



# HOUSEHOLD AIR POLLUTION

August 2020



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This Report is a part of the project Clean Air for Montenegro 2019/2020, aimed at highlighting the negative effects of coal combustion on the environment, quality of life and human health, as well as the importance of gradual switching to alternative ecological energy sources, through the just energy transition process.

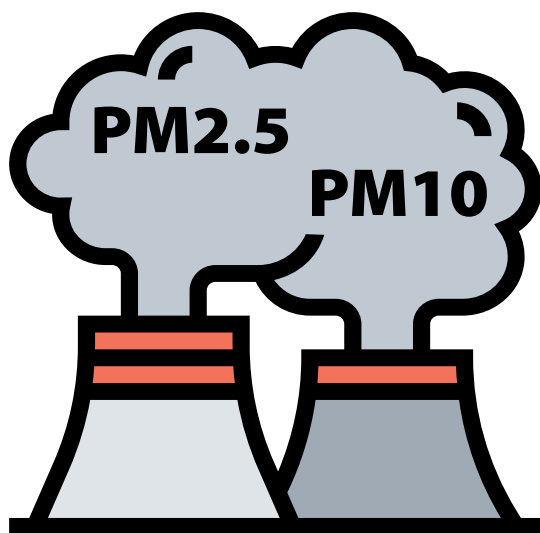
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## **Air pollution impact on households in Montenegro**



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## SUMMARY

**W**HO estimates that ambient (outdoor) air pollution accounts for an estimated 4.2 million deaths every year, while household air pollution causes an estimated 3.8 million deaths – 20% due to consequences of chronic obstructive pulmonary diseases and acute infections of lower respiratory system, 8% from lung cancer, 27% pneumonia, 18% deaths from stroke and 27% due to ischemic heart disease. In 2016, the WHO Country Office in Montenegro presented the findings of the analysis “Health Impact Assessment of Air Pollution in Montenegro”<sup>1</sup> which indicates that over 250 premature deaths and 140 hospital admissions per year, and a number of other health outcomes are associated with the exposure exceeding the level of particulate matter recommended by WHO Air Quality Guidelines. More than half of these effects are associated with elevated levels of pollution in winter mainly by combustion of solid fuels for heating. The analysis focused on cities of Pljevlja, Nikšić and Podgorica. Occurrence of health effects of air pollution in Pljevlja is more common than in other two cities, but, due to larger population of Podgorica and Nikšić, absolute burden of pollution to health in these cities is similar to that in Pljevlja. It is confirmed that excessive air pollution is largely caused by households: *“Substantial part of the burden can be attributed to the*

1 Health impact of air pollution in Montenegro, World Health Organization 2016



*excessive air pollution occurring in winter months. This high pollution can be due both to the combustion of solid fuels (wood and, mainly in Pljevlja, coal) for households heating and to weather conditions reducing dispersion of the pollution. Combustion of solid fuels for cooking and heating is also significantly increasing the total exposure to air pollution of residents of houses using solid fuel for cooking and heating due to direct emission of pollution to indoor spaces”.*

**A**wareness of the existence of emissions of polluting matters in households and knowledge of their impact on health is an important step towards creation of innovative solutions with the aim to reduce exposures to risks threatening human health and life expectancy. Tobacco smoke, building materials used for residential houses and apartment blocks fuels used for cooking, heating and lighting, use of air fresheners and various products for protection against insects or chemicals used for household cleaning, chemical or biological products for plant protection, as well as use of artificial cosmetic products are the most common sources of air pollution in households. During life, people spend most of their time in indoor environments – homes, offices or schools, and they breathe air whose quality is defined by the impact of natural gasses and artificial pollutants.

**C**ategories of population which are most vulnerable and the health of which is most largely exposed to the harmful impacts of air pollution, and which most frequently become ill or prematurely die, are persons with pulmonary diseases such as asthma, chronic bronchitis, emphysema and chronic obstructive pulmonary disease, babies, young children, people who work or exercise outdoor, persons above 65 years, persons with cardiovascular diseases, people in poverty, those who do not have access to healthcare, people who consume cigarettes or are exposed to tobacco smoke, all who work in sectors characterized by great exposure to polluted air, as well as people who spend a lot of their time in the vicinity of heavy traffic routes, industrial plants, construction sites or thermal power plants working on coal.



# 1

## IMPACT OF POLLUTED AIR ON PUBLIC HEALTH AND ECONOMY OF MONTENEGRO

**T**he quality of air in indoor spaces is an important indicator of human health and wellbeing. There are numerous scientific proofs of detrimental impact of polluted air in households, sources of pollution and living conditions which cause the weakening of human immunological system and very often lead to premature deaths. Household as closed environments in which people spend a large part of life, should be recognized as a factor which seriously endangers human health today, instead of being a safe, clean and healthy place for life. Due to a large number of factors which define the seriousness of this problem, it is

necessary to include both public and private sector as well as individuals in the creation of a healthier environment that will contribute to the improvement of conditions and quality of life of every man. Man should be a centre for bringing all decisions, political and strategic, for the welfare of the whole society and its further growth and prosperity. Decision-makers are responsible for preservation of health of citizens, and they have to take into consideration all benefits that come as a result of reduction of air pollution in households – decrease in the number of diseases caused by air pollution, economic benefits that will enable the quality of life to be

further upgraded in the society, as well as premature deaths to be considerably reduced.

**G**overnmental authorities should abandon electricity production from coal thermal power plants and enlarge capacities for power generation from renewable energy source; remove vehicles with diesel engines, and provide subsidies for the purchase of hybrid or electrical vehicles; expand the network of city transport and cycle routes; provide incentives for reconstruction and building of houses with adequate insulation and technologies for saving electrical energy; encourage the implementation of legal framework and policies aimed at the payment of environmental taxes according to the polluter pays principle, and follow best practice examples regarding the growth and development of sustainable communities in order to reduce the adverse impact of climate changes on the society in whole.



PHOTO BY S. HERMANN & F. RICHTER / PIXABAY



## MONTENEGRO ON THE ROAD TO THE EUROPEAN UNION **2**

**I**n December 2010, Montenegro has become a candidate for membership in the European Union, while on 29 June 2012 it formally started negotiations

with the EU. As a candidate country, Montenegro receives financial assistance from the EU within the instrument for pre-accession assistance (IPA). In



the period of 2007-2013 (IPA I), Montenegro had at its disposal EUR 235.2 million, and for the period of 2014-2020 (IPA II), the amount of EUR 270.5 million has been allocated to Montenegro. Diplomatic relationship between Montenegro and the European Union has been maintained through the Diplomatic Mission of Montenegro to the European Union in Brussels established in 2006, and the Delegation of the European Union to Montenegro, in Podgorica, started in November 2007.

**T**he policy in the domain of environment and climatic changes is aimed at promoting and fostering the sustainable development and environmental protection. The environment protection policy is based on preventive action according to the polluter pays principle, combating environmental damage at source, shared responsibility, and integration of environmental principles into other policies in order to maintain biological balance. The EU Acquis in the Chapter 27 Environment and Climate Change comprises over 200 legal acts in 10 areas: horizontal legislation, water quality, air quality, waste

management, nature protection, control of industrial pollution and risk management, chemicals, noise, civil protection, and climate change.

**N**egotiations within the Chapter 27 have been opened on the Intergovernmental Conference that held on 10 December 2018 in Brussels. Montenegro fulfilled the opening benchmark within the Chapter 27 by adopting the National Strategy with Action Plan for Transposition, Implementation and Enforcement of the EU Acquis on Environment and Climate Change, with Action Plan for the period 2016-2020 (NEAS), on 28 July 2016.

**O**bjectives of environmental protection are protection and preservation of human life and health, quality of eco systems, protection of plant and animal species and cultural heritage created by man, maintenance of balance and ecological stability, rational and sustainable use of natural resources.

**L**egal framework of the EU, unlike that of Montenegro, is based on *mandatory legal instruments*: decrees, directives

and decisions, *non-mandatory instruments*: resolutions and opinions, as well as other instruments such as internal regulations of EU institutions, programs of activities, etc.

**E**uropean Union policy on air quality aims to develop and implement appropriate instruments to improve air quality. The main instruments are a series of Directives setting ambient air quality standards to provide protection from excessive pollution concentrations, based on the latest research on the health effects of air pollution. The first major instrument was the Air Quality Framework Directive 96/62/EC and its daughter Directives, which established standards for a range of pollutants including ozone, particulate matter (PM10) and nitrogen dioxide (NO<sub>2</sub>), in the period up to 2004. As a part of the 2005 Thematic Strategy on Air Pollution, the Commission proposed to consolidate the Framework Directive and first three daughter directives into a single Ambient Air Quality

Directive adopted as 2008/50/EC, and set objectives for fine particulate matter (PM<sub>2.5</sub>). Together with the fourth daughter Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air – the Ambient Air Quality Directive provides the current framework for the control of ambient concentrations of air pollution in the EU. The control of emissions from mobile sources, improving fuel quality and promoting and integrating environmental protection requirements into transport and energy sector are part of these aims. The EU has developed an extensive body of legislation which establishes health standards and objectives for a number of pollutants in air. Data of the World Health Organisation are based on the 99% precision. In the air quality analysis, toxicological evidence is observed, which indicate that hourly and/or annual concentrations at that level can impact the health of vulnerable categories of population.

TABLE 1. OVERVIEW OF REQUIREMENTS FOR AIR QUALITY MONITORING

EU AIR QUALITY DIRECTIVE				WHO GUIDELINES
POLLUTANT	PARAMETERS	LIMIT VALUES	COMMENTS	CONCENTRATIONS
PM2.5	Hourly value			25 µg/m <sup>3</sup>
PM2.5	Annual value mean	Limit value, 25 µg/m <sup>3</sup>		10 µg/m <sup>3</sup>
PM10	Hourly value	Limit value, 50 µg/m <sup>3</sup>	Not to be exceeded on more than 35 days per year	50 µg/m <sup>3</sup>
PM10	Annual value mean	Limit value, 40 µg/m <sup>3</sup>		20 µg/m <sup>3</sup>
O <sub>3</sub>	Maximum daily and 8-hour value	Target value, 120 µg/m <sup>3</sup>	Not to be exceeded on more than 25 days averaged over three years	100 µg/m <sup>3</sup>
NO <sub>2</sub>	Hourly value	Limit value, 200 µg/m <sup>3</sup>	Not to be exceeded on more than 18 times a calendar year	200 µg/m <sup>3</sup>
NO <sub>2</sub>	Annual value, mean	Limit value, 40 µg/m <sup>3</sup>		40 µg/m <sup>3</sup>

**S**electing EU standards and the World Health Organization guidelines are summarized in the table above and are meant to be guidelines to decision makers when creating national policies and plans on air quality. These apply over differing periods of time because the observed health impacts associated with the various pollutants occur over different exposure times. The WHO guideline values are set for



the protection of health and are generally stricter than the comparable EU standards.

**T**he World Health Organization has developed Guidelines for indoor air quality, as people spend a considerable amount of time indoors, at work, at homes or schools, and the air quality plays a significant part in their general state of health. This is particularly true for children, elderly people and other vulnerable groups. Guidelines of this Organization address three groups of issues that are most relevant for the public health: (1) biological indoor air pollutants (dampness and mould), (2) pollutant-specific guidelines (chemical pollution) and (3) pollutants from indoor combustion of fuels. More than 80% of people living in urban areas that monitor air pollution, are exposed to air quality levels that exceed WHO limits, while low and middle-income countries suffer from the largest exposure, both indoor and outdoor<sup>2</sup>.

ILLUSTRATION BY EUCALYP / FLATICON



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2 World Health Organization, Air Pollution



PHOTO BY GRZEGORZ POLAK / FOTOLIA

## IMPACT OF POLLUTED AIR IN HOUSEHOLDS

# 3

**E**xposure to polluted indoor air may cause a wide spectrum of adverse health outcomes, both among children and adults, from respiratory and cardiovascular diseases to cancer.

The quality of air is defined by small particles and gasses, such as particulate matters (PM2.5, PM10), carbon monoxide,

nitrogen oxides, sulphur dioxide, and easily vaporizable organic or chemical compounds that cause adverse impact on environment and human health.

One in four or 25% of deaths from chronic obstructive pulmonary disease (COPD) among adults in low and middle income countries occur due to exposure



to household air pollution<sup>3</sup>. Women exposed to high levels of indoor smoke, such as tobacco and furnace smoke are twice as likely to suffer from COPD than women who use cleaner fuels and technologies<sup>4</sup>. Among men who already have a heightened risk of COPD due to their higher rates of smoking, exposure to household air pollution nearly doubles that risk.

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3 WHO, Household Air Pollution and Health

4 WHO, Household Air Pollution and Health

5 WHO, Household Air Pollution and Health

6 WHO, Household Air Pollution and Health

12% of all deaths due to stroke can be attributed to the daily exposure to household air pollution arising from cooking with solid fuels and kerosene.

**A**pproximately 11% of all deaths due to ischemic heart disease, accounting for over a million premature deaths annually, can be attributed to the exposure to household air pollution.

Exposure to household air pollution almost doubles the risk for childhood pneumonia and is responsible for 45% of all pneumonia deaths in children less than 5 years old. Household air pollution is also a risk for acute lower respiratory infections (pneumonia) in adults and contributes to 28% of all adult deaths to pneumonia<sup>5</sup>.

Approximately 17% of lung cancer deaths in adults are attributable to exposure to carcinogens from household air pollution caused by cooking with kerosene or solid fuels like wood, charcoal or coal<sup>6</sup>. Risk for women is higher due to



their role in food preparation and longer stay in indoor space. Air pollution causes and exacerbates a number of diseases ranging from asthma, hypertension, atherosclerosis, to preterm birth, preeclampsia, low birth weights, oxidative stress and many other.

**A**ir pollution is now considered to be the world's largest environmental health threat, accounting for 7 million premature deaths around the world due to consequences of poor air quality<sup>7</sup>. Breathing in polluted air may cause serious health

problems related to cardiovascular and chronic respiratory diseases that frequently lead to premature death. Impacts on health caused by air pollutants represent enormous burden on people's health. Polluted air damages DNK, can cause preeclampsia, preterm birth, low birth weight or hyperactivity disorder or endanger the quality of seminal fluid, it cause occurrence of new cases of asthma, larger frequency of respiratory diseases, brings to the development or progression of diseases, such as chronic obstructive pulmonary disease,

7 WHO, Review

damages lung alveoli, causes lung cancer, it can change heart function, contributes to the development of ischemic heart disease, incites angina pectoris, causes hypertension, oxidative stress and atherosclerosis.

NGO Green Home has conducted an onsite research in Pljevlja, at the end of June and beginning of July 2020, that included 150 households, with the objective to determine the types of fuels used in households, as well as to find out what is the state of awareness of population in that Montenegrin city of the health impact of poor air quality.

**M**ajority of households use the combination of wood and coal for heating, and they do not consider the possibility of switching to other fuels. However, after being informed on negative impacts of polluted indoor air on their health, majority of them has changed opinion and expressed their wish to start using clean fuels. Financial incentives would further motivate households to switch to clean sources of energy. Almost a half of households is without any kind of thermal insulation, what is one of preconditions for energy efficiency. Details of the brief study are presented in Annex 2 of this Report.



# REGULATORY FRAMEWORK **4** FOR AIR PROTECTION

**M**ontenegro has adopted a series of laws from the domain of environment which prescribe competencies, obligations, responsibilities, enforcement and monitoring of protection measures, for the purpose of preservation of natural resources and health of population. Due to the fact that neither the European Union nor Montenegro have brought any special directives on the indoor air quality, they are obligated to abide by Air Quality Standards adopted by the European Parliament, as well as by the Government of Montenegro.

**T**he Law on Air Protection in Montenegro defines competencies and powers of administrative bodies at both national and local level in charge of issues of environmental protection. In Montenegro in the domain of environmental,

including thus air protection, actively involved, either directly or indirectly, are: (1) Directorate for Environment, in charge of activities related to laws, bylaws, policies, strategies, action plans and environmental protection and improvement systems, (2) Directorate for Horizontal Legislation, in charge of activities of harmonization of regulations in the domain of environmental protection with EU legislation, (3) Directorate for Air Protection and Environmental Noise Protection, in charge of activities related to the establishment of systems for environmental protection and preservation, (4) Directorate for Control of Industrial Pollution, Management of Chemicals and Protection of Environment, in charge of activities related to harmonization of legislation with EU regulations in the domain of industrial pollution,

(5) Directorate for Management of EU Pre-Accession Support and Other Funds, in charge of activities related to coordination, preparation and revision of operative programs, project proposals, terms of references, that are funded wholly or partially through EU funds, (6) Agency for Environmental Protection, in charge of professional duties and related administrative activities from the domain of environmental protection: monitors environment, prepares analyses and reports, issues permissions, maintain communication with relevant national and international bodies and organizations, communicates with public, performs other duties set forth by the Law on Environment and other by-laws, (7) Hydro-Meteorological Institute of Montenegro conducts analyses and forecast of air quality, (8) Centre for Eco-Toxicological Researches – Podgorica, in charge of implementation of annual program of air quality monitoring on measuring locations within the national network established for air quality monitoring, (9) Accreditation Body of Montenegro in charge of implementation of procedures for accreditation

of legal entities in the domain of air quality supervision, measuring of emissions from stationary sources, measuring of fuel quality, (10) Institute for Standardization in charge of adoption and implementation in Montenegro of European and international standards from the domain of air quality that are of interest for Montenegro, and participate in the elaboration of technical regulations, and (11) Administrative Authority in charge of customs affairs, conducts control over export and import of substances that damage ozone layer, and products that contain these substances, as well as other substances that affect or may affect air quality.

**A**ir quality improvement and environmental protection are issues that are not strategically defined solely by the Law on Air Protection and Law on Environment, but also by other legislative acts that, either directly or indirectly, contribute to the air quality and state of environment, namely to the health and wellbeing of the citizens of Montenegro. Besides these two laws, the following laws are also applicable in Montenegro: Law on Environmental Impact

Assessment, Law on Strategic Environmental Impact Assessment, Law on Integrated Environmental Pollution Prevention and Control, Law on Waste Management, Law on Chemicals, Law on Industrial Emissions, Law on Liability for Environmental Damage, Law on Ratification of the Kyoto Protocol, and the UN Framework Convention on Climate Change, Law on Ratification of Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, Law on Protection of the Sea against Pollution from Vessels, Law on Protection against Non-ionizing Radiation, Law on Biocidal Products, and Law on Efficient Use of Energy, Law on Public Administration, Law on Administrative Proceedings, Law on Administrative Dispute, Criminal Code, Law on Misdemeanors, Law on Inspection Supervision, Law on Free Access to Information, Law on Data Protection, Law on Foreign Trade, Law on Spatial Planning and Construction, and Law on Health Care.

**T**ogether with the already existing legislative

framework in Montenegro, the European Green Deal, adopted by the EU Parliament, that provides a roadmap with actions for making the EU's economy sustainable, by turning climate and environmental challenges into opportunities and making the transition just and inclusive for all, should be accepted by the Government of Montenegro accessing the EU membership, as its strategic framework and thus ensure a cleaner, healthier and safer environment for its citizens. The European Green Deal aims to protect, preserve and enhance the EU's natural capital and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, this transition must be just and inclusive. It must put people first, pay attention to the regions, industries and workers who will face the greatest challenges. The European Green Deal is a response to these challenges. It is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gasses in 2050 and



economic growth is decoupled from resource use.

**T**here is also the 2030 Climate and Energy Framework presented by the European Commission on 22 January 2014. It is a communication setting out a framework for EU climate and energy policies in the 2020-2030 period. The 2030 framework aims to help the EU to address issues such as: taking the next step toward the goal of reducing greenhouse gas emissions by 80-95% below 1990 levels by 2050; high energy prices and the EU economy's vulnerability to future price rises, especially for oil and gas; the EU's dependence on energy imports, often from politically unstable areas; the need to replace and upgrade energy infrastructure and provide a stable regulatory framework for potential investors; and agree on a greenhouse gas reduction for 2030. Four important targets are also endorsed: (1) a binding EU target of at least 40% less greenhouse gas emissions by 2030 compared to 1990, (2) a

target, binding at the EU level, of at least 32% renewable energy consumption in 2030, (3) an indicative target at EU level of at least 32,5% of improvement in energy efficiency in 2030, (4) support the completion of the internal energy market by achieving the existing electricity interconnection target of 10% as a matter of urgency not later than 2020, in particular for the Baltic states and the Iberian Peninsula, and the objective of achieving a 15% target by 2030. This will enable the EU to move towards a climate-neutral economy and implements its commitments under the Paris Agreement – a global agreement within the United Nations Framework Convention on Climate Change (UNFCCC), signed at the XXI meeting of the Conference of the Parties (COP) in Paris, verified also by the Parliament of Montenegro, and thus Montenegro confirmed its commitment to the fight against impacts of climate changes together with other signatory countries.

# 5

## IMPACT OF ENVIRONMENT ON AIR QUALITY

**E**nvironment can directly and indirectly affect our health and wellbeing. There are many aspects of our environments – both built and natural, that can impact on the quality of our life. Therefore, it is important to interpret public health issues in a wider context of our environment and the place where we live. Health and environment should be seen and understood as the interaction between the need of people for a healthier, safer and cleaner environment and their contribution to the overall pollution of environment. Man



needs environment as a source of clean air, drinking water, food, as a safe place for living, as well as a source of energy and other resources that must not be misused but exploited with the utmost responsibility in order to ensure sustainability of the community and prevent occurrence of health problems and premature deaths caused by environmental pollution.

Polluted air is a result of rapid industrialization and urbanization, and ambient air pollution is constantly growing.



Everyday life has been subject to drastic changes over several last decades, characterized by the trend of fast changes to the style of living. It is due to the increasing needs for time planning, high rates of urbanization, technological development, and specific professional orientations, that a large majority of population spends a considerable part of their time indoor, what affects significantly the human health. At the same time, inadequate ventilation, lack of air purification, together with the presence of tobacco

smoke, microbe growth, use of fossil fuels or various chemical products deteriorates household air quality, burdening thus health of people and polluting their living environment. The majority of households in developing countries still uses open windows as natural ventilation what spontaneously brings to the increased concentrations of pollutants from outdoor – products of industry, energy sector, traffic, agriculture and other.



PHOTO BY JORGE SALVADOR / UNSPLASH

**I**n developing countries, one of major sources of household air pollution is fuel that is used for heating and cooking, most frequently fossil fuels – coal and kerosene or biomass, such as biodegradable by-products of wood industry, agricultural waste and residues of biological origin (both plant and animal matters), as well as biodegradable fraction of industrial and municipal waste, while households in developed countries use electricity, natural gas or liquefied petroleum gas (LPG).

The main reason for concern from residential heating using wood and coal is the effect it has

on ambient air pollution and health. The types of fuel used for residential heating are an important determinant for both outdoor and indoor air quality in many countries. At the total level, combustion of solid fuels like wood and coal generates greater pollution with PM than the use of electricity, gas or liquefied fuels for heating. Particulate matters (PM<sub>2.5</sub>, PM<sub>10</sub>) are classified as carcinogenic as they cause malign changes on various organs in human body. Solid fuels continue to be used for cooking or heating by nearly 3 billion people worldwide, and almost 2 million kilograms of biomass are



burnt every day. Households that use biomass have a high level of particulate matters and gaseous air pollutants, such as carbon, iron, lead, cadmium, silicon, phenol and free radicals, carbon-monoxide, nitrogen-dioxide, sulphur-dioxide, formaldehyde, complexes of hydrocarbons and organic matters including polycyclic aromatic hydrocarbons, volatile organic compounds and chlorinated dioxins.

**T**obacco smoking in any form is a significant source of household air pollution. About 1.1 billion people worldwide smoke and that number is expected to rise. Tobacco smoke particles deposit on furniture, hair, cloths and floor. They remain suspended in the household air for a long time, even after smokers leave indoor space, creating thus conditions for occurrence of respiratory or cardiovascular diseases, asthma, lung cancer, middle ear inflammation, it can also cause preterm delivery, complications on delivery, birth of children with reduced lung function or sudden infant death. When smoking tobacco burns and generates smoke with several hundreds of harmful matters, among which are: nicotine, benzene, acrolein,

benzo (a) pyrene, ammonium, carbon-dioxide, heavy metals (lead, cadmium), nitrosamines, and many other, the effects of which disturb significantly the health of people.

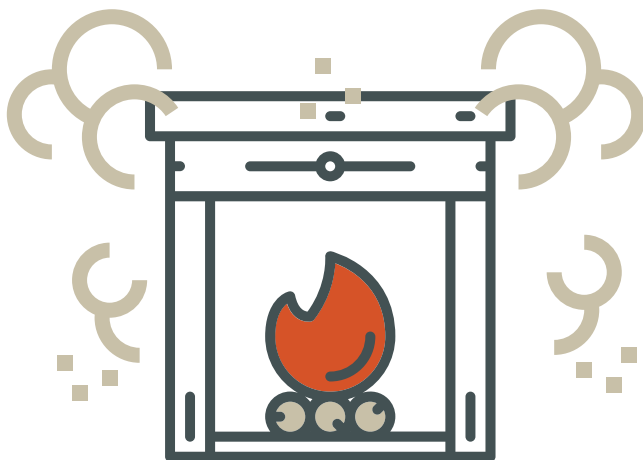
Regulation of air temperature, i.e. cooling and heating of indoor spaces is of utmost importance when defining the household air quality. In order to ensure an optimum room temperature, insulation materials and air temperature management can contribute to a larger extent, while preventing air to leave indoor space will result in bad ventilation and cause spontaneously accumulation of pollutants in households. Opening of windows is a form of natural ventilation. However, pollutants from ambient (outdoor) air, like particulate matters (PM) that contain copper, iron, potassium, nickel, silicon, vanadium and zinc, with the size of particulate matters between 2.5 i 10 microns (PM2.5 and PM10), and ozone gas find easily their way from ambient air into households aggravating thus household air pollution and impairing human health. Households situated in the vicinity of large traffic routes, industrial zones and coal thermal

power plants have the highest exposure to harmful impacts of polluted air.

**C**onstruction materials used for insulation of residential houses contribute also to the overall household air pollution. There are also paints and lacquers that emit considerable quantities of volatile organic compounds and increase the effect of other already present pollutants. Furniture made of plywood is also responsible for emission of pollutants similar to that from volatile organic compounds because it contains a large quantity of glue. Construction materials, such as bricks and cement, contain silicon. The

presence of high-tech devices in households causes higher ozone emissions, due to the use of computers, printers, tablets, mobile phones, etc.

Many households accumulate evaporations produced during cooking and thermal food processing, or use of perfumes, air fresheners, detergents, fabric softeners, personal hygiene products, living space cleaners. Breathing air that is polluted with the combination of such household evaporations can cause the occurrence of headache, dizziness, sickness, vomiting, coma, poisoning, asthma, liver damages, irritation of airways and allergic reactions.



# RECOMMENDATIONS

# 6

## RECOMMENDATIONS TO THE GOVERNMENT OF MONTENEGRO:

1. Development of the plan of a just low-carbon energy transition for Montenegro in cooperation with all stakeholders in the process. The plan should include all aspects of energy transition, from power generation, heating, transport, etc. A special consideration has to be given to the areas dependent on fossil fuels.
2. Vulnerable categories of population, particularly those exposed to poverty, has to be given priority by the Government of Montenegro in the transition to cleaner and healthier solutions of heating systems and energy efficiency, in order to mitigate their exposure to poverty and reduce toe total energy costs.
3. The Government of Montenegro, in collaboration with local self-governments and within the development strategy for heating system transition, should continue to define subsidies as a support to households to transfer as soon as possible from the present to renewable energy sources for the needs of heating. The governmental support has to be accessible to all municipalities in Montenegro, with a special attention paid to the city of Pljevlja.
4. The Government of Montenegro has to establish funds for granting subsidies to citizens for the purchase of construction materials in order to further enhance energy efficiency, not only of households but of the entire energy sector.

## RECOMMENDATIONS TO THE MUNICIPALITY OF PLJEVLJA:

1. The vision of cleaner and renewable energy sources of the Municipality of Pljevlja has to be a basis for energy transition in Pljevlja.

2. The Municipality of Pljevlja has to define objectives of the development strategy for introducing renewable and cleaner energy sources for the needs of heating system transition in Pljevlja. The development strategy must meet all preconditions of a transparent process of elaboration, in cooperation with all interested parties, first of all with citizens, non-governmental organizations, health professionals, energy cooperatives, as well as local authorities and other business entities. Creation of a feasible and realistic development strategy of heating system transition in Pljevlja will be possible solely within the participative decision making process.
3. Development strategy for the needs of heating system transition must have precisely defined deadlines for the transition to be achieved. The development strategy for transition must also specify a deadline that will guarantee the delivery of assistance to households and other interested parties which participate in the process of transition to cleaner and renewable energy resources and thus in the creation of a cleaner and healthier environment in Pljevlja.
4. When deciding on the change of heating system, the Municipality of Pljevlja, in collaboration with the Government of Montenegro must take into consideration all costs that can be incurred during the transition process – for example, healthcare costs due to the pollution from potential heating systems. Coal, and especially lignite, has the most harmful impacts on health, causing diseases, shortening life expectancy, causing premature deaths. Therefore, the use of these fuels for heating should be completely abandoned.
5. Vulnerable categories of population, particularly those exposed to poverty, has to be given priority by the Government of Montenegro in the transition to cleaner and healthier solutions of heating systems and energy efficiency, in order to mitigate their exposure to poverty and reduce the total energy costs.



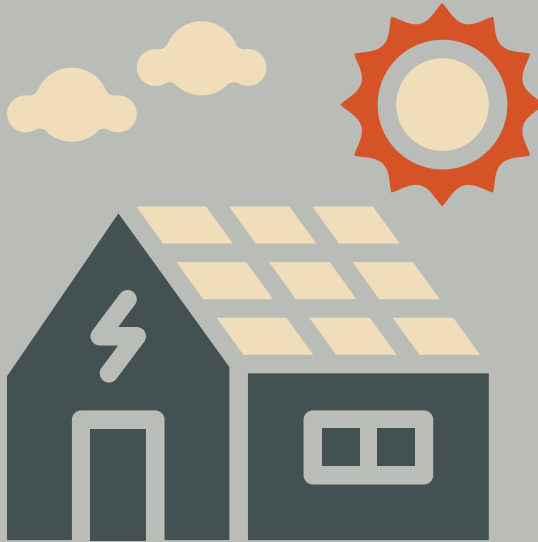
6. The Municipality of Pljevlja has to prepare a feasibility study on the possibilities of using clean energy sources for heating in Pljevlja. Such study must take into account the availability of natural resources (such as sun, wind, geothermal resources), feasibility (installation of heating pumps or solar collectors and photovoltaic devices), as well as economic factors, availability of financial resources, health burden and long-term healthcare expenses caused by individual types of heating, etc.
7. One of the most important measures in the process of transition to clean energy sources should be energy saving through investments into insulation and energy efficiency of households. This measure will help reducing not only harmful effects of emissions, but also household heating expenses due to the need for less fuels, and therefore contribute to the improvement of the quality of household air and people's health, and prevention of dampness and mold growth in households.
8. The Municipality of Pljevlja, within the development strategy for heating system transition, should continue to define subsidies as a support to households to switch away as soon as possible from the present to renewable energy sources for the needs of heating.
9. The Municipality of Pljevlja has to establish a fund for granting subsidies to citizens for the purchase of construction materials in order to further enhance energy efficiency, not only of households but of the entire energy sector.
10. Transition to cleaner energy sources for the needs of heating will contribute not only to the reduction of adverse effects of fossil fuels on climate change and people's health, but also to the further economic development of the Municipality of Pljevlja.
11. Heating energy transition is expected to produce positive effects on decarbonisation of households, public institutions and industry in Pljevlja.

## **RECOMMENDATIONS TO THE CITIZENS OF PLJEVLJA FOR TRANSITION TO CLEAN HEATING TECHNOLOGIES AND THEIR CONTRIBUTION TO ACHIEVING GOOD AIR QUALITY:**

1. Improvement of health and reduction of healthcare costs switching away from coal and wood as fuels for cooking and heating in households to acceptable fuels will enhance the household air quality and at the same time reduce harmful effects on human health, as well as contribute to lowering the ambient air pollution which through natural ventilation enters households and becomes again a part of the total household air pollution.
2. Thermal savings: the use of ecologically acceptable construction materials and thermal insulation in households will contribute considerably to the energy efficiency i.e. much less energy will be needed for heating, ambient air quality will be upgraded due to the reduced fuel consumption, regardless of the type of fuels used. Such savings are visible immediately after installation of thermal insulation.



PHOTO BY VIVIANE MONCONDUIT / PIXABAY



## CASE STUDY

### A BRIEF STUDY OF AIR QUALITY MEASUREMENT IN HOUSEHOLDS THAT USE DIFFERENT TYPES OF FUELS FOR HEATING, AND HEALTH IMPACTS OF INDOOR AIR POLLUTION

#### BACKGROUND:

In Montenegro, 7.22% (6.08%-8.44%) of all deaths are attributable to air pollution, where 2.61% (1.74%-3.68%) of all death cases are from indoor air pollution<sup>8</sup>. According to the World Health Organization, the mortality rate due to air pollution in Montenegro is one of the highest in Europe, 78.6 deaths at each 100.000 citizens<sup>9</sup>. In the region, only Bosnia & Herzegovina and Northern Macedonia have higher mortality rates.

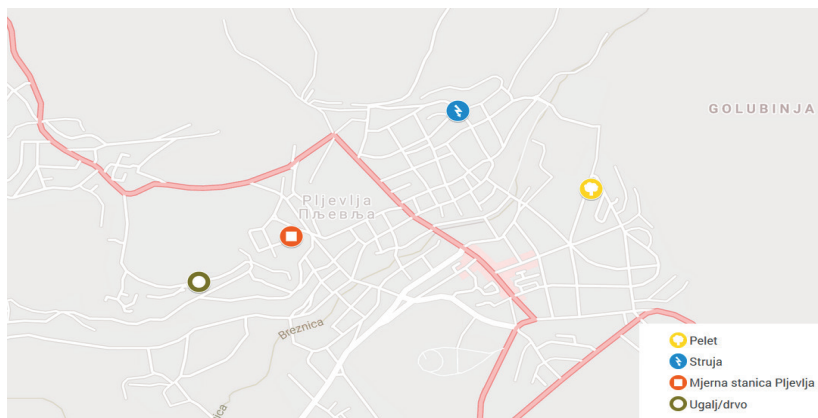
8 Data from the most recently available year 2017 GBD study. Visualizations are available at: <https://vizhub.healthdata.org/>

9 World health statistics 2018: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization; 2018.

## METHODOLOGY

### Locations, fuels and air measurement periods

The present study is conducted for the city of Pljevlja. The map contains locations of households where indoor air quality measurements are carried out: pellet/yellow, electricity/blue, coal & wood/dark green, and the location of the official measuring station of the Nature and Environment Protection Agency of Montenegro / red.



Indoor air quality is measured in three households that use different fuels; (1) pellet, (2) electricity and (3) combination of coal and wood.

The measurement period covered the heating season – from 17 February to 20 April 2020. The measurement is conducted in continuity during 74 days of the heating period.

Households are selected according to the following criteria: 1. That are not smoking households, 2. That are not situated in the vicinity of on large crossroads; 3 That measurement is conducted in the living room (surface area not exceeding 40m<sup>2</sup>); 4. That households dwell in houses/not apartments.

## INSTRUMENTS USED IN THE STUDY

### Indoor air quality monitor

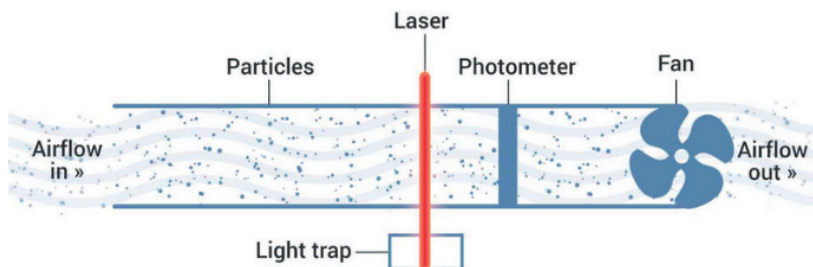
A smaller device, AirVisual Pro, is used in the study. The device measures particulate matters, PM10 and PM2.5. It was installed in houses and measured the indoor air quality (PM) and at the same time it measured the ambient air quality on the basis of information received from the nearest measuring station.



SOURCE [WWW.IQAIR.COM](http://WWW.IQAIR.COM)

It is the only station in Pljevlja that measures particulate matters ((its location is marked on the map). AirVisual Pro is a low-cost air quality monitor which uses a light scattering laser sensor for PM2.5 measurements.

Laser sensors are the most accurate devices for PM2.5 measurement by low-cost monitors. How it works is that within the sensor's measuring chamber, a laser light beam is shone onto particles, and this light is then irradiated in all directions from these particles (scattering) A light detector then measures all of this scattered light, and from this, the



IQAir®

sensor can calculate the concentration of particles within the chamber. In this way, the sensor is able to detect microscopic particles ranging from 0.3 to 2.5 $\mu\text{m}$ ), and thus the quantity of pm per m<sup>3</sup>.

Disturbed air flow that is not precisely recorded appears usually to be a source of mistakes in low-cost monitors. The sensor in AirVisual Pro has also a small fan to ensure the constant flow of air through the measuring chamber.

## **Ambient air quality data**

Data on the ambient air quality are taken from the official website of the Nature and Environment Protection Agency of Montenegro. We have consulted also the real-time data, as well as monthly reports of the Agency<sup>10</sup>.

## **Population and health Data**

Data related to the number of citizens for the Municipality of Pljevlja have been collected from the Statistical Office of Montenegro (MONSTAT)<sup>11</sup>. The Public Health Institute has publicised the 2017 data related to mortality and morbidity<sup>12</sup>. Data regarding the percentage of households that use different type of fuels for heating have been provided by the Municipality of Pljevlja, Secretariat for Municipal-Residential Affairs, Traffic and Waters.

## **Quantitative health impact estimate**

AirQ + software version 2.0 is used for the purpose of this study. We used functions ‘pollution concentration->health outcome’ for each function ‘concentration->response’ for mortality caused by PM<sub>2.5</sub> and PM<sub>10</sub>. These functions are set in accordance with the WHO guidelines. We calculated the burden of disease for the citizens of the Municipality of Pljevlja due to long-term exposure solely to the indoor air pollution. The burden of disease due to exposure to ambient air pollution is not presented in this study.

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10 <https://epa.org.me/monthly/mjesecni-izvjestaji-o-kvalitetu-vazduha/>

11 <https://www.monstat.org/cg/page.php?id=273&pageid=48>

12 Statistical yearbook 2017.on health of poplutaion & healthcare

The software tool AirQ+ is developed by the WHO Regional Office for Europe, European Centre for Environment and Health (ECEH), Office in Bonn, Germany, in order to calculate the degree of burden of disease and impact of air pollution on the health of population. All calculations performed by AirQ + are based on methodologies and concentration-response functions established by epidemiological studies. Concentration-response functions used in the software are based on the systematic review of all studies available by 2013 and their meta-analysis<sup>13</sup>.

We used the statistical software package R version 3.6.2 for computing the statistical significance in differences between the quality of air in relation to the type of fuel used in households.

## RESULTS

### Results of indoor air quality measurement

**I**n the period of 17 February to 20 April 2020, the average air pollution in households by different fuels used for heating, is presented in Table 2. According to the data obtained from indoor air measurement for particulate matters, the household that used pellet for heating had somewhat better air quality compared to the household that used electricity, as well as coal and wood. The household with combustion of coal for heating had the poorest indoor air quality<sup>14</sup>, 3 times larger value for PM<sub>2.5</sub> than the recommended health level. According to the World Health Organization, the average for PM<sub>2.5</sub> should not exceed the value of 10 µg/m<sup>3</sup>. Even households that used pellet and electricity for heating had excessive indoor air pollution, with the unhealthy pollution level, 26.0 and 26.1 µg/m<sup>3</sup>.

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13 Héroux, M.E.; Anderson, H.R.; Atkinson, R.; Brunekreef, B.; Cohen, A.; Forastiere, F.; Hurley, F.; Katsouyanni, K.; Krewski, D.; Krzyzanowski, M.; et al. Quantifying the health impacts of ambient air pollutants: recommendations of a WHO/Europe project. *Int. J. Public Health* 2015, 60, 619–627, doi:10.1007/s00038-015-0690-y.

14 Statistically significant difference in air quality in relation to the type of fuel has been calculated by Kruskal-Wallis using the rank sum test, at the value of  $p=0.019$ .

In the same period, the ambient air quality (PM2.5) in Pljevlja was very bad, and 6 times exceeded the limits set for health preservation (10 µg/m<sup>3</sup>), while in Pljevlja that value was 57.9 µg/m<sup>3</sup>.

TABLE 2. AVERAGE VALUE OF INDOOR AIR POLLUTION FOR PARTICULATE MATTERS, PM10 AND PM2.5, IN HOUSEHOLDS, BY TYPES OF FUELS USED FOR HEATING, EXPRESSED IN µG/M<sup>3</sup>

AVERAGE PM VALUE MEASURED IN THE PERIOD OF 17 FEBRUARY TO 30 APRIL 30 2020	LIMIT VALUES FOR THE PROTECTION OF HEALTH*	PELLET MG/M <sup>3</sup>	ELECTRICITY MG/M <sup>3</sup>	COAL/ WOOD MG/M <sup>3</sup>	PLJEVLJA AMBIENT AIR**
PM10	20	32	33.6	38.3	51
PM2.5	10	26	26.1	30	57.9

\*WHO Guidelines for air quality, thresholds for health-harmful pollution levels, annual average

\*\* Official monitoring station in Pljevlja data from monthly reports Feb-April

**I**n consideration of the fact that ventilation of indoor space is carried out through windows and that indoor air is mixed with ambient air, it is clearly visible that a good air quality can hardly be achieved without a satisfactory quality of ambient air. There is a significant correlation of indoor-outdoor air quality.

In households that used pellet, in the measuring period of 74 days, the maximum daily threshold value for PM10 was exceeded during 10 days, which value for ambient air quality is set at 50 µg/m<sup>3</sup>. For PM2.5, there are regulations only for annual but not for daily threshold values. Excessively polluted air (25 µg/m<sup>3</sup>) was present during 31 days in the household that used pellet for heating.

In the household that used electricity for heating, the value for PM10 was exceeded during 10 days, and 22 days for PM2.5. The household that used electricity for heating had the lowest exposure to pollution in relation to the number of exposure days. However, even in this case, in the period of 74 monitoring days, the PM2.5 level was exceeded during 30% of that period, while PM10 exceeded daily limit values during 10% of that time.



**A**s regards the household that burned coal and wood for heating, there was a significantly larger number of days with air pollution, 16 days for PM10 and 36 days for PM2.5. However, the household that used coal was exposed to excessive indoor air pollution during almost 50% of the monitoring period.

TABLE 3. NUMBER OF DAYS WITH EXCESSIVE INDOOR AIR POLLUTION FOR PARTICULATE MATTERS, BY TYPES OF FUEL USED FOR HEATING OF HOUSEHOLD

NUMBER OF DAYS WHEN THE MAXIMUM DAILY LIMIT VALUE OF POLLUTION WAS EXCEEDED, FOR	PELLET	ELECTRICITY	COAL/WOOD
PM10 >50µg/m <sup>3</sup>	10	10	16
PM2.5 >25µg/m <sup>3</sup>	31	22	36

NUMBER OF DAYS WHEN THE MAXIMUM DAILY LIMIT VALUE OF POLLUTION WAS EXCEEDED (RED) AND WHEN THE AIR QUALITY WAS GOOD (GREEN)

- Number of days the indoor air quality was good
- Number of days the air was excessively polluted (PM2.5 >25 µg/m<sup>3</sup>)

Fuel Type	Number of days the indoor air quality was good	Number of days the air was excessively polluted (PM2.5 >25 µg/m <sup>3</sup> )
ELECTRICITY	52	22
PELLET	43	31
COAL/WOOD	38	36

## INDICATIVE HEALTH IMPACTS OF INDOOR AIR POLLUTION

**I**n the present case study, we used the 2019 data on the number of population for the Municipality of Pljevlja. This is an imprecise estimate of health cases attributable to indoor air pollution but, due to the lack of specific data, this number represents presently the best possible estimate and may serve as a case review. It is very likely that that respiratory diseases morbidity is larger in highly polluted areas, such as Pljevlja.

For health impact estimate we used the method called Burden of Disease which represents the annual number of cases of disease. The aim is to make a summary of the current situation. The burden of disease is expressed as a number of death cases or a number of

incident or prevalent cases on the yearly level. The burden of air pollution should be interpreted as measure of the total number of population or performance average. It is not appropriate to use these results of burden calculation to show how the burden is distributed among specific individuals in the population. The burden that can be avoided is a fraction of burden of a specific disease that can be mitigated if the percentage of solid fuels consumption in households is reduced. According to the data provided by the Municipality of Pljevlja, Secretariat of Municipal-Residential Affairs, Traffic and Waters, the percentage of households that use coal and wood for heating is 83% (5000 households). This percentage is used in the present case review for calculation of the burden of disease.

TABLE 4. INDICATIVE NUMBER OF ANNUAL CASES OF DISEASE IN PLJEVLJA DUE TO THE INDOOR AIR POLLUTION CAUSED BY COMBUSTION OF COAL AND WOOD

DISEASES IN PLJEVLJA, INDICATIVE	TOTAL NUMBER (RANGE)	WOMEN (NUMBER)	RANGE (LOWER-UPPER LIMIT)	MEN (NUMBER)	RANGE (LOWER-UPPER LIMIT)
RESPIRATORY SYSTEM DISEASES	156 (119-179)				
TRACHEA INFLAMMATION AND OTHER OBSTRUCTIVE LUNG DISEASES	1,264	693	(490-848)	571	(190-848)
LUNG CANCER	93	51	(28-58)	42	(24-51)
ISCHEMIC HEART DISEASES	217	117	(67-136)	100	(67-136)
STROKE	36	18	(10-22)	18	(8-22)

**O**n the basis of indicative data it can be concluded that 156 persons would have respiratory system diseases caused by their exposure to household air pollution from combustion of coal and wood for heating. It is estimated that indoor air pollution causes more than a half of all respiratory diseases in Pljevlja (51.9%, range 39.9%-59.9%).

**I**t is calculated that 1264 persons had trachea inflammation and other obstructive lung diseases. Women are more vulnerable and there were more cases of trachea inflammation in women, 693 women, and 571 men. In women, indoor air pollution is a cause of over a half of trachea inflammation 52% (37%-64%), while in men the pertaining estimated proportion is somewhat lower, 43% (14%-64%) where trachea inflammation can be attributed to indoor air pollution.

According to this estimate, indoor air pollution caused 93 cases of lung cancer in Pljevlja. Women proved to be more exposed again, 51 cases of disease in women and 42 in men. In women, over a half of lung cancer is attributable to indoor air quality, 52% (29%-60%), while in men polluted indoor air is a cause of 43% (25%-52%) of lung cancer.

It is estimated that 217 cases of ischemic heart disease is caused by indoor air pollution, in women 43% (25%-50%) and in men 37% (25%-50%) of total cases of ischemic heart disease from indoor air pollution.

Indoor air pollution caused 36 cases of stroke, equal number in women and men. Out of the total number of stroke cases in Pljevlja, 43% (25% – 54%) cases can be attributed to air pollution.

The Montenegrin legislation sets maximum levels for certain pollutants in ambient air, however it does not prescribe acceptable levels for indoor air quality. According to the World Health Organization, there is no level of pollution that can be considered safe. The latest researches indicate that long-term exposure even to very low levels of air pollution can result in significant heart problems<sup>15</sup>.

## **LIMITS OF THE STUDY – CASE REVIEW**

**T**he present study is of an indicative character and can serve solely as a brief case review. Any generalization regarding the indoor air quality could not be done due to a limiting number of households where measurement was conducted. Furthermore, for the estimate of the burden of disease, the percentage of households with combustion of coal for heating is used. However there is possibility that the estimate

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15 Mortality-Air Pollution Associations in Low-Exposure Environments (MAPLE): Phase 1



SOURCE BANKWATCH.ORG

of 83% of households which use coal for heating is overestimated or underestimated. In that case, the burden of disease should be corrected accordingly.

**H**ealth data represent an indicative estimate of health burden from indoor air pollution. This kind of estimate is recommended by the World Health Organisation for indoor air pollution.

What should be emphasized is that the present study does not deal with the burden of disease from the exposure to the ambient air pollution, but only to the indoor air pollution. The burden of disease would be larger if the ambient air pollution was taken into account.



## CONCLUSION

**A**irs quality in indoor space represents a serious threat to the health of citizens in Pljevlja. This city is a hotbed of ambient air pollution from the thermal power plant and coal combustion. At the same time, its citizens are largely exposed to the poor quality of indoor air caused by combustion of coal and wood in households.

Significant health benefits could be achieved with the improvement of both indoor and ambient air in Pljevlja. Transition to heating without combustion of coal and wood would be a logical step towards improvement of health of citizens of Pljevlja. The use clean fuels for heating would upgrade the health of people in Pljevlja, in short-term and particularly in long-term. This estimate can be useful for providing additional evidences of health burden that are of crucial importance for clean air policies and action plans.

# ANNEX 1

TABLE OF PM<sub>10</sub> AND PM<sub>1.25</sub> MEASUREMENTS OF AVERAGE DAILY VALUES BY TYPES OF FUELS USED, IN µG/M<sup>3</sup>

DATE	PELLET PM2.5	PELLET PM10	ELEC TRICITY PM2.5	ELEC TRICITY PM10	COAL PM2.5	COAL PM10
2/17/2020	44.2	55.3	268.0	420.9	87.1	113.9
2/18/2020	34.7	41.4	58.0	76.8	45.2	54.0
2/19/2020	21.1	24.8	19.1	25.3	23.7	29.2
2/20/2020	13.3	15.6	12.1	15.2	21.9	26.4
2/21/2020	19.7	23.4	19.5	24.4	29.6	37.5
2/22/2020	16.1	18.6	21.6	27.1	31.4	38.9
2/23/2020	44.7	52.3	52.1	66.6	86.4	113.6
2/24/2020	59.1	71.1	70.9	92.2	73.0	86.5
2/25/2020	52.6	63.7	58.7	81.1	69.0	85.4
2/26/2020	48.1	65.1	12.2	17.3	10.8	14.7
2/27/2020	13.4	17.2	13.7	16.9	15.7	18.0
2/28/2020	19.4	24.6	20.2	26.7	14.3	16.3
2/29/2020	31.3	37.2	29.2	39.2	33.7	40.5
3/1/2020	32.7	38.8	38.5	52.3	20.7	23.2
3/2/2020	16.0	20.5	11.5	15.3	8.1	12.1
3/3/2020	12.7	16.4	10.6	13.6	11.6	14.4
3/4/2020	15.4	20.1	17.3	21.5	19.8	24.6
3/5/2020	18.4	23.6	15.7	19.8	26.3	32.4
3/6/2020	28.1	32.9	28.2	35.8	18.2	23.7
3/7/2020	47.3	60.7	13.6	17.4	16.3	21.8
3/8/2020	32.2	38.7	40.7	50.2	71.1	89.6
3/9/2020	25.4	29.4	23.6	27.4	41.2	49.4
3/10/2020	26.2	30.3	20.9	23.6	32.8	38.3

DATE	PELLET PM2.5	PELLET PM10	ELEC TRICITY PM2.5	ELEC TRICITY PM10	COAL PM2.5	COAL PM10
3/11/2020	26.0	31.7	24.1	28.2	35.3	39.8
3/12/2020	26.1	32.4	33.3	39.9	76.6	95.6
3/13/2020	31.5	37.7	37.8	46.0	41.9	52.0
3/14/2020	13.3	16.4	7.4	8.7	12.7	17.3
3/15/2020	21.1	27.9	10.6	12.7	22.4	31.8
3/16/2020	21.0	25.3	22.8	26.1	29.4	36.6
3/17/2020	35.8	43.8	32.1	37.0	41.6	50.6
3/18/2020	34.6	42.0	29.7	34.9	44.1	60.1
3/19/2020	36.2	44.2	27.8	31.8	34.3	46.2
3/20/2020	38.7	46.9	50.8	68.1	60.3	78.5
3/21/2020	58.4	68.3	51.1	60.2	82.2	110.9
3/22/2020	23.9	29.0	21.0	24.7	36.3	44.9
3/23/2020	13.7	16.9	10.8	11.9	12.5	15.2
3/24/2020	15.8	18.2	15.5	17.4	15.4	19.8
3/25/2020	17.1	20.7	10.6	12.5	25.5	35.4
3/26/2020	16.7	21.3	12.0	13.3	15.2	18.8
3/27/2020	21.7	34.9	14.2	26.2	26.2	43.2
3/28/2020	36.4	52.5	23.1	38.8	39.3	60.9
3/29/2020	28.9	37.7	26.3	33.4	37.9	51.4
3/30/2020	28.6	36.4	23.0	27.0	28.3	36.8
3/31/2020	11.9	14.1	12.7	14.5	24.2	31.1
4/1/2020	14.8	17.3	11.4	12.4	16.3	19.9
4/2/2020	18.0	21.9	12.8	13.9	16.6	20.7
4/3/2020	22.5	26.1	24.5	27.7	28.2	35.5
4/4/2020	22.2	26.3	14.1	15.2	24.7	32.0
4/5/2020	16.5	19.8	13.4	16.0	32.3	42.1



DATE	PELLET PM2.5	PELLET PM10	ELEC TRICITY PM2.5	ELEC TRICITY PM10	COAL PM2.5	COAL PM10
4/6/2020	25.7	31.2	23.7	26.7	29.2	36.7
4/7/2020	21.1	24.8	22.6	27.6	16.7	22.2
4/8/2020	24.8	29.0	22.4	26.4	23.7	30.4
4/9/2020	36.9	45.3	28.1	34.6	26.6	33.4
4/10/2020	29.6	33.9	32.9	38.1	50.1	62.6
4/11/2020	23.3	27.5	25.7	30.2	31.3	40.1
4/12/2020	28.3	34.0	22.6	26.6	29.7	36.3
4/13/2020	52.0	63.7	48.5	57.1	41.8	51.3
4/14/2020	20.6	24.7	31.7	38.7	17.9	23.4
4/15/2020	15.0	18.7	18.1	22.6	13.3	16.3
4/16/2020	19.4	23.1	21.7	25.3	24.0	31.6
4/17/2020	20.6	24.8	18.4	21.2	29.6	39.2
4/18/2020	25.7	33.2	16.0	19.1	21.3	27.7
4/19/2020	74.3	96.2	17.3	21.5	17.9	24.4
4/20/2020	12.2	14.6	10.0	12.7	18.6	23.9
4/21/2020	12.0	14.6	10.0	11.5	10.0	12.1
4/22/2020	19.9	26.3	9.7	11.5	12.6	15.7
4/23/2020	19.1	23.2	13.3	15.6	17.1	21.4
4/24/2020	15.9	18.5	12.7	14.6	21.2	29.1
4/25/2020	17.4	20.3	19.9	24.6	22.0	28.0
4/26/2020	24.6	29.8	17.8	20.7	20.8	22.8
4/27/2020	15.8	21.5	10.1	12.2	17.3	22.3
4/28/2020	15.6	20.1	12.1	14.7	13.8	17.5
4/29/2020	12.3	15.9	7.1	8.4	9.5	12.3
4/30/2020	16.6	22.0	10.7	18.1	16.1	21.7

## ANNEX 2

DATA FROM THE QUESTIONNAIRE: PLJEVLJA, VISITING AND INTERVIEWING 150 HOUSEHOLDS

FUEL	NUMBER OF HOUSEHOLDS
Wood	47
Combined coal/wood	86
Pellet	14
Electricity	3
<b>Total</b>	<b>150</b>
HAVE YOU THOUGHT TO CHANGE FUEL (BEFORE OBTAINING KNOWLEDGE ABOUT ITS HEALTH IMPACTS)?	NUMBER OF HOUSEHOLDS
Yes	24
No	93
Perhaps	24
WHAT COULD MAKE THE CHANGE OF FUEL EASIER ?	NUMBER OF HOUSEHOLDS
Financial reliefs (subsidies or loans provided by the government)	91
Central city heating	15
Without answer	44
DOES COAL AFFECT INDOOR AIR QUALITY	NUMBER OF HOUSEHOLDS
Yes	142
No	3
Don't know	5

FUEL		NUMBER OF HOUSEHOLDS			
Have you thought to change fuel (after obtaining knowledge about its health impacts)		Number of households			
Yes		94			
No		17			
Perhaps		30			
Without answer		9			
AIR QUALITY AT THE TIME OF VISITS TO HOUSEHOLDS					
PM2.5 ( $\mu\text{g}/\text{m}^3$ )	Number of households	AQI	Number of households	CO <sub>2</sub> (ppm)	Number of households
Less than 20	97	0 – 50	78	0 – 700	103
21 – 50	14	51 – 100	29	701 – 1000	36
51 – 100	20	101 – 150	8	1001 – 1500	10
101 – 200	10	151 – 200	23	Over 1500	1
Over 200	9	201 – 301	5		
		Over 301	7		
Fuel expenses					
Coal		1 ton = 60 EUR			
Wood		1 meter = 35 EUR			
Pellet		1 ton = 108 EUR with subsidies, 200 EUR market price			



**Green Home** is a leading non-governmental organization for environmental protection, founded on February 14, 2000. The organization arose from the desire of biology students and citizens for active participation in preserving and improving the environment, through public advocacy and advocacy of environmental policies in practice, support in implementation of national, European and world standards in the field of environmental protection and achievement of the concept of sustainable development in Montenegro in practice.

In achieving this, we are committed to strengthening civil society organizations and improving dialogue with all social actors in the field of ecology, in order to empower cooperation and jointly contribute to sustainable development and affirmation of Montenegro as an ecological state.

Our work is divided in two programmes:

**Programme for Environmental Protection** aims to promote, educate and support local and regional initiatives in nature protection and conservation. Through the programme we want to help in solving problems in the area of environmental protection and conservation as well as sustainable use of natural resources.

**Programme for Energy and Climate** aims to promote, educate and support local and regional initiatives on energy efficiency and use of alternative energy sources. Through the programme for energy we want to emphasize the importance of implementing energy efficiency measures and the positive effects that this method can achieve both in terms of environmental protection and improvement of living comfort.



