

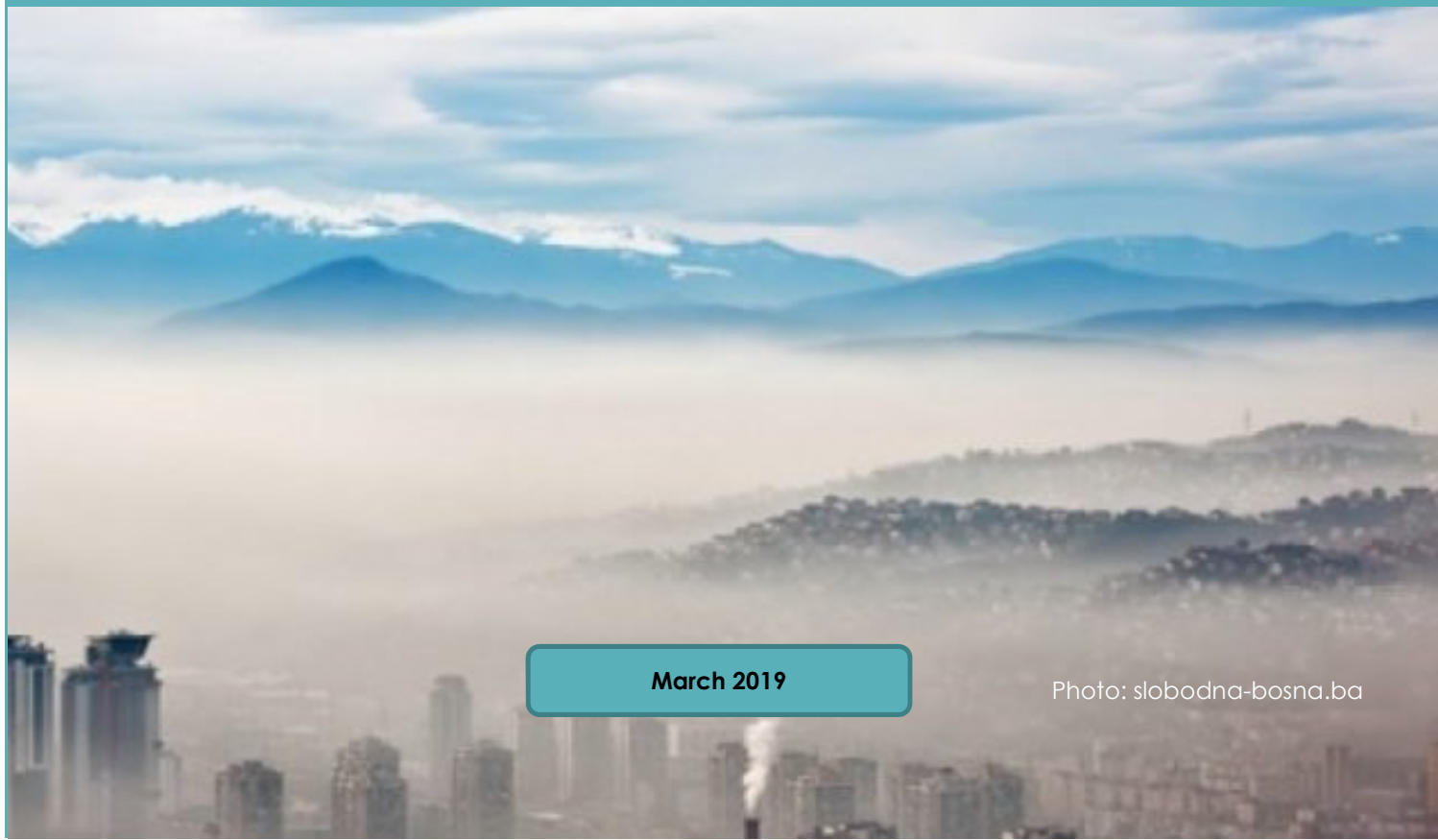
*Policy Brief:
Priority Measures for
Air Quality Improvement in the Sarajevo
Canton*

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March 2019

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Policy Brief:

Priority Measures for air Quality Improvement in the Sarajevo Canton

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Introduction

The air in the Sarajevo canton has been polluted for many years now. There are many causes for this condition, the most visible ones being in the cadastre of pollutant emissions, which indicates an increase, especially in solid particles, in many parts of the Sarajevo canton. The existing data on air quality measurements is underused. It should be primarily used for dispersion model calibration and air quality monitoring in real and integrated time. The effects of air pollution reduction measures, both in the periods of over-pollution and in the long run (multi-annual trend) can only be monitored by using an appropriate dispersion model that is calibrated by measuring. The use of such a model is required in managing all new emission sources, where the model serves as a tool which identifies the conditions under which new buildings may be planned, and whether they can be built or not.

It is necessary to take into consideration the aspect of influencing air quality in the process of the canton's development planning. The construction of new buildings increases the resistance to air flow and thus, the ventilation of the air is reduced. This is why it is necessary to conduct modelling of influences for planned operations to the air flow before adopting urban and zoning plans. This can be done by using specialised models, where the model optimises the planned operation, i.e. providing a solution that will have a minimum impact on the quality of air.

In order to reliably determine the share of individual emission sources in air pollution, it is necessary to conduct specific measurements in specific meteorological conditions. For example, during temperature inversion it is required to conduct air quality sampling at different heights, in settlements (with different heating systems), next to roads, etc.

Apart from the abovementioned activities, successful air quality management requires the inclusion of lower and higher levels of authority, certain ministries, inspection directorates, professional bodies, health protection organisations, etc. The air quality management system in the Sarajevo canton would be established through their systematic participation and defined responsibilities, duties, and rights, with clear procedures for conducting previously defined measures and ways of reporting on their implementation.

The lack of institutional, professional, and staff capacities, as well as the lack of equipment and use of modern environmental technologies in the area of air quality management was defined as a key issue in the canton's 'Environmental Protection Plan' for the following five-year period.

1. Air quality issues in the Sarajevo canton

The main aim of air quality management is to enable local development and at the same time, to provide favourable physical and chemical air characteristics. In terms of chemical air characteristics, "favourable" characteristics refer to a certain balance between the necessity of having clean air and the requirements for conducting activities that pollute the air.

In considering a strategy for preserving air cleanliness, it is important to split this issue into several different levels. The simplest is the division into four different levels of air pollution issues – local, regional, national, and global. Each level is defined by a time and space ratio, specific emission amounts and air pollution, the manifestation and effects of polluted air, and by appropriate air protection measures (technical and others). The division into levels enables a simpler understanding of the issue and the development of the strategy to maintain air cleanliness.

Emission sources are also differentiated by levels – at the local and regional level emission sources include the heating of homes and institutions, as well as industry and traffic, while at the national and global level, emissions come from stronger sources (big industrial facilities and thermal power plants), as well as emissions from surface sources (cities) and the emissions of certain countries and continents. The emission of traffic pollutants is significant at the local level only. The local level is particularly interesting for air pollution in the Sarajevo canton. The air pollution at this level originates from products of incomplete combustion of small fire beds and plants, as well as traffic. There are many small sources. The negative effects are felt only in the area of emission or in the area directly adjacent to it.

The ambient air quality monitoring in the Sarajevo canton is done by the Public Health Institute of the canton, which manages a network of monitors that measure basic pollution parameters (sulphur dioxide, nitrous oxide, solid particles, carbon monoxide, ozone, etc). The monitoring is done in accordance to the regulations of the Rulebook that contains instructions on how to monitor air quality and defines the types of pollutants, threshold values, and other air quality standards (Official Gazette of the FB&H, No. 1/12). The Rulebook fulfils the needs of the Ministry of Physical Planning, Construction and Environmental Protection of Canton Sarajevo. Air quality monitoring in Sarajevo is done through four automatic monitors that create a local network of monitors owned by the Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton, and two monitors owned by the Hydrometeorology Institute of the Federation of B&H, one of which is a background monitor. The monitors are located in Ilidža (Community Health Centre), Ilijaš, Otoka, and Vijećnica, while the FB&H monitors are located in Ivan Sedlo and Bjelave.

The monitoring of emissions from combustion plants is the responsibility of laboratories that are accredited with an ISO 17025 standard. The data collection and provision of records on combustion plants operators are the responsibility of the ministry with technical support from the Informatics and Statistics Institute of the Sarajevo canton. Due to the major importance of chimney sweeping operations in preserving air quality, the 'Decision on air quality protection and improvement in the Sarajevo canton', adopted by the canton's assembly upon the proposal of this ministry, defines the conditions that need to be met by natural and legal persons providing these services. Furthermore, it also includes the need to cooperate with the ministry and the inspection for environmental protection in cases where irregularities and excessive pollution are noted during the inspection of flue installations. Due to the

complexity and fragmentation of the administration (Federation, cantons, municipalities), as well as the lack of coordination mechanisms, it may be concluded that the air quality management is highly inefficient, even though competencies are appropriately defined to some extent.

1.1. Geographic and meteorological features

The geographic location of the Sarajevo canton "conditions" the emergence of several valleys which do not have an air connection between each other; the air quality in the Sarajevo valley is not the same as in the area of Vogošća, Ilijaš, Hadžići, etc. Central parts of the city are located in a composite Sarajevo valley that stretches from east to west and ends in the Sarajevsko Polje, surrounded by the mountains Bjelašnica and Igman in the south-west, Trebević in the south-east, as well as central mountains and inter-valley capes in the north and north-west. The average altitude of Sarajevsko Polje is 500 m.

The annual air temperature range has a fairly balanced growth from January to July and an articulate fall towards December. January is the coldest month with a negative average monthly value. However, it has happened over the years for February to be significantly colder or even warmer than March, so such temperature oscillations in the winter months result in the emergence of prolonged fog and temperature inversions. The strong valley character of the terrain is the main cause of frequent fog, especially in the morning.

Temperature inversion is a natural occurrence that is specific to the Sarajevo valley. An anthropogenic influence may strengthen this phenomenon. It is normal that air temperature decreases with height. In that case, there is a buoyancy of warm flue (exhaust) gas up in the air. However, it may happen that air temperature rises with height – near the ground (ground inversion) and at a certain height (raised inversion). Ground inversion occurs when the cold night air "slides" from a mountain and fills a valley. Raised inversion occurs in the case of a warm wind at a certain height. In temperature inversion zones, buoyancy of flue gases is downward and they pile up in the valley. Such meteorological conditions mostly impact negatively on the conditions of life in Sarajevo, in terms of air quality, because they cause thick fog that covers the city area.

Apart from temperature inversion, air flow has a great influence on air quality. In the winter period, when emissions reach their highest level, the Sarajevo canton area is characterised by a lack of wind. This is why the phenomenon of buoyancy flow is significant for ventilation. However, smog prevents sunrays from reaching the ground and buoyancy flow is difficult to achieve (as a result of the ground warming up), which again slows down the processes of air self-purification. The same effect occurs with snow on the ground, which should be removed from the streets. The ratio between the sunny and shady sides of a city in a valley is also important for the air self-purification processes. In winter, the sun is low in the south and during the day it warms the sunny side (the north slopes around Sarajevo). The buoyancy flow occurs on the same side and the polluted air from the valley rises up to the shady (north) side.

Besides atmosphere self-purification processes by air flow, another important process is a so-called turbulent diffusion, i.e. flow of polluted air from a place of higher concentration to a place of lower concentration. An example for this is the development of the Alipašino Polje settlement. This settlement (located in the western part of Sarajevo) led to a change in air quality in the east part of the city (Old Town and Centre). Namely, the intensity of the natural atmosphere self-purification is equal to the coefficient of turbulent diffusion and the

difference in concentrations of pollutants. Introducing new air pollution sources (in that period Alipašino Polje homes were heated using oil which contained a significant amount of sulphur) meant lowering the concentration gradient, which resulted in the slower ventilation of the Old Town and Centre municipalities.

At the same time, the air quality in the Sarajevo canton is strongly influenced by so-called heat islands. All the heat that is released is lost from buildings through chimneys, windows, walls, so this heated air warms up the surrounding area. This is why cities are warmer by 0.5 to 1°C than their surrounding areas. This air lifts up, creates sub-pressure and the air from the city periphery flows towards the centre. If there is an air pollution source in the periphery, the city gets ventilated with polluted air. There are two heat islands in Sarajevo, which explains why the highest air pollution is in the area of the Otoka settlement. This is the result of the existence of the two heat islands – the settlements to the east and west of Otoka. Polluted air from both heat islands comes down to the Otoka area.

1.1. Air quality and steps taken for its improvement

In order to take preventive and short-term measures to reduce emissions and slow down the trend of increasing air pollutants in case of unfavourable meteorological conditions in Sarajevo, the government of the Sarajevo canton has adopted an 'Intervention measures plan' in circumstances of increased air pollution. The 'Intervention measures plan' is a set of steps and a plan of action in case of an increased concentration of air pollutants.

As stated above, the geographical configuration of the Sarajevo canton and relatively high emissions into the air during certain periods of the year cause the accumulation of pollutants with a special emphasis on droplets floating in the air. Such episodes may last several weeks, in which period there is no air exchange in the canton's valleys, resulting in long periods of extremely high PM10 concentrations in the air.

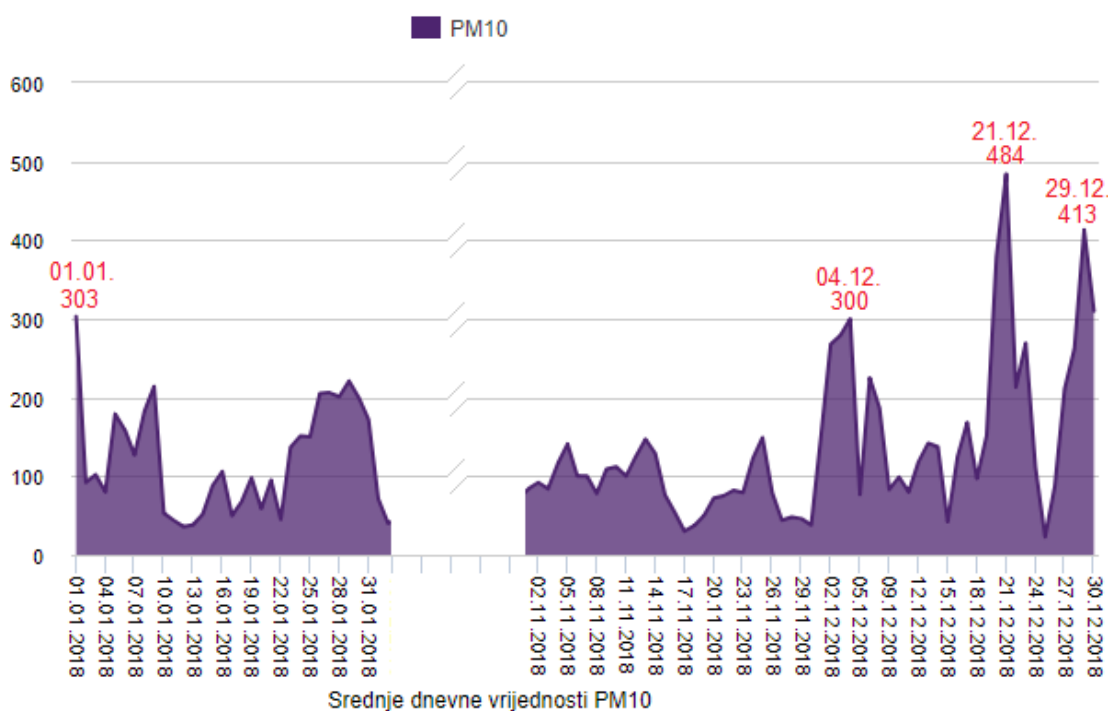


Figure 1 Overview of air quality in the Sarajevo canton in 2018 (part of the year) from the perspective of solid particles – PM₁₀ (source: EKO AKCIJA)



Solid particles (PM₁₀) influence air quality in the Sarajevo canton most. Their threshold value of 50 µg/m³ was exceeded 169 times in 2018. The number of times this is allowed to happen in one year is 35. Therefore, the average daily concentration of solid particles was exceeded almost **five times more than it is allowed**, when episodes lasting several days/weeks, during which the solid particles concentration is significantly above the threshold value, are highly indicative. This problem is significantly present in January, November and December, but it was recorded in other months of the year as well.

Although there is no formal indexing of air quality (which takes into account the synergistic effect of several pollutants), there are web portals that perform air quality indexing based on used methodologies, and warn the population of the consequences of excessive exposure. It is an extremely common occurrence that the air in Sarajevo is declared

"DANGEROUS", which is a warning that all categories of the population can suffer health consequences.

After a stable meteorological situation and temperature inversion occurs, it only takes 24-76 hours for the air pollutant concentration to reach extremely high values in Sarajevo. Hardly anything can be done to reduce the concentrations after the accumulation of pollutants. The resulting actions are slowing down or stopping the increase of air pollutants.

The biggest pollution sources in the Sarajevo canton are solid fuels (firewood, coal, etc.) and traffic. With the purpose of seeing the bigger picture of the air pollution range, it is necessary to conduct measuring and analysis campaigns in order to get real data on the origin of solid particles in this period and, in accordance with this, define and implement long-term and short-term measures. Considering that there are many individual sources, the influence of inspections is limited because they should be directed at bigger sources of floating particles, which means that the limited capacities of the inspection services could be used in a more efficient manner. The biggest number of solid fuel fire beds in the Sarajevo canton is found in small fire beds (in houses) and it is possible to systematically solve their emissions through the 'Intervention measures plan'. The activities for the reduction of emissions resulting from these sources should be implemented within long-term measures, which is limited in this plan. Vehicle emissions emerge after fuel combustion, as a result of the breaking system and use of tires, as well as due to road dust lifting up into the air. Most emissions come from vehicles with old diesel engines, where traffic congestions, general age, and technical malfunction of vehicles play a significant role.

One problem is the fact that the number of residential buildings in the Sarajevo canton is increasing, while the existing green areas, including protected zones, are used for their development. One may also note the inappropriate manner of construction in terms of spatial planning (the insufficient spatial distance between neighbouring buildings and

buildings that are too high reduce the air flow). At the same time, developing buildings with many apartments (therefore residents), is not followed by the development of accompanying public infrastructure (parks, parking lots, playgrounds, kindergartens, schools, banks, stores, etc.). The mixed character of certain zones and mixed purpose of space is common, i.e. there are buildings with different purposes (industrial buildings, tourism and recreation facilities, residential buildings, etc.) at a relatively small spatial distance between zones. Zone mixing has a negative impact on air quality, causing high levels of noise, but it also has a negative effect on health because spatial distance between zones is not respected, even though it was introduced to provide undisturbed quality of work or time spent in that area. Small parts of the Novi Grad municipality and the area of the Ilidža and Vogošća municipalities are exposed to the most intensive construction processes. Individual fire beds create the biggest problems in the area of housing and regarding the use of energy.

New residential buildings are mostly constructed without central air cooling and sanitary water preparation. In this way, an opportunity is missed for the sustainable use of natural gas through cogeneration and a whole spectrum of other positive effects.

2. Critical analysis of air quality in the Sarajevo canton

Due to its complexity, air quality management requires a multidisciplinary approach and taking different perspectives into consideration. For the needs of this document, several interviews have been conducted with local and international experts from different backgrounds. This document is a synthesis of different opinions, with the purpose of providing a critical analysis of the air quality in the Sarajevo canton, for the following aspects:

- heating (fuel, furnaces/boilers, energy efficiency)
- traffic (sustainable mobility, electric cars)
- spatial planning (sustainable urban planning)
- political action (changing the way of adopting and implementing decisions).

The critical analysis has been written while considering each aspect in terms of identifying the causes of excessive air pollution, proposing short-term and long-term measures, and identifying key interest groups (Figure 2).



Figure 2. Methodological approach to critical analysis

All experts who were interviewed agree that the air quality issue has multiple dimensions and that there are many causes and several potential solutions. Also, some experts doubt that there is enough evidence that may be used to determine the exact causes of excessive

pollution. Therefore, they urge for a stronger cooperation between all actors responsible for air quality management. In general, it is considered that citizens are not aware of the air pollution issue and its impact on their health, which results in low or no pressure on law makers.



The pressure is reduced to the period of the year when the pollution exceeds alarming values and when it is very difficult to improve the situation.

When it comes to **key causes**, the majority of the experts consider that the great need for **heating** (primarily in areas where solid fuel is used for heat generation) is one of the key causes of excessive air pollution. The origin of this cause is often related to an economic standard that is considered insufficient for citizens to afford environmentally friendly energy-generating products (gas, pellets). However, illegal construction is a cause of great need for

heating energy, which implies the use of coal, resulting in large emissions from furnaces.

Owners of non-efficient houses (often without any kind of facade) cannot afford to use gas due to the high costs that are primarily associated with the large amounts needed, and less so with its price.

Traffic is considered to be the second biggest air pollution cause, primarily due to old vehicles (private cars and public transport). Apart from this, an increase in motorisation has been noted, i.e. the tendency for most citizens to own a personal car, while the popularity of public transport is decreasing. Furthermore, it was noted that roads are not well-maintained (in terms of cleaning), which results in dust swirling and influencing the pollutant concentration in the air. Also, it has been stressed that the existing infrastructure is a bottleneck in certain parts of the city, which leads to traffic congestions.

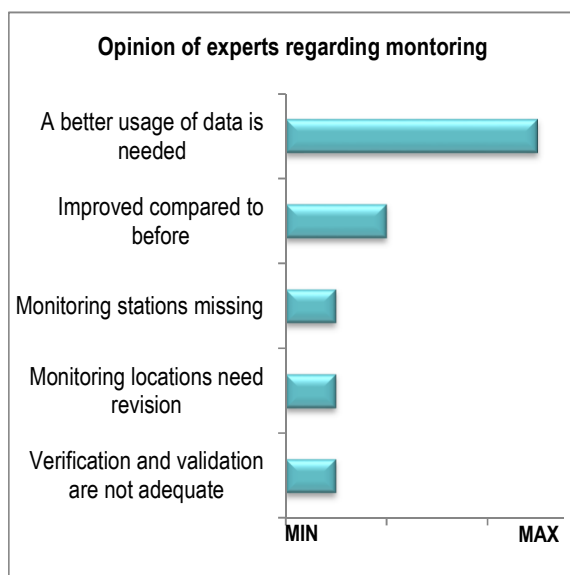


A certain number of experts consider that topographic characteristics, (i.e. naturally unfavourable position-valley) play a significant role in air quality. The complex terrain structure also influences the planning and development of infrastructure projects (building construction, civil engineering works) and it is considered that this is not aligned with the capacities and needs of the Sarajevo valley. From that perspective, **spatial planning** is also seen as an important cause, i.e. bad spatial planning decisions in the past contributed to the worsening of the air quality. In the past several decades, the

city of Sarajevo went through a significant urbanisation process that is not aligned with its natural capacities. The consequences of such an urbanisation reflect in other spheres as well,

such as water supply, etc. The social structure of the city is also significantly changed, and the modern Sarajevo is incomparable with the early Sarajevo, when its citizens were active participants in the city's development. Current spatial planning decisions are mostly based on the economic benefits of private investors' projects, while other elements that have an impact on the quality of life, are significantly or completely neglected. Architects and building contractors often do not have enough knowledge of high standards in construction that would have an influence on air quality (energy efficiency, good planning of heating systems, etc). This does not relate to the design of buildings whose shape can lead to an increase in the need for heat (in case of unfavourable shape factor) or those that can have a negative influence on air flow (high buildings). Spatial planning does not regulate the types of heating by defining the fuel that may be used in a certain area nor does it restrict the introduction of new emission sources.

Apart from the abovementioned causes, the **lack of political will and knowledge** is also very significant. The government of the Sarajevo canton does not have an integrated environmental policy that engages all ministries and all governmental organisations, but instead, the issue is solved within a single department in one ministry. The loss of knowledge, which is a consequence of migration in the past 25 years, is present in this field, just like in many others. The lack of knowledge is noticed both in contracting authorities and implementers, which is a kind of a stalemate.



Even though an improvement was made in air quality monitoring in the past several years, most experts believe that the quality of the data collection should be improved as well. Namely, **the existing data should be used in a better way (especially for spatial planning needs)**, which implies better cooperation between the different actors that collect information (the Public Health Institute of the Sarajevo Canton, the Hydrometeorology Institute of the Federation of B&H, NGOs, and embassies). The number of monitors is not brought into question, but certain experts do question the location of some of the monitors and the credibility of the data that is collected.

Also, they question the data gathered in the period before 2015, considering that those measuring devices were not calibrated on a regular basis and the data for this period may not be considered **verified or valid**. Regular calibration by an accredited laboratory has been done since 2017, while elements of quality control system were introduced in 2015.

The processed and published data mostly relates to the real time from different sources – those operating according to local regulations and the ones following some other standards. Also, air quality data has not been used so far for making urban and spatial planning decisions, i.e. decisions related to the development of the canton.

Most experts believe that there is no **air quality management** in the Sarajevo canton. In some segments, this management exists only on paper, but the assumed obligations are not

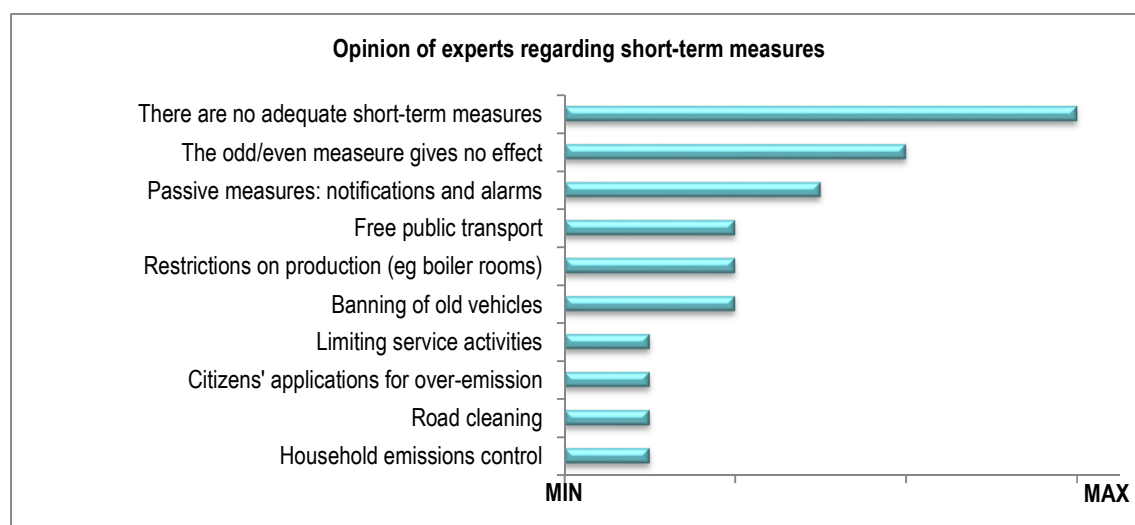
implemented because there is no coordination between the different actors (e.g. vehicle roadworthiness tests, energy certification of buildings, illegal construction, etc.). It often happens that different actors relate in a competitive manner to each other (academia, public institutions, NGOs) and the work of inspections in solving this issue is highly neglected.

Air quality management should engage a whole set of staff (who do not have to possess knowledge of air quality, but on whom air quality should depend), as well as a manager. It should have policy, frameworks and operational objectives, work procedures, work loggings, and periodic reports. There should be a responsibility system for the functioning of the air quality management system. Another important factor is adding external consultants from different fields (energy, traffic, etc.) to this system. The establishment of an air quality management centre dealing with the issues of traffic as well is strongly recommended.

3. Recommendations for decision makers

The Sarajevo canton, especially its urban centre, has been fighting for air quality for several decades. Numerous activities were taken in the past to contribute to the improvement of the situation. Currently there are several plans and programs in effect that deal with the issue of air quality in the canton. One should stress the 'Decision on the Protection and Improvement of air Quality in the Sarajevo Canton', the 'Intervention Measures plan in Circumstances of Increased air Pollution in the Sarajevo Canton', the 'Action plan for the Reduction of Particles in the air in the Area of the Sarajevo canton', and the 'Environmental Protection Plan of the Sarajevo Canton'.

The '**Priority measures proposal**' has been drafted on the basis of the conducted critical analysis and the interviews with experts. The priority measures may be launched and/or fully implemented within a planned period of three years. Most of these measures already have their basis in certain existing plans and programs, while some of them are initiatives of the authors and associates of this document.

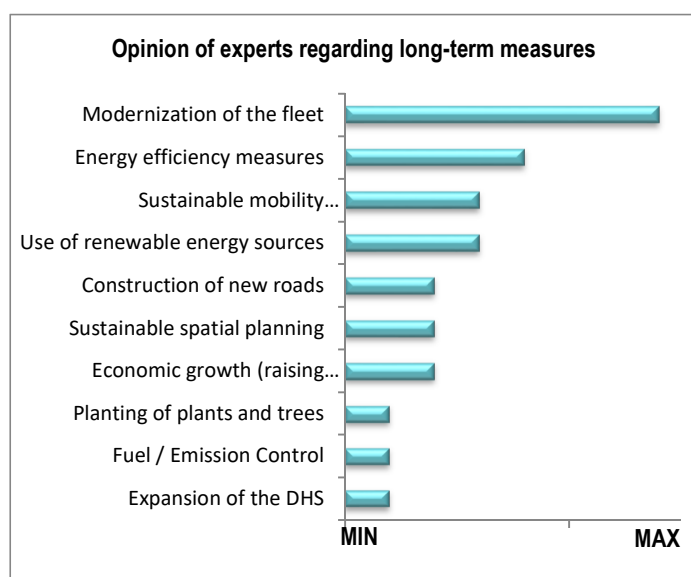


It is very important to note that most experts believe that there are no **appropriate short-term measures** (during the episodes of excessive pollution), i.e. they cannot lead to the needed impact and improve the air quality. This is justified by the fact that institutional support is

lacking for the implementation of most measures and/or it is difficult to implement in practice. When it comes to the “even/odd” measure, it is believed that it gives no results, i.e. that the way in which it is implemented cannot contribute to the improvement of air quality (there is no cooperation with the Ministry of Internal Affairs). However, experts propose conducting an analysis on the possibilities of zoning the implementation of this measure, i.e. implementing it specifically in the canton’s areas that suffer from excessive air pollution. In conditions of excessive pollution, one of appropriate short-term measures is informing citizens of the dangers of prolonged exposure to high concentrations of air pollutants. In general, it is believed that the improvement of air quality needs long-term measures that require more resources, but also that provide better results. In this case, it is very important to achieve cooperation between different actors and their clear coordination (through a centre for air quality management).

As already mentioned, Sarajevo experienced significant urbanisation in the past and modern Sarajevo is not an industrial city anymore (as it was considered in the period after the Second World War until the 1980s). Instead, Sarajevo got became a more touristic city. Therefore, short-term measures such as the reduction in the operation of great furnaces (such as power plants) play an insignificant role in the improvement of air quality within a short period of time. It is suggested to conduct an analysis on the possibilities of limiting the work of the service industry operators who use solid fuels for heat generation during the period of excessive pollution.

Examples from EU cities, such as Ljubljana, show that measures related to traffic are very important for various reasons. First, they contribute to the reduction of emission of air pollutants, but also they create synergy effects that contribute to other measures. Above all, they improve the life quality of the residents. This is why it is very important to advocate for sustainable mobility principles (through a sustainable mobility plan – SUMP) which brought significant contributions to many EU cities (not only in terms of air quality).



A very important aspect in the entire process of air quality improvement in the Sarajevo canton is the **low economic standard** of its residents. Bosnia and Herzegovina as a country is going through a transition phase, so Sarajevo is in the same position as well. One should note that B&H is among some of the poorest European countries. These facts are a significant obstacle in the implementation of all plans and programs, not only in the area of air quality. When it comes to air quality, citizens with the lowest

incomes face at least two problems. First, their properties are often great energy consumers, and the high energy needs result from the bad energy characteristics of buildings (with insufficient wall and roof heat insulation or no insulation at all, old windows, etc.). The second problem is the fuel they use and one should bear in mind that the decision for the type of fuel

to be used is solely the result of their purchasing power. Coal is the cheapest fuel. Compared to firewood and gas, its price is 30-40% lower and it is two or three times cheaper than electrical energy. However, practice has shown that the same amount of fuel is used irrespective of the size of the home (7 t of coal or 10-12 m³ firewood), which comes to an annual cost of BAM 1,000 – 1,300. In the case of using environmentally friendly fuel environmentally friendly, heating costs would significantly rise, which is not an option for the current standard of life. These are strong arguments for the **promotion of energy efficiency measures** that would significantly reduce the needs for energy, which would eventually create conditions for using other fuel (gas, electrical energy, heat pumps, etc.).

An important segment of long-term measures are those measures which relate to spatial planning. **Sustainable spatial planning** influences other environmental aspects, including air. Inappropriate building planning (energy consumers and emission sources) and space organisation (mobility and traffic) contribute to the degradation of air quality.

An overview of the proposed priority measures for improvement of the air quality in the Sarajevo canton is presented below.

An important aspect, not only in air quality preservation, is using the benefits of modern technologies, such as the Internet of things, big data, artificial intelligence, etc.

As a reply to the canton's government actions during excessive air pollution episodes, the following short-term measures are suggested, which can primarily stop the growth trend of the pollutants' concentration, but also contribute to its decrease:

Preparedness:

- Informing the citizens about the concentration level, urging them to stay in their homes and to reduce their activities
- Increasing the public transport capacity and urging citizens to reduce the use of their private vehicles
- Urging organisations (public and private) to be more flexible regarding working hours in order to reduce traffic congestions (especially in public transportation vehicles, which is the reason many people avoid it). Flexible working hours may be introduced in public institutions
- Warning all plants that heat individual buildings with solid and liquid fuels, and whose power exceeds 50 kW, to adapt the intensity of their work so that the temperature in buildings is lowered by at least 2°C
- Informing industrial plants (it is required to make a list of industrial plants that this measure relates to) to make preparations for the possible reduction or halting of their operations
- Fare-free charging of electric vehicles in all public chargers

Warning (all measures from preparedness episode remain in force, followed by the following measures):

- Introduction of free public transport with maximum use of "clean" vehicles in public transportation (electric drive, CNG, LPG and highest EURO norms)

- Reducing or halting the operations of industrial plants (it is required to make a list of plants that must reduce the intensity of their operations by at least 20% and a list of plants that must halt their operations)
- Banning traffic for vehicles below the EURO 2 norm (where EURO 2 is allowed)
- Warning all plants that heat buildings with solid and liquid fuels, and whose power exceeds 50 kW, and natural gas plants whose power exceeds 1 MW, to adapt the intensity of their work so that the temperature in buildings is lowered by at least 3°C
- Increasing parking price for individual vehicles in zones 1 and 2 by 100%
- Banning all outdoor construction works

Alert:

- Banning traffic for all vehicles below the EURO 4 norm (where EURO 4 is allowed) – relates to public transport vehicles as well
- Closing schools
- Granting the right to work from home to all those who have this possibility
- Regulating traffic on the main city road by traffic officers.

Apart from the abovementioned measures, this document provides priority measures (short-term, medium-term, and long-term) for the improvement of air quality in the Sarajevo canton during periods of excessive air pollution. The table below gives an overview of the suggested measures.

Table 1. Overview of the proposed priority measures for improvement of air quality in Canton Sarajevo

RB	NAME OF MEASURE	IMPLEMENTATION PERIOD	COMPETENT INSTITUTION
HEATING			
1	Regulating the use of solid fuel in the Sarajevo canton	Short-term/ Medium-term	The Ministry of Physical Planning, Construction and Environmental Protection of Canton Sarajevo, the Ministry of Internal Affairs of the Sarajevo canton , Inspection
2	Encouraging energy efficiency in construction	Medium-term	The Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton, SERDA
3	Expansion of the district's heating system	Long-term	The Ministry of Urban Engineering and Infrastructure of the Sarajevo canton, the Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton, Power Plants
TRAFFIC			
4	Stricter emission standards for vehicles in the city centre	Medium-term	The Ministry of Traffic, Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton
5	Improvement of parking management in the city centre	Short-term	The Ministry of Traffic, the Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton
6	Real time traffic	Medium-term	The Ministry of Traffic

	management			
7	Public transport improvement	Short-term – long-term		The government of the Sarajevo canton
8	Electric vehicle promotion	Long-term		The Ministry of Traffic, Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton
9	Improvement of vehicle roadworthiness tests	Short-term		The Ministry of Internal Affairs of the Sarajevo canton
SPATIAL PLANNING				
10	Construction of walkways and bicycle lanes	Medium-term		The Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton The canton, municipalities, The Development Planning Institute of the Sarajevo canton
11	Regulating requests for the central preparation of sanitary water in new buildings	Long-term		The Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton ,The canton, municipalities, The Development Planning Institute of the Sarajevo canton
12	Development of green areas and tree planting	Long-term		The Ministry of Urban Engineering and Infrastructure of the Sarajevo canton
AIR QUALITY MANAGEMENT				
13	Improvement of information systems and public campaigns	Medium-term		The Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton, the Ministry of Health of the Sarajevo canton
14	Revision of information and alarm thresholds in cases of excessive air pollution	Short-term		The Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo canton, the Ministry of Health of the Sarajevo canton

Short-term (up to 1 year); Medium-term (1-3 years); Long-term (more than 3 years)

SECTOR: HEATING

Regulating the use of solid fuel in the Sarajevo canton

*Base: Environmental Protection Plan of the Sarajevo Canton (KEAP)
Action plan for the reduction of particles in the air in the Sarajevo canton*

Considering that solid fuel combustion in individual furnaces has been identified as the primary cause of low air quality, the first measure for the improvement of the condition is regulating the use of solid fuels, which includes:

- Ban on the use of coal for heating buildings in the entire Sarajevo canton
- Ban on sales of wet firewood and pellets without a quality certificate
- Ban on sales of furnaces running on solid fuels which do not have a certificate with an analysis of their efficiency and the emissions they release in the air.

The decision on air quality preservation needs to be updated with the abovementioned measures and the description of mechanisms for their implementation. The ban on the use of coal includes sales of coal in retail trade in the area of the Sarajevo canton. This means that companies that sell solid fuels in retail trade must not sell coal. Apart from this, coal must not

be transported in the area of Sarajevo for heating needs. The ban also includes a ban on advertising the sale of coal and coal furnaces. The implementation of this prohibition should be under the competency of the market inspection (for the ban on the sales in the Sarajevo canton) and that of the police (for the transportation ban). Those who use coal are given an opportunity, through energy efficiency incentives (see the following measure), to get 45% grants, as well as a set of other benefits after they decide to use some other energy-generating product instead of coal (natural gas where this is possible). This does not threaten the ones who at the moment cannot afford using a better, but more expensive, energy-generating product.

The ban on the sale of wet firewood should be implemented through inspections by regularly controlling the amount of humidity in firewood repositories, using portable hygrometers. The decision should limit the acceptable share of humidity in firewood which is placed within a range of 25%. The sale of pellets without a quality certificate is a measure that can relatively easily be implemented. Out of 50 pellet producers in Bosnia and Herzegovina, only 19 of them have a valid quality certificate. Therefore, in case of firewood and pellets, the inspection should check the quality as it does for liquid fuels. Considering that emissions depend on the combination of fuels and furnaces, it is necessary to ban the sales of furnaces which do not have a certificate of efficiency analysis and for the emissions they release into the air. The market inspection can easily monitor the implementation of this measure. With the purpose of limiting sales of non-certified furnaces from other cantons, the police can request the analysis certificate when they check the delivery vehicles.

This measure should be conveyed to solid fuel traders, furnace producers, and the citizens, at least 6 months before the heating season, whereas the ban on using coal should be announced at least two years in advance (so that the owners of buildings can change furnaces and receive incentives). The inspection authorities and the police should receive special training in order to understand everything required for the implementation of this measure.

Examples from Dublin (Ireland) and Graz (Austria) and measures taken in these cities to reduce emissions resulting from solid fuel combustion are outlined below.

Ban on the use of coal in Dublin

In the early 1990s, major cities in Ireland faced the problem of poor air quality. Winter smog was a growing problem in urban areas at that time due to the widespread use of coal, which resulted in serious adverse health effects. The ban on advertising, sales, and distribution (known as smoky coal ban) was first introduced in Dublin in 1990 in response to significant episodes of winter smog that arose as a result of the widespread use of coal for the heating of housing units. The ban was proven to be effective in reducing the concentration of smoke and sulphur dioxide and was therefore extended to other areas. The ban is now applied in 26 cities, and these areas are called Low Smoke Zones. Air quality monitoring by the Environmental Protection Agency showed lower concentrations of PM10 in these areas compared to the cities where the ban is not applied. The ban on the use of coal and other prohibited fuels is now applied in all low smoke zones in addition to prohibiting the advertising, sales and distribution of coal.

Research has shown that the Dublin coal ban has resulted in over 350 less deaths per year. It is estimated that the financial savings achieved by this measure exceeded 20 million Euros.

An additional benefit of this regulation is that many households have switched from using solid fuels, which are less efficient and more polluting, to more efficient and less polluting gas and oil. This reduced the annual cost of purchasing energy products by 184 million Euros. In areas where solid fuels are still used in households, there is now a whole range of low-polluting solid fuels, such as low smoke coal.

The ban on the sale of coal in the existing zones, which has existed for some time in major cities, was extended to the whole country in the autumn of 2018. Until then, coal distributors had 12 months to sell existing coal supplies before the full ban came into force in 2019.

Legal regulations from the aspect of influencing air quality in the City of Graz (Austria)

Legislation regulating the possibility of using solid fuels for heating is in force in the City of Graz. This is the so-called Heating regulation. According to this regulation, the use of solid fuel is permitted, but emissions from the solid fuel-based system must comply with the prescribed emission limit values. This legal regulation allows the use of all combustion technologies. In Graz, legislation regulates the obligation to reduce emissions for certain heating systems or technical systems. This regulation defines maximum permissible emissions of solid particles from solid fuel-based systems (4 g/m² of heated area per year). Furthermore, according to this regulation, the use of solid fuel is permissible, but it must be high quality solid fuel in terms of emissions, and the facilities in which biomass is used must have high energy performance, which means that these facilities have lower energy consumption for heating.

The second legal regulation defines specific heating requirements for facilities, which indirectly solves the issue of air quality. This is a federal legal regulation that limits the consumption of heat in buildings. This is in fact a legal regulation that was transposed from the EU acquis, which stipulates that by 2019 each building must not exceed a certain regulated amount of heat consumption in kWh/m² annually. Also, it is stipulated in this regulation that by 2021 all buildings should have almost zero heat consumption. In the past (2013/2014), this legislation applied only to the urban part of the city (centre), but was subsequently extended to the whole area of the city (all facilities in the city of Graz). This legal regulation is intended only for newly constructed facilities, and for the existing fund of buildings there is another legal regulation, which defines that existing facilities must be renovated (improvement of the building envelope) and/or the heating system has to be replaced/improved. In this way, the total existing and future property fund is covered.

In the city of Graz, spatial planning has defined specific areas. This primarily means that the areas in which they use biomass, coal, etc. is limited are clearly defined. This is because in these areas people are encouraged to use district heating that covers a large part of the city. The city of Graz is strategically committed to reducing the use of biomass, coal and the like, so ten years ago the city started developing a district heating network, which has so far proved to be very successful. In the areas where district heating is available, other heating options are permitted, but such a system must comply with the defined emission limit values (4 g/m² for solid particles), which means that they must be the most modern technical biomass heating systems.

Encouraging energy efficiency in residential buildings

Base: *Environmental Protection Plan of the Sarajevo Canton (KEAP)*

Action plan for the reduction of particles in the air in the Sarajevo Canton

In December 2017, the cantonal government adopted the Energy Efficiency Model in the Sarajevo canton area (promotion). The model involves encouraging the energy efficiency of residential buildings (houses and collective housing buildings) in the cantonal area in the amount of 45% of the total cost for the purpose of increasing energy efficiency of a particular building. The incentive comes from the budget of the canton, municipalities and the city. The aim of the model is to enable owners to use natural gas for heating by reducing heating needs. This means that the use of gas would be affordable to owners after implementing energy efficiency measures because the cost would be acceptable. The government has allocated funds in 2019 for the implementation of this model. Until February 2019, all the municipalities in the canton joined the model except for the municipalities of Novi Grad and Trnovo, because there is still no political will to engage. It is necessary to include these two municipalities for the successful implementation of the model.

Parallel to improving the energy efficiency of residential buildings, it is necessary to continue to improve the energy efficiency of public buildings, as well as stimulating businesses to work on this issue.

Below is an overview of possible financial savings when implementing some of the energy efficiency measures.

Table 2. Financial effects of thermal insulation (external walls and roof) and installation of energy efficient windows and doors

	Type of heating	Investment (KM)	Savings (KM/a)	Refund period (years)	Specific investment (KM/m ²)
Single house	coal	17,820	1,070	16.66	111.38
	gas		1,826	9.76	
	electric energy		3,328	5.35	
Residential building (apartment)	gas	6,200	593	10.46	103.33
	District heating		702	8.83	
	electric energy		1,080	5.74	

The previous table shows that the refund period in the case of coal is rather long because coal is cheap and the refund period in case of gas or electricity is financially acceptable. However, in the context of air quality, the primary goal is to make the use of natural gas affordable to citizens. The goal is to replace coal (and firewood) with gas. Below is an overview of emissions from the heating of a non-insulated house on coal or firewood.



7 tons of coal per year			12 m ³ firewood per year		
Annual emission			Annual emission		
SO ₂	176.4	kg/a	SO ₂	0.0	kg/a
NO _x	10.8	kg/a	NO _x	3.8	kg/a
PM10	47.0	kg/a	PM10	60	kg/a

The table below shows how the model can enable the use of gas for heating and thus reduce emissions to an acceptable level. If we analyse the house from the figure above, its surface area is about 250 m². It takes about 22 tons of coal per year to heat the entire area. Of course, the real consumption is significantly lower because only a small part of the whole house is heated, so the consumption of coal is 7-8 tons per year. Thermal insulation measures, i.e. the completion of the house, may reduce heating needs by more than 50%. In this case, the cost of gas heating is lower than the cost of coal heating before the insulation. The necessary investment for heating and introducing central gas heating is about BAM 25,000. According to the described model, the owner of the house invests BAM 13,750, and the rest is received as a grant. The annual energy cost is almost BAM 900 lower, and the emissions of sulphur dioxide and dust are completely eliminated, while nitrogen oxide emissions are minimized. Similar results are obtained in the case of switching from firewood to gas.

	Surface	Heat demand before EE measures	Coal price	Heat demand after EE measures	Gas cost	Savings	Investment	Personal investment
	m ²	MWh/a	KM/a	MWh/a	KM/a	KM/a	KM	KM
House	250	62.5	3,429	34.37	2,539	890	25,000	13,750

The biggest problem in the above described case is the non-representational initial condition in which only a small section of the house is heated. After the insulation, the entire house would be heated, which means that the comfort would be increased, not the heating costs. This is a way to identify the real problem - a relatively big housing unit which citizens do not have enough resources to maintain, heat, etc.

Expansion of district heating system

Base: *Environment Protection Plan of the Sarajevo Canton (KEAP)*
Action plan for the reduction of particles in the air in the Sarajevo Canton

This measure has two dimensions

1. Connection of new users to the district's heating system,
2. Use of new technologies in the district's heating.

The public company of the Sarajevo canton "Toplane Sarajevo" (power plant) heats close to 55,000 apartments, while 45,000 apartments are heated individually by using natural gas. Therefore, from the total number of apartments in the Sarajevo canton (210,589 according to the most recent census), almost 100,000 apartments (Report on the Environmental Condition in the Sarajevo Canton, draft, 2016) are heated using natural gas. Bearing in mind the boiler power of about 330 MW and the installed power of about 500 MW, it is concluded that there is a significant potential for the expansion of the district heating, which would result in improved air quality. Therefore, a significant expansion can be achieved on the basis of existing boiler rooms. In this context, each new building should be conditioned to be connected to the district heating (if feasible, which is proven by a confirmation from the operator of the nearest district heating system) or to use non-polluting heating methods (heat pumps, solar energy, waste heat from the industry). This would lead to avoiding the situation that has been present for the last 15 years in the Marijin Dvor settlement, where many new boiler rooms have been installed even though there is a boiler room and a network in the University Campus that can heat the entire Marijin Dvor settlement. Although all of these boiler rooms are modern and use natural gas, managing one source of pollution is much more efficient, especially in periods of excessive pollution.

Another aspect of expansion is the construction of modular district heating systems in the slopes of the canton. Such modular systems with a basic source of energy (natural gas and/or biomass) can also use renewable energy sources using modern technologies such as heat pumps, heat conversion technologies, etc. With heat exchangers, the share of these technologies can be significant (over 50%).

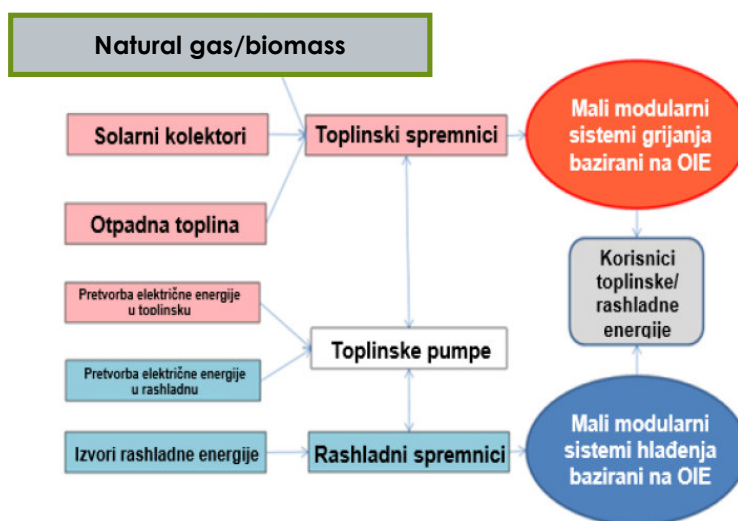


Figure 3. Modular district heating systems

These systems provide a heating service in the range of several houses to one entire settlement. The basic advantage over bringing gas infrastructure to individual users, in addition to the aspect of work management and maintenance, is a relatively simple

possibility to monitor the development of technologies and changes in general. If, for example, the Sarajevo canton is heated from TPP Kakanj, it would be very difficult to bring a heating pipeline to the users in the slopes. In the case of modular district heating, the heat is brought into one place, in the boiler room, and then distributed to all users. Therefore, funds that are persistently allocated for the expansion of the natural gas network should be directed to the development of modular district heating in the slopes. It should be stressed that in terms of cash flows, such district heating is not profitable. For this reason, when analysing the cost-effectiveness, it is necessary to take into account the avoided external costs (avoidance of pollution). Considering that these are new systems, it is necessary to immediately introduce consumption meters, and to regulate heating methods in a particular settlement. For example, it is necessary to adopt a decision according to which anyone who can connect to the district heating must either connect to it or use low polluting heating fuel. Furthermore, it is necessary to regulate the method of disposal of ash from households, storage of fuel, etc. – all with the aim of connecting as many users as possible to the centralised heating system. In order to make the cost affordable to users, in parallel with the construction of district heating, users should be encouraged to implement energy efficiency measures in their homes (link to the previous measure).

SECTOR: TRAFFIC

Stricter emission standards for vehicles in the city centre

Base: Action plan for the reduction of particles in the air in the Sarajevo canton

This measure suggests the introduction of LEZ (Low Emission Zone) where vehicles that do not meet a certain standard would be restricted or completely banned from this zone. It is possible to influence the reduction of pollutants emission, primarily PM10, but also nitrous oxide (NOx), and therefore contribute to the air quality's improvement. EUR4 norm (PM10 emission is 0.025 g/km) is mostly used in EU cities as a "threshold" based on which it is determined whether vehicles may or may not operate in a certain zone. Methods of checking whether a particular vehicle meets the norm are different (sticker, video control, etc.).



Figure 4 Zone in which vehicles that do not meet EUR4 norm would be banned from driving
(Source: Action plan for the reduction of particles in the air in the Sarajevo canton)

The Action plan gives an example of one such zone in Sarajevo - the city centre (the municipalities of Centre and Old Town). It is estimated that by implementing this measure it would be possible to reduce the emissions of solid particles by 10 t/year, or up to 5% of the total emissions of solid particles caused by traffic, if the traffic for vehicles that do not meet the Euro4 norm is completely restricted. The benefits of this measure can be even greater if the LEZ is expanded to a larger area.

Improvement of parking management in the city centre

Base: Action plan for the reduction of particles in the air in the Sarajevo canton

Parking management has proven as an exceptional tool for air quality improvement in EU cities. In Ljubljana, this was proven to be one of the best measures implemented within the Sustainable Mobility Plan. Significant traffic control may be achieved by managing supply and demand, and through an appropriate parking price policy. The prevailing policy in the Sarajevo canton is the construction of additional parking lots which in the long run does not solve the problem of stationary traffic, and contributes to the deterioration of air quality. Building a larger capacity for stationary traffic "invites" drivers in, leading to a higher frequency of cars, and consequently higher emissions of air pollutants.

This measure stimulates the use of public transport, which implies ensuring a satisfactory level of this type of infrastructure. This measure proved to be a good solution in many cities, and it is characterised by two aspects: an increase in the cost of parking in the city centre and a time limit.

Real time traffic management

Base: Environment Protection Plan of the Sarajevo Canton (KEAP)
Action plan for the reduction of particles in the air in the Sarajevo canton

A large number of cities are facing the problem of the increase, as well as the variability of transport requirements. Accordingly, city authorities in most EU cities are increasingly concentrating on the most efficient use of available infrastructure through advanced traffic management by information systems. The basic tasks of these systems are to increase

efficiency, responding to incidental situations within the network, reducing the cost of updating fixed signal plans, and maintaining a high level of traffic safety. Regarding this, so-called Intelligent Transport Systems (ITS) have been developed. ITS include information, communication and sensory techniques that are applied with the aim of continuously raising the level of traffic safety and the quality of travel and transportation services in terms of reducing crowds. This basically means that an upgrade of the classical traffic and transport system is carried out, which leads to higher permeability and more environmentally friendly effects compared to classical solutions. These systems have the ability to adapt to changing situations, where it is necessary to collect enough data and process it in real time. ITS reduces traffic congestion as well as transport costs and emissions of smoke from traffic, while at the same time increasing traffic safety. The system performs dynamic control of vehicle routes and provides drivers with route selection based on current real-time traffic conditions. This type of traffic control and management greatly contributes to reducing the emissions of PM10 and NOx in traffic, since it leads to a better flow of vehicles with minimum retention and traffic stops in zones that are identified as zones with significant concentrations of harmful substances in the air.

Cameras, i.e. video surveillance, are an integral part of these systems. These cameras are equipped with microprocessors located in the device for image detection. Using microprocessors, the data is processed for the need of further analysis of the gathered information. While recording traffic, the camera uses certain algorithms for recording and identifying vehicles that pass through the field of vision. This kind of real time traffic control enables checking the registration plates of each vehicle, but also the identification of the Euro norm. In this way it is possible to conduct control of entry and exit of a certain norm (e.g. EURO 3 and below) in and out of eco zones, as well as behaving in accordance with the "even/odd" measure in traffic when the measure is implemented.

Public transportation improvement

*Base: Environmental Protection Plan of the Sarajevo Canton (KEAP)
Action plan for the reduction of particles in the air in the Sarajevo canton*

Public transportation infrastructure improvement

The public transport in the Sarajevo canton is not at a satisfactory level and significant capital investments are required for its improvement. Public transport brings a number of benefits, one of them being a reduction in emissions and positive effects on air quality. Public transport infrastructure itself does not guarantee the benefits, but it requires good governance and synergy with other measures. This document does not aim to propose improvements to infrastructure (trams, rails, trolleybuses, buses, mini buses, etc.), as this is considered to be imperative for implementing these measures. Some sub-measures are suggested here in the context of improving the local public transport.

Free public transportation in exceptional situations

The city of Tübingen (Germany) has launched a free public transport project (on Saturdays) that will last 20 months. It started in February 2018. The funds used to subsidize the public transport are provided by the city budget (around € 200,000). The starting point for the introduction of this free line is the renovation of the central public garage in the city centre.



Figure 5 Bus used by the citizens of Tüben on Saturdays fare-free (source: www.swtue.de)

However, free public transport is not seen as a permanent solution, as it requires high costs, increases tourist complaints, and also the risk of overloading the capacity of the public transport. For these reasons, free public transport must be well planned and introduced only in special cases.

Collective transport of public institution employees

This measure involves the organization of bus transport for employees of the canton's institutions to and from work. For this purpose, it is necessary to draft a plan for the development of collective transport, taking into account the place of residence of employees and the location of the public institutions. According to the draft budget of the Sarajevo canton for 2019, item "611200 - Transport and transport costs for commuting to and from work", close to BAM **9 million** is planned for approximately 14,000 employees. This amount is more than enough to organize public transport for the majority of the canton's employees, and the investment of these funds would result in synergy effects that are reflected in:

- Reducing pollutant emissions based on fewer vehicles in use
- Reducing traffic congestions
- Signalling the citizens that the canton's government is determined to implement measures for the reduction of pollutant emissions and to improve air quality in the Sarajevo canton
- Providing additional support for the development and sustainability of operators that provide public transport to citizens
- Improvement of the city image.

The possibility of including employees of the institutions of the Federation of B&H, which are located in the Sarajevo canton, should also be added here.

Express lines and "park and ride" systems

Express lines connect marginal settlements with the administrative and business centre of the city. It is suggested to introduce at least two departure stations (Ilidža and Dobrinja), which will operate along two different routes. This would ensure a faster flow of passengers.

"Park and ride" systems involve the construction of large parking lots at locations that are outside of the city centre (e.g. Pofalići, Šip), where users will have the ability to park their vehicles, and use shuttle busses to reach the city centre. In EU cities, the most frequent pricing

policy is requiring convenient parking prices, where one return ticket is included in the price of a parking space. Combined with the measure of "Improvement of parking management in the city centre", which implies a strict parking policy, this measure motivates drivers to use this system. The benefits of these measures are multiple and are reflected in the reduction of harmful emissions, reduction of crowds and traffic accidents, etc.

Temporary motor vehicle restriction

Restricting the use of private cars during precisely defined periods is one of the most effective measures in the transport sector. A very successful project of this type has been implemented in Sao Paolo, Brazil, a city with millions of residents. A project called "Operação Rodízio", which began in 1995, brought a ban on the use of all motor vehicles for one day a week (based on the number on registration plates). This reduces the number of motor vehicles by about 15%. In the case of the Sarajevo canton, different options may be considered – for example, a temporary prohibition on the use of certain motor vehicles (depending on the eco norm) in periods of traffic jams (7 am - 9 am and 3 pm – 5 pm). It is necessary to exclude certain categories of vehicles from this program such as public transport, police cars, ambulances, fire-fighters, vehicles adapted for disabled persons, delivery vehicles, etc. For a successful implementation, it is necessary to introduce a real time traffic management system (a system that would recognise vehicles based on their registration plates).

Electric vehicles promotion

Base: Environmental Protection Plan of the Sarajevo Canton (KEAP)

The use of electric vehicles is a global trend driven mostly by the struggle to preserve air quality in urban areas. The key issue that arises regarding this measure is the existence of infrastructure and the availability of electric vehicles on the market. Of course, the former has to come before the latter. However, investment in infrastructure and the sales of electric vehicles will intensify after the adoption of a clear policy related to this issue, followed by specific mechanisms for encouraging the use of electric vehicles. It should be emphasized that the incentive mechanisms should not be limited to providing subsidies for the purchase of vehicles, but rather they should focus on providing incentives throughout the cycle of the process (e.g. priority or cheaper parking, cheaper registration, no restriction in accessing parts of the city that vehicles with internal combustion engines are restricted from, etc.).

The canton's government should develop a strategic plan for the electrification of traffic in Sarajevo, that would define the vision and steps, and incentive mechanisms. After the development of the necessary infrastructure, the first step may be the introduction of electric buses and providing subsidies for electric taxis. That would be the best way to promote electric vehicles. Fare-free charging of such vehicles on public charging stations could be offered for a certain period. It should be requested that the charging power is generated from renewable energy sources. This can be provided through a tender for the supply of electrical energy with clearly defined requirements.

Improvement of conduct of vehicle roadworthiness test

Base: Environmental Protection Plan of the Sarajevo Canton (KEAP)

The vehicle roadworthiness test in B&H is a legal obligation and is defined by the law as an activity of general social interest, from the perspective of traffic safety on roads and environmental protection. Therefore, vehicle roadworthiness and the need for maintenance

cannot be a matter of the subjective feeling of vehicle owners. Thus, the state obliges vehicle owners to periodically inspect their vehicles and make repairs so that the vehicles can meet the appropriate criteria defined by the regulations in this field.

Stations that conduct vehicle roadworthiness tests must carry out their work (checking the technical safety of motor vehicles and trailers) in accordance with the provisions of the Law on Basic Safety of Road Traffic in B&H, the Law on Road Transport of the FB&H and bylaws adopted on the basis of these laws, using all defined devices and equipment at the station, and applying the procedures for the vehicle roadworthiness test defined on the basis of the abovementioned regulations. Knowing that traffic is one of the major causes of poor air quality in the Sarajevo canton, it is necessary to ensure that the vehicles are technically in line with the right level of flue gas emissions.

In this regard, stations that conduct vehicle roadworthiness tests should be obliged to regularly submit a report on the conducted tests of exhaust gases to the competent authorities so that the competent ministry (Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo Canton), with the support of professional institutions, can conduct a thorough analysis of the validity of the exhaust gas measurement procedure during the vehicle roadworthiness test (expert supervision of the operation of the stations that conduct vehicle roadworthiness tests). Furthermore, in cases of excessive air pollution episodes, it is necessary to implement preventive and repressive measures in cooperation with the Ministry of Internal Affairs and BIHAMK (B&H Automoto Club) by inspecting the technical safety of vehicles on roads, control the fleets of transport companies, etc. In this sector, it is also recommended to establish an expert institution for vehicle roadworthiness tests that would serve as support to employees at stations that conduct the tests. The role of this institution would be to present the stations with new technologies and new activities already applied in the more developed EU countries.

SECTOR: SPATIAL PLANNING

Construction of walkways and bicycle lanes

Base: Environmental Protection Plan of the Sarajevo Canton (KEAP)

With the purpose of reducing the share of personal vehicles in traffic, it is necessary to systematically work on the construction of walkways and bicycle lanes on the territory of the entire canton. Due to the lack of safe walkways and bicycles lanes, citizens are forced to use their cars even for short routes which take as little as 15 minutes on foot. Walkways and cycling lanes must be a functional network built according to standards. Close attention must be paid to the safety of users on these lanes, for example offering protection from vehicles, and appropriate lighting. In addition, lanes must have benches and other facilities that would attract citizens to use the lanes.

These lanes would be very important during episodes of increased air pollution. In those periods, citizens would be urged to avoid using cars and use lanes for distances taking up to 15-20 minutes.

Regulating requests for the central preparation of sanitary water in new buildings

Base: Initiative of authors and associates

The relatively high price of natural gas is partly a consequence of its much uneven consumption. Namely, gas in the Sarajevo canton is predominantly used for heating, i.e. when the weather is coldest. If gas would be used rationally and independently of the outside temperature, i.e. of the heating needs, the entire gas system would be more sustainable, and citizens would note this through slightly lower prices (gas price, and especially gas-generated heat price). Among other things, a more balanced use can be achieved by using gas in cogeneration plants. The main problem with the sustainability of such plants is the lack of heat demand beyond the heating season. One possible heat demand is sanitary water heating. It is complicated to install a central system for the preparation of sanitary water in existing buildings. However, this should be a requirement for all new buildings. In this way, conditions for high efficiency cogeneration would be created (especially in the case of the development of settlements like Nova Otoka), and the peak loads of the electricity network would be further reduced.

The conditions for central cooling systems in buildings using heat from cogeneration should also be determined in this direction.

This measure should be implemented through spatial planning by defining the described requirements for all new buildings.

Development of green areas and tree planting

*Base: Environmental Protection Plan of the Sarajevo Canton (KEAP)
Action plan for the reduction of particles in the air in the Sarajevo canton*

Green areas can significantly contribute to improving air quality (apart from other benefits). Each plant has absorption power for different pollutants. The so-called urban vegetation is often concentrated in parks and gardens, where the concentration of PM₁₀ is relatively low. In addition to other benefits (reduction of heat islands, biodiversity), planting vegetation closer to contaminated areas will have greater effects.

Tree planting is often used to reduce the concentration of particles in the air. By planting trees on one quarter of the land, the average concentration of PM₁₀ can be reduced by 2 to 10%. The type of trees with the largest leaf surface, such as larch, pine and jasper, are best for PM₁₀ absorption, and their individual planting contributes to greater improvement of air quality than planting in groups. The absorbed PM₁₀ then travels through the trees into the ground. When planting trees, the dispersion of pollutants should be taken into account, since the reduction of self-cleaning mechanisms can aggravate the situation at the given micro location.

Within these measures it is necessary to consult experts from the Faculty of Forestry and the Department of Biology of the Faculty of Natural Science at the University of Sarajevo in order to determine plant species with the highest capacity for absorption of dust and other harmful substances, and which can achieve optimum development under the conditions of the climate and other characteristics of the Sarajevo basin.

There is a large number of buildings with flat roofs in the Sarajevo canton. Growing green roofs is a measure that is increasingly practiced in Western European countries. The technical capabilities of already built roofs, that is, the endurance to weight that would be added to the existing roofs should be taken into account here. It would be useful to build green areas in cases where it is estimated that the roof can hold an additional load. In collaboration with

experts, such as biologists, determine which types of plants are most suitable for this measure. In addition, this measure can positively influence the microclimate characteristics of the city of Sarajevo, raise the energy efficiency of buildings, as this measure would improve the thermal insulation properties of buildings, as well as the visual appeal of the city of Sarajevo. This measure's quantitative impact on dust reduction would depend on the height of the roof and the selection of chosen plants. The city of Milan in Italy is an example of the implementation of this measure. The city administration decided to 'green' Milano with 3 million new trees by 2030. They estimate that the planned program will increase the number of trees by 30%. The trees will "absorb" an additional 5 million tons of CO₂ annually. This quantity is equal to 4/5 of the total CO₂ emissions of the city of Milan. Over a period of ten years, trees will remove about 3,000 t of solid particles from the atmosphere. It is expected that the temperature in the city will drop by 2°C in the summer period. The Milano Greening Project is a plan for transforming a non-functional railway network into 7 parks with 25,000 seedlings. It includes the enrichment of flat roofs of a total area of 10 million m² of greenery, as well as planting trees in all school yards.

SECTOR: AIR QUALITY MANAGEMENT

Improvement of information systems and public campaigns

*Base: Environment Protection Plan of the Sarajevo Canton (KEAP
Air pollutants emission register for the area of the Sarajevo canton- 2010 and 2013*

One of the essential elements of the fight for the preservation of air quality is the citizens' awareness of the negative impacts that excessive pollution can have on people's health. Raising awareness is achieved through the transparency of air quality data. This data must be easily accessible and understandable to all categories of citizens, and citizens must be aware of the consequences. This can be achieved through campaigns in which citizens are informed about the way they can get data on air quality through the media. Only when the citizens become aware of the problem, will they start putting pressure on decision-makers, and then the decision-makers will begin acting to release the pressure created. For this reason, the role of the NGO sector is of great importance for conducting campaigns and informing citizens about air quality. It is proposed to have a cantonal TV broadcast a special TV show discussing air quality. The show would cover questions such as the current air quality, the impact of polluted air on health, ways to reduce emissions, how to act during increased pollution episodes, promotion of emission reduction activities, good practice examples, etc. The show should be broadcasted once a week during the winter period, and once a month during the summer period. It would be necessary to educate a team of two or three journalists who would prepare the show. The show should be organised in a way in which viewers are able to ask questions to the guests of the show.

Citizens can be informed in real and integrated time. Real time means informing citizens about air quality at a given moment, while integrated time involves reporting for a period of several years back.

Informing citizens in real time involves alerts, alarms and warnings by ministries if excessive concentrations of air pollutants pose a threat to citizens. Real-time monitored data can be used for issuing alerts in conditions of high concentrations (smog).

Information systems should be improved, which includes the following:

- Official integration of the data collected at municipal, cantonal and Federation levels;
- Integration of reports received from NGOs;
- Mandatory engagement of health workers in the assessment of the impact of air quality on the health of the population, and the analysis of causes and trends;
- The ability to communicate and inform citizens about the state of air quality through smartphones; Support for NGOs and others in the organization of public campaigns.

Revision of information and alarm thresholds in cases of excessive air pollution

Base: Initiative of authors and associates

The following pollutants are the biggest problem in terms of air quality management in EU cities:

- Nitrogen Dioxide (NO₂)
- Sulphur Dioxide (SO₂)
- Ozone (O₃) and/or
- Solid particles (PM_{2,5} and PM₁₀)

In cases of excessive pollution, the first necessary measure is to inform citizens of the risks of prolonged exposure to high concentrations of various pollutants. Most cities in the EU have adopted thresholds of information/alerts that involve changing behaviour patterns in these episodes. In general, the **EU does not have a single alert threshold** but it rather limits average concentrations of pollutants (for PM₁₀, this value should not exceed 40 µg/m³ per year and 50 µg/m³ per day, and it should not be exceeded more than 35 times per year). Therefore, the way of defining information/alert thresholds differs from country to country, or city to city.

A two-step methodology for decision making in declaring different episodes is generally accepted:

- Information threshold - at this level, it is an obligation to inform citizens of the air quality, the negative consequences for health, especially for vulnerable groups (children, sick and elderly). In some cases, measures are taken to reduce contamination.
- Alarm threshold - at this level, it is an obligation to act according to the established plans, i.e. specific measures are being taken to reduce pollution.

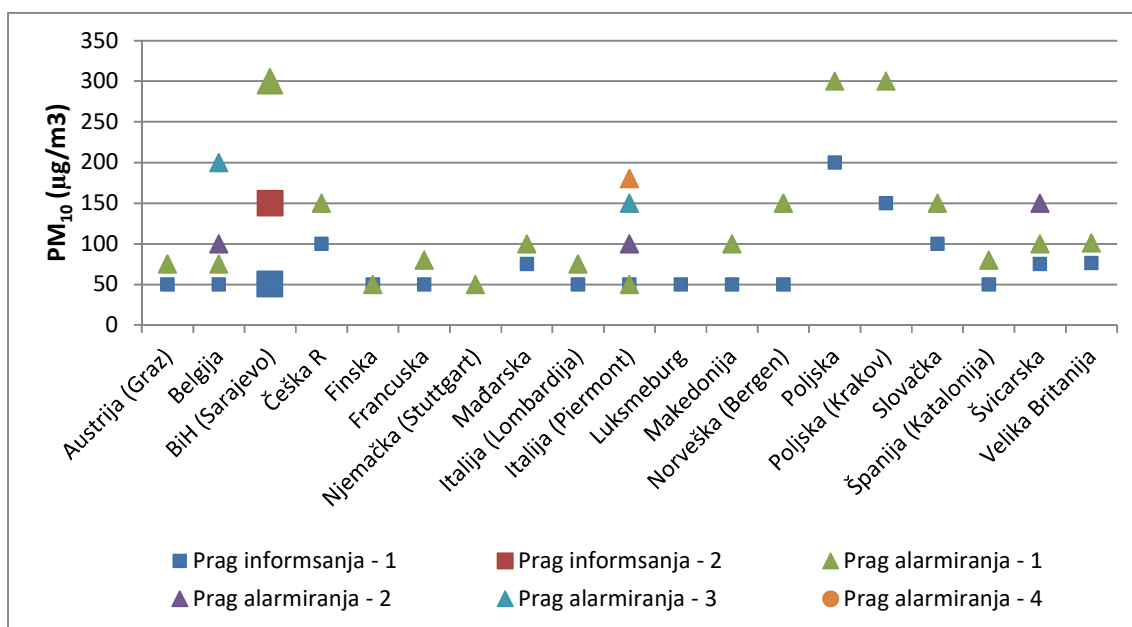
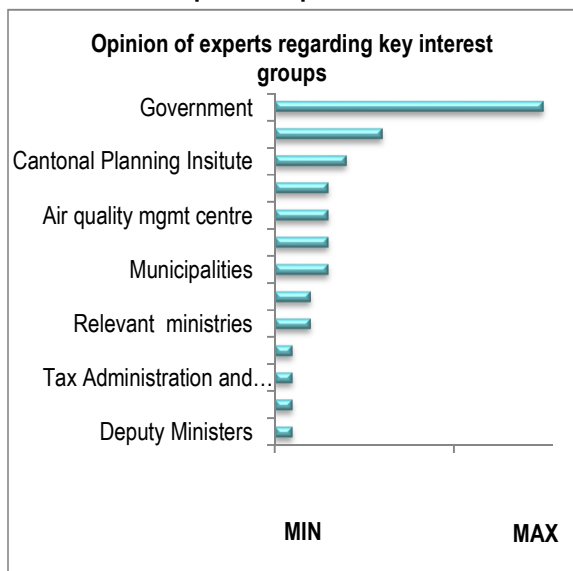


Figure 6 Comparing information and alert thresholds in cases of excessive concentration of solid particles (PM₁₀) in different countries (adjusted; source: Marcus Wiesen; Otto von G \ddot{u} ricke Magdeburg University)

Figure 6 shows the information and alarm thresholds for Sarajevo and different cities/countries in the EU. As shown in the Figure, more than 60% of the cases observed reach information threshold when the PM₁₀ concentration exceeds 50 µg/m³. It is indicative that in comparison with the observed countries/cities, Sarajevo has a significantly higher alert threshold of 300 µg/m³. If Poland is omitted, the highest alarm threshold is in Belgium (200 µg/m³), Piedmont region in Italy (180 µg/m³), Czech Republic and Switzerland (150 µg/m³). For this reason, it is considered important to **lower information and alarm thresholds in the Sarajevo canton**, i.e. lowering the threshold for the "WARNING" episode (from 150 to 100 µg/m³) and "ALARM" (from 300 to 200 µg/m³).

4. Education and engagement of interest groups

In order to implement any measure (regardless of sector and phase), political will is the first requirement. **Political will** does not assume declarative statements, but **systematic and continuous adoption, implementation and monitoring** of measures for improving air quality in



the Sarajevo canton. The issue of air quality cannot and should be reduced to only one ministry (the Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo Canton) and several public institutions (such as the Development Planning Institute of the Sarajevo canton and the Public Health Institute of the Sarajevo canton). The issue of air quality is the issue of the **government of the Sarajevo canton** and it should use all available resources in the fight for the preservation of air quality. **The local government is considered to be a key player**, i.e. interest group in the overall problem of air quality. The example of the city of Ljubljana shows

that the **political will** (that is, the mayor and his cabinet) was the **key factor** for positive changes in Ljubljana in the past 10 years.¹

At the same time, most experts believe that it is the government of the Sarajevo canton that is often uninvolved and/or inactive. In order to reach a systematic solution for the air quality issue, it is necessary to work 365 days a year, not solely during periods of excessive pollution. This is largely contributed to by citizens who are not aware of the pollution issue and who are not putting enough pressure on the canton's government and decision-makers.

It is very important to mention here that young people are very important, but they are very inactive and rarely get involved in the problem. Unfortunately, this is not the case only regarding the air quality issue, but there is a collective lethargy of the youth. For this reason it is very important to conduct campaigns that will first involve young people in their implementation, and then see them as a target group. The awareness of young people and other social categories in terms of air quality is at a very low level, which is another reason for conducting public campaigns.

The key method for raising awareness on air pollution and the need to take concrete steps is educating all interested parties. In this context, it is necessary to introduce content which concerns air quality into kindergartens, primary schools, high schools, and universities. At least one class should be dedicated to the issue of air quality each semester. Experts (relevant institutions, the University in Sarajevo, NGOs, expert organisations, etc.) would educate teachers and professors in order to prepare them for these classes. Children and students would be presented in a simple and interesting way with ways of reducing emissions, being less exposed to polluted air, etc. In order to trigger creativity, it is recommended to organise

¹ In 2016, the City of Ljubljana received the title of European Green Capital

competitions among high schools for innovative ideas in the field of air pollution in the Sarajevo canton.

Another group which plays a key role in education, is formed by the government organisations that deal with spatial planning, issuing licenses, air quality monitoring, etc. (i.e. environmental inspections, the Public Health Institute, the Spatial Planning, Construction, and Environment Ministry, the other cantonal ministries, etc.). Their education would be directed towards estimating the impact of a certain activity in a certain area on air quality, modelling the spread of pollutants, emission reduction measures, means of informing the citizens, emission controls, etc.

When it comes to other interested parties, it is necessary to educate politicians on air quality regulatory measures, primarily through examples of good practice and the EU legislation framework. A special education program should be directed towards NGOs that are active in this field. Their education should be directed towards ways of advocating for an active air quality policy, raising the awareness of the citizens, etc.

5. Key messages for decision makers

The previous chapters of this document illustrate the complexity of the air quality management system in the Sarajevo canton and recommends specific measures to be taken. The majority of these measures have already been adopted, so there is an institutional basis for their implementation.

SYSTEMATIC AND CONSISTENT APPROACH

T serious improvement of air quality requires primarily single and consistent political will. The question of air quality must not be a subject of disputes and political disagreements because its negative consequences are massive and far reaching. Apart from the political will, air quality improvement also requires a systematic approach, which includes the involvement of a large number of different actors and their synergetic action, which can be achieved through the establishment of an air quality management centre and thematic trainings, all with the purpose of achieving a better implementation of the law, the prevention of illegal construction, the control of purchase of certified furnaces and fuels, etc.



HEALTH IMPACTS

Polluted air is the greatest threat to the health of the residents and visitors of the Sarajevo canton. The high concentrations of pollutants may cause serious damage to people's health, primarily of the most vulnerable groups. According to the estimates of the World Health Organisation (WHO), BiH is among the countries with the highest number of deaths caused by polluted air. Measures such as energy efficiency directly influence the reduction of pollutant emissions and therefore the lowering of the concentrations, which has a positive impact on the environment.



IMPACT TO EMPLOYMENT AND ECONOMY

The implementation of measures for air pollution reduction in the Sarajevo canton would result in synergetic effects, one of which is employment. This primarily relates to energy efficiency measures, which apart from its impact on the environment and health, it also contributes to the local economy. The implementation of these measures enables resource multiplication, i.e. it enables the resources spent for these measures to be kept in the Sarajevo canton, considering that technical and technological solutions for most of these measures are available there.



IMPACT ON TOURISM



Air pollution has a negative impact on the image of Sarajevo. In many local and international media outlets (press, web, TV), Sarajevo is often labelled as the most polluted city in the world. Such messages may only negatively influence the decisions of foreign tourists to visit Sarajevo and BiH in general. Considering that Sarajevo attracts tourists both in winter and summer, and that the issue of air pollution is strongly visible during winter, less tourists will visit then.. Bearing in mind that tourism is the fastest growing economic sector in Sarajevo and that it employs a large number of workers, polluted air is a serious threat to this branch of the economy.

6. Useful information

Information on the measuring carried out by the Ministry of Physical Planning, Construction and Environmental Protection of the Sarajevo Canton (canton and Federation automatic monitors)

www.kvalitezraka.ba

Average hourly values of pollutants published by the Hydrometeorological Institute of the Federation of B&H

www.fhmzbih.gov.ba/latinica/ZRAK/vrijednostiPolutanata.php

Air Quality Information - Air Quality Index according to NGO EKO AKCIJA

www.zrak.ekoakcija.org/sarajevo

International website that publishes air quality index in real time (AQI)

www.aqicn.org/city/bosnia-herzegovina/sarajevo/vijecnica/

A free mobile application that publishes air quality index in real time

www.plumelabs.com/en/air/