared to evaluate the program and to specify the targets and measures. It is also important to start to clarify funding of the measures and other possibilities to implement the measures.

Since most of the measures will need resources, time and more detailed planning, it would be important to start the implementing some of the measures as soon as practically possible. Implementation of the long-term measures can start after they have been planned detailed enough and when their implementation is guaranteed also in other ways (e.g. necessary funding is decided).

ANNEX 1

DESCRIPTION OF AIR QUALITY IMPROVEMENT MEASURES

General remarks on cost estimations

A partly qualitative, partly quantitative approach was chosen to assess the costs of implementing each measure.

When assessing the cost of policies ex-ante in a qualitative way, it is first of all useful to differentiate between administrative costs, compliance costs and economy-wide costs. ***Administrative costs*** are those that the city government must incur to monitor and enforce compliance with the policy and might involve setting up necessary infrastructure such as offices, staff or online registration platforms. ***Compliance costs*** are those incurred by the actors targeted by the measure, which could be businesses, households or, in the case of public infrastructure investment, government itself. These costs include, for instance, the costs to businesses of installing filters or other emissions-reducing technologies, or the costs to households of installing new heating systems or paying higher charges for car parking in the city centre. At the broadest level, there are ***economy-wide costs*** that arise as the changes triggered by the policy have knock-on effects on other sectors and factor markets. These general-equilibrium impacts can be substantial, but they will not be assessed here since they require a full model of the economy to be appropriately measured.

It is important to note that when assessing the cost of policy measures from an overall economy-wide, social perspective, only real resource costs are taken into account. Transfers from one sector of society to another, such as payments of taxes or subsidies between the household/business sectors and government, are excluded (but they are mentioned where they are substantial).

Overall, the measures are categorized based on a simple four-point evaluation scale as:

- Inexpensive (0), with annual costs ranging from 0 to 100.000 EUR
- Moderately expensive (1), with annual costs between 100.000 and 500.000 EUR
- Expensive (2), with annual costs between 500.000 and 1 million EUR
- Very expensive (3), with annual costs from 1 million EUR upwards.

MEASURE NO	**1**
MEASURE NAME	**Ban of wood burning in the district heating area**
Target sector	Domestic heating
Description of the measure	By local regulations wood burning in small stoves and ovens can be banned or restricted. The ban can be adopted mainly in the area covered by district heating.
Objective of the measure	Objective is to decrease emissions, especially PM emissions, from domestic heating.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	Potentially large.
Air quality impact	Significant.
Other impacts	Decreases exposure to pollutants also inside dwellings.
Responsible authority	City of Skopje and Municipalities in the City of Skopje, Ministry of Environment and Physical Planning
Timeframe for implementation	Medium – long
Costs	This measure requires some small ***administrative costs*** for monitoring and enforcing the ban. For this purpose, additional environmental inspectors may need to be hired, but the costs are likely small. The ***compliance costs*** fall onto households, who need to switch from wood, a very cheap heating material, to other heating methods such as district heating. This requires households to invest in setting up a new heating system in their houses and to pay the likely higher price per heat unit. With data on the number of households potentially affected, the investment expenditures for new private heating installations for the average household as well as on the price differential between wood and new heating methods per heat unit, the total compliance costs can be calculated. Assessment: 2 (expensive)
Other requirements (technical, social etc.)	The ban area must be defined by the City of Skopje. May need to be supported by a national act.
Connection to other plans	
Present status	Not implemented. A. study on the impact of wood as heating fuel on air quality is under preparation.

MEASURE NO	**2**
MEASURE NAME	**Define areas with obligatory connection of new houses to district (central) heating network**
Target sector	Domestic heating
Description of the measure	The city can define areas, especially new building areas, where new all new houses must be connected to the central heating network.
Objective of the measure	Objective is to decrease emissions from domestic heating in general.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	Potentially large.
Air quality impact	Significant.
Other impacts	Decreases energy consumption at the municipal level, because heating energy is produced more efficiently in power plants.
Responsible authority	City of Skopje and municipalities in the City of Skopje, energy companies
Timeframe for implementation	Medium - long
Costs	The ***administrative costs*** of this measure involve changing regulatory guidelines in city planning as well as monitoring/enforcing compliance with the obligation, which may require additional staff. Overall, however, the administrative costs are likely to be small. Regarding ***compliance costs***, this measure requires investment in expanding the heating network to connect the newly-built houses, and potentially also in the construction of new cogeneration plants. These costs would fall onto the private energy companies. For households, the cost of a new house would increase to cover the new district heating installations. As for all infrastructure investments, these costs are likely to be substantial but depend on the size of the defined areas for which district heating would become obligatory. The costs can be calculated with data on the number of houses potentially affected as well as the size of the network expansion required. Assessment: 2-3 (expensive to very expensive)
Other requirements (technical, social etc.)	The area where the connection to the district heating is compulsory must be defined in co-operation with the City of Skopje. and municipalities in the City of Skopje and the companies providing the district heating Extension of the heating network must go hand in hand with city planning and building of new city areas.
Connection to other plans	Sustainable Energy Action Plan, Strategy for Health and Environment
Present status	Not implemented

MEASURE NO	**3**
MEASURE NAME	**Substitution of old solid fuel heating systems with modern pellet heating units by financial incentives**
Target sector	Domestic heating
Description of the measure	Providing financial incentives to replace old wood fuel heating systems with pellet ones with better energy efficiency and lower emissions.
Objective of the measure	Objective is to decrease emissions, especially PM emissions, from domestic heating
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	Significant if adopted in large scale
Air quality impact	According to the official EU-emission factors for PM_{10}, the substitution of a traditional stove with a pellet unit can reduce the PM_{10} emission about 25 kg/unit/year.
Other impacts	Decreases exposure to pollutants also inside dwellings and increases energy efficiency in household heating.
Responsible authority	City of Skopje and Municipalities in the City of Skopje.
Timeframe for implementation	Medium - long
Costs	This measure would incur some ***administrative costs*** to run the programme of financial incentives, i.e. receiving applications, responding to queries and disbursing the funds. Depending on the number of households eligible for the programme, the costs would range from hiring a few to a larger number of additional staff. The ***compliance costs*** are those costs incurred by households for the purchase of the new pellet heating units that go beyond the financial incentive (e.g. subsidy) they receive from the government/municipality (recall that the subsidy is a transfer and only real resource costs count from an overall socio-economic evaluation perspective). For the subsidy in the Skopje City area that was introduced for the year 2016, 196 households received at most MKD 30,000 per heating unit. In total, 5.9 million MKD were disbursed for the subsidy. According to experts from the City of Skopje, a new pellet stove costs between 60,000 and 70,000 MKD - i.e. about twice the subsidy amount - so individual households still need to fund another 30,000 to 40,000 MKD from on their own. For 2017, Skopje is planning to raise the total subsidy amount available to 10 million MKD, covering approx. 333 households if the same upper limit of 30,000 MKD per household is maintained. Households will therefore have to spend an additional 200,000 EUR. In addition, the likely higher costs of heating with pellets than with solid fuels must also be incurred by households. <u>Assessment: 1-2 (moderately expensive to expensive) [same categorisation if subsidy is included, i.e. from financial perspective]</u>
Other requirements (technical, social etc.)	Modern technology for pellet burning is available with reasonable costs. A minimum efficiency requirements for the new heating units should be set. The financial incentives should be allocated after a certification of a proper installation of the heating system.

Connection to other plans	At the national level a subsidizing fund was allocated for the same purposes for the period 2017-2020.
Present status	At the local level the measure is implemented in 2016 for 196 households and is planned to be implemented also in 2017.

MEASURE NO	**4**
MEASURE NAME	**Ban on burning of coal in domestic heating units**
Target sector	Domestic heating
Description of the measure	Burning of coal in domestic heating units can be gradually banned totally because burning of coal can produce and release very harmful substances both in the indoor environment and to the atmosphere.
Objective of the measure	Objective is to decrease emissions of PM, SO_2, NO_x, PAHs and VOCs
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also SO_2, NO_x, CO, VOCs and PAHs are widely affected.
Change in concentration	Locally noticeable.
Air quality impact	May be significant locally
Other impacts	Decreases exposure to pollutants also inside dwellings.
Responsible authority	City of Skopje, municipalities in the City of Skopje, municipal environmental units (inspections).
Timeframe for implementation	Medium - long
Costs	This measure requires some small ***administrative costs*** for monitoring and enforcing the ban. For this purpose, additional environmental inspectors may need to be hired, but the cost is unlikely to be large. The ***compliance costs*** fall onto households, who need to switch from coal, a relatively cheap heating material, to other heating methods such as district heating. This requires households to invest in setting up a new heating system in their houses and to pay the likely higher price per heat unit. With data on the number of households potentially affected, the investment expenditures for new private heating installations for the average household as well as on the price differential between coal and new heating methods per heat unit, the total compliance costs can be calculated. Assessment: 2 (expensive)
Other requirements (technical, social etc.)	Changing to other fuels or connecting to the central heating network may need subsidizing
Connection to other plans	
Present status	Not implemented

MEASURE NO	**5**
MEASURE NAME	**Enforce the ban on burning of inappropriate or waste materials in domestic heating units**
Target sector	Domestic heating
Description of the measure	Burning of inappropriate materials in domestic heating units can be banned totally, especially waste burning, because they can produce and release very harmful substances both in the indoor environment and to the atmosphere.
Objective of the measure	Objective is to decrease emissions of PM, PAHs and VOCs and to avoid the formation of other carcinogenic compounds like dioxins and furans.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	Locally noticeable.
Air quality impact	May be significant locally, especially for health effects due to the reduction of dioxins and furans formation.
Other impacts	Decreases exposure to pollutants also inside dwellings.
Responsible authority	City of Skopje, municipality's environmental units (inspections). Ministry of Local Self-Government and Ministry of Economy
Timeframe for implementation	Can be started after the change in the national legislation
Costs	This measure incurs potentially substantial ***administrative costs*** to improve the monitoring and enable an enforcement of the ban. Additional environmental inspectors may need to be hired, and the recycling system for domestic waste must be modernised, so that households have an alternative to burning their waste. Appropriate waste collection and disposal systems must be implemented, which requires e.g. purchasing additional garbage trucks and constructing waste incineration plants. This could make the measure quite costly. For households that have so far burned waste for heating, ***compliance costs*** arise from the need to purchase alternative heating materials. These are likely to be small as long as cheap alternative materials (e.g. wood) are available or moderate in case wood firing is banned. Assessment: 2 (expensive)
Other requirements (technical, social etc.)	Ban of waste burning and related controls requires change in the national legislation. The domestic waste burning should be clearly banned by legislation. Moreover local environmental inspectors should be allowed to enter in the private households to make inspections. Modern collection and treatment systems for domestic waste must be put in practice, to support the correct management of the domestic wastes.
Connection to other plans	
Present status	Not implemented

MEASURE NO	**6**
MEASURE NAME	**Promotion of use of good quality wood in domestic heating**
Target sector	Domestic heating
Description of the measure	Providing information and guidance to households and citizens of the need to use only good quality wood in stoves and ovens and of the dangers of burning inappropriate or waste materials (especially domestic waste but also wood by-products, painted logs etc.). Wood quality is one important aspect, when decreasing emissions.
Objective of the measure	Objective is to decrease emissions, especially PM emissions, from domestic heating.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	May be significant if also the other good practices in conducting and maintaining the biomass heating systems are adopted at the same time by the population.
Air quality impact	Significant.
Other impacts	Decreases exposure to pollutants also inside dwellings. May increase energy efficiency of the heating units.
Responsible authority	City of Skopje and the municipalities in the Skopje region
Timeframe for implementation	Can start immediately.
Costs	An information campaign run by the city government incurs only relatively small ***administrative costs***. These mainly consist of the costs of organising the campaign (which may require hiring additional staff) as well as designing, printing and distributing the information materials. The costs also depend on the geographical reach of the campaign (Skopje or nation-wide). Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Information must be widely available in many forms. It would be useful to produce material for the whole country at the same time. Enough good quality wood must be available at the markets. The good practices in conducting and maintaining the biomass heating systems include also the adoption of measures 7 and 8.
Connection to other plans	
Present status	Some national material by MEPP available already

MEASURE NO	**7**
MEASURE NAME	**Promotion of good practices concerning domestic heating with wood: good firing habits, heating units maintenance and dry wood storing**
Target sector	Domestic heating
Description of the measure	To reduce emissions it is important that combustion circumstances and maintenance of the stoves and heating units in general are as good as possible. Information and guidelines concerning the good practices in conducting and maintaining domestic heating units are fundamental to guarantee that the emissions are as low as possible.
Objective of the measure	Objective is to decrease emissions, especially PM emissions, from domestic heating
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	May be significant if also the other good practices in conducting and maintaining the biomass heating systems are adopted at the same time by the population.
Air quality impact	Significant.
Other impacts	Decreases exposure to pollutants also inside dwellings. May increase energy efficiency of the heating units.
Responsible authority	City of Skopje and the municipalities in the Skopje region
Timeframe for implementation	Can start immediately.
Costs	An information campaign run by the city government incurs only relatively small ***administrative costs***. These mainly consist of the costs of organising the campaign (which may require hiring additional staff) as well as designing, printing and distributing the information material. The costs also depend on the geographical reach of the campaign (Skopje or nation-wide). Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Information must be widely available in many forms. It would be useful to produce material for the whole country at the same time. The good practices in conducting and maintaining the biomass heating systems include also the adoption of measures 6 and 8.
Connection to other plans	
Present status	Some national material by MEPP available already. In 2015 the City of Skopje prepared a brochure to advice the citizens on how to achieve high quality combustion in domestic heating. It was distributed to the households in 2015-2016 through the local communities.

MEASURE NO	**8**
MEASURE NAME	**Recommendation for regular chimney sweeping and inspection of private stoves and ovens**
Target sector	Domestic heating
Description of the measure	If chimneys of houses are swept regularly and also at the same time the heating units are inspected generally by chimney sweepers or other personnel, it would partly guarantee that the emissions of those units are as small as possible. People are not aware about the need to sweep the chimneys.
Objective of the measure	Objective is to decrease emissions, especially PM emissions, from domestic heating.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	Together with other measures concerning house hold heating with wood may have significant effect at least locally.
Air quality impact	Significant
Other impacts	Decreases exposure to pollutants also inside dwellings. May increase energy efficiency of the heating units.
Responsible authority	City of Skopje, municipalities in the City of Skopje and companies providing chimney sweeping services (recommendations) Protection and Rescue Directorate (inspections)
Timeframe for implementation	Information can start immediately.
Costs	This measure incurs some small ***administrative costs*** to improve the monitoring and enforcement of regular chimney sweeping and to run an information campaign for households to increase their awareness of the necessity to have chimneys swept. This may involve hiring some additional environmental inspectors as well as organising the information campaign and designing, printing and distributing the information material. The ***compliance costs*** for households and businesses involve organising and paying for regular chimney sweeping, e.g. on an annual basis. According to experts from the City of Skopje, there are approx. 160,000 households in the city of which 33% use wood for heating. If each of these had to incur an annual cost of e.g. 5 EUR to pay for the chimney sweep, this would amount to a total of 260 000 EUR. Assessment: 1 (moderately expensive)
Other requirements (technical, social etc.)	There is a need to inform population about the importance of chimney sweeping practice. Chimney sweepers must have enough resources for the task. The good practices in conducting and maintaining the biomass heating systems include also the adoption of measures 6 and 7.
Connection to other plans	Strategy for Health and Environment, Local Environmental Action Plan
Present status	Requirements are in the national legislation (Rulebook on regular cleaning and maintenance of smoke ducts 146/10), but they are not put into practice very efficiently.

MEASURE NO	**9**
MEASURE NAME	**Recommendation to change from domestic heating to district (central) heating network**
Target sector	Domestic heating
Description of the measure	To replace small ovens and boilers that now are used for heating of the buildings to central heating.
Objective of the measure	Objective is to decrease emissions in housing areas, especially PM emissions, from domestic heating
Target pollutant	Especially PM_{10}, $PM_{2,5}$, NO_x and SO_2, but also VOCs and PAHs are affected
Change in concentration	In the long-run may be effective to decrease emissions.
Air quality impact	In the long-run may be effective to decrease emissions.
Other impacts	Decreases energy consumption at the communal level, because heating energy is produced more efficiently in power plants.
Responsible authority	City of Skopje, district heating companies.
Timeframe for implementation	Medium - long
Costs	As a recommendation, the implementation of the measure is open to the city government. If it is turned into action, the policy is likely to be very expensive. The ***administrative costs*** to the government involve organising the procurement of the services of companies that will plan and carry out the expansion of the city's district heating network and the connection of existing buildings in the areas that are not yet connected to the network. New power plants will also need to be built in order to supply the enlarged network. If a subsidy programme is implemented, this will also incur administrative costs. The ***compliance costs*** fall on the city government as well as energy supply companies, who will have to fund the network expansion, the connection of buildings as well as the construction of new plants. In addition, households and businesses incur costs for the installation of district heating units as well as for the higher price of district heating supply compared to cheaper alternatives. <u>Assessment: 3 (very expensive)</u>
Other requirements (technical, social etc.)	The costs for households must be reasonable. To be efficient the measure requires that a major part of the individual residential, public, commercial and industrial buildings are connected to the district heating network. The implementation of the measure may need some subsidizing. The measure must be implemented taking into account measures 1 and 2.
Connection to other plans	Sustainable Energy Action Plan, Strategy for Health and Environment
Present status	Not adopted.

MEASURE NO	**10**
MEASURE NAME	**Recommendation to use modern energy sources (solar, geothermal, etc.)**
Target sector	Domestic heating
Description of the measure	As an alternative to connecting to central heating network or substituting old stoves with new ones, it is possible to use modern energy sources to heat the houses and to produce warm water. The utilization of these modern energy sources may also be done in smaller local networks.
Objective of the measure	Objective is to decrease emissions from domestic heating in general.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	May be significant locally in the long run.
Air quality impact	In the long-run may be effective to decrease emissions.
Other impacts	New technologies are usually more energy efficient than the present ones.
Responsible authority	City of Skopje (recommendations). Ministry of Economy (subsidies).
Timeframe for implementation	Medium - Long
Costs	The ***administrative costs*** of this measure to government include planning, organising and paying for the provision of city-wide network infrastructure, if required, such as local networks for the modern renewable energy sources. In addition, if a subsidy programme to private households is implemented, this also incurs administrative costs. ***Compliance costs*** for businesses and households include purchasing energy production units (solar panels, geothermal heat pumps) and heating installations in buildings. According to experts from the City of Skopje, solar panels cost between 400 and 500 EUR per installation and household, while geothermal energy installations cost from 2,500 EUR upwards. Funding the installation of modern energy sources to any significant degree could therefore quickly become expensive. On the other hand, the everyday heating costs using solar and geothermal energy are low compared to traditional energy sources (electricity, district heating). <u>Assessment: 3 (very expensive)</u>
Other requirements (technical, social etc.)	The costs for households must be reasonable, subsidies may be needed. According to the position and the latitude of Skopje, the use of solar and geothermal energy have the most potential.
Connection to other plans	Sustainable Energy Action Plan, National Programme for gradual reduction of emissions of certain polluting substances, -Third national communication on climate change
Present status	No action on local level. National policy promotes the use of solar panels by subsidizing the households.

MEASURE NO	**11**
MEASURE NAME	**Recommendations that in urban planning the possibility to expand the district (central) heating network is taken into account**
Target sector	Domestic heating
Description of the measure	District heating represents an efficient way to provide heat energy to the new house areas, using a low-emission fuel and techniques. District heating network can be expanded to new building areas, if it is taken into account also in city planning.
Objective of the measure	Objective is to decrease emissions in residential areas, especially PM emissions, from domestic heating.
Target pollutant	Especially PM_{10}, $PM_{2,5}$, NO_x and SO_2, but also VOCs and PAHs are affected
Change in concentration	In the long-run may be effective to decrease emissions.
Air quality impact	In the long-run may be effective to decrease emissions.
Other impacts	Decreases energy consumption at the municipal level, because heating energy is more efficiently produced in power plants.
Responsible authority	City of Skopje, district heating companies.
Timeframe for implementation	Medium - long
Costs	This measure, if taken up by the city government, incurs mainly small ***administrative costs*** of adjusting urban plans to allow for a possible future expansion of the district heating network in collaboration with the district heating companies. This involves ensuring that urban plans make it possible that necessary network infrastructure can be installed underground and that houses can be connected to the network. No new city government staff must be hired for this purpose. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	To be efficient the measure requires that a major part of the individual residential, public, commercial and industrial buildings are connected to the district heating network. The implementation of the measure may need some subsidizing. Requires co-operation between the City of Skopje and the energy companies.
Connection to other plans	Sustainable Energy Action Plan, Strategy for Health and Environment
Present status	Not adopted.

MEASURE NO	**12**
MEASURE NAME	**Prevention of street dust by intensification of street and sidewalk cleaning**
Target sector	Traffic
Description of the measure	Dust emissions from street and sidewalk surfaces and also from courtyards (resuspension) may be a significant local emission source, although the impacts may be temporary at each site. During driest periods and wintertime resuspension of dust from streets can be prevented by more intense and regular cleaning.
Objective of the measure	Aim is to reduce local PM_{10} concentrations in the city area.
Target pollutant	PM_{10}.
Change in concentration	Locally and during dry periods effects may be even large, regionally small
Air quality impact	Locally and during dry periods effect may be even large, regionally small
Other impacts	May improve the general cityscape.
Responsible authority	City of Skopje and municipalities in the City of Skopje
Timeframe for implementation	The plan for the street cleaning may be prepared immediately.
Costs	Both ***administrative and compliance*** costs of this measure fall on the city government. The measure requires improving the organisation and intensity of the existing operation, e.g. with a system whereby street types are classified and categorised according to the required cleaning intensity. This new system requires training staff as well as monitoring, for which additional personnel would need to be hired. In addition, more cleaners are necessary to cover the increased cleaning intensity. Existing equipment also needs to be upgraded and better maintained. The overall costs can be calculated given data on the additional staff and equipment required. Assessment: 1 (moderately expensive)
Other requirements (technical, social etc.)	Enough effective equipment must be available, may need some supervision by the local authorities. A very simple document could be prepared to show the frequency of cleaning and classify the streets, how often they are cleaned and washed and which streets belong to the cleaning program. Cleaning may vary between seasons street types to optimize the cost and the efficiency of the measure. The fleet of cleaning machinery should be improved, according to the measure 12. Wintertime cleaning needs change in the legislation.
Connection to other plans	Sustainable urban mobility plan
Present status	Takes place, but not very efficiently

MEASURE NO	**13**
MEASURE NAME	**Improvement of street cleaning fleet by modern machinery**
Target sector	Traffic
Description of the measure	Dust emissions from street and sidewalk surfaces and also from courtyards (resuspension) may be a significant local emission source, although the impacts may be temporary at each site. Street cleaning can be improved step by step by adopting modern cleaning techniques like wet salt technology and dust-collectors with high water pressure etc. New equipment is needed for the street cleaning in the municipalities, where now no machinery is in use.
Objective of the measure	Aim is to reduce local PM_{10} concentrations in the city area.
Target pollutant	PM_{10}.
Change in concentration	Locally and during dry periods effect may be even large, regionally small
Air quality impact	Locally and during dry periods effect may be even large, regionally small
Other impacts	May improve the general cityscape.
Responsible authority	City of Skopje and municipalities in the City of Skopje, public enterprise for municipal hygiene
Timeframe for implementation	Medium-long time
Costs	This measure incurs mainly the ***compliance costs*** of investing in modern street cleaning technology and equipment as well as some personnel. New equipment like trucks must be purchased for those municipalities where currently no machinery is used. Cleaning staff also need to be trained in using the new technologies and equipment, which may require hiring temporary training personnel. The expansion of the street cleaning programme will likely require hiring additional cleaners. There are also some small ***administrative costs*** of organising the expansion of the cleaning programme, so possibly more personnel is also required in the city administration. The overall costs can be calculated given data on the additional equipment, staff and training programmes needed. Assessment: 2 (expensive)
Other requirements (technical, social etc.)	The street cleaning machinery should be equipped with the latest technology to be most effective
Connection to other plans	
Present status	The public enterprise for municipal hygiene invests in renewal of the vehicle fleet and equipment each year. The enterprise for municipal hygiene completely renewed its vehicle fleet and equipment, 4 vehicles for municipal hygiene used in the center of the city are electric.

MEASURE NO	**14**
MEASURE NAME	**A study of creation of a low emissions zone(s) (LEZ) in the city center**
Target sector	Traffic
Description of the measure	Low emission zones in the central city area of Skopje could decrease emissions from traffic, mainly private cars. The aim of the measure is to decrease traffic volumes in the city. Restrictions in LEZ could concern all vehicles or certain types of vehicles or vehicles of certain age or/EURO classes.
Objective of the measure	By decreasing traffic in the city area also the emissions to air decrease.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Medium if the measure decreases traffic significantly. Main effects in the city center.
Air quality impact	Medium if the measure decreases traffic significantly. Main effects in the city center
Other impacts	The measure decreases traffic noise at the same time and improves traffic safety. May change pollution to new areas.
Responsible authority	City of Skopje, municipalities in the City of Skopje, Ministry of Interior and Ministry of Environment and Physical Planning
Timeframe for implementation	Medium - long
Costs	The ***administrative costs*** of this measure concern planning and setting up the LEZ and creating alternative routes for the traffic that would be excluded from the LEZ. Some additional staff may need to be hired to monitor and enforce the LEZ. Overall, these costs are likely small. The ***compliance costs*** involve purchasing and installing traffic signs to identify the LEZ as well as adjusting the existing road network to allow for increased traffic volumes in other parts of the city due to the diversion from the LEZ of private cars, public transport and freight transport. Depending on how much traffic must be re-routed, this can require substantial infrastructure investments. Assessment: 2-3 (expensive to very expensive)
Other requirements (technical, social etc.)	A study is required to assess the possibilities to create LEZ in Skopje and show what kind of alternative solutions are possible and how they affect traffic circumstances and also environmental impacts of traffic. The study should also define the criteria for LEZ (euro class definition, type of vehicles allowed in each zone etc.). Needs re-routing of traffic and changes in public and freight transport. Measures concerning traffic require careful planning and also funding needs to be guaranteed.
Connection to other plans	Sustainable urban mobility plan, Sustainable energy action plan
Present status	Not implemented

MEASURE NO	**15**
MEASURE NAME	**Extension of the zone(s) where heavy vehicles are prohibited**
Target sector	Traffic
Description of the measure	Volumes of heavy traffic can be decreased locally by defining zones, where heavy duty vehicles are not allowed to drive.
Objective of the measure	To decrease emissions from heavy vehicles locally
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	May decrease highest concentrations locally, where there is much heavy traffic
Air quality impact	Mainly local importance. Effects not very drastic.
Other impacts	Improves traffic safety and decreases noise levels locally.
Responsible authority	City of Skopje, Ministry of Interior
Timeframe for implementation	Medium - long
Costs	The types of costs incurred by this measure are similar to those of measure 14. In terms of size, they are likely to be smaller, since the measure only applies to heavy-duty vehicles and therefore will not require setting up dedicated zones and re-routing substantial amounts of private cars. Assessment: 1 (moderately expensive)
Other requirements (technical, social etc.)	Needs re-routing of traffic and changes in freight transport and new vehicles (light duty vehicles). May need changes for the business enterprises. This measure is supported by measure 16.
Connection to other plans	Sustainable urban mobility plan
Present status	Already some streets are shown for heavy traffic in the City of Skopje. Implementation on field by Ministry of Interior.

MEASURE NO	**16**
MEASURE NAME	**Study of organized sustainable freight transport in urban areas for major companies: distribution centers, effective signing and providing maps of designated routes to all major companies in the city, guidance on how to enable deliveries out of peak hours**
Target sector	Traffic
Description of the measure	Freight transport and delivery in the central parts of the city can be done more environmentally friendly way by utilizing small and middle-size duty vehicles. The delivery routes and time-tables can be adjusted so that the freight transport causes as little as possible interruptions. Distribution centers outside the city area should be part of the modern freight transport system. A preliminary study should be carried out to assess the possible solutions to setup the sustainable freight transport.
Objective of the measure	Objective is in the long run to reduce the emissions from freight transport.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	In the long-run may be notable
Air quality impact	In the long-run may be notable
Other impacts	May also decrease noise in the central parts of the city
Responsible authority	City of Skopje
Timeframe for implementation	Medium
Costs	The ***administrative costs*** of this measure for the city government include carrying out the preliminary feasibility study; compiling and issuing the guidance on deliveries outside peak hours; producing and issuing the maps of designated routes to all major companies in the city; and purchasing and installing traffic signs to indicate the routes to these companies. The ***compliance costs*** for freight transport companies involve replacing the lorry fleet with more small and mid-sized vehicles; re-organising delivery routes and timetables to achieve more off-peak deliveries and follow the designated routes to the major companies; and investment in building distribution centres outside the city area. Overall, these costs can be substantial, depending on the scope of the measure. Assessment: 2 (expensive)
Other requirements (technical, social etc.)	Requires careful planning together with private companies.
Connection to other plans	Sustainable urban mobility plan, National plan for the ambient air quality protection
Present status	Not implemented

MEASURE NO	**17**
MEASURE NAME	**Further reduction of traffic congestion: traffic lights synchronization and substitution of traffic lights with roundabouts**
Target sector	Traffic
Description of the measure	Smooth traffic flows cause less emissions than traffic flows that are very varying. By traffic lights synchronization and roundabouts etc. it is possible to create a traffic environment, which causes less congestion.
Objective of the measure	Objective is to decrease emissions from traffic in general
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	May have positive effects in city level
Air quality impact	Impact not very large.
Other impacts	More fluent traffic flows and saving of travel time
Responsible authority	City of Skopje and municipalities in the City of Skopje
Timeframe for implementation	Implementation can start immediately
Costs	The city government bears the ***administrative and compliance costs*** of this measure. The former include planning the changes in the traffic lights system to improve its synchronisation and deciding at which points in the city network traffic lights should be replaced with roundabouts. These tasks can be carried out by existing staff and/or external consultants, and the costs are likely small. The compliance costs, on the other hand, involve considerable expenditures for adjusting the traffic lights and constructing the roundabouts. The city government has already spent 300,000 EUR to improve traffic lights at 30 cross-sections in the city; it has received an additional credit from the European Bank for Reconstruction and Development (EBRD) over 2.5 million EUR to improve an additional 60 cross-sections (in total there are 130 cross-sections); 140,000 EUR are spent from the city budget annually for maintenance. The costs of turning cross-sections into roundabouts range from 500,000 to 1 million EUR, depending on land ownership rights. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	At the same time parking of private cars has to be organized, so that they don't block traffic.
Connection to other plans	Sustainable urban mobility plan
Present status	Implementation has started by introducing traffic management and control system and constructing roundabouts on locations where this was possible.

MEASURE NO	**18**
MEASURE NAME	**Re-routing traffic**
Target sector	Traffic
Description of the measure	Re-routing traffic from e.g. living areas to other parts of the city outside living areas is applicable in situations, where air pollution is very high and there are good possibilities to build new traffic connections without causing severe problems to new areas.
Objective of the measure	Objective is to improve air quality in very polluted areas by shifting the traffic to new streets outside living areas.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Locally can be very high, but only changes the pollution to new areas.
Air quality impact	Locally can be very high, but negligible at city level.
Other impacts	Changes the pollution to new areas.
Responsible authority	City of Skopje, traffic department of City of Skopje, municipalities in the City of Skopje, Ministry of Interior
Timeframe for implementation	Long
Costs	The ***administrative costs*** of this measure include planning the necessary changes to the traffic network and procuring the services of construction companies to carry it out. Depending on the scope of the chosen intervention, these organisational costs could be small to moderate. The ***compliance costs*** cover the expenditures required to fund the alterations to the city traffic network. Again, these depend on the scope of the measure, i.e. the size of the city area affected. In general, infrastructure projects are among the most expensive policy measures. However, according to the deputy head of the Department of Traffic of the City of Skopje, for recently completed re-routing projects, no new infrastructure had to be built, and the only expenditures needed were for road signs. Assessment: 1-3 (moderately expensive to very expensive)
Other requirements (technical, social etc.)	Requires new infrastructure, which must be located so that no new problems will arise. Re-routing of traffic should be planned together with measures concerning smart mobility (public transport etc.).
Connection to other plans	Sustainable urban mobility plan
Present status	Has been taken into account in traffic planning already.

MEASURE NO	**19**
MEASURE NAME	**Support for use of zero or low emission vehicles**
Target sector	Traffic
Description of the measure	At local level it is possible to promote the use of modern vehicles with zero or low levels of emissions (hybrid cars, electric vehicles etc.). This can be done e.g. by giving preference to this kind of vehicles in parking policy and fees, possibility to use bus lanes, etc. The zero and low emission vehicles can also be used by the city organization as an example for others.
Objective of the measure	Objective is to decrease traffic emissions in general,
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low at the start, but may be significant in the long-term.
Air quality impact	Low at the start, but may be significant in the long-term.
Other impacts	
Responsible authority	Municipalities in the City of Skopje, City of Skopje
Timeframe for implementation	Changes in parking policy can be implemented immediately.
Costs	In terms of ***administrative costs***, this measure will require some additional staff effort going into planning and organising the preferential parking policy and fees, using bus lanes etc. as well as the construction of the necessary energy infrastructure for low-emission vehicles like charging spots. The ***compliance costs*** concern mainly the expenditures for building this infrastructure, which would fall on government and/or private energy companies. These costs are probably substantial if the measure is to be implemented on a scale that makes it effective. For example, a supercharger costs 25,000 EUR, and ideally, one such charger would be needed at every gas station in the city. The implicit subsidy via reduced parking charges for low-emission vehicles is a transfer to the owners of these vehicles and is therefore not a cost from a socio-economic perspective. (Since parking fees are already rather low at 30 MKD per hour on average in the city, the revenue lost from reduced fees for low-emission vehicles would also not be very large.) Assessment: 2-3 (expensive to very expensive)
Other requirements (technical, social etc.)	Requires financial support or e.g. benefits in parking charges. Hybrid and electric vehicles require new infrastructure (charging places etc.).
Connection to other plans	National plan for the ambient air quality protection, Strategy for Health and Environment, Third national communication on climate change, Sustainable urban mobility plan, Sustainable energy action plan

Present status	Some parking places are already free for electric cars and some charging places are already available. National policy subsidizing electric cars supports the local policies.

MEASURE NO	**20**
MEASURE NAME	**Further implementation of policies of Green Public Procurement concerning the vehicles used by the City of Skopje and the municipalities in the City of Skopje**
Target sector	Traffic
Description of the measure	The City of Skopje and the municipalities can take into account in procurement environmental aspects of vehicles (like emissions) and promote the use of low emission vehicles. This acts as an example to the public and private sector.
Objective of the measure	Objective is to decrease traffic emissions in general.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low
Air quality impact	Low
Other impacts	Good example to the public.
Responsible authority	City of Skopje, municipalities in the City of Skopje, public enterprises under the City of Skopje.
Timeframe for implementation	Can be implemented immediately
Costs	Both the ***administrative and compliance costs*** of this measure fall onto the city government. The latter include both the costs of purchasing low-emissions compared to conventional vehicles as well as expanding the construction of the necessary charging infrastructure for low-emissions vehicles. For example, the City of Skopje has recently bought a Nissan electric car for approx. 30,000 EUR, and there are so far two superchargers available, which cost 25,000 EUR each. If the policy is to be expanded, these costs would rise, but not to the scale of measure 19, as fewer vehicles would be concerned. The administrative costs concern organisational efforts regarding the infrastructure. Assessment: 1 (moderately expensive)
Other requirements (technical, social etc.)	Hybrid and electric vehicles require new infrastructure (charging places etc.).
Connection to other plans	Sustainable urban mobility plan, sustainable energy action plan
Present status	Implementation has started by procurement of 1 electric vehicle, 5 e-bikes, 5 electric scooters, 10 e-bikes and 5 electric cars for tourists and 2 charging stations.

MEASURE NO	**21**
MEASURE NAME	**Promoting flexi-time or graduated working hours to council staff and also to other employers**
Target sector	Traffic
Description of the measure	Part-time working at home reduces traffic volumes during working days and flexi-time reduces traffic volumes during the morning and afternoon rush-hours. This may reduce the emission especially during the days and hours, when air quality in traffic environments is the poorest.
Objective of the measure	Objective is to reduce emissions in the city area at times, when air quality is poorest.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low at city level, but may locally decrease the highest concentrations.
Air quality impact	Low at city level, but may locally decrease the highest concentrations.
Other impacts	May improve urban mobility and quality of life among the citizens.
Responsible authority	City of Skopje, other administrative bodies, private companies
Timeframe for implementation	Can be implemented immediately
Costs	This measure requires only minimal administrative effort going towards putting in place part-time and/or teleworking arrangements for public employees and towards promoting these solutions to other employers. These tasks can be carried out by existing staff, so no additional costs arise. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Mainly a voluntary action, but may be promoted effectively.
Connection to other plans	
Present status	Not implemented

MEASURE NO	**22**
MEASURE NAME	**Supporting car-pooling and car sharing**
Target sector	Traffic
Description of the measure	Promoting car-pooling and car sharing voluntarily by information campaigns etc. may reduce traffic volumes in the city area
Objective of the measure	Objective is to reduce traffic emission in general.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low
Air quality impact	Low
Other impacts	
Responsible authority	City of Skopje, companies providing the car-pooling and car-sharing services
Timeframe for implementation	Can be implemented immediately.
Costs	An information campaign run by the city government incurs only relatively small ***administrative costs***. These mainly consist of the costs of organising the campaign (which may require hiring additional staff) as well as designing, printing and distributing the information material. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	A voluntary action, which can be promoted by the city and the municipalities.
Connection to other plans	Sustainable energy action plan
Present status	A local pilot project has been implemented

MEASURE NO	**23**
MEASURE NAME	**Expand and develop systems for renting electric scooters and bicycles**
Target sector	Traffic
Description of the measure	Promoting vehicle renting services voluntarily by information campaigns etc. may reduce traffic volumes in the city area
Objective of the measure	Objective is to reduce traffic emission in general.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low
Air quality impact	Low
Other impacts	
Responsible authority	City of Skopje, municipalities in the City of Skopje, private companies
Timeframe for implementation	Can be implemented immediately.
Costs	This measure incurs some small ***administrative costs*** for organising the information campaign as well as designing, printing and distributing the information material; additionally, for expanding the rental systems for electric scooters and bikes. The ***compliance costs*** of purchasing, installing and maintaining more public city bikes and scooters fall mostly on the government but can ideally be supplemented with some sponsorship by private companies. The costs are relatively small, as some infrastructure already exists and the scheme only needs to be expanded. Currently, the City of Skopje funds the purchase of 100 bikes per year with 10,000 EUR. To this must be added a moderate additional amount for maintenance. Households incur the expense of renting the bicycles, but this only costs 10 MKD per hour. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	
Connection to other plans	Sustainable urban mobility plan
Present status	250 bikes already available in 5 renting points by a Public Enterprise City Parking Skopje. Further adoption in 2017.

MEASURE NO	**24**
MEASURE NAME	**Improving public (bus) transport: e-tickets, smart ticketing, tariff policy, information system (smart mobility), etc.**
Target sector	Traffic
Description of the measure	Improving bus transport services gives a better alternative for the use private cars in the city area. Modern technology gives numerous possibilities for so-called high-quality public transport with good quality of service. The introduction of a unique ticket to be used for all public transports should be promoted. The creation of real-time e-bus showing real-time time-tables and waiting times increases the quality of the service. Smart phone applications can be created for the system.
Objective of the measure	Objective is to reduce traffic emission in general and to promote the use of public transport and make it more user-friendly.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	In the long-run may be effective, if public transport becomes a real alternative for the use of private cars.
Air quality impact	In the long-run may be effective, if public transport becomes a real alternative for the use of private cars.
Other impacts	Good quality public transport may have a positive effect on the general atmosphere of the city and citizens.
Responsible authority	City of Skopje, bus companies
Timeframe for implementation	Short - Medium
Costs	The ***administrative costs*** of this measure are not small. Especially the unique ticket for all means of public transport requires substantial negotiations to co-ordinate an agreement among the city transport companies, regarding time-tables as well as tariffs. Setting up the e-ticketing and other online systems likely also requires hiring the services of additional IT experts, if only temporarily. The ***compliance costs*** involve funding the construction and maintenance of the necessary physical and electronic infrastructure (GPS system for the buses, monitors showing the real-time time-tables, readers for e-tickets and smart ticketing, development of mobile phone apps etc.). According to the City of Skopje Department of Traffic, the IT system for e-ticketing and the real-time timetables alone cost 3 million EUR. <u>Assessment: 3 (expensive)</u>
Other requirements (technical, social etc.)	The possibility of introduce a unique transport ticket requires an agreement among the transportation companies in Skopje.
Connection to other plans	National plan for the ambient air quality protection, Strategy for Health and Environment, Sustainable urban mobility plan
Present status	New E-ticket system with new information systems starts 1.1.2017. Other forms of support are planned.

MEASURE NO	**25**
MEASURE NAME	**Increasing bus fleet and expanding and re-routing the bus network**
Target sector	Traffic
Description of the measure	Increasing the present bus fleet (traffic frequencies etc.) and expanding the bus network without any other improvements may be the first step to improve the competitiveness of the public transport. Rerouting bus network so that the routes are as effective as possible, also taking into account the public demand.
Objective of the measure	Objective is to reduce traffic emission in general.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Immediate effects may be minor.
Air quality impact	Effects depend on how much public transport can substitute the use of private cars.
Other impacts	
Responsible authority	City of Skopje, bus companies
Timeframe for implementation	Some changes can be made in a short time.
Costs	The administrative tasks required to implement this measure can probably be carried out by the present staff of the city administration with some assistance from external consultants and in collaboration with private bus companies. They involve re-organising the bus schedules such that an expanded service can be offered (increased frequency, greater area coverage, better interconnections between lines). In addition, negotiations and co-ordination will be needed between the city and the bus companies in order to achieve the service improvements. Overall, the ***administrative costs*** are likely to be moderate. The ***compliance costs*** involve expenses for purchasing additional buses as well as investments in physical infrastructure (bus stops and time-table posts, online information). Depending on the scale of the measure (area coverage, extent of bus fleet expansion), these costs can be substantial. For instance, the City of Skopje is planning to spend 15 million EUR on 25 new e-buses at 600,000 EUR for a bus. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	Requires investments to the bus fleet. May need some financial support from the city. Optimization of the network may require an agreement between the City of Skopje and the bus companies.
Connection to other plans	National plan for the ambient air quality protection
Present status	Implementation in progress

MEASURE NO	**26**
MEASURE NAME	**Substituting old buses with new ones and/or installing particle filters to the public transport buses and defining minimum emission standards for the city buses**
Target sector	Traffic
Description of the measure	As long as the present bus fleet is in use, particle filters may be installed to them to reduce the particle emissions. At the same time substitution of the old bus fleet should start. For the new buses progressively tightening emission limits may be defined, especially for the buses that are used in the central parts of the city.
Objective of the measure	Objective is to decrease emission from city buses.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Effect may be noticeable at the city level in traffic environments.
Air quality impact	Noticeable at city level in the long-run.
Other impacts	
Responsible authority	City of Skopje, bus companies
Timeframe for implementation	Medium
Costs	The ***administrative costs*** of this measure include co-ordinating and enforcing with the private bus companies the replacement of the bus fleet and the installation of the particle filters; and defining the minimum standards for the city buses. This may be possible to achieve with existing staff, so the administrative costs should be low. Implementing this measure likely requires substantial ***compliance costs***. Eventually, the entire existing bus fleet must be substituted with new, environmentally friendlier vehicles, which are costlier than the older models. Until the substitution is achieved, particle filters need to be purchased and installed. Depending on the scale of the replacement chosen, this can be a considerable investment, falling both onto the city government and private bus companies. For example, the 300 new Euro-4 class buses (double-decker and regular) purchased in 2012 cost 60 million EUR. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	Requires investments to the bus fleet. May need some financial support from the city. May need change in the license policy with the private bus company.
Connection to other plans	National plan for the ambient air quality protection, Sustainable urban mobility plan, Sustainable energy action plan
Present status	Implementation in progress; 312 new buses procured with Euro 4 and Euro 5 engines. New electric buses come into use in the near future

MEASURE NO	**27**
MEASURE NAME	**Further construction of separate traffic lanes for buses and taxis and related signs**
Target sector	Traffic
Description of the measure	Constructing separate lanes for buses and taxis in the city center and in the main streets giving priority to public transport. The bus and taxi lanes must be signed better.
Objective of the measure	Objective is to decrease the traffic emissions in general and increase attractiveness of public transport.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low
Air quality impact	Low
Other impacts	
Responsible authority	City of Skopje
Timeframe for implementation	Medium
Costs	Regarding ***administrative costs***, the measure requires planning the new layout of the traffic lanes and procuring the services of construction companies to put it into practise. Furthermore, there are some small costs to incur for the information campaign raising public awareness of the new rules regarding priority for public transport on the bus lanes. Overall, administrative costs are minimal. The ***compliance costs*** mainly involve the expenditures for altering the street layout, turning some lanes into priority lanes for public transport and/or paving entirely new lanes. In addition, new road signs must be purchased and installed, indicating the new lanes reserved for public transport. The overall costs of the measure depend on the scale chosen. The measures recently taken by the City of Skopje did not require constructing new lanes and were therefore relatively inexpensive. Assessment: 0-1 (inexpensive to moderately expensive)
Other requirements (technical, social etc.)	May requires investments to the street infrastructure. Moreover public campaigns are required in order to raise the awareness of population in keeping the bus lanes free from other traffic.
Connection to other plans	Sustainable urban mobility plan
Present status	Partially implemented and further implemented in 2017

MEASURE NO	**28**
MEASURE NAME	**Progressive renewal of the taxi fleet e.g. by license release policy**
Target sector	Traffic
Description of the measure	Renewal of the present taxi fleet can be done e.g. with license release policy so that the requirement for a license renewal is that the taxi in use meets certain emission limits.
Objective of the measure	Objective is to decrease emission from taxis.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	May be low at the start.
Air quality impact	May be low at the start
Other impacts	Causes extra costs for the taxi companies.
Responsible authority	City of Skopje
Timeframe for implementation	Medium - long
Costs	The ***administrative costs*** associated with this measure are minimal. The license release policy must be reformed and the new policy applied, monitored and enforced. This can be achieved with current city government staffing levels. The ***compliance costs*** fall onto the private taxi companies, who will be required to invest in new low-emission cars such as hybrid and electric ones, in order to get their licenses renewed. These costs are likely substantial, given that low-emission cars are still on the expensive side. For instance, of the 300 licenses for e-, green or hybrid taxi vehicles introduced in 2011, so far only one has been taken up, most likely because of the cost of these cars. <u>Assessment: 3 (very expensive)</u>
Other requirements (technical, social etc.)	Requires investments to the taxi fleet. May need some financial support from the city.
Connection to other plans	Sustainable urban mobility plan
Present status	Partially implemented: City of Skopje has released 300 taxi licenses for hybrid and electric cars (only 1 licence issued)

MEASURE NO	**29**
MEASURE NAME	**Further subsidizing ticket prices for public transport**
Target sector	Traffic
Description of the measure	To increase the attractiveness of public transport the City of Skopje can subsidize ticket prices. This may decrease the use of private cars. The subsidizing should be permanent and could be raised in the future.
Objective of the measure	Objective is to decrease traffic emissions.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low unless the ticket price is really low.
Air quality impact	Low unless the ticket price is really low.
Other impacts	
Responsible authority	City of Skopje
Timeframe for implementation	Can be implemented immediately
Costs	Additional ***administrative costs*** should be minimal, as the existing subsidy programme simply needs to be extended. This can be done with current staff in the city government. The ***compliance costs*** from an overall socio-economic viewpoint do not include the subsidy payment, as it is a transfer from government that benefits households. However for the city administration, the subsidy could mean a substantial funding requirement. This can be calculated using data on the number of public transport passengers that would benefit from the new subsidies and the subsidy amount per person. For example, the current subsidies for students, pupils and pensioners overall cost the City of Skopje some 1.5 million EUR per year. Assessment: 2 (expensive) [from financial not economic perspective]
Other requirements (technical, social etc.)	Can also be put into practice only during the most severe pollution episodes, if funding is limited. Can be put into practice also only for certain groups of people (students, elderly people, handicap etc.)
Connection to other plans	
Present status	Already free bus transport weekly for retired people and free transport for university and high school students and disabled people.

MEASURE NO	**30**
MEASURE NAME	**Introducing park-and-ride system to Skopje: providing parking in peripheral areas and creation of public transport connections to the city center**
Target sector	Traffic
Description of the measure	Park-and-drive system gives an opportunity for the citizens coming from outside the central city area to use the public transport system easily and safely.
Objective of the measure	Objective of the measure is to decrease traffic volumes and emissions in the central city area.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Combined with other measures concerning improvement of public transport may have positive effects in the long-run.
Air quality impact	Low at the start, but may be noticeable in the long-run.
Other impacts	Decreases traffic congestion in the city center.
Responsible authority	City of Skopje and municipalities of the City of Skopje
Timeframe for implementation	Long
Costs	The ***administrative costs*** of this measure include mainly planning and procuring the services of construction and transport companies who will be responsible for building the park and rides and expanding the public transport networks and infrastructure. The ***compliance costs*** will be borne by the city government and transport companies and will be large. Park and rides need to be carefully located at points where many passengers change transport modes, and they must be well-connected with a dense and accessible public transport network. If these conditions are met, they can be a very effective policy. To achieve this however, substantial infrastructure investments in parking garages and expanding public transport must be incurred. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	Needs investments to the parking areas and co-operation with the bus companies. Service level of the public transport must be better compared to the use private cars. The implementation of the measure shall be made together with the increasing bus fleet and expanding the bus network. Parking in the park-and-ride areas should be free.
Connection to other plans	Sustainable urban mobility plan
Present status	Not implemented

MEASURE NO	**31**
MEASURE NAME	**Parking policy and charges in the city center**
Target sector	Traffic
Description of the measure	With determined parking policy and with higher parking charges it is possible to decrease traffic coming into the city center.
Objective of the measure	Objective is to reduce traffic emissions in the city center.
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	May be noticeable in certain areas.
Air quality impact	May be noticeable in certain areas.
Other impacts	Increases incomes for the city
Responsible authority	City of Skopje, municipalities of City of Skopje
Timeframe for implementation	Can be implemented quite quickly
Costs	This measure may cause some small ***administrative costs***. The new parking zones must be planned and organised and the parking charges collected. Furthermore, additional parking inspectors may need to be hired to monitor and enforce the new parking zones. ***Compliance costs*** fall on the city government, which has to put up the required additional infrastructure (parking meters and signs) associated with the new parking zones. The costs to households in the form of higher parking charge payments represent a transfer to government and are therefore not included in an overall socio-economic assessment. From a financial viewpoint, their size depends on the precise fee increase that is implemented. This revenue could be used to fund supporting measures such as expanding the public transport network. <u>Assessment: 0 (inexpensive)</u>
Other requirements (technical, social etc.)	May not be socially acceptable among the citizens, especially before the implementation of improved public transportation. The money collected by parking fees should be used to promote the traffic measures.
Connection to other plans	Local Environmental Action Plan, Sustainable urban mobility plan, Sustainable energy action plan
Present status	In the city center parking is no longer free and zoning for parking fees already exists.

MEASURE NO	**32**
MEASURE NAME	**Expanding bicycle network and removal of urban barriers and establishing safe bicycle parking places**
Target sector	Traffic
Description of the measure	By improving cycling network and infrastructure it is possible that cycling becomes a better alternative to the use of private cars.
Objective of the measure	Objective is to reduce traffic and traffic emissions especially in the central parts of the city
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low at the start
Air quality impact	Low at the start
Other impacts	Public health benefits to the population
Responsible authority	City of Skopje, municipalities of City of Skopje
Timeframe for implementation	Can be implemented in a few years
Costs	The ***administrative costs*** are likely small, as the planning and enforcement of the measure can be accomplished with existing staff at the city government. The ***compliance costs*** for the city government and construction companies can be large, depending on the scale at which the measure is implemented. They involve infrastructure investments for expanding the bike lanes and removing barriers to ensure that smooth bicycle travel is possible. The number of existing bicycle parking spaces would need to be significantly expanded. For example, for bicycle routes 1 and 2 which are currently under construction, the cost is approx. 1.6 million EUR; routes 3 and 4, which will be built in future, will cost approx. 3.3 million EUR. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	Requires investments to the infrastructures
Connection to other plans	National plan for the ambient air quality protection, Strategy for Health and Environment, Third national communication on climate change, Sustainable urban mobility plan, Sustainable energy action plan
Present status	The City of Skopje is in the process of implementing the Project “Skopje – City of Bikes” for marking and partial reconstruction and construction of cycling roads, 4 corridors along the city and 6 connections in 2014-2017.

MEASURE NO	**33**
MEASURE NAME	**Establishment of new pedestrian zones and networks**
Target sector	Traffic
Description of the measure	By improving pedestrian zones and network and infrastructure it is possible that walking becomes easier and more attractive especially in the central parts of the city.
Objective of the measure	Objective is to decrease traffic emissions in general
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Low at city level
Air quality impact	Low at city level
Other impacts	Public health benefits to the population
Responsible authority	City of Skopje and municipalities in the City of Skopje
Timeframe for implementation	Can be implemented in a few years
Costs	The ***administrative costs*** of this measure are minimal, as the planning, procurement and monitoring tasks should be feasible to be carried out by current staff. The ***compliance costs*** involve expenditures on infrastructure, such as turning streets into pedestrian zones with new paving and some decoration, as well as signposts to indicate the pedestrian zone. In addition, alternative routes for the traffic that will be banned from the pedestrian zones must be found, requiring adjustments to the existing road network to allow for increased traffic volumes in other parts of the city, depending on how much traffic must be redirected. These costs are likely to be high. For example, according to the deputy head of the Department of Traffic in the City of Skopje, the currently planned pedestrian zone near the parliament (500 m in length) involves a cost of 4 million EUR alone to tear down an existing building to make way for a diversion street for traffic, among other reasons due to property rights issues. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	Requires investments to the infrastructure
Connection to other plans	Sustainable urban mobility plan
Present status	Study has been prepared on greening and afforestation of the City of Skopje, including the formation of so called green corridors along the banks of Serava and Lepenec rivers. The study envisages creation of continuous green and pedestrian corridors and connected greenery systems. A new pedestrian street is planned to the city centre.

MEASURE NO	**34**
MEASURE NAME	**Grants to employers and local authorities, if they encourage staff and clients to cycle or walk.**
Target sector	Traffic
Description of the measure	Local administrative bodies and private employers can encourage their workers to come to work by cycle or by walking. This can be promoted e.g. by campaigns or competitions.
Objective of the measure	Objective is to decrease traffic emissions in general,
Target pollutant	Primary pollutants are NO_2, CO, PM_{10} and $PM_{2.5}$.
Change in concentration	Effect minor at the city level
Air quality impact	Effect minor at the city level
Other impacts	Positive health effects for personnel
Responsible authority	City of Skopje, other administrative bodies, private companies
Timeframe for implementation	Implementation can take place immediately
Costs	Organising the promotional campaigns and/or competitions for this measure incurs small ***administrative costs***. Some ***compliance costs*** for local authorities and firms might also arise due to the need to provide bicycle parking spaces if more of their staff and clients choose to cycle. Assessment: 0-1 (inexpensive to moderately expensive)
Other requirements (technical, social etc.)	Workers must be motivated.
Connection to other plans	
Present status	Not implemented in the city administration. Is implemented in some private companies, for example in the cement factory.

MEASURE NO	**35**
MEASURE NAME	**Car-free days**
Target sector	Traffic
Description of the measure	Organizing car-free days supports citizen's consciousness of the environmental issues like air pollution. Car-free days are a European wide initiative aimed to stop the motor vehicles for a day (usually on Sunday) and to promote sustainable city traffic in general. During these days administrations can organizes further initiatives to raise the awareness of people toward environmental issues.
Objective of the measure	Objective is to raise awareness among the citizens so that they have a better understanding how and how much traffic influences the local air quality.
Target pollutant	All.
Change in concentration	May be locally significant during the day of stop.
Air quality impact	Low
Other impacts	Citizen's general awareness of environmental issues rises.
Responsible authority	City of Skopje and municipalities in the City of Skopje
Timeframe for implementation	Implementation can the place immediately.
Costs	Implementing this awareness-raising measure involves only the small ***administrative costs*** of organising the accompanying information campaigns. These require some organisational effort as well as designing, printing and distributing the information material and can likely be covered with current staff levels at the city government. Assessment: 0 (Inexpensive)
Other requirements (technical, social etc.)	Requires information and campaigns for support. Social acceptance may be higher if the car free days are promoted during the week-end (no work related commitments). Needs enhanced public transport during the event. Environmental and social NGOs can be involved in the measure arrangement.
Connection to other plans	Sustainable energy action plan
Present status	Not implemented. European mobility week has been adopted.

MEASURE NO	**36**
MEASURE NAME	**Continuous supervision of A and B permits installations and their emissions and measures proposed for air protection by installations**
Target sector	Industry
Description of the measure	Usually the most efficient way to reduce emissions from industry and energy production is to apply stricter emission limits. Authorities in the permit processes must apply new and modern emission limits, which are based on the most recent guidelines or limit values. Regular supervision of the permits and companies is important to be guaranteed, that the regulations are obeyed.
Objective of the measure	Aim is to reduce the emissions to a level, which is in accordance with the present legislation and guidelines, and take into account that the emissions do not cause harmful effects at the local level.
Target pollutant	All, but especially PM_{10}, NO_x, SO_2 and VOC.
Change in concentration	Varies from installation to installation. May be noticeable locally, but at city level small.
Air quality impact	Varies from installation to installation. May be noticeable locally, but at city level small
Other impacts	Provides reliable emission data for air quality planning
Responsible authority	Local environmental administration responsible for supervision, State environmental inspectorate and Ministry of Environment and physical planning
Timeframe for implementation	Continuous
Costs	Some small administrative costs related to this measure arise if there is a need to hire more inspectors to monitor and enforce the implementation of the proposed stricter emission limits and measures for air protection at the installation level. The compliance costs fall onto the firms responsible for the installations holding A and B permits. These costs can be substantial in the longer term, as firms are required to continuously improve their emissions abatement technology to comply with the policy. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	A permit installations are at the responsibility of the state inspectors. Implementation of the new limit values for emissions considering time-table must be realistic, but also short enough. Supervising personnel need to have the required knowledge.
Connection to other plans	National plan for the ambient air quality protection, Strategy for Health and Environment
Present status	In progress

MEASURE NO	**37**
MEASURE NAME	**Promotion of voluntary tools for environmental improvement (eco-label, ISO 14 001, EMAS, cleaner production concept, ESCO etc.)**
Target sector	Industry
Description of the measure	Voluntary environmental improvement e.g. with environmental management systems give the companies a possibility to improve their technology, energy efficiency etc. in a way that is most suitable for them.
Objective of the measure	Objective is to decrease emissions in general
Target pollutant	Primary pollutants vary from company to company
Change in concentration	May have local importance. Low at city level.
Air quality impact	May have local importance. Low at city level
Other impacts	May also save money for the companies, if e.g. energy or material efficiency is improved.
Responsible authority	City Of Skopje, municipal environmental unit, Ministry of Environment and Physical Planning
Timeframe for implementation	Implementation can take place immediately
Costs	This measure incurs only the small administrative costs associated with the city government organising information campaigns about the voluntary tools for environmental improvement. For example, these require designing, printing and distributing information material. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	A voluntary and information measure
Connection to other plans	National plan for the ambient air quality protection
Present status	Some action has been taken already by the City of Skopje

MEASURE NO	**38**
MEASURE NAME	**Regular dust control at construction and demolition sites: water spraying and regular washing of truck wheels before they leave the construction or demolition site**
Target sector	Industry
Description of the measure	Dust emissions from local construction and demolition sites may be a significant local emission source, although the impacts may be temporary at each site.
Objective of the measure	Aim is to reduce local PM_{10} concentrations in the city area.
Target pollutant	PM_{10}
Change in concentration	Locally large, regionally small
Air quality impact	Locally large, regionally small
Other impacts	
Responsible authority	Local environmental unit, City of Skopje (inspection), construction and demolition companies
Timeframe for implementation	Immediately
Costs	The ***administrative costs*** of this measure are related to its monitoring and enforcement. Since the measure would expand on existing similar ones covering road construction, some additional inspectors would probably need to be hired. The ***compliance costs*** fall onto the private construction companies whose responsibility it would become to ensure the dust emissions from their sites are minimised via washing of equipment such as truck wheels before they leave the site. These costs are generally not large. Assessment: 1 (moderately expensive)
Other requirements (technical, social etc.)	Requires decrees and inspection. The measure shall be mandatory by local or national legislation.
Connection to other plans	Strategy for Health and Environment
Present status	In progress for road construction etc., but not for all construction sites. In accordance with the Law on Public Cleanliness, intensified inspection controls were made at the construction sites in the City of Skopje regarding heavy vehicles exiting the sites with dirty tires and proper covering of the load of the trucks by municipal inspectors of the City of Skopje.

MEASURE NO	**39**
MEASURE NAME	**Study on developing waste management systems: waste recycling, reuse and recovery as energy source prior to its final disposal; energy recovery from incineration of municipal waste; recovery of biogas from organic fraction of municipal solid waste**
Target sector	Waste management
Description of the measure	A study of the future waste management of the Skopje region or even larger area is needed to define the possible solutions and techniques. Modern waste treatment systems decrease emissions from landfills and also emissions from illegal burning of waste and farming residues. Energy recovery from incineration of municipal waste replaces energy production by other fuels and decreases total emissions. By collecting the biodegradable and non-recyclable waste fractions effectively and treating them in modern waste treatment plants decreases emissions to air.
Objective of the measure	Objective is to decrease all emissions from inadequate and illegal waste disposal and treatment at the city level.
Target pollutant	Primary pollutants are PM_{10}, $PM_{2.5}$, VOCs, PAH and methane.
Change in concentration	In the long-run may have noticeable effect
Air quality impact	In the long-run may have noticeable effect at city level
Other impacts	Improves quality of waste management in general. Decreases the use of other fuels in energy production and green-house gas emissions Decreases also other effects of landfills (water and ground water pollution) and decreases general untidiness of the environment.
Responsible authority	City of Skopje, municipal environmental unit (supervision)
Timeframe for implementation	Implementation can take place gradually, but as a whole may need long time.
Costs	The ***administrative costs*** of this measure include carrying out - or paying for external experts to carry out - a feasibility study and deciding within the city government the appropriate course of action regarding which systems to implement and how. Given the scale of the task of introducing an entirely new waste management system for the city, additional expertise from consultants or new staff may be required. Information campaigns will also be needed to educate citizens on the new system. Finally, the new system must be monitored and enforced, requiring inspectors. Overall, the administrative costs are likely to be moderate. The ***compliance costs*** involve the expenditures for setting up a modern waste collection, recycling and treatment infrastructure including garbage collection trucks for different types of waste (recyclable/non-recyclable), waste incineration plants and energy recovery facilities. In addition, households incur smaller costs for regularly recycling their waste. The measure does have the beneficial effect of reducing energy input costs from other fuels if energy recovery from waste is effectively implemented. In total, however, costs of several million EUR are likely.

	Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	Requires investments to the collection and transport and treatment technologies. Increases costs for the households. Requires also proper feasibility study and safeguarded funding with the support of government. Requires up-to-date waste legislation and its supervision. Funding must be guaranteed. May also need public information to support the requirements.
Connection to other plans	National plan for the ambient air quality protection
Present status	Not implemented. The City of Skopje adopted the second Waste Management Plan. The City is in favor of the policy for separation and recycling, and the citizens are being educated for a longer period now, and there are also a number of recycling companies.

MEASURE NO	**40**
MEASURE NAME	**Introduction of a systems for collection of gases released from landfills**
Target sector	Waste management
Description of the measure	Landfill gases have local negative air quality impacts and cause odour problems and they are also greenhouse gases that speed up climate change.
Objective of the measure	Objective is to reduce the emission from landfills, especially methane and VOC emissions.
Target pollutant	Primary pollutants are VOCs
Change in concentration	Locally may be significant
Air quality impact	Locally may be significant
Other impacts	Landfill gas can be used for local energy production
Responsible authority	City of Skopje, municipal environmental unit, waste management company
Timeframe for implementation	Medium - long
Costs	The ***administrative costs*** of this measure cover planning, monitoring and enforcing it. These tasks can be completed with current levels of city government staffing. The ***compliance costs*** fall onto the public and/or private companies managing landfills. The infrastructure for collecting gases must be installed and maintained, and so must facilities for recycling the gases for energy production. Since there is currently only one landfill in operation in the city of Skopje, the overall costs are not likely to be very large. Assessment: 1-2 (moderately expensive to expensive)
Other requirements (technical, social etc.)	Investments needed at the landfill. Gas must be utilized for energy production.
Connection to other plans	National plan for the ambient air quality protection
Present status	Studies made in the past to find out the economic possibilities to collect landfill gas. So far it has not been profitable.

MEASURE NO	**41**
MEASURE NAME	**Increase the use of renewable energy sources in energy production in public buildings: solar power, geothermal energy, biofuels etc.**
Target sector	Energy production and use
Description of the measure	The City of Skopje could increase the use of renewable energy sources in its own municipal buildings.
Objective of the measure	The decease emissions especially from machinery, traffic and heating. In this way public administration may at the local level give an example to private sector of environmentally friendly activities.
Target pollutant	All
Change in concentration	Small at first. If changes in the use of fossil fuels are large, also changes in concentrations of pollutants may be significant later on.
Air quality impact	Small at start, may be greater later on.
Other impacts	Other environmental benefits may be gained at the same time.
Responsible authority	City of Skopje and municipalities in the City of Skopje, public administrations
Timeframe for implementation	Medium - long
Costs	The costs arising from this measure are similar in type to measure 10: ***administrative costs*** relate to planning and organising the construction of local networks for renewable energy sources. ***Compliance costs*** relate to purchasing and installing renewable energy production units (solar panels, geothermal heat pumps) and heating installations in public buildings. According to experts from the City of Skopje, solar panels cost between 400 and 500 EUR per installation and household, while geothermal energy installations cost from 2,500 EUR upwards. However, the everyday heating costs using solar and geothermal energy are low compared to traditional energy sources (electricity, district heating). The overall costs of using modern energy sources in public buildings are lower than for measure 10, since likely only a double-digit number of buildings must be converted instead of larger areas of the city. Assessment: 2 (expensive)
Other requirements (technical, social etc.)	Renewable energy sources must be available locally with reasonable price.
Connection to other plans	Sustainable Energy Action Plan, National Emission Reduction Program, National Plan for the ambient air quality protection, Third national communication on climate change
Present status	

MEASURE NO	**42**
MEASURE NAME	**Increasing energy efficiency and energy management and control in public buildings in general: thermostat sets, energy saving lamps, thermal insulation (wall, roof, windows)**
Target sector	Energy production and use
Description of the measure	Better energy efficiency decreases energy use and thus also emissions into the atmosphere.
Objective of the measure	Objective is to decrease emission in energy use and production
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	May be significant in the long-run
Air quality impact	May be significant in the long-run at the city level
Other impacts	Decreases energy costs in the long-run
Responsible authority	City of Skopje
Timeframe for implementation	Implementation can take place immediately step by step
Costs	The ***administrative costs*** of this measure cover planning, monitoring and enforcing it. They are likely to be minimal, as these tasks can be completed with current levels of city government staffing. ***Compliance costs*** fall onto government and can be substantial. The City of Skopje allocates an annual sum of approx. 330,000 EUR to increasing the energy efficiency of schools alone. Roofs, facades and windows are being replaced so that schools meet energy efficiency standards. To extend this measure to all public buildings would increase these costs, depending on the scale chosen. Assessment: 2 (expensive)
Other requirements (technical, social etc.)	
Connection to other plans	Sustainable Energy Action Plan, National plan for the ambient air quality protection
Present status	In progress. All buildings under the jurisdiction of the City which are connected to district heating have secondary regulation, i.e. economical regulation of the sub stations. The City of Skopje replaced the windows in all high schools, as well as in other buildings under its jurisdiction.

MEASURE NO	**43**
MEASURE NAME	**Minimum requirements of energy efficiency for new buildings (energy classes)**
Target sector	Energy production and use
Description of the measure	Better energy efficiency of the houses decreases heat consumption and thus energy consumption as well. Better energy efficiency may be gained by improving insulation of the windows, walls and roof of the houses.
Objective of the measure	The objective is to decrease emissions from heat production in general.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	In the long-term may be important.
Air quality impact	In the long-run may be important.
Other impacts	Decreases energy costs in long-term
Responsible authority	City of Skopje and municipalities in the City of Skopje (construction licenses), MTS
Timeframe for implementation	Medium
Costs	The ***administrative costs*** of this measure arise from designing the energy classes together with experts, as well as monitoring and enforcing their implementation. Extra costs are probably small, as the work can be completed by current city government together with a few external experts. The ***compliance costs*** must be incurred by builders, construction companies and homebuyers. New houses must be built with better-insulating materials that are more expensive and raise house prices. These investments are substantial but will be partly offset in the longer term by the energy savings they enable. Assessment: 1-2 (moderately expensive to expensive)
Other requirements (technical, social etc.)	The costs for households must be reasonable. Can be promoted by building licenses.
Connection to other plans	Sustainable Energy Action Plan, National Emission Reduction Program, National Plan for the ambient air quality protection, Third national communication on climate change.
Present status	According to the law new buildings need an energy efficiency passport.

MEASURE NO	**44**
MEASURE NAME	**Further improvement in public lightning: LED-lamps etc.**
Target sector	Energy production and use
Description of the measure	Less energy using public lightning decreases energy demand and thus emissions into the atmosphere
Objective of the measure	Objective is to decrease all emissions in energy use and production
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also CO, VOCs and PAHs are widely affected.
Change in concentration	Low, since power used in Skopje is produced outside Skopje agglomeration
Air quality impact	Effects at the national level.
Other impacts	Decreases energy costs in the long-run
Responsible authority	City of Skopje and municipalities in the City of Skopje
Timeframe for implementation	Medium - long
Costs	The ***administrative costs*** of this measure are minimal, as the planning and inspection tasks can be carried out by current staff. ***Compliance costs*** fall onto government and involve changing the public lighting system. The capital investment costs of introducing LED light systems in areas of the city that are not yet covered would be substantial, as LED lights are about two to four times more expensive to install than conventional lights. On the other hand, LED lighting achieves substantial energy and maintenance cost savings when operational (40% to 80% energy savings depending on the incumbent lighting source and 50% to 75% maintenance savings). However, these savings are small compared to the initial infrastructure investments required. Assessment: 3 (very expensive)
Other requirements (technical, social etc.)	
Connection to other plans	Sustainable Energy Action Plan
Present status	Some energy saving lamps are in use. The entire illumination in the city center (buildings, bridges etc.) is with LED lights.

MEASURE NO	**45**
MEASURE NAME	**Information campaigns: energy efficiency, waste burning, burning of farming residues and wild fires, low-impact mobility systems (cycling, walking etc.) and health effects of air pollutants**
Target sector	Public information
Description of the measure	Different kinds of campaigns that are related to air quality issues rise citizen's awareness. Raising awareness gradually leads to changes in people's behaviour. General information of air pollutants, their origin, their effects and ways to avoid emissions can be given to citizens and also to private sector. It is also important to inform, where one can find data of local air quality, especially since the national air quality portal is in use. Information can be delivered through media (newspapers, radio, TV), in internet, in schools etc. There are regulations and guidelines concerning waste burning and burning of farming residues and also concerning wild fires. However these activities are still quite common and occasionally may affect local air quality significantly.
eObjective of the measure	Objective is to raise people's awareness and to change their behaviour to be more environmental friendly. Aim is also to decrease diffuse emissions at local level. These emissions are especially connected to back-ground concentrations of PM_{10}.
Target pollutant	All, but primary pollutants are PM_{10} and $PM_{2.5}$, but also VOCs and PAHs are affected
Change in concentration	In general level the impact is small, but locally may be significant at certain periods of time, and especially for acute episodes of pollution.
Air quality impact	Small or medium
Other impacts	Citizen's general awareness of environmental issues rises.
Responsible authority	City of Skopje and municipalities in the City of Skopje, support from Ministry of Environment and Physical Planning, Ministry of Health and Institute of Public Health
Timeframe for implementation	Implementation can start immediately.
Costs	An information campaign run by the city government incurs only relatively small ***administrative costs***. These mainly consist of the costs of organising the campaign (which may require hiring additional staff) as well as designing, printing and distributing the information material. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Requires carefully planned information and campaigns to be effective. Information should be regularly planned as mandatory in the schools. It would be useful to produce materials for the whole country.
Connection to other plans	Third national communication on climate change, National plan for the ambient air quality protection, Sustainable Energy Action Plan, Strategy for Health and Environment
Present status	Air quality portal at the national level. Some materials has been produced. The City of Skopje has an office in charge of energy efficiency, which works with companies and

	interested citizens. Each year an event is organized called energy efficiency week in the City of Skopje with lectures, practical examples, promotions, education, new ideas etc.

MEASURE NO	**46**
MEASURE NAME	**Training of journalists at the local level concerning air quality issues: providing interactive seminars, workshops and briefing meetings etc.**
Target sector	Public information
Description of the measure	Media has a fundamental role in delivering correct information concerning air quality issues and situation. For this reason they must have the basic knowledge concerning air quality issues, in order to provide a correct information to the public.
Objective of the measure	Objective is in general to raise public awareness of air quality issues
Target pollutant	All
Change in concentration	No direct effects on concentrations
Air quality impact	Low at start, but more significant in the long-run
Other impacts	
Responsible authority	Ministry of Environment and Physical Planning, City of Skopje, municipal environmental unit
Timeframe for implementation	Implementation can take place immediately.
Costs	This measure incurs administrative costs for designing and organising training courses for journalists and the compliance costs of funding these. Both costs fall onto local government but are likely to be small. For the City of Skopje and its municipalities, the courses would probably need to allow for about 50 to 100 journalists covering relevant subjects over a 10-week period. It should be possible to cover this with five to six trainers. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	
Connection to other plans	
Present status	Not implemented

MEASURE NO	**47**
MEASURE NAME	**Regular upgrading and updating of the local emission cadastres with sufficient scale of data and Improvement of the inventory of air emission**
Target sector	Administrative policies
Description of the measure	Reliable and updated cadastres of pollutants emissions are essential for emission inventories and air quality planning. Cadastres must be kept also at the local levels concerning B permit installations, traffic, domestic heating, construction etc. Emission inventory should be updated each year and also emissions from non-point sources (traffic, domestic heating, SMEs) should be calculated regularly
Objective of the measure	Objective is to provide reliable and accurate emission data for air quality planning. Emission database is the basis for air quality assessment and also for the measures to improve local air quality.
Target pollutant	All
Change in concentration	No direct effect on concentrations
Air quality impact	Indirectly significant
Other impacts	In the future emission inventories are easier and quicker prepare
Responsible authority	City of Skopje, municipal environmental unit
Timeframe for implementation	Implementation can take place immediately
Costs	Both ***administrative*** and ***compliance costs*** associated with this measure fall on the city government and the municipalities. Introducing, maintaining and expanding the local emission cadastres and improving the air emission inventory should require hiring at most one or two additional experts per municipality (if at all), so the overall costs would be low. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Requires continuous data collection and updating. May require separate data systems.
Connection to other plans	National plan for the ambient air quality protection, Strategy for Health and Environment
Present status	Basic local cadastre build in 2016.

MEASURE NO	**48**
MEASURE NAME	**Use of dispersion models for air quality assessment in urban areas (EIA) in especially city and traffic planning**
Target sector	Administrative policies
Description of the measure	Dispersion modelling gives an opportunity to assess what is the air quality impacts of different emissions sectors and emission points and also calculate the impact of future scenarios. By using model calculations it is possible to assess air quality at local and regional level and to assess what is influence of certain air quality measures to the local concentrations.
Objective of the measure	Objective is to improve air quality assessment and to help choosing the most effective measures to be implemented for air quality improvement.
Target pollutant	Mainly SO_2, NO_x, CO and PM_{10} and $PM_{2.5}$.
Change in concentration	No direct effect
Air quality impact	Indirectly may be significant
Other impacts	
Responsible authority	City of Skopje, municipal environmental unit and urbanism and traffic units, consulting companies, Ministry of Environment and Physical Planning
Timeframe for implementation	2-5 years
Costs	Implementing this measure incurs only minimal ***administrative costs***, as the tasks of procuring the services of consulting companies who would provide the dispersion modelling can be completed by current staff of the city. The ***compliance costs*** of paying for these services should also be relatively low, especially if the modelling is not required at frequent intervals but e.g. only once a year. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Reliable models must be available for local circumstances. Reliable local meteorological data should be available. May need some support from MEPP. Consulting companies that provide the calculations must be skilled.
Connection to other plans	National plan for the ambient air quality protection, Strategy for Health and Environment
Present status	Preliminary actions have been taken by MEPP

MEASURE NO	**49**
MEASURE NAME	**Improved inspections concerning open waste burning, burning of farming residues and wild fires**
Target sector	Administrative policies
Description of the measure	There are regulations and guidelines concerning waste burning and burning of farming residues and also concerning wild fires. However these activities are still quite common and occasionally may affect local air quality significantly. Local authorities should pay more attention to these activities and take legal actions against performers of these activities.
Objective of the measure	To decrease diffuse emissions at local level. These emissions are especially connected to back-ground concentrations of PM_{10}.
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also VOCs and PAHs are affected.
Change in concentration	In general level the impact is small, but locally may be significant at certain periods of time, and especially for acute episodes of pollution.
Air quality impact	Small or medium
Other impacts	Improves general awareness of citizens in air quality issues.
Responsible authority	Municipal environmental inspectors, state environmental inspectors, Ministry of Agriculture, Forestry and Water Economy
Timeframe for implementation	Immediately
Costs	There are only ***administrative costs*** associated with this measure, and they are likely to be small. They relate to intensifying the monitoring and enforcement of the regulations that ban the burning of waste, farming residues as well as wild fires. Some additional staff may need to be hired to carry out the increased inspections. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Requires some time resources at the municipal level. The issue related to this measure concerns mainly the rural area surrounding the City of Skopje. The efforts should be focused to these zones.
Connection to other plans	
Present status	Partly implemented

MEASURE NO	**50**
MEASURE NAME	**Integration of air quality improvement to other policies**
Target sector	Administrative policies
Description of the measure	Effects on air quality and emissions are included in all other local policies that may affect air quality. These kinds of policies are especially climate policies, local traffic planning, local land use planning and waste management planning
Objective of the measure	To ensure that air quality policies are in accordance with other policies and that common benefits are gained by different policies.
Target pollutant	All
Change in concentration	May be significant in long-term.
Air quality impacts	May be significant in long-term.
Other impacts	Optimizes environmental benefits in general
Responsible authority	Skopje Region, Ministry of Transport and Communications, Ministry of Economy, Ministry of Health, Ministry of Interior. and all other relevant institutions
Timeframe for implementation	2-5 years
Costs	This measure would "mainstream" air quality issues into local legislation, similar to "climate change mainstreaming", which is promoted by supra-national organisations like the United Nations, the European Union or the World Bank. Implementing this measure requires technical knowledge on air quality impact across the whole range of local polices as well as developing, monitoring and enforcing a comprehensive, long-term local air quality improvement strategy. This process may require hiring additional experts, but overall, these ***administrative costs*** are likely to be low. Assessment: 0 (inexpensive)
Other requirements (technical, social etc.)	Requires that the bodies that are responsible for each sector have the basic knowledge of air quality issues. Requires co-operation in the administration. If the policies are not in accordance, with each other, mitigation of negative consequences should be planned.
Connection to other plans	
Present status	Not implemented

MEASURE NO	**51**
MEASURE NAME	**Protection of existing green areas and enlargement of green areas in urban areas**
Target sector	Administrative policies
Description of the measure	Because green areas (vegetation) in some degree absorb air pollutants and prevent dust dispersion, especially if the areas are big enough, the existence of vegetation should be guaranteed in city planning and building of new areas. New parks and green areas can be built to the living areas.
Objective of the measure	Objective is to create environmentally friendly and healthy city in general
Target pollutant	Primary pollutants are PM_{10} and $PM_{2.5}$, but also other pollutants may be affected.
Change in concentration	Low
Air quality impact	Low
Other impacts	Creates more comfortable city landscape. Improves citizen's mental health and well-being
Responsible authority	City of Skopje and municipalities in the City of Skopje
Timeframe for implementation	Medium - long
Costs	This measure incurs no ***administrative costs***, as the tasks can be carried out by existing experts employed by the city or municipality administration. Moderate ***compliance costs*** could arise for the maintenance and expansion of existing green areas. These include the costs of purchasing additional land area as well as vegetation and constructing new parks. Assessment: 0-1 (inexpensive to moderately expensive)
Other requirements (technical, social etc.)	Protection of green areas must be taken into account in town planning and building of new areas.
Connection to other plans	National plan for the ambient air quality protection, Strategy for Health and Environment
Present status	Law on greenery was adopted (Official Gazette 71/16), Law on proclamation of the locality Park-Wood Gazi Baba as nature park (Official Gazette 55/15). Currently a Green Cadastre of the City of Skopje is being made (phase 1 completed – surveying of the areas). In 4 years 46,253 various types of trees and bushes were planted, including tree avenues along the boulevards, jardinières etc. A total of 308,000m^2 of green surfaces were established and reconstructed, including a hydrant network of 37 km long.