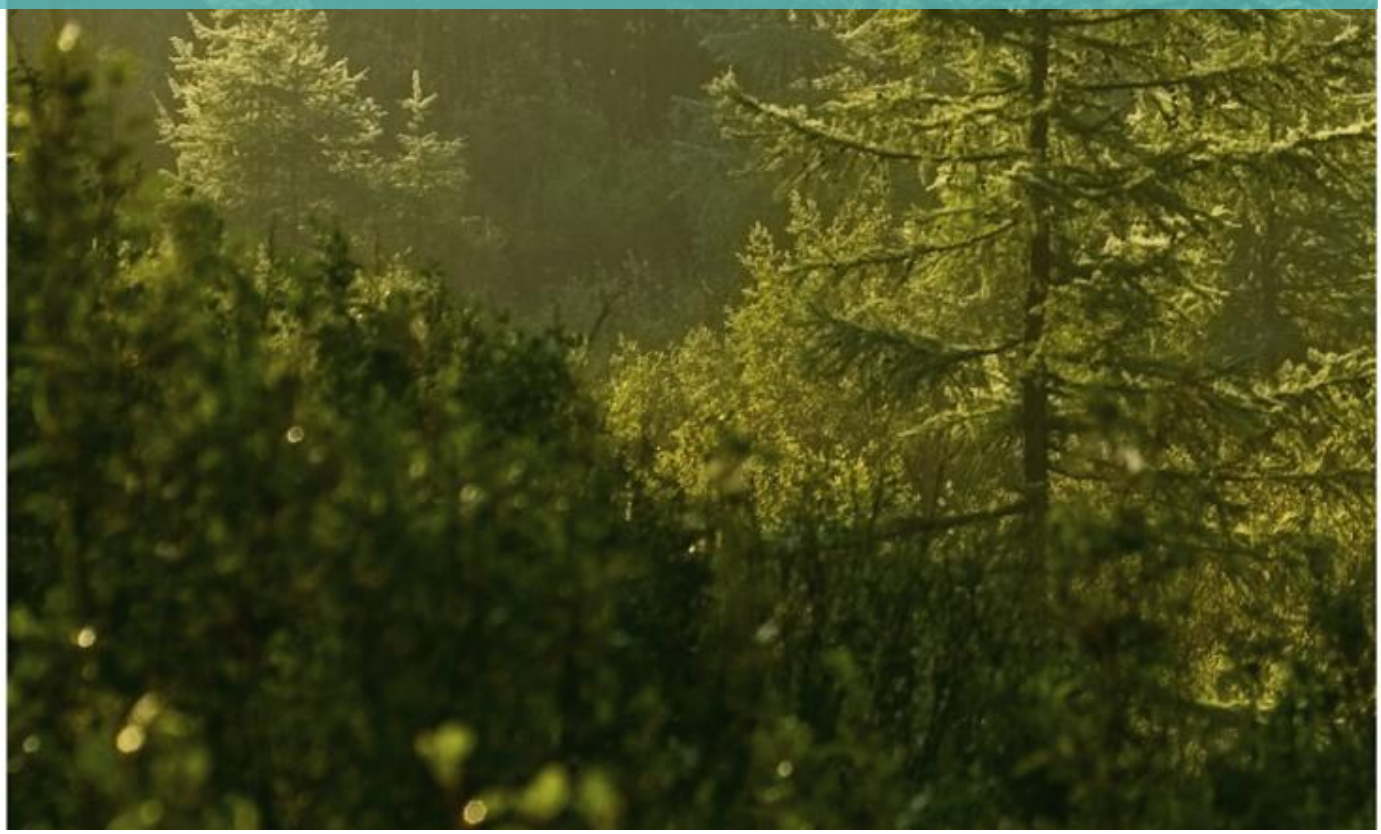
Improving Air Quality

Strategies and measures for air quality plans



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[Air quality, air quality plans, Western Balkans, air pollution]

Summary

Improving Air Quality- strategies and measures for air quality plans is aiming to be a source of inspiration and smorgasbord[1] of measures that can be included in local air quality plans to improve local air quality.

The catalogue's target audience is local governments from the Western Balkans. Keeping in mind that this region is geographically diverse, local conditions must be taken into account when deciding on whether or not the measures are relevant for a particular locality. The suggested measures have been grouped in the following categories: *residential heating, transportation and urban planning, electricity and heat supply, industry and miscellaneous*.

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Abbreviations

AAQD – Ambient Air Quality Directive

AQP- Air Quality Plans

CO – Carbon monoxide

NOx – Nitric oxide

PM2.5 – Particulate matter with maximum size of 2.5 micrometer

PM10 – Particulate matter with maximum size of 10 micrometer

SOx – Sulphur oxide

VOCs – Volatile organic compounds

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1 Introduction

1.1 Aim

The aim of this report is to provide support for selection of measures in Air Quality Plans to improve air quality in cities in the Western Balkans.

1.2 Background

Polluted air is a major cause of health problems, especially in urban areas. In 2022, air pollution is estimated to have caused premature death for over 300 000 EU citizens[2].

Besides the personal tragedies and the societal impact, polluted air also causes economic costs for society. These costs are due to shortened life expectancy, chronic diseases, health care and less productivity.

Finding solutions to improve air quality is of great urgency, in Europe and worldwide, and not less so in the Western Balkans. Western Balkan countries have been urbanizing continuously despite widespread population decline, and the population is increasingly concentrated in cities that often suffer from poor air quality[3]. Western Balkans cities are in fact called European hotspots for air pollution by the World Bank. The three-year PM2.5 average (2016–18) is above the exposure concentration obligation. Ozone levels are well above the EU Air Quality legislation limits across several cities. 93 % of premature deaths from air pollution in the Western Balkans countries are associated with PM2.5 and ground-level ozone (O_3)[4].

[2] https://www.eea.europa.eu/en/newsroom/news/premature-deaths-due-air-pollution#:~:text=According%20to%20the%20EEA%E2%80%99s%20latest%20estimates%2C%20at%20least,ozone%20to%2024%2C000%20early%20deaths%20in%20the%20EU.
[3] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
4 World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.

All countries in the region are actively pursuing membership in the EU. As of the publication of this report, Albania, North Macedonia were in accession negotiations, BiH has been granted candidate status, Kosovo is a potential candidate, and both Montenegro and Serbia are actively negotiating nearly all chapters and have even closed a few.[5] To access the EU market, aligning with EU environmental and climate standards is essential. This is a step already underway in most Western Balkan countries and involves adopting and enforcing air quality, emissions, energy efficiency, renewable energy, waste management, and biodiversity conservation standards[6].

Achieving this involves adopting and enforcing EU standards for air quality, emissions, energy efficiency, renewable energy, waste management, and biodiversity conservation[7].

Major obstacles that hinder investments and innovation needed for the green transition in the Western Balkans and that are raised by energy entrepreneurs and investors is the regulatory uncertainty. Identified challenges include a lack of transparent data on grid capacity, price fluctuations, and non-tariff barriers affecting equipment availability and prices of solar panels. The EU's regulatory framework for green investments presents a solution[8].

1.2.1 Legislation

To protect human health and the environment, the EU's Ambient Air Quality Directive (AAQD)[9] sets air quality standards with limit or target values for a number of air pollutants: sulphur dioxide (SO2), nitrogen dioxide (NO2)/ nitrogen oxides (NOx), particulate matter (PM10, PM2.5), ozone, benzene, lead, carbon monoxide, arsenic, cadmium, nickel, and benzo(a)pyrene[10].

According to the AAQD, Member States must prepare an Air Quality Plan to ensure compliance and to keep exceedance periods as short as possible when the

[5] The Western Balkans | Fact Sheets on the European Union | European Parliament (europa.eu)
[6] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[7] World Bank (2024) *Western Balkans 6 - Country Climate Development Report: Executive Summary (English).* Washington, D.C. : World Bank Group http://documents.worldbank.org/curated/en/099092624072011312/P17920510ad45200e18d531049127312370
[8] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[9] Directive 2008/50/EC, revised 2024/2081
[10] Directive - 2008/50 - EN - EUR-Lex

concentrations of pollutants in ambient air "exceed any Limit value or Target value"[11]. In an Air Quality Plan, appropriate and cost-effective measures to achieve compliance with air quality Limit or Target values are required according to the AAQD[12].

Chapter 27 of the EU acquis pertains to Environment, and the transposition and implementation of the EU Ambient Air Quality Directive (EU/50/2008) falls under this chapter. All Western Balkan countries have transposed the 2008 Ambient Air Quality Directive, meaning that the requirements under the directive are legally binding in each country. Implementation of the directive is however moving at a slower pace.

A revised version of the Ambient Air Quality Directive in October 2024 (2024/2081) sets new air quality standards for pollutants to be reached by 2030, and to contribute to the EU's objective on zero pollution by 2050. The new standards are more closely aligned with WHO recommendations and include, among other things, revised more stringent thresholds for exceedances of several pollutants. The annual limit value for fine particulate matter (PM2.5) will be reduced by more than half, as an example[13].

The stricter air quality standards in the revised directive requires Air Quality Plans with more stringent measures to be drafted, adopted, and implemented in the Western Balkan member states. These plans will require enhanced measures to address pollutants, aligning national strategies with the EU's tightened air quality standards to safeguard public health and the environment.

For more about Air Quality Plans, see section "*Air Quality Plans to reduce air pollution*" below.

1.2.2 Health effects of air pollution

Air pollution poses significant risks to human health, with both short-term and long-term effects. Exposure to pollutants such as particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and ground-level ozone (O_3) can lead to a range of health problems. Short-term exposure can cause

[11] Air Quality - European Commission
[12] Air Quality - European Commission
[13] Air quality: Council gives final green light to strengthen standards in the EU - Consilium

respiratory issues, such as asthma exacerbation, bronchitis, and other lung infections. Long-term exposure is linked to more severe health outcomes, including chronic respiratory diseases like chronic obstructive pulmonary disease (COPD), cardiovascular diseases, lung cancer, premature mortality, cognitive outcomes across the lifespan, learning disabilities, low birth weight, adverse birth outcomes.

In the Western Balkans, particulate matter (including PM10 and PM2.5), SO_2, O_3 and NO_2 often occur in concentrations that exceed legal thresholds. According to UNEP[14], city dwellers in the Western Balkans lose up to 13–16 months of life to air pollution, and the total number of premature deaths directly attributable to air pollution in the region is nearly 5,000 per year.

In Western Balkans, sources of air pollution are largely local[15]. Main causes of air pollution are human activities such as industry including electricity production, household heating and transport[16]. While Western Europe has mostly moved away from residential heating and cooking with wood- and coal-fired stoves, there is a high level of reliance on these energy sources in the Western Balkans. The burning of firewood and coal in inefficient domestic heating systems is a major source of emissions leading to poor air quality and negative health consequences[17]. The same is true for coal power plants.

Most adverse health impacts from air pollution are caused by fine particulate matter ($PM_{2.5}$), a complex chemical mixture of solid and liquid particles that are many times smaller than the diameter of a human hair. $PM_{2.5}$ result from primary combustion emissions, naturally generated particles, and chemical reactions of particles and gases in the atmosphere. Health effects of $PM_{2.5}$ are among the world's leading causes of illness and death, associated with lung cancer, ischemic heart disease (IHD), stroke, chronic obstructive pulmonary disease (COPD) and respiratory disease[18]. Not only can fine particles penetrate deep inside the lungs,

[14]UNEP () Air Pollution in the Western Balkans.
[15] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[16] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[17] JRC Publications Repository - Status of air pollutants and greenhouse gases in the Western Balkans (europa.eu); World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[18] World Bank (2019) Western Balkans Regional AQM - Western Balkans Report – AQM in Kosovo. Report No: AUS0001229, October 2019. World Bank Document

but the very small size fractions <0.1µm can also enter the bloodstream where they are pumped to all organs of the body, causing a variety of health problems across the lifespan including cardiovascular disease that accounts for the majority of global mortality.

Vulnerable parts of the populations that are particularly at risk are children, the elderly, and those with pre-existing health conditions. The elderly and individuals with pre-existing heart or lung conditions are more likely to experience severe effects, including heart attacks, strokes, and acute lower respiratory infections. Recent studies show a correlation between air pollution and adverse birth outcomes, such as low birth weight and preterm birth. Exposure to high levels of $PM_{2.5}$ is associated with higher rates of early fetal loss, preterm delivery – and lower birthweight. Reductions in intrauterine growth of the fetus significantly increase the risk of childhood and adult diseases.

Emerging evidence also suggests that air pollution may have detrimental effects on cognitive function and mental health, further underscoring the pervasive impact of poor air quality on overall well-being.

In 2022, the Western Balkans countries, air pollution is estimated to cause over 39,000 deaths annually[19]. In North Macedonia, every year about 1,600 people die prematurely as a result of exposure to ambient air pollution (PM2.5), and about 80 % of these are from cardiovascular diseases, of which about 95 % occur in age groups 50 years and above[20].

In Kosovo, about 760 people die prematurely every year because of exposure to ambient air pollution, of which 90 % from ischemic heart disease and stroke combined. Population age groups between 50 and 69 years old carry the largest share (about 45 %) of the total health burden associated with exposure to ambient air pollution [21].

In Bosnia and Hercegovina, as many as 3,300 people die prematurely every year following exposure to ambient PM2.5 air pollution. About 81 % of these are from

[19] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[20] World Bank (2019) Western Balkans Regional AQM - Western Balkans Report – AQM in North Macedonia. Report No: AUS0001228, October 2019. Air-Quality-Management-in-North-Macedonia.pdf
[21] World Bank (2019) Western Balkans Regional AQM - Western Balkans Report – AQM in Kosovo. Report No: AUS0001229, October 2019. World Bank Document

cardiovascular diseases and the majority of air pollution-related mortality occurs in people ages 50 years and older[22].

1.2.3 Impacts of health on children in the Western Balkans

Air pollution is the largest environmental health risk for children in the Western Balkans. Nearly every child – 99 per cent of all children in the region[23] – is exposed to excessive levels of air pollutants detrimental to their health and development[24]. Approximately 17% of total infant deaths in five countries in the Western Balkans reported by the Institute for Health Metrics and Evaluation were attributable to causes linked to air pollution in 2021, more than double the average rate in countries in the European Union.

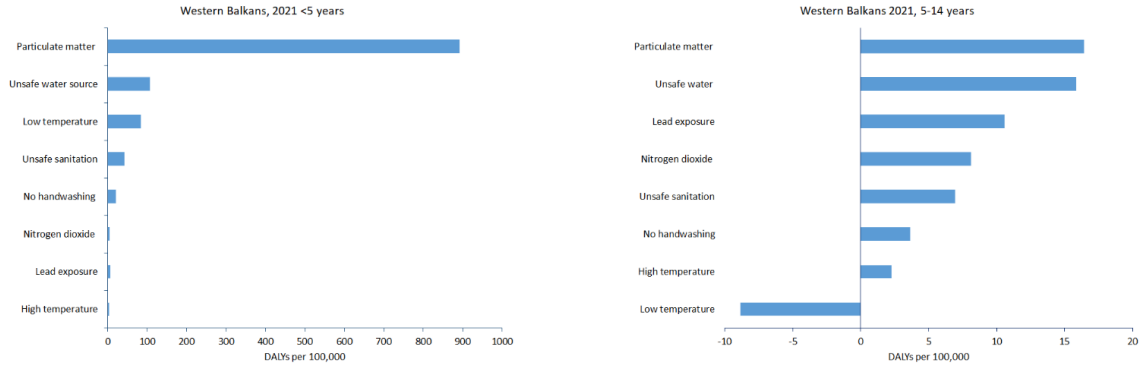

Figure 1 DALYs per 100 000 population. One DALY represents the loss of the equivalent of one year of full health.

Children are uniquely vulnerable to impacts of air pollution on their health and development, with the greatest vulnerability during development in the womb and during the first days of life.

Fine particulate matter air pollution exposures in the womb affects lung and brain development predisposing children to respiratory diseases such as asthma later in life. In the first few days of life children are particularly vulnerable to acute lower respiratory infection (pneumonia), which is often fatal without rapid treatment and

[22] World Bank (2019) Air Pollution Management in Bosnia and Hercegovina. AirQualityManagementinBosniaandHerzegovinaExecutiveSummaryeng.pdf

[23] UNICEF 2021, Children's Climate Risk Index

[24] World Health Organization Air Quality Guidelines

is a major cause of infant mortality and disease burdens in the region. Reducing exposures during pregnancy and the first year of life are a high priority.

Young children are physiologically more vulnerable to air pollution than adults because their brains, lungs and other organs are still developing making them more vulnerable to toxic pollutants leading to damaged growth and development resulting in long-term consequences over the lifespan.

- Fine particles can cross from the lungs to enter the blood stream where they are transported to all organs of the body. These particles can cross the blood brain barrier to cause neuroinflammation and disrupt brain development, which is particularly damaging in the womb as children's brains go through a period of rapid development during the last trimester. Children's brains continue rapid growth through the first years of life, where fine particle exposures impact cognitive development.
- Air pollution can also seriously affect birth outcomes. Exposure to high levels of PM2.5 is associated with higher rates of early fetal loss, preterm delivery – and lower birthweight. Reductions in intrauterine growth of the fetus significantly increase the risk of childhood and adult diseases.
- Air pollution exposure in the womb and in early infancy can cause higher rates of both childhood and adult asthma.
- Early and frequent exposure to air pollution in children leads to reduction and restructuring of lung growth that has impacts across the lifespan including increased pulmonary disease, cardiovascular disease, lung cancer, neurodevelopmental impacts and neurodegenerative disease and diabetes.

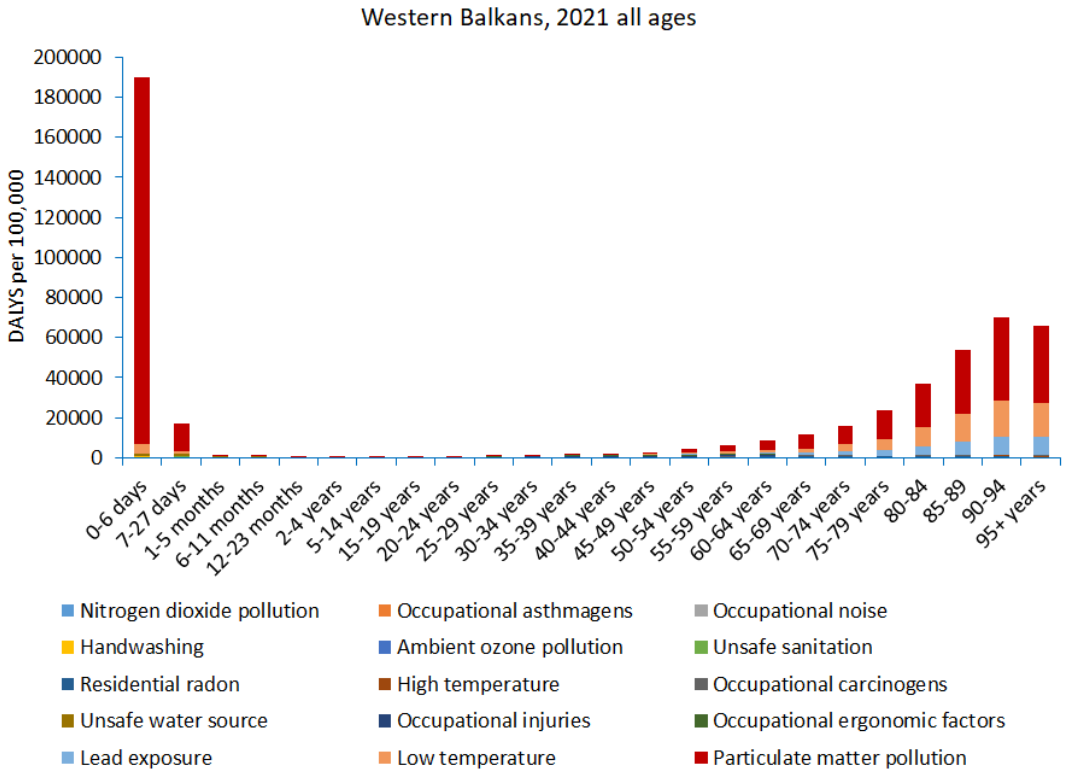

Figure 2 Visualization of data from Institute for Health Metrics and Evaluation, 2021.

Most adverse health impacts from air pollution are caused by fine particulate matter ($PM_{2.5}$), a complex chemical mixture of solid and liquid particles that are many times smaller than the diameter of a human hair. $PM_{2.5}$ result from primary combustion emissions, naturally generated particles, and chemical reactions of particles and gases in the atmosphere. Not only can fine particles penetrate deep inside the lungs, but the very small size fractions <0.1µm can also enter the bloodstream where they are pumped to all organs of the body, causing a variety of health problems across the lifespan including cardiovascular disease that accounts for the majority of global mortality. In children less than 5 years old in the Western Balkans breathing PM2.5 pollution accounts for more than three-quarters of years of healthy life lost due to premature mortality and years lived with a disability from environmental risks, more than all other environmental risk factors combined[25].

[25] IHME 2021 Global Burden of Disease estimates in Disability adjusted life years per 100,000 individuals.

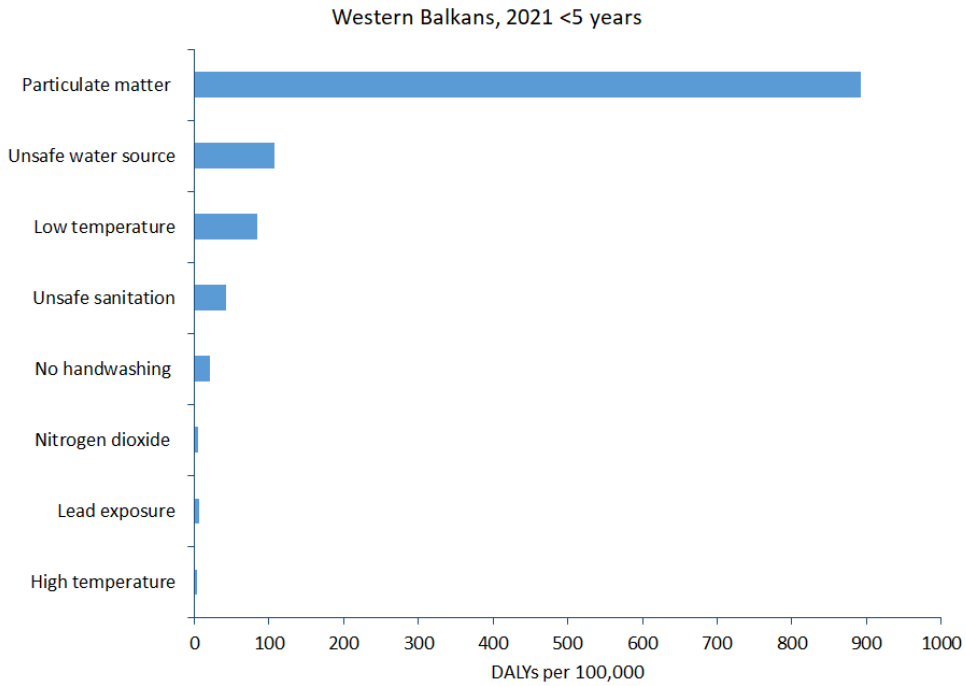

Figure 3 Visualization of data from Institute for Health Metrics and Evaluation, 2021

An assessment by UNICEF and the Swedish Environment Protection Agency found that municipal air quality plans lack references to children.

The importance and benefits of lowering air pollution concentrations on children are clear, and there is a need to identify and include measures to reduce the burden of air pollution attributable diseases on children. Particular attention must be paid to addressing the magnified health risks faced by the most vulnerable children.

1.2.4 Societal costs of air pollution

Illness and premature death caused by air pollution impact not only individuals but also society at large. The economic burden of air pollution is substantial, due to healthcare costs, chronic illness, shortened life expectancy and losses in productivity. The overall societal cost of air pollution within EU is assessed by the World Bank to as much as around 5 % of the GDP for EU.

In the Western Balkans countries, air pollution is estimated to cause an estimated welfare cost of US$16 billion (15 % of GDP) annually26.

The economic cost associated with health damage from exposure to ambient air pollution (PM2.5) in North Macedonia is estimated to 6.9 % of GDP in 2016. This includes only economic impacts from premature mortality associated with specific diseases, but not costs for other impact such as hospital stays, cost of illness, and lost workdays, which means that the cost to society and percentage of GDP is actually higher[27].

For Kosovo, the economic cost for mortality from exposure to air pollution is estimated to 2.5 %–4.7 % of gross domestic product (GDP) for 2016, and the economic costs associated with the health damage from ambient air pollution in Kosovo is on average US$240 million, equivalent to 3.6 % of GDP (2016)[28]. For Bosnia and Hercegovina, the estimated economic cost associated with mortality from exposure to air pollution is estimated to as much as 5.9–10.5 % of gross domestic product (GDP) for 2016[29].

1.2.5 Improving air quality in the Western Balkans has many benefits

The Balkan region is home to 7 of the 10 most polluting coal-fired power stations in Europe[30]. Biomass burning for domestic heating and outdated coal power plants are main sources of PM2.5 and ozone emissions[12]. Transport is another main source of PM2.5 and ozone emissions, due to an aging fleet of diesel-fueled vehicles[12]. Manufacturing plants with inadequate pollution control and mining are other significant sources of air pollution[31].

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[26] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[27] World Bank (2019) Western Balkans Regional AQM - Western Balkans Report – AQM in North Macedonia. Report No: AUS0001228, October 2019. Air-Quality-Management-in-North-Macedonia.pdf
[28] World Bank (2019) Western Balkans Regional AQM - Western Balkans Report – AQM in Kosovo. Report No: AUS0001229, October 2019. World Bank Document
[29] World Bank (2019) Air Pollution Management in Bosnia and Hercegovina. AirQualityManagementinBosniaandHerzegovinaExecutiveSummaryeng.pdf
[30] World Bank (2019) Western Balkans Regional AQM - Western Balkans Report – AQM in Kosovo. Report No: AUS0001229, October 2019. World Bank Document
[31] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.

In the Western Balkans, approximately 75 % of regional GHG emissions come from energy supply and use which is also an important source of emissions that affect urban air quality. This means that there are significant potential synergies between abating poor air quality and greenhouse gas emissions, particularly in the power/heat and transport sectors. Therefore, decarbonisation policies and measures are not only necessary to mitigate climate change but have the potential to improve air quality while also enhancing energy security and create long-term economic benefits[32].

All Western Balkans countries import their gas from a single country, Russia. Besides potentially contributing to better air quality, switching to alternative local energy sources would reduce energy import bills and improve the security of the supply[33].

[32] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.
[33] World Bank (2024) Western Balkans 6. World Bank Group Country Climate and Development Report. October 2024.

2 Air Quality Plans to reduce air pollution

To improve air quality in areas where concentrations of pollutants in ambient air exceed limit or target values for protection of human health, Air Quality Plans are compulsory according to EU legislation. The Air Quality Plan is a strategic planning instrument introduced by the Ambient Air Quality Directive (AAQD).

2.1 What is an Air Quality Plan?

In an air quality plan (AQP), a geographical jurisdiction such as a city, or a region, outlines how to reach air quality objectives on its territory, in co-operation with other authorities and economic sectors. Its main purpose is to identify measures that, by themselves or in combination, will succeed to bring down the levels of air pollutants below the limit values.

The drafting on an AQP is compulsory for any 'zone' within which the concentrations of pollutants in ambient air 'exceed any limit value or target value' designed for the protection of human health. When levels are exceeding above limit or target values stated in the directive, Member States need to prepare an air quality plan to ensure compliance and to keep exceedance periods as short as possible[34]. The AAQD legislation requires that an air quality plan sets out appropriate, cost-effective measures to achieve compliance with air quality limit or target values.

2.2 Air Quality Plans in Western Balkans

Air quality plans in the Western Balkans are typically implemented at the municipal level, although there are some exceptions where larger urban agglomerations implement one plan together. It is also common for countries to have country-level air quality strategies. According to Bankwatch, as of 2022, air quality plans are generally not adopted for all zones and agglomerations that have exceedances of the air quality standards.[35]

[34] Air Quality - European Commission
[35] 2022-02-14_Implementation-of-the-Air-Quality-Directive-by-Western-Balkan-countries_final.pdf (bankwatch.org)

2.3 How should an Air Quality Plan be designed and implemented?

There are several resources available to guide localities on how to draft and implement an air quality plan. For example, the document "*Code of good practices for cities air quality plans*"[36] gives guidance about the formal requirements, and what should be included when designing and implementing an Air Quality Plan. Furthermore, "*Guidance for Developing Local Air Quality Plans*[37]" provides a roadmap for developing air quality plans specifically with the Western Balkan context.

In brief, the general outline of an air quality plan shall include the following:

- **Assessment:** An overview of the current air quality status, detailing pollutant levels and their sources, and the impacts of emissions on public health and the environment within the geographical jurisdiction concerned.

- **Source appointment**, to identify the actual sources of emissions, is key in developing an AQP. It should also estimate the expected time required to attain the air quality objectives.

- **Target Setting:** Clearly define specific pollutant reduction targets that align with regulatory standards and so that objectives for air quality will be reached.

- **Proposed Measures:** A comprehensive list of strategies and interventions designed to achieve the outlined targets, addressing emission sources, and improving overall air quality. (This report provides support for choosing among measures to put together in an air quality plan). The listed measures should be described regarding responsibility for implementation of the measure, time for its implementation, its estimated contribution to reduction of pollutant levels, and when this will be achieved.

Choice and prioritization of measures are supported by, and in most cases require:

- Impact assessments of effects of listed measures for air quality, health, environment, and climate.
- Assessment of cost effectiveness
- Cost benefit analysis

[36] 2019.02.18_code_of_good_practices_for_cities_aqps_full_report.pdf
[37] Improving Air Quality: EU4Green Guidance for the Western Balkans - EU4Green

Learn more:

Impact assessment:

- Strategic Environmental Assessment - European Commission;
- Strategic Environmental Assessment Directive: guidance - GOV.UK;
- Environmental Impact Assessment - European Commission;
- Health impact assessments (WHO)

Assessments of cost effectiveness:

- Cost-effectiveness analysis | Capacity4dev

Cost benefit analysis:

- EU guidelines for CBA in infrastructure projects, https://ec.europa.eu/regional_policy/sources/studies/cba_guide.pdf
- Canadian government guidelines for CBA regarding policy and regulations: https://www.canada.ca/en/government/system/laws/developing-improving-federal-regulations/requirements-developing-managing-reviewing-regulations/guidelines-tools/policy-cost-benefit-analysis.html

Enforcement and implementation of measures listed in air quality plans involve different governance levels: local, regional, national and/or EU authorities and governments. Co-operation between different levels of governance is thus a key to achieve successful improvement of urban air quality. More guidance and information about legal requirements can be found in "*Code of good practices for cities air quality plans*"[38], and in a number of other tools available to support evidence-based planning and decision making to improve air quality, such as:

- Clean Household Energy Solutions Toolkit (CHEST) by WHO[39]
- Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE) by American EPA[40]
- AirQ+: software tool for health risk assessment of air pollution, by WHO[41].

The following sections will focus on presenting an array of measures that can reduce air pollution and that can be included in air quality plans for cities.

[38] 2019.02.18_code_of_good_practices_for_cities_aqps_full_report.pdf
[39] Clean Household Energy Solutions Toolkit (CHEST)
[40] Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE) | US EPA
[41] AirQ+ software tool for health risk assessment of air pollution

2.4 Setting up an Air Quality Plan – choosing measures

An efficient air quality strategy combines different types of measures, to achieve pollution reduction synergies. As an example: information and education campaigns seldom make significant changes in behavior on their own. However, combined with physical measures or economic instruments, they can contribute substantially to the purpose, by explaining and promoting the change.

As the Western Balkan region is geographically diverse, local conditions need to be considered when deciding on which measures, or which combinations of measures, are relevant for a particular locality. The choice of measures to include in an AQP will vary depending on local conditions and the local mix and character of air pollution sources.

Choosing measures with high impact for low cost is generally an effective strategy, as limited financial resources often play a critical role in successful implementation. Measures that are quick to implement can be carried out and have effect for reducing emissions in the short term, while more complex and demanding measures take longer to implement. Since the requirement in the directive is that localities experiencing exceedances must quickly reduce concentrations, sometimes quick but more costly measures may need to be taken instead of more cost-effective ones that takes longer time to implement and deliver impact. Cost benefit analysis is an important tool to help identify which measures, and which combination of measures, will be cost efficient to achieve the targets for air quality.

It is important that the strategy for better air quality is cost-efficient. Although improved air quality saves lives and environment and contributes to a better prosperity of the municipality, measures need financial resources to be carried out. Some measures have a low financial cost but can have big impact, for example legislation.

2.5 Economic, informative, and administrative instruments - description and synergies

There are several types of measures that can be implemented to reduce air pollution, separately or in combinations.

Economic instruments that can reduce air pollution include financial incentives and market-based mechanisms to influence behavior. Examples: taxes on pollution, subsidies for clean technologies, and tradable permits for emissions. These tools aim to internalize environmental costs and to make it economically advantageous to reduce pollution and adopt sustainable practices. Low-income households are especially vulnerable and may need financial support to improve the energy performance of their houses to reduce energy demand or shift heating system to be able to reduce use of high-polluting fuels.

Informative instruments focus on raising awareness and providing knowledge to influence behavior. This includes public information campaigns, environmental education programs, and labeling schemes. These tools aim to change attitudes and behaviors by informing people about the environmental impact of their actions and the benefits of more sustainable practices. Typically, a communicative design, where those who meet the message will have some possibility to respond, if not always literally or personally, leads to deeper involvement and makes the message more relevant for the groups addressed. The more a campaign aims to create mind-shifts or new habits beyond the scope of legislation or simple rules, the more useful it is to create opportunities for the target group to provide feedback or ask follow-up questions. Of course, the campaign organizer must set off enough resources to handle these answers and give a good, personal, and encouraging response in return. Information can strengthen the effect of measures aiming to change behavior. *Example: A campaign to promote increased cycling connected to the opening of a new bike lane in the area. Example: Information campaigns promoting exchange of firewood stoves to gas or electric heated stoves will help achieve better impact of offers to buy the new equipment cheaper* For more information and inspiration about how to design and target information and communication as measures in air quality plans, see Annex A.

Administrative instruments involve legislation, regulations and standards set by authorities to control pollution and manage resources. These include laws, permits, and environmental standards that require compliance. Administrative tools provide the legal framework for environmental protection within which economic and informative instruments operate.

2.6 Synergies and reinforcement

Economic, informative, and administrative instruments work together to create a comprehensive approach to environmental management. Economic incentives can

be designed to align with administrative regulations. For example, pollution taxes can be implemented alongside regulatory emission limits, making it cost-effective for companies to comply with legal standards and exceed them.

Informative instruments can support both economic and administrative measures by educating the public and businesses about the benefits and requirements of these policies. Awareness campaigns about the health impacts of pollution can increase public support for regulatory measures and the adoption of cleaner technologies incentivized by economic instruments.

Administrative instruments provide the necessary legal and institutional framework for the effective implementation of economic and informative tools. Regulations can mandate the use of eco-labels or require participation in educational programs, ensuring that information dissemination is widespread and impactful.

By combining economic, informative, and administrative approaches, municipalities and governments can establish a framework for enhancing environmental quality and promoting sustainable development. Economic instruments, such as taxes, subsidies, and tradable permits, provide the financial incentives necessary to drive behavioral change and encourage the adoption of cleaner technologies. Informative instruments, including public awareness campaigns and educational programs, raise awareness and disseminate crucial information about the benefits and methods of sustainable practices, thereby empowering individuals, and businesses to make informed decisions.

When these instruments are used in combination, they reinforce each other, creating a synergistic effect that enhances overall policy effectiveness. For instance, economic incentives can make regulatory compliance more feasible and attractive, while educational campaigns can increase public support for both economic and regulatory measures. This integrated approach not only addresses the immediate environmental challenges but also fosters a culture of sustainability in the longer term.

Poor economy and lack of financial resources certainly is a barrier for investments in cleaner technology and products. Better understanding and awareness about energy saving measures can lead to potential money savings at the same time. Hence, educational programs and advice to the public are generally beneficial both for the environment and for the household economy.

Awareness of bad air quality and knowledge on how to reduce emissions within everyday life, is important. Authorities at all levels, as well as companies, should be able to provide correct facts and figures and be able to distribute awareness and knowledge in conditions that make impression and lead to behavioural changes among the residents. The mere existence of data and information, however, does not necessarily lead to behavioural changes. Very often, people might feel concern for a certain problem and be aware of both how they contribute to it and what change in behaviour that would ease the burden, yet they stick to the unwanted behaviour. Psychologists label such situations as “cognitive dissonance”. Information campaigns and education alone are often insufficient to change behaviour because they rely on voluntary action without providing tangible incentives or consequences. Without additional measures such as regulations, financial incentives, or penalties, individuals and organizations may lack the motivation to alter their habits, especially if the changes require significant effort or cost.

Moreover, deeply ingrained behaviors and systemic issues often need structural changes and supportive policies to facilitate and sustain meaningful improvements in air quality. However, information campaigns can still be useful by raising awareness, educating the public about the health impacts of poor air quality, and fostering a culture of environmental responsibility.

Information campaigns and educational efforts of all kinds should therefore be planned carefully to achieve long-lasting or permanent change of habits among the inhabitants, or, rather, among certain groups of inhabitants.

3 How to categorize measures

In chapter 4 a catalogue of measures is presented. Its aim is to serve as an inspiration for appropriate measures in the various specific local and regional contexts of cities in the Western Balkans.

This catalogue of measures has been structured in four groups, or steps, of measures. The division has been made based on the estimated resource consumption and cost efficiency of measures, following a principle that physical investments in infrastructure and buildings are more expensive and resource consuming[42]. Measures within the earlier steps (rethink, optimize) are often not only quicker and cheaper to implement, but also less consuming of natural resources.

This categorization of potential measures has been chosen because it is relatively easy to use and manageable and does not require data, which can be an advantage in areas where there is a lack of data.

It is often possible to describe a single measure as part of either one of two steps. When putting together a selection of measures in an air quality plan, it is important to consider all four steps and what combination of measures that will be the most cost efficient to achieve the air quality standards in the specific local context.

The first step includes measures aiming at changing behavior (Step 1 Rethink). Subsidies, regulations, and informative measures are typical "rethink" measures. Measures within the second step aim at using already existing systems and infrastructure more efficiently (Step 2 Optimize). The third step is about rebuilding

[42] This structure is inspired by the Swedish so called "four step principle". This is a model originally developed and intended for decision support in transport infrastructure planning in Sweden. The principle involves selecting measures based on a four-step scale. Measures within the first steps address behavioral change (step 1) and how to use already existing infrastructure and systems more efficiently (step 2). These first 2 steps are considered quicker to implement and less expensive and more resource efficient. The principle lines out that these first 2 steps should be considered prior to choosing more expensive and complex ones, such as rebuilding infrastructure (step 3) and investment (step 4) in new infrastructure, as the latter measures generally are expensive and also consumes more nature resources.

physical infrastructure (Step 3, Rebuild) and the fourth step (Step 4, Construct) includes measures that mean building new systems or new infrastructure.

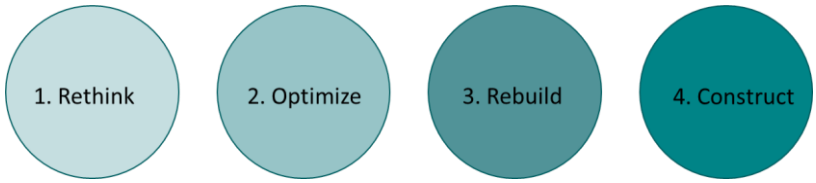

Figure 4. Measures can be described according to four steps.

Overall, measures within the first two steps (Step 1 Rethink, Step 2 Optimize) have less physical character and are less material consuming. This means they generally have less direct negative impact on the physical environment than rebuilding or new construction.

In some situations, measures in Step 1 and 2 can be less expensive due to being less resource consuming, compared to rebuilding (Step 3) or construction of new buildings or infrastructure (Step 4). However, this does not mean that measures listed as Step 1 and Step 2 generally should be prioritized. Depending on the local, regional, and national case-specific context as well as which sector that is addressed, rebuilding systems and infrastructure, or even building new systems and infrastructure could be the best solution to address crucial emission sources in a certain area.

Example: New systems for household heating, such as central district heating, may be necessary, if current heating systems will have too large emissions even if the fuel is changed.

At a first glance, categorizing a measure as rethink, optimize, rebuild, or construct can be challenging and requires some practice to fully grasp the concept. In some cases, small alterations can place a measure into multiple categories. For example, replacement of old stoves can be placed in *Rethink* if achieved through an information campaign or subsidies. However, since the replacement involves a physical change, it can also be viewed as *Rebuild* or *Construct*.

3.1 Rethink

The first step in measure selection analyses if the problem as such can be avoided, or at least reduced, by rethinking and reducing demand (for example energy demand or transport demand). Most economic policy instruments are characterized as Step 1 measures, as well as information initiatives and campaigns.

Example: Within the energy and heating sectors, measures that reduce electricity and heating needs in homes can be appropriate billing of electricity and district heating that triggers more energy efficient energy use and heating. In transport planning, pricing of road and parking for car traffic, is an obvious way of reducing demand for car traffic, and thus reduce pollution, noise, and traffic injuries. Video meetings, which replace commuting to work and physical gatherings and thus reduce demand for transport, is another a good example.

3.2 Optimize

This step is about optimizing already existing structures and systems, such as more efficient use of transport infrastructure, plants, or buildings etc. It can be applied when first step measures don't seem to be appropriate. Measures that optimize existing resources are considered. In the case of transport, sustainable transport modes like public transport, walking and cycling are more efficient in aspects of land use for urban transport compared to private car.

Example: In the energy sector, change of fuels to less polluting fuels while using existing plants and pipes. In transport, measures can involve adjusting bus timetables or moving a bus stop to a more suitable location for accessibility to services, shops, etc. so that the attractivity for bus transport increases, to increase bus travel and patronage and a modal shift from private car occurs. This makes the use of existing road infrastructure in cities more efficient as buses can carry more passengers than private cars. Adjusted signal control at regulated intersections that promotes public transport accessibility is a measure that similarly increases public transport attractivity and travel, which can lead to more efficient use of street space if a modal shift occurs from private cars. Another example is converting parking spaces for cars to space for walking, cycling and public transport, which leads to more efficient use of existing street space.

In the energy sector, Step 2 measures can include more efficient household energy use, such as exchange of older light bulbs to modern LED lights. Within industry, measures like

demand-based air flows in ventilation might save large amounts of electricity and hence have a very short pay-off.

3.3 Rebuild

Step 3 measures encompass minor alterations to existing structures. The border between "optimization" in Step 2 and "rebuilding" in Step 3 is seldom clearly defined, but Step 3 measures are characterized by more extensive work and costs than measures in Step 2.

Example: In the energy sector, Step 3 measures can include improved insulation of house walls and attics or replacement of heating systems. Within industry, a step 3 measure could consist of a limited re-building or re-processing scheme to improve energy efficiency and/or productivity. In transport, this may involve rebuilding street lanes for all transport modes to dedicated lanes for public transport, walking and cycling. It may also involve extending the platforms at a railway station to allow longer trains.

3.4 Construct

In Step 4, measures are considered that involves new construction of different kinds which generally is expensive, complex and time- as well as space consuming.

Example: Development of an entirely new district heating network, the establishment of a new waste dump or construction of a new power plant, or the building of more road capacity.

4 Catalogue of measures

This part constitutes the catalogue of measures. It is divided into the following sectors: Residential Heating, Transportation and Urban Planning , Electricity and Heat Supply, Industry, and Miscellaneous. Selection criteria for these sectors were based on their significant contributions to air pollution. Key sources of concern encompass emissions from thermal power plants, traffic, domestic heating, mines, and industrial activities.

The presented measures are categorized as *Rethink*, *Optimize*, *Rebuild* or *Construct*. For each measure, a brief description is provided as well as recommendations about effective design and implementation when relevant. Furthermore, each description provides details about which pollutants that are addressed by the specific measure, the geographical scale of effects, time scale, and approximate costs when such information has been available.

Where effects and costs are cited, they need to be considered as examples in a specific context. It is important to remember that the effect as well as the cost for a specific measure will be dependent on the local, regional, and possibly also national context where they will be applied. This means that the outcome depends on the situation in the specific town/municipality/heating system/vehicle fleet etc. Which measures that are best suited to improve air quality needs to be considered in the specific context, including what other measures and changes that are made at the same time.

When selecting measures, it is important to consider how the chosen measure will affect vulnerable groups in society, e.g., children and elderly. People with lower socio-economic status are often more exposed to poor air quality due to living close to sources of pollution and in areas of high-intensity traffic[43].

[43] Balkanfund, 2022. https://www.balkanfund.org/general-news/what-is-polluted-air-doing-to-us-in-the-western-balkans-1

5 Residential heating

With almost 3 million households in the Western Balkans using old solid fuel stoves, they contribute to a major part of the particulate matter (PM) sources in the area. By focusing on measures targeting residential heating there are great potential to reduce the air pollution from this source. A lot of these stoves' efficiency is estimated to be around 30-40% while modern eco-design alternatives are at 86%. Changing old stoves to modern could save fuel and up to 90% in emissions.[44] Changing to non-burning heating can save even more. Of course, a rapid transition to sustainable and renewable heating sources and systems is strongly recommended. However, in case of financial or other constraints much can be gained from improving the current system.

When considering residential heating, there are several ways to reduce negative environmental impact. In the best-case scenario, households would utilize renewable energy sources such as solar power or geothermal energy to heat their homes. These options are not only less polluting but can also help reduce energy costs in the long run.

A next-best scenario would involve replacing existing heating systems with more energy-efficient options. Preferably, this could mean installing heat pumps but, in certain cases, modern and efficient pellet stoves may also represent a significant improvement depending on the baseline. These alternatives decrease carbon emissions and lessen reliance on fossil fuels. Additionally, investments in energy-efficient systems can prove cost-effective in the long term through reduced energy bills.

A third scenario could involve encouraging the use of cleaner fuels for traditional heating systems like gas instead of pellets, coal, and oil. While these fuels still emit pollutants, modern burners and technologies can mitigate their environmental impact compared to older, less efficient systems. However, if gas requires extensive investments, both financial and structural, the recommendation is to consider other energy sources. This is to avoid making heavy investments in a transition fuel with the risk of locking countries and regions in a fuel and import dependency.

[44] Accelerating the change-out of obsolete household heating devices in the Western Balkans, RES Foundation Feb 2022. (https://www.resfoundation.org/accelerating-the-change-out-of-obsolete-household-heating-devices-in-the-western-balkans/)

It's important to note that every step towards sustainability is meaningful, and the transition to more eco-friendly heating options should be seen as a long-term investment in both human health and the planet's well-being. With the implementation of appropriate incentives and policy measures, it is possible to promote residential heating that is both efficient and environmentally sustainable. When considering home heating, it is important to evaluate various scenarios to encourage sustainability and eco-friendliness. Ideally, households would utilize renewable energy sources such as solar or geothermal energy for heating. These options not only have minimal environmental impact but also have the potential to reduce energy costs over time.

Learn more: The report *Heating in the Western Balkans- overview and recommendations for clean solutions* provides an overview of the current heating situation in the Western Balkans, a nuanced picture of possible measures and pros and cons of different heating alternatives. https://bankwatch.org/wp-content/uploads/2021/05/BW-Heating-Report-4th-27May21.pdf The report "Guidance for Effective Air Quality Management – Tackling Emissions from Domestic Heating" identifies solutions within the household heating sector and includes examples of where effective measures have been implemented. Guidance for Effective Air Quality Management - Tackling Emissions from Domestic Heating - EU4Green

5.1 Residential heating: "Rethink" measures

5.1.1 Encourage improved insulation of houses

Subsidies combined with information campaign aimed at improving house insulation, which aims to reduce residential heating demand and thus PM emissions from residential heating. Improving insulation of houses provides several benefits ranging from energy saving to cost-effectiveness and increased comfort. It is a practical and effective measure for homeowners to enhance the efficiency and sustainability of their homes. Improved insulations require less energy and thus reduced the demand for fossil fuels and non-renewable resources for electricity generation. Lower energy consumption also entails reduced greenhouse gas emissions associated with heating and cooling of homes.

Thermal insulation includes installing insulation material and replacing windows where necessary. The cost per house has been estimated to 6 000- 10 000 EUR45, according to the Local action plan for air quality for Pristina 2023-2028. Updated cost estimations must be adapted to local context.

Time scale for implementing subsidies, information and as a result achieving improved isolation of houses is estimated to 3-5 years. Improved insulation of houses can be performed in several steps and on different levels. The first step is to prevent heat leakage (see **Fel! Hittar inte referenskälla.**) which is a quick measure. The next step is to install insulation material and thus improve the energy performance of the house. This is more cost intensive and more time consuming.

Administrative level:	Local, regional, or national depending on source of financing of subsidies and/or campaign.
Socio-economic effects:	Positive effects for households through energy cost savings, increased value of properties, and increased job opportunities. Installation of insulation can generate jobs in the construction business and increased demand for energy-efficient products and services can create job opportunities in related industries and sectors.
Impact on children:	Improved insulation of houses prevent heat leakage and thus reduced energy consumption. If the heat is generated through domestic burning of fuels, improvement in this area can contribute to improved indoor air quality which will benefit children who typically spend a lot of time in the home. If coal is the primary energy source, improved insulation contributes to decrease the dependence of coal and thus brings benefits in terms of improved air quality for people.
Impact on gender:	Improved insulation of houses prevent heat leakage and thus reduced energy consumption. If the heat is generated through domestic burning of fuels, improvement in this area can contribute to improved

[45] Local action plan for air quality for Pristina 2023-2028- *Kosovo Prishtine plan i cilesise se ajrit per_prishtinen 2023-2028*

indoor air quality which will benefit women who typically spend a lot of time in the home.

Example: *In Canada, subsidies are provided through the Canada Greener Homes Grant with grants-up- to-$5,000 for households to get part of the costs for eligible home retrofits covered*[46]*. Another subsidy is the Canada Greener Homes Loan, which is an interest-free loan up to $40,000 with a repayment term of 10 years to help Canadians make their homes more energy efficient and comfortable, and reduce air pollution.*

5.1.2 Subsidy for installation of modern heat pumps

Modern heat pumps are efficient systems for providing heating both as single and complementary energy source. Compared to conventional heating systems using fossil fuels, heat pumps can contribute to reduce emissions. Since heat pumps do not incinerate onsite fuels, they do not produce any harmful indoor pollutants. Modern heat pumps are durable and have long expected lifetime (20-25 years[47]). They will reduce emissions of PM, CO, NOx from residential heating.

According to a local air quality action plan for Pristina[48], the change from heating equipment using wood to electric heat pump can reduce emissions of PM10 by 1 290 tons/year. The estimated cost for this shift, was in the Pristina local air quality plan estimated to 40-50 million EUR for subsidizing the heat pumps. In the municipality of Pristina 7 500 houses were targeted and the cost per house is estimated to range between 6 000- 7 200 EUR. Time scale for implementation in a city scale is 1-4 years.

Administrative level:	Municipality
Owner:	Municipality
Socio-economic effects:	Though an initial heavy investment, this measure can lead to long-term savings due to lower operational and

[46] UNDP accelerator labs (2024). Canada Greener homes initiative. https://solutions.sdg-innovation-commons.org/en/view/pad?id=7297
[47] Evergreen Energy (2024). *How long does a heat pump last?* https://www.evergreenenergy.co.uk/heat-pump-guides/how-long-do-heat-pumps-last/#:~:text=Heat%20pumps%20are%20long%2Dlasting,years%20before%20they%20need%20replacing.
[48] Local Air Quality Action Plan for Prsitina 2023-2028. Plani Lokal i Veprimit për Cilësinë e Ajrit për Prishtinën 2023-2028

	maintenance costs. Installation of the heat pumps creates job opportunities.
Impact on children:	Positive impact on children due to improved indoor air quality.
Impact on gender:	Positive impact due to improved indoor air quality, which will benefit women to a greater extent than men as they typically spend more time in the home compared to men.

Example: *In Canada, subsidies are provided through the Oil to Heat Pump Affordability program consisting of grants up-to-$10,000-$15,000 (depending on province) to switch from oil heating to an eligible heat pump*[49].

EU Member States have been encouraged to set up subsidy schemes for heat pumps by a range of EU legislative initiatives covering the energy transition and decarbonization policies[50].

5.1.3 Encourage replacing seals to prevent heat leakage

Subsidies combined with information campaigns directed to households aimed to encourage replacing seals to prevent heat leakage from buildings. The measure is cost-effective offering several benefits: energy savings, improved comfort, reduced emissions of PM and NOx and enhanced durability of building systems.

The cost for setup depends on factor such as size of building, extent of sealing required, and materials used. The primary cost is the material including sealing material such as weatherstripping, caulking, sealants, and insulation. Installation of sealing strips around windows and doors is relatively simple and does not require any additional labor costs. Time scale for implementing subsidies, information and as a result achieving replaced seals of houses is estimated to 3-5 years.

Administrative level:	Local, regional, or national depending on source of financing of subsidies and/or campaign.

[49] Solutions
[50] EHPA_Subsidies-for-residential-heat-pumps-in-Europe_FINAL_March-2023.pdf

Owner:	Municipality
Socio-economic effects:	The primary effect is energy cost savings due to lower utility bills for homeowners and tenants. Reduced energy consumption is positive from a property value point of view.
Impact on children:	Improved insulation of houses prevent heat leakage and thus reduced energy consumption. If the heat is generated through domestic burning of fuels, improvement in this area can contribute to improved indoor air quality which will benefit children who typically spend a lot of time in the home. If coal is the primary energy source, improved insulation contributes to decrease the dependence of coal and thus bring benefits in terms of improved air quality for people.
Impact on gender:	Improved insulation of houses prevent heat leakage and thus reduced energy consumption. If the heat is generated through domestic burning of fuels, improvement in this area can contribute to improved indoor air quality which will benefit women who typically spend a lot of time in the home.

Learn more about energy characteristics and savings with different type of roof materials: Energy-Efficient Roofs: Types, Costs, and Benefits for Homeowners

Learn more about energy characteristics and savings with different type of house insulation: How Home Insulation Helps Reduce Your Energy Bill - This Old House

5.1.4 Campaigning to raise awareness on harmful effects of fuels for household heating

Campaigning to increase knowledge about the harmful effects of household heating is crucial for raising awareness about the environmental and health impacts associated with emissions of PM10, PM2.5 and CO. The aim is to reduce such emissions from combustion of fuels for heating in households and that arise from inefficient heating practices and improper use of polluting fuels.

By educating the public about the negative effects of using certain types of fuels or appliances, such as wood-burning stoves or outdated heating systems, campaigns can promote the adoption of cleaner and more sustainable heating alternatives. These efforts aim to reduce air pollution, minimize greenhouse gas emissions, and

improve indoor air quality, contributing to healthier and more sustainable communities. Effective information campaigns can empower people to make informed choices and take actions that support cleaner heating solutions for their homes and neighborhoods.

Time scale for planning, designing, and carrying out an information campaign is estimated to 1-3 years.

Administrative level:	Municipality
Owner:	Municipality
Socio-economic effects:	Positive, as local air quality will improve.
Impact on children:	Positive, as children spend a lot of time in their homes compared to employed adults, and thus will be less exposed to harmful emissions.
Impact on gender:	Women to a less extent than men have an employment and thus spend more time in the household, as well as carry a larger part of the household workload[51]. This means women are to a larger extent exposed to exhausts from poor heating systems in households and will benefit from advice that help shift to less polluting heating sources.

Example: Wood Burning — Mums for Lungs. *Mums for Lungs is campaigning against wood burning due to its harmful effects on air quality and public health. Their campaign focuses on raising awareness about the dangers of wood smoke, advocating for stricter regulations, and pushing for policy changes in the UK.*

Learn more: Biomass_brief_EN.pdf

[51] European Institute for Gender Equality (2023) Gender Equality Index: Measuring progress in the Western Balkans. Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia. 04 Oct 2023. Gender Equality Index: Measuring progress in the Western Balkans | European Institute for Gender Equality (europa.eu)

5.1.5 Information campaign about proper use of wood stoves

Campaigning on the proper use of wood stoves is essential to reduce air polluting emissions of PM10, PM2.5, CO and improve indoor air quality associated with combustion of wood. This would have impact for air quality on local and regional level.

Proper use includes using dry and seasoned wood, maintaining adequate airflow, and regularly cleaning and inspecting the stove and chimney. By educating users about these practices, campaigns can minimize harmful emissions like particulate matter and carbon monoxide, benefiting both public health and the environment. Such efforts promote safer and more efficient wood stove use, contributing to cleaner air and healthier communities.

A successful campaign is typically implemented in several steps and can span over several phases. The cost for running must be adjusted to the level of ambition and the time perspective for the campaign.

An information campaign is a relatively fast measure to implement, and the time scale for planning, design and implementation is estimated to 1-3 years. Though it can take longer time before the effects become notable in terms of increased awareness and changed behaviour, and thus improved air quality. Aspects that influence the timeline: campaign duration, target audience engagement etc. Significant behavior change often requires sustained efforts over an extended period.

Administrative level:	Municipality
Owner:	Municipality
Socio-economic effects:	This measure can yield socio-economic benefits by improving human health, reduce adverse environmental effects, promote societal engagement as well as creating economic opportunities.
Impact on children:	Children in particular are sensitive to air pollution; thus, proper use of wood stoves can have significant health benefits for children.
Impact on gender:	Women and girls often have the main responsibility for household chores, including cooking and heating. Proper wood stoves improve indoor air quality thus bring health benefits. Women to a less extent than men

have an employment and thus spend more time in the household, as well as carry a larger part of the household workload[52]. This means women are to a larger extent exposed to exhausts from poor heating systems in households.

Example: *In UK, the national government initiated a "Ready to Burn" fuel certification scheme. The labelling makes it easy for people to buy the cleanest fuels for burning at home. Using fuels that are approved and labelled as Ready to Burn also means it's easy to comply with the national legislation Air Quality (Domestic Solid Fuels Standards) (England) Regulations 2020. This regulation outlaws the sale of wet wood and housecoal, which are the most polluting fuels. The Air Quality (Domestic Solid Fuels Standards) (England) Regulations 2020 is a regulation that aim to prevent harmful pollution from domestic burning of all solid fuels. This by ensuring that wood sold in volumes of under 2m3 is certified as having a moisture content of 20% or less. Manufactured Solid Fuels should contain less than 2% sulphur content.*

Learn more:

- "Tänd i toppen"- The guide *Tänd i toppen* promotes a cleaner and more efficient way to light fires in wood stoves and fireplaces. The method, called "top-down lighting," involves stacking larger logs at the bottom and placing kindling and fire starters on top. This technique reduces smoke and harmful particle emissions, leading to better air quality and a more complete combustion process. The guide aims to educate households on reducing pollution while maintaining efficient heating. Tänd i toppen - Lär dig elda i vedkaminen på ett sätt som gynnar miljö, hälsa och plånbok.

- Ready to Burn | Administered by Woodsure on behalf of Defra
- Another UK national information campaign aiming to reduce air pollution from improper use of stoves is Burn Better. Burn Better, Breathe Better: Reduce the negative impact your stove or open fire can have on your health - Defra, UK

[52] European Institute for Gender Equality (2023) Gender Equality Index: Measuring progress in the Western Balkans. Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia. 04 Oct 2023. Gender Equality Index: Measuring progress in the Western Balkans | European Institute for Gender Equality (europa.eu)

5.1.6 Energy advice

Municipalities can appoint local and regional energy advisors, to provide information and guidance to inhabitants, house owners and companies on how to reduce their energy use switch to or increase the share of renewable energy to reduce environmental impact from energy use and to lower their energy costs. Advice should be free of cost and independent. Advising could be both adapted and tailored for individuals and their circumstances or be more general information and education that is less adapted.

By providing tailored advice, energy advisors help individuals and organizations to make informed decisions to reduce energy consumption, lower utility bills, and minimize environmental impact from emissions of PM10, PM2.5, CO from residential heating and residential energy use at local and regional level. Energy offices contribute to creating more energy-conscious communities. Costs for energy advisors are associated with hiring and educating staff and running an office. The costs will depend on what tasks the advisors carry out, for example personalized advice direct to households, or information campaigns. Time scale for appointing energy advisors and educating them if necessary is estimated to 1-3 years.

Administrative level:	Local. Financing may be regional or national.
Owner:	Municipality
Socio-economic effects:	Positive as reduced energy consumption and more efficient fuel combustion practices in households lead to improved air quality and reduce household costs for residential heating.
Impact on children:	Positive as reduced energy consumption in households also reduce household costs, which benefit the children in the households. Better local air quality benefits children and young people who are generally physically active outdoors, and thus exposed to air quality conditions at street level as pedestrians, cyclists, and public transport users.
Impact on gender:	Women to a less extent than men have an employment and thus spend more time in the household, as well as

carry a larger part of the household workload[53]. This means women are to a larger extent exposed to exhausts from poor heating systems in households and will benefit from advice that help shift to less polluting heating sources.

Example: *In Sweden, public energy advising is a policy measure that is used to provide energy information and guidance to energy end-users, to encourage more efficient and optimized energy use and reduce environmental impact from energy use. Public energy advising also contributes to policy implementation by communicating national policy to the local level and have been found to thus play an important role in implementation of policies aimed at accelerating the energy transition*[54].

5.1.7 Prohibition on burning household and agricultural waste

Open burning of household waste, or backyard burning, is common world-wide and can include paper, plastics, food rests, and any materials. Burning is done in a burn barrel or box, wood stove, outdoor boiler, or open pi55t. Burning of household and agricultural waste releases air emissions directly to the atmosphere without being treated or filtered. Harmful air pollutants that are emitted include particulate matter (PM10, PM2.5), CO, dioxins, and other toxic substances. This contributes to respiratory problems and other health issues among the population at local and regional scale.

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[53] European Institute for Gender Equality (2023) Gender Equality Index: Measuring progress in the Western Balkans. Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia. 04 Oct 2023.

Gender Equality Index: Measuring progress in the Western Balkans | European Institute for Gender Equality (europa.eu)

[54] Mignon, I. & Winberg, L. (2023) The role of public energy advising in sustainability transitions – empirical evidence from Sweden. Energy Policy, Volume 177, 2023, 113525, ISSN 0301-4215, https://doi.org/10.1016/j.enpol.2023.113525. (https://www.sciencedirect.com/science/article/pii/S0301421523001106)

[55] Backyard Burning | Wastes | US EPA;
Powrie W, Velis C, Cook E, & Ingham, H. (2021) Open uncontrolled burning of solid waste undermines human health: Time to act. *Waste Management & Research*. 2021;39(1):1-2. doi:10.1177/0734242X20981800.
Open uncontrolled burning of solid waste undermines human health: Time to act - William Powrie, Costas Velis, Ed Cook, Hazel Ingham, 2021

Besides improving air quality, this measure contributes to sustainable waste management practices. To ensure compliance with waste disposal guidelines, public awareness campaigns and enforcement are essential. When enforcing a prohibition on burning household and agricultural waste, authorities need to ensure that comprehensive and safe solid waste collection services are in place together with subsequent management such as recycling, composting, and controlled incineration in specialized facilities. The cost to setup such prohibitions vary depending on scale of enforcement, awareness campaigns and alternative waste management strategies. Costs to consider are hiring and training enforcement personnel e.g., environmental inspectors or local authorities tasked with monitoring and enforcing the prohibition. Investing in improved waste collection system, programs to promote recycling or composting. Establish systems monitoring and reporting compliance. Develop systems for citizens to report violations and illegal activities. Legal and administrative costs develop and improve regulations and policies related to waste management.

The time scale of this measure depends on if new legislation is needed to implement a prohibition. In that case, time national legislative procedure must be considered.

Administrative level:	Municipality, regional
Owner:	Municipality
Socio-economic effects:	Improved public health is one of the primary socio-economic benefits. It can also entail economic opportunities in terms of development of waste management and recycling industries.
Impact on children:	Besides health benefits, a prohibition can contribute to shaping responsible behavior and attitudes among children. They may adopt practices like recycling, composting etc.
Impact on gender:	If the waste is incinerated in household burning practices this can lead to more exposure of harmful substances for women who traditionally spend more time indoors. Increased workload for disposal and recycling of waste could possibly add more work burden to women if alternative waste management options are not adequately accessible.

Example/Learn more: The document *Agricultural and Garden Waste Burning*

Legislation in European Countries provides various examples of how different European countries regulate agricultural waste burning. *The Crop Residues (Burning) Regulations 1993* in the United Kingdom prohibit the burning of certain crop residues. In Germany municipal ordinances often allow "burning days" (*Brenntagen*), with specific times for burning garden waste. Switzerland has an *Air Pollution Regulation (LRV)*. Since its 1992 amendment, the LRV regulates outdoor waste incineration, allowing it only in dedicated facilities, with exceptions for dry natural waste, special permits for insufficiently dry waste, and restrictions in areas or periods with high emissions.
(source: agricultural_waste_burning_legislation_final.pdf)

5.1.8 "No burn zones"

Ban on burning raw coal and other solid fuels, including household and agricultural waste, in a specified area where other alternatives are available. The measure is a way to start phasing out coal in designated urban areas. This measure aims to reduce air polluting emissions of PM and CO from combustion of solid fuels, thus mitigating the release of harmful substances. In Sweden, district heating has been effective at minimizing burning. However, this requires significant investments. Time scale for preparing and implementing the ban is estimated to 1-5 years, as legislation may be needed.

Administrative level:	Municipality, national. Implementing a no burn zone can require supportive legislation.
Owner:	Municipality
Socio-economic effects:	Positive impact. This measure leads to areas free of coal and waste burning and its associated air pollution.
Impact on children:	Positive impact. By reducing air pollution in urban areas, especially around schools and residential areas children can experience improved respiratory health.

Example: *In Krakow in Poland, a ban of coal and wood as heating fuels was adopted in 2016 through a specific Municipal Regulation (so-called anti-smog resolution). The ban came into force in September 2019, and already at the beginning of 2018, less than 10,000 boilers and stoves remained in Krakow out of 24,000 in 2015. The acceptance among the city inhabitants for these new laws by has been possible by long-term information initiatives such as the 'Krakow Smog Alert' as well as economic subsidies from regional and local authorities, offering up to 100% subsidy for replacement of solid fuel boilers, and*

additional assistance to cover more expensive heating costs for people affected by energy poverty. More info: https://powietrze.malopolska.pl/en/anti-smog-resolution/

5.1.9 Subsidy for replacement of inefficient heating systems in households

Subsidies directed to households for a shift to cleaner and more sustainable, less polluting heating alternatives in households can speed up a shift from wood and coal burning stoves or other outdated heating systems. Effects will be reduced air polluting emissions PM10, PM2,5, CO which will contribute to improved local and regional air quality. Time scale for implementing subsidies is estimated to 2-3 years and 2-3 more years for the replacement of heating systems. Impact of subsidies can be strengthened by accompanying information campaigns and/or advice educating the public about the advantages of more efficient heating systems. Such campaigns can empower people to make informed choices and take actions that support cleaner heating solutions for their homes and neighborhoods.

Administrative level:	Local, regional, or national depending on source of financing of subsidies and/or campaign.
Owner:	Households
Socio-economic effects:	Positive effects for the population from improved outdoor air quality at local and regional level as well as indoor air quality in the households that upgrade to more effective less polluting heating.
Impact on children:	Improves indoor air quality which will benefit children who typically spend a lot of time in the home.
Impact on gender:	Improves indoor air quality which will benefit women who typically spend more time in the home compared to men. Women to a less extent than men have an employment and thus spend more time in the household, as well as carry a larger part of the household workload[56]. This means women are to a

[56] European Institute for Gender Equality (2023) Gender Equality Index: Measuring progress in the Western Balkans. Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia. 04 Oct 2023. Gender Equality Index: Measuring progress in the Western Balkans | European Institute for Gender Equality (europa.eu)

larger extent exposed to exhausts from poor heating systems in households and will benefit from a shift to cleaner heating system.

Example: In Austria a central government grant scheme promoting the Replacement of fossil-fuel heating systems with sustainable alternatives was presented. The interventions promoted the connection to a district heating system or, where not possible, the transition to centralized wood heating or to a heat pump is financed. 5.000 euros for single-family buildings, 1.000 euros for multi storey buildings (for heat pumps with a refrigerant with a GWP between 1.500 and 2.000, the calculated financing is reduced by 20%.). Read more in ANALYSIS OF EXISTING INCENTIVES IN EUROPE FOR HEATING POWERED BY FOSSIL FUELS AND RENEWABLE SOURCES (2020), Analysis-of-Fossil-Fuel-Incentives-in-Europe_FINAL.pdf

Learn more: The report list and summarize economic promotion schemes for fossil fuel and for renewable energy domestic heating systems. Analysis-of-Fossil-Fuel Incentives-in-Europe_FINAL.pdf

5.2 Residential heating: “Optimize” measures

5.2.1 Routines for regular organized chimney sweeping

Using a fireplace will create a buildup of soot along the walls in the chimney which can restrict the airflow, lead to inefficient burning, and increase PM emissions from incineration in indoor fireplaces. Chimney sweeping is essential not only to reduce harmful emissions of PM and CO associated with blocked or dirty chimneys, but also for safety, maintaining indoor air quality, ensuring appliance efficiency. Proper chimney maintenance will reduce the fireplace’s impact on the environment as well as bring benefits in terms of a fire burning longer and hotter. A fireplace used regularly should be maintained annually. It's recommended to have chimneys inspected and cleaned regularly by qualified professionals to address any potential issues and maintain a safe and healthy living environment.

Financial resources required from the municipality for setting up routines for chimney sweeping are estimated as small. Individual households will have small costs for chimney cleaning.

Administrative level:	Municipality
Owner:	Municipality
Socio-economic effects:	This measure reduces the risk of fires which can save money for both individuals as well as for the society. Improvement in indoor air quality reduces health risks and can lead to fewer cases of respiratory illness and reduced or avoided healthcare costs households.
Impact on children:	Correct burning practices and regular chimney maintenance improve indoor air quality which will benefit children who typically spend a lot of time in the home.
Impact on gender:	Correct burning practices and regular chimney maintenance improve indoor air quality which will benefit women who typically spend more time in the home compared to men. Women to a less extent than men have an employment and thus spend more time in the household, as well as carry a larger part of the household workload[57]. This means women are to a larger extent exposed to exhausts from poor heating systems in households and will benefit from a shift to cleaner, less polluting heating practices and routines.

5.2.2 Installation of energy meters and appropriate billing

This measure creates incentives for increased energy efficiency as customers – households and companies - will be incentivized to use less energy. Energy metering data also provides policymakers and energy companies with insights regarding areas of high energy demand, optimization of infrastructure investments and plan for future energy needs. By empowering consumers with better

[57] European Institute for Gender Equality (2023) Gender Equality Index: Measuring progress in the Western Balkans. Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia. 04 Oct 2023. Gender Equality Index: Measuring progress in the Western Balkans | European Institute for Gender Equality (europa.eu)

information and incentives, energy metering contributes to reducing energy waste and minimizing environmental impact.

This measure requires installing of energy meters and associated infrastructure and systems for billing. Time scale for installation can be 1-3 years. The first phase requires installation of energy meters. After installation, it will take some time for consumers to adapt their energy usage.

Administrative level:	Energy company
Socio-economic effects:	Energy metering and appropriate billing systems have the potential to improve affordability, equity, and energy efficiency. Energy meters ensure billing accuracy, promoting fairness and transparency in billing practices. Specific impacts vary depending on regulatory frameworks, consumer engagement and local context.
Impact on children:	This measure can contribute to greater awareness and education among children about energy conservation and sustainability. As future stakeholders, children can play an important role in advocating for sustainable energy practices.
Impact on gender:	The measure leads to reduced energy consumption, and if the heat is generated through domestic burning of fuels, improvement in this area can contribute to improved indoor air quality which will benefit women who typically spend a lot of time in the home.

Example: *Smart meters are replacing traditional gas and electricity meters across Great Britain with the goal of making the energy system more efficient and flexible, helping the country in using more renewable energy. A key principle of the roll out is for consumers to be able to use smart meter data to gain a better understanding of their energy consumption and, where desirable, reduce it to save money and minimise carbon emissions. The Government anticipates that smart meters will average energy consumption reductions of 3.0% for electricity and 2.2% for gas (0.5% for gas prepay), driven by multiple behavioural mechanisms:*

1. *Direct feedback on consumption via In-Home Displays (IHDs) - offered at no extra cost during the smart meter installation*
2. *Indirect feedback via more accurate billing*

3. Engagement and advice provided before the installation, during (e.g. on how to use the IHD and how to save energy) and after (e.g. Smart Energy GB's communication campaigns and postinstall communications from energy suppliers). (Reviewing energy supplier evidence on impacts of smart metering on domestic energy consumption)

5.3 Residential heating: "New construction" measures

5.3.1 District heating

District heating is a heating system providing multiple buildings with heat from a centralized source. The heat is distributed through underground pipes and can utilize different sources of energy e.g., biomass (pellets, agricultural residues, wood chips), solar thermal, heat generated from burning municipal waste etc. It is important to note that the district heating system is only as good as its energy source. It is listed here as a measure since it can be an effective means of distributing clean energy on a large scale. District heating is a popular alternative in Sweden, Denmark, and the Baltic countries where >50% of the citizens get their heat from district heating[58]. In Sweden, the district heating was introduced as way of improving the air quality in cities through moving incineration from individual households to one place.

In the Western Balkan, approximately 14% of the heat demand is produced and distributed through district heating[59]. However, the district heating is mainly using fossil fuels. Furthermore, the district heating system have high losses of heat due to poor insulation of the pipelines, losses are estimated to between 15 to 30 % and even 60% in some cases.

According to Montenegro Pljevlja Air Quality Plan, the usage of coal for heating is one of the main sources of particles and a switch to district heating have potential of substantially reduce air pollution. The air quality plan estimates a 78% reduction

[58] W.E District. (2024) *Interactive map: share of district heating and cooling across Europe.* https://www.wedistrict.eu/interactive-map-share-of-district-heating-and-cooling-across-europe/
[59] CEE Bankwatch Network (2021). Heating in the Western Balkans. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://bankwatch.org/wp-content/uploads/2021/05/BW-Heating-Report-4th-27May21.pdf

of PM, NOx, SOx and BaP from going from individual heating solutions to district heating[60]. Furthermore, an old and outdated district heating system can bring environmental benefits if modernized. The city of Banja Luka's, Bosnia and Herzegovina, district heating system was reliant on crude oil and experienced energy transmission losses. After being upgraded the new system yielded a 94% reduction of harmful air pollutants as well as saved cost for fuel[61]

Since district heating is a relatively cost intensive solution to invest in it can be recommended to replace old heating systems with new and more energy efficient stoves, boilers etc. until a district heating system is in place.

Administrative level:	Municipality
Owner:	Municipality or state-owned enterprises
Socio-economic effects:	Improved energy efficiency and cost savings. Initially a heavy investment but this measure can lead to long-term savings. District heating is more efficient than individual heating solutions.
Impact on children:	Positive impact on children due to improved indoor air quality.
Impact on gender:	Positive impact due to improved indoor air quality, which will benefit women to a greater extent than men as they typically spend more time in the home compared to men.

Learn more:

- BW-Heating-Report-4th-27May21.pdf
- 2022-05-10_EBRD-AGM-issue-paper_District-heating-WB6.pdf
- District Heating - Energy System - IEA
- Decarbonizing district heating:
    - Strategies for decarbonizing European district heating: Evaluation of their effectiveness in Sweden, France, Germany, and Poland - ScienceDirect

[60] Air quality plan for the municipality of Pljevlja (2023)
[61] UN Environment programme (2019. District energy: a secret weapon for climate action and human. https://www.unep.org/news-and-stories/story/district-energy-secret-weapon-climate-action-and-human-health

- District heating in cities as a part of low-carbon energy system - ScienceDirect

6 Transportation and urban planning

Car traffic in and around cities contribute to air pollution through exhaust emissions from combustion engines in cars, buses, and lorries, from the use of tyres and brakes as well as from the road surface. These emissions of particulate matters, NOx and VOC have negative effects for public health.

Reducing traffic levels (number of kilometers travelled by vehicles in the cities as well as reducing number of vehicles) by shifting from cars to sustainable transport modes like walking and cycling leads to improvements of air quality and has therefore benefits for the public health. A shift from conventional fossil fuels to electric vehicles reduces exhaust emissions but still contributes to particulate matter from tyres, road surfaces, and brakes. Upgrading the vehicle fleet to vehicles complying with the Euro 6 standard would reduce air pollution of the vehicle fleet, compared to older models of vehicles, however not as much as when upgrading to electric vehicles that have zero end-of-pipe emissions.

To achieve more sustainable transport that reduces urban air pollution, traffic volumes need to be reduced. This means avoiding or reducing travel demand. This can be achieved through integrated land-use planning that increases proximity and makes everyday life possible without driving a car. For the travel needed, it is necessary to shift to walking, cycling and public transport which are modes of transport that have less environmental impact than private car use. This can be achieved by giving priority to these sustainable transport modes into and within the city, in roads and streets. For those car trips that can’t be avoided, a shift to less polluting and more fuel-efficient vehicles is needed. Emission regulations and standards are important to develop a less polluting car fleet. Electric cars, buses and vans are preferable in an urban context due to their lack of exhaust emissions. It is important that vehicles are light in weight, to reduce emissions from tyres, brakes, and the road surface, and thus the size of private cars matters.

Measures aimed to reduce car traffic and that increase accessibility by increased proximity and mix of functions in the city have positive socio-economic effects. In cities designed for less car-dependent accessibility distances are shorter, space and resource consumption for transport are reduced, and car dependence is reduced for everyday transport. Households' financial burden for car ownership and car journeys can then be reduced.

6.1 Transportation and urban planning: "Rethink" measures

6.1.1 Low emission zones with supporting measures

This measure contributes to reduced emissions of VOC, NOx, PM, PM10 from exhaust gases from motorized vehicles by only allowing less polluting motorized vehicles in an area. If the measure leads to an overall decrease in car traffic, in the zone or outside the zone, PM emissions from brakes, tyres, and road surfaces will also decrease. Emissions are reduced at local level and regional (by affecting commuter trips by car from areas around the zone to the zone).

Introducing low emission zones in the city or in parts of the city is a regulatory measure that may need national legislation. The measure aims to eliminate the use of motor vehicles that have exhaust emissions that exceed a specified limit per travelled kilometer, in the specified zone. Vehicles that exceed the given limits are prohibited in the zone or may travel in the zone if the owners pay a penalty fee.

The revenue from the fee can be used for investments that increase accessibility in more sustainable ways, such as an increase of bike lanes[62] and bike parking, improved walking infrastructure[63], bus lanes and increased public transport. Such supporting measures are important to increase more sustainable alternative accessibility to and within the zone, and to increase support and acceptance for the low emission zone among citizens, alongside with measures to create a more attractive city environment like parks, social areas, etc. A fair transition for vulnerable groups must be ensured when setting up the low emission zones. This can be achieved by for example introducing subsidies for bike purchases, reduced public transport fares, and shared mobility hubs in poorly connected areas. For low-income households, such accessibility is usually more affordable than car ownership and thus this kind of measure package often has positive effects for social and economic sustainability. (See more about some of these measures below.)

The design and implementation of low emission zones vary and depend on geographical size, stringency, timescales and exemptions. It is especially important

[62] Conventional Bike Lanes | National Association of City Transportation Officials (nacto.org)
[63] CS_PedestrianReport_Final_WEB-1.pdf (nlc.org)

to identify groups that can be affected and are vulnerable. For smaller enterprises that for example use vans for deliveries and services the cost of upgrading to a vehicle that complies with the emission regulations for the zone can be a burden. Therefore, support schemes for such user categories that may be vulnerable can be developed, for example with subsidies that reduce the cost for upgrading to a less polluting vehicle.

For low emission zones to be successful in maximally reducing air pollution in a city, several aspects should be considered:

- Clear demarcation of the area of the low emission zone[64].
- Clear communication of the intentions of the zone, and the requirements of vehicles banned from and allowed to the zone[65].
- Gradual introduction of stricter requirements for vehicles that are allowed to enter the zone[66]. The biggest improvements in air quality can be achieved in case a high-EURO emission standard (low emission levels) is required for vehicles to enter the low emission zone but to maintain public support the introduction of the zone can allow a lower EURO standard than the highest and increase the requirements gradually[67].
- To monitor and enforce compliance for vehicles that are driving in the zone. The low emission zone can be combined with charging penalty fees for those driving into the city with vehicles that don't fulfil the emission requirements.
- The income generated by these fees can be directed to investments for making alternative more sustainable modes more attractive, such as increased public transport frequency, more bike lanes and bike parking facilities, pedestrianized areas etc. Such combined packages of measures, consisting of measures to both "push" away from car use (especially combustion engine car use) and to "pull" to use of more sustainable modes, are very efficient for reducing car traffic levels in urban areas. Low emission

[64] Hoen, A., Hilster, D. Király, J., de Vries, J. & de Bruyn, S. (2021) Air pollution and transport policies at city level. Module 2: policy perspectives. Delft, CE Delft, March 2021.
[65] Hoen, A., Hilster, D. Király, J., de Vries, J. & de Bruyn, S. (2021) Air pollution and transport policies at city level. Module 2: policy perspectives. Delft, CE Delft, March 2021.
[66] Hoen, A., Hilster, D. Király, J., de Vries, J. & de Bruyn, S. (2021) Air pollution and transport policies at city level. Module 2: policy perspectives. Delft, CE Delft, March 2021.
[67] Hoen, A., Hilster, D. Király, J., de Vries, J. & de Bruyn, S. (2021) Air pollution and transport policies at city level. Module 2: policy perspectives. Delft, CE Delft, March 2021.

zones that are designed to only allow residents, taxis, and utility transport to use cars in the zone can reduce traffic levels by 10-20 %[68].

A well-known example of low emission zones combined with measures to increase alternative accessibility that is less car dependent is the ULEZ, ultra-low emission zone, in London which has had proven positive effects in a short time span for air quality[69]. Other good examples of cities that have implemented low emission zones are Milan, Lisbon, and several Dutch and German cities[70].

In Pristina, the cost for planning and design of the zone was estimated to 30 000 euro. Public consultation process, 15 000 euro. Parking spaces for bicycles: Cost 500 000 € (Pristina). Cost for bike lanes: MKD 1 500 000,00 (Kavadarci). Cost for surveillance cameras and automatic number plate recognition, ~1 000 000 euro. In Kavadarci, bike purchase subsidies cost around 3000 MKD/person and bike.

Time scale for this measure is 2-3 years for planning and designing the zone regulations, for decision making and public consultation, and for planning and implementing measures to improve alternative transport modes.

Administrative level:	Local (legislation on national level may be required for example regarding compliance monitoring schemes).
Owner:	Municipality
Socio-economic effects:	Negative impact on car users can be mitigated by measures to improve and promote better accessibility to and in the area with more sustainable transport modes, and by subsidies for shifting to vehicles that comply with zone regulations. Positive impact on groups more relying on walking, cycling, public transport, as well as positive impact for residents in the area with reduced air pollution and noise levels. Low-emission zones can have a positive impact on a city's retail sector when the local neighborhood

[68] Litman, T. (2023b) Comprehensive Transportation Emission Reduction Planning Guidelines for Evaluating Transportation Emission Reduction Strategies. Victoria Transport Policy Institute, 4 January 2023.

[69] Mayor of London (2024) Air Quality Programme Achievements. Link: Air Quality in London 2016-2024 | London City Hall

[70] Hoen, A., Hilster, D. Király, J., de Vries, J. & de Bruyn, S. (2021) Air pollution and transport policies at city level. Module 2: policy perspectives. Delft, CE Delft, March 2021.

	becomes more attractive due to less traffic noise and air pollution. A low emission zone in Madrid was linked to an increase of 8.6% in retail sales in the city's central corridor[71].
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality[72].

Learn more:

- Low-Emission Zones: The Essential Guide - Clean Cities Campaign
- Are low emission zones and on-street parking management effective in reducing parking demand for most polluting vehicles and promoting greener ones? - ScienceDirect

6.1.2 Incentives for shift from combustion engine vehicle fleet to electric vehicles

By shifting to electric vehicles instead of combustion engine vehicles, exhaust pipe emissions will be reduced if less kilometres are driven with combustion engine vehicles. Time for planning and implementation is estimated to 1-5 years (planning, design, decision making, public consultation, and actual implementation).

Administrative level:	Local or national depending on source of financing of incentives and subsidies.
Owner:	Municipality, national government
Socio-economic effects:	The purchase of a new electrified vehicle, to replace a combustion engine vehicle, is an economic burden for households.

[71] Low-Emission Zones: The Essential Guide - Clean Cities Campaign
[72] Are mobility systems gender-neutral? - Ramboll Group

Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit of better air quality and reduced noise.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit of better air quality and reduced noise[73].

Example: *In Uganda, electric motorcycles (e-motos) are offered through a unique lease-to-own model and a network of convenient battery-swapping station. These converted e-motos are not only cost-effective and environmentally friendly but also rugged enough to handle Uganda's demanding roads. Drivers can lease these motorcycles with an affordable daily fee and complimentary maintenance, significantly boosting their income while transitioning to clean energy[74]. This makes it possible to use electric vehicles without having the economic resources to purchase a new vehicle.*

6.1.3 Expansion of green areas in the city, green corridors, green public spaces. Creating green barriers with vegetation (trees) around industrial facilities.

Vegetation can filter air pollutants while also giving other benefits for health and for climate adaptation by contributing to cooling of temperature in cities during heat waves, and positive effects for biodiversity. The principle is that plants act like natural air filters as they absorb and filter out harmful pollutants. Pollutants that are addressed are PM, NOx, CO, NMVOC and impact is mainly local. The effects of urban green spaces on local air quality are context specific and vary depending on context and conditions of the location and other factors such as species of plants, leaf size and more.

Implementation time can be estimated to 1-5 years depending on whether it is about improving already existing green areas or planting/arranging new ones. Estimated cost for setup of green areas was in Kavadarci MKD 3 000 000,00.

Administrative level:	Local
Owner:	Municipality

[73] Are mobility systems gender-neutral? - Ramboll Group
[74] Solutions

Socio-economic effects:	Positive. Increased access to greenery and green spaces have proven positive effects for the public health in several aspects.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit of better air quality.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit of better air quality[75]. Positive as women as a group suffers more from heat waves.

Learn more:

- The Impact of Urban Green Spaces on Air Quality
- Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection | npj Climate and Atmospheric Science
- Impact of urban green spaces on air quality: A study of PM10 reduction across diverse climates - ScienceDirect
- Reassessing the role of urban green space in air pollution control | PNAS

6.1.4 Car-free days, car-free streets/places

Car free streets or areas in cities are an efficient way of reducing emissions from exhaust emissions from motorized road transport, as well as PM emissions from brakes, tyres, and the road surface, as traffic levels are immediately reduced in the areas. The reduction of car traffic also makes walking and cycling safer, quick, and thus more attractive as more space becomes available for pedestrians and bikers. Pollutants that are addressed are VOC, NOx, PM, PM10 and impact is local and regional (commuter trips from surrounding areas).

Restrictions for car traffic in zones/areas/parts of a city that only allow residents, taxis, and utility transport to use cars in the zone can reduce traffic levels by 10-20 %[76]. Time for planning and implementation is estimated to 1-3 years (planning, design, decision making, public consultation).

[75] Are mobility systems gender-neutral? - Ramboll Group
[76] Litman, T. (2023b) Comprehensive Transportation Emission Reduction Planning Guidelines for Evaluating Transportation Emission Reduction Strategies. Victoria Transport Policy Institute, 4 January 2023.

Administrative level:	Local
Owner:	Municipality
Socio-economic effects:	Research and monitoring show only marginally longer travel times for car users, and only marginally more car traffic on adjacent streets. Another finding is that even if there may be initial concern among business and inhabitants about reduced accessibility, after implementation the opinion generally becomes positive to the measure. Positive impact on groups more relying on walking, cycling, public transport, as well as positive impact of residents in the area.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality[77].

Examples: Car-Free Cities Around the World: 12 Great Urban Examples

6.1.5 Car parking policy

Car traffic levels in a city are to a high degree influenced by the amount of available car parking spaces, and the pricing of car parking. The easier it is to find a parking space, and the cheaper it is to park your car, the more car traffic is generated in the city. Thus, a parking policy consisting of higher parking fees and reduction of parking spaces for cars has proven to be one of the most efficient policies to reduce car traffic and thus air pollution from road traffic. Stricter car parking policies are effective for reduction on local and regional level of emissions of VOC, NOx, PM, PM10 from motorized vehicles in road transport.

Parking policies with market pricing for parking spaces and reduced number of parking spaces can reduce car trips by 10-30 %[78]. If parking spaces become less

[77] Are mobility systems gender-neutral? - Ramboll Group
[78] Litman, T. (2023b) Comprehensive Transportation Emission Reduction Planning Guidelines for Evaluating Transportation Emission Reduction Strategies. Victoria Transport Policy Institute, 4 January 2023.

available, this can reduce the car use for commuting into the area from other parts of the city or from outside the city, thus having a potential regional impact on car traffic levels.

Impact on air quality of car parking availability and pricing is urban specific and depends on context and conditions in the actual urban area[79]. Pricing should be set for on-street curb side car parking so that cruising can be reduced, and this leads to a decrease of emissions of air pollutants. The overall impact on the emission of NOx and PM emission is estimated to be in the range of 5-10%.

Time scale for designing, adopting, and implementing parking policies is 1-3 years.

Administrative level:	Local
Owner:	Municipality
Socio-economic effects:	Negative impact on car owners and car users, positive impact on groups more relying on walking, cycling, public transport, as well as positive impact of residents in the area.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality when car traffic levels are reduced.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality[80].

Example: *A study on the effects of parking management on air pollution in Belgrade found that parking prices for car parking on-street and off-street and time restrictions for on street parking could reduce the level of NOx emissions would decrease with up to 14 %*[81].

Example: Higher parking fees in Paris for large, high-emitting vehicles
Paris's parking policy for healthier cities - The Lancet Planetary Health

[79] Hoen, A., Hilster, D. Király, J., de Vries, J. & de Bruyn, S. (2021) Air pollution and transport policies at city level. Module 2: policy perspectives. Delft, CE Delft, March 2021.
[80] Are mobility systems gender-neutral? - Ramboll Group
[81] Hoen, A., Hilster, D. Király, J., de Vries, J. & de Bruyn, S. (2021) Air pollution and transport policies at city level. Module 2: policy perspectives. Delft, CE Delft, March 2021.

Learn more:

- Are low emission zones and on-street parking management effective in reducing parking demand for most polluting vehicles and promoting greener ones? - ScienceDirect
- Parking, energy consumption and air pollution - ScienceDirect

6.1.6 Improved vehicle inspection routines

Regular inspections of heavy trucks and buses to ensure compliance with emission standards and to ensure proper filters are installed, will lead to reduced NOx, PM, PM10 emissions from exhaust emissions from these vehicles at local and regional level. Time scale for designing, adopting, and implementing updated inspection routines is estimated to 1-3 years (the longer time frame if new legislation is needed). Regular inspection and maintenance of passenger cars and trucks is important to ensure that vehicles are operating according to vehicle emissions standards[82].

Administrative level:	Local (national legislation regulating the frequency of and the standards for vehicle inspection is a possible supporting measure)
Owner:	Municipality
Socio-economic effects:	Slightly increase in costs for vehicle owner. Positive impact on groups more relying on walking, cycling, public transport, as well as positive impact of residents in the area. Positive impact for economy by increased employment for service staff.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit from better air quality.
Impact on gender:	Positive as women more often than men don't have a driving license, have lower car ownership, and are more dependent on walking, cycling and public transport and thus benefit from better air quality.

[82] United States Environmental Protection Agency () Overview of Vehicle Inspection and Maintenance (I/M) Programs. Overview of Vehicle Inspection and Maintenance (I/M) Programs - Program Overview (EPA-420-F-21-067, October 2021)

Learn more:

- Overview of Vehicle Inspection and Maintenance (I/M) Programs - Program Overview (EPA-420-F-21-067, October 2021)

6.1.7 Lower speed limits and more efficient speed monitoring

Driving in lower speed reduces emissions of particulate matters (PM, PM10) at local and regional level from road transport caused by friction of brakes, tyres, and road surfaces. Driving in lower speed also improves the perceived traffic safety for pedestrians and cyclists, which has the positive effect of increasing attractivity for walking and cycling and can thus promote a modal shift to more sustainable modes than private cars in the area. Time scale for planning, adopting, and implementing is estimated to 2-3 years.

Administrative level:	Local (national legislation regulating the frequency of and the standards for vehicle inspection is a valuable supporting measure)
Owner:	Municipality
Socio-economic effects:	Lower speed leads to only minor increases in travel time. Negative impact on car owners and car users can be counteracted by measures to promote better accessibility to and in the area in alternative ways such as more attractive sustainable modes, subsidies for bike purchases and such. Empirical evidence shows that fears before implementation about longer travel times and increased congestion for car traffic rarely occur in reality [83]. Positive impact for car drivers and users when traffic safety increases with lower speeds. Positive impact on all other groups more relying on walking, cycling, public transport, as well as positive impact of residents in the area because of increased traffic safety, increased perceived safety, better air quality.

[83] Cairns, S., Atkins, S. & Goodwin, P. (2002) Disappearing traffic? The story so far. Proceedings of the Institution of Civil Engineers - Municipal Engineer 2002 151:1, 13-22. Disappearing traffic? The story so far | Proceedings of the Institution of Civil Engineers - Municipal Engineer (icevirtuallibrary.com)

Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit of increased traffic safety as well as better air quality[84].

Learn more: The state of the evidence on 20mph speed limits with regards to road safety, active travel and air pollution impacts: August 2018Assessing the Impact of Vehicle Speed Limits and Fleet Composition on Air Quality Near a School - PMC

6.2 Transportation and city planning: "Optimize" measures

6.2.1 Transforming street and parking space to pedestrian, bike, and bus lanes (road space reallocation)

Converting existing street space and parking lots for cars into dedicated lanes for more sustainable transport modes (walking, cycling, public transport) has proven to be efficient to reduce levels of car traffic in a city area, and thus also emissions of VOC, NOx, PM, PM10 from car traffic in the local context (regional if commuting from surrounding areas is affected). This measure has proved successful in many cities around Europe and elsewhere, both in smaller towns and larger cities. In general, evaluations show that such road space reallocation reduce levels of car traffic by 10 % or more[85], meaning that these car trips are not just replaced to other streets but are avoided altogether. This measure also reduces the cost for the road infrastructure needed for new bike and bus lanes etc. Increasing the space and number and length of lanes for walking, cycling and public transport has proven extra effective when being implementing by converting car lanes into dedicated

[84] Are mobility systems gender-neutral? - Ramboll Group
[85] Shergold, I. et al. (2016a) The Economic Benefits of Sustainable Urban Mobility Measures. Independent Review of Evidence: In-depth Reviews of Measures.

lanes for walking, cycling and public transport86. The cost for walking, cycling and public transport87 infrastructure varies depending on standard and conditions. The cost for walking88, cycling and public transport lanes is lower when existing street space for car traffic is converted to and dedicated for these modes, compared to the cost for building new such lanes.

Time scale for implementation is estimated to 1-4 years for planning and implementing the reallocation, for decision making and public consultation, and for planning and implementing measures to improve alternative transport modes. It is recommended following experience from for example Belgian cities that reallocation of street space from car lanes to walking, cycling and public transport can be implemented within a short time frame by setting up new signs, road obstacles and by painting the road space. These physical measures are quick to implement and will give the users immediate practical experience of the measure, practical experience that has proven to contribute to increased popularity of the reallocation. Rebuilding the street space to for example separated bike lanes can be done later.

Administrative level:	Local
Owner:	Municipality
Socio-economic effects:	Positive impact on groups more relying on walking, cycling, public transport, as well as positive impact for residents in the area with reduced air pollution and noise levels. For low-income households, accessibility by walking, cycling and public transport is usually more affordable than car ownership and thus this kind of measure package often has positive effects for social and economic sustainability. With improvement of less car-dependent accessibility, car dependence is reduced for everyday transport and households' financial

[86] Hagen, O. H. & Tennøy, A. (2021) Street-space reallocation in the Oslo city center: Adaptations, effects, and consequences, Transportation Research Part D: Transport and Environment, Volume 97, 2021, 102944, ISSN 1361-9209, https://doi.org/10.1016/j.trd.2021.102944.
Shergold, I. et al. (2016a) The Economic Benefits of Sustainable Urban Mobility Measures. Independent Review of Evidence: In-depth Reviews of Measures.
[86] Litman, T. (2023a) Are Vehicle Travel Reduction Targets Justified? Why and How to Reduce Excessive Automobile Travel. Victoria Transport Policy Institute, 30 October 2023.
Litman, T. (2023b) Comprehensive Transportation Emission Reduction Planning Guidelines for Evaluating Transportation Emission Reduction Strategies. Victoria Transport Policy Institute, 4 January 2023.
[87] Infrastructure cost per kilometer (US$ million per km) (brtdata.org)
[88] CS_PedestrianReport_Final_WEB-1.pdf (nlc.org)
[88] Conventional Bike Lanes | National Association of City Transportation Officials (nacto.org)

	burden for car ownership and car journeys can then be reduced. The cost for implementing walking, cycling and public transport lanes is lower if existing street space for car traffic is converted to and dedicated for these modes, compared to the cost for building new lanes. Negative impact on car owners and car users can be mitigated by measures to promote better accessibility to and in the area in alternative ways such as more attractive sustainable modes, subsidies for bike purchases and such. Empirical evidence shows that fears before implementation about longer travel times and increased congestion for car traffic rarely occur in reality [89]. Several studies show positive effects for local business, for example property owners and [90][91][92][93]. Reduced car traffic reduces travel times for business transport. Route optimization and coordination of freight transport reduces costs for business and increases its competitiveness.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport for their mobility, and thus benefit of increased accessibility, traffic safety as well as better air quality.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport for their mobility, and thus benefit of increased accessibility, traffic safety as well as better air quality[94].

Example: *Mobility Policy and Air Quality. The effect of a new bike lane and community space on air pollution: a real-world experiment in Berlin. Potsdam: Institute for Advanced*

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[89] Cairns, S., Atkins, S. & Goodwin, P. (2002) Disappearing traffic? The story so far. Proceedings of the Institution of Civil Engineers - Municipal Engineer 2002 151:1, 13-22. Disappearing traffic? The story so far | Proceedings of the Institution of Civil Engineers - Municipal Engineer (icevirtuallibrary.com)
[90] Transport for London () Walking and cycling: The economic benefits. Walking and cycling: the economic benefits (tfl.gov.uk) Fetched 2023-11-04; The New York City Department of Transportation () The Economic Benefits of Sustainable Streets. nyc.gov/html/dot/downloads/pdf/dot-economic-benefits-of-sustainable-streets.pdf.
[91] Herbert, G. (2023) What are the economic benefits of car-free cities? EuroNews.next, Published on 21/09/2023. Updated 10/10/2023. https://www.euronews.com/next/2023/09/21/what-are-the-economic-benefits-of-car-free-cities Fetched 2023-12-15.
[92] Soni, N. & Soni, N. (2016). Benefits of pedestrianization and warrants to pedestrianize an area. Land Use Policy. 57. 139-150. 10.1016/j.landusepol.2016.05.009.
[93] createstreets.com/wp-content/uploads/2024/03/MoveFree_190324_CreateStreets.pdf
[94] Are mobility systems gender-neutral? - Ramboll Group

Sustainability Studies (IASS). *Mobility Policy and Air Quality. The effect of a new bike lane and community space on air pollution: a real-world experiment in Berlin | Research Institute for Sustainability*

6.2.2 Installation of particle reduction filters in existing buses

By improving technical standards in the existing bus fleet, with the installation of particle reduction filters, exhaust emissions of PM10 from bus transport can be reduced. Cost for setup was 10 000 € - 20 000 €/filter in Pristina. Time scale for implementation is 1-3 years (procurement may be needed).

Administrative level:	Local
Owner:	Bus operator
Socio-economic effects:	Positive: better air quality. Increased employment for service staff.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit from better air quality.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit from better air quality[95].

Example: *To improve the air quality for the citizens, 299 diesel busses in Copenhagen were fitted with a NOx reduction technology that neutralizes NOx emissions even at low motor temperatures. This reduced NOx emissions from buses by 90-95% and made the buses fulfil Euro VI emissions legislation in all real driving conditions. City of Copenhagen has reduced NOx emissions by up to 95% on its public buses since they were retrofitted with new clean air filters in 2016, and the total amount of NOx emissions in Copenhagen have been reduced by 4% as a result.* Liveable City: Copenhagen's Buses Cut Pollution

[95] Are mobility systems gender-neutral? - Ramboll Group

6.2.3 Making public transport more appealing – better bus schedules, real time information at bus stops, cleaner busses, etc.

The attractiveness of public transport is affected by the quality it offers. Modal shift from private car to public transport (with low emitting, modern vehicles) reduces NOx, PM, PM10, VOC emissions from private car exhaust emissions, at local and regional level.

Service frequency, travel time that is competitive with and preferably shorter than by car, perceived reliability, cleanliness and perceived safety, simplicity, information, price, and comfort are important factors that affect how attractive it is to choose public transport instead of private car. It is for example important that it is cheaper to travel by public transport than to drive and park your car. Attractive public transport that is fast, comfortable, accessible with a high frequency, with flexible payment systems and services (like free Wi-Fi) generally increases travel by public transport in the affected routes by 20-50% and at the same time reduces car travel by 5-15%, in some cases more. shows positive effects on the transfer of car journeys to public transport when positive incentives to travel by public transport (expanded and improved service, attractive ticket prices and convenient ticket handling, smooth and easy transfers between modes of transport and when travelling across regional borders) are combined with making car travel less attractive by measures like less parking spaces and less road lanes for private cars[96] Preferable is to convert existing lanes for car traffic into dedicated space for public transport. This both reduces the cost for the public transport infrastructure when using already existing road infrastructure with smaller adjustments such as paint and signs, compared to building new infrastructure. When buses are given priority over cars, car traffic levels become lower. When implementing measures to increase bus travel and reduce car travel, it is important to use buses that are low emission vehicles, so that increased bus movements doesn't contribute to air pollution.

Cost for infrastructure will be associated with implementation of bus lanes, bus stops, tram tracks, charging infrastructure for electric vehicles, bike lanes, bike parking, pedestrian lanes. Cost for vehicle purchase. Additional costs will occur for running the increased public transport by costs for staff (public transport), fuel

96 Litman, T. (2023b) Comprehensive Transportation Emission Reduction Planning Guidelines for Evaluating Transportation Emission Reduction Strategies. Victoria Transport Policy Institute, 4 January 2023

(public transport) and maintenance. Depending on measures, implementation can be made in 1-4 years.

Administrative level:	Local, regional
Owner:	Municipality, bus operator
Socio-economic effects:	With improvement of less car-dependent accessibility, car dependence is reduced for everyday transport and households' financial burden for car ownership and car journeys can then be reduced.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport[97].

Learn more:

- planning_for_attractive_public_transport.pdf
- Real-time information systems for public transport: user perspective - ScienceDirect

6.2.4 More effective city logistics (better coordination of urban goods transport)

In urban consolidation centers, goods arriving to a city can be reloaded to less emitting vehicles, and coordinated so that the total number of vehicle movements into urban areas are reduced[98]. According to empirical evidence in a European context, coordinated distribution of goods from loading centers in cities results on average in a 30-80% reduction in the number of vehicle movements, a 30-45% reduction in the number of vehicle kilometers, a 15-100% increase in the degree of occupancy and a 25-60% reduction in emissions from cargo vehicles[99]. This addresses exhaust emissions from goods vans and lorries, at regional and local level. Improved coordination including planning and collaboration can be achieved in a time frame of 1-5 years.

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[97] Are mobility systems gender-neutral? - Ramboll Group

[98] Katsela, K., Pålsson, H., & Ivernå, J. (2021). Environmental impact and costs of externalities of using urban consolidation centres: a 24-hour observation study with modelling in four scenarios. International Journal of Logistics Research and Applications, 25(12), 1542–1563. https://doi.org/10.1080/13675567.2021.1915261. Full article: Environmental impact and costs of externalities of using urban consolidation centres: a 24-hour observation study with modelling in four scenarios.

[99] Shergold, I. et al. (2016b) The Economic Benefits of Sustainable Urban Mobility Measures. Main report. Independent Review of Evidence: Main report.

Administrative level:	Local
Owner:	Municipality
Socio-economic effects:	Positive. Lower costs for logistic companies when number of vehicle movements can be reduced.
Impact on children:	Positive as children more often than adults are dependent on walking, cycling and public transport and thus benefit from better air quality and improved road safety.
Impact on gender:	Positive as women more often than men are dependent on walking, cycling and public transport and thus benefit from better air quality and improved road safety[100].

Learn more:

- Towards More Sustainable Cities: Tools and Policies for Urban Goods Movements
- Mapping out the potential for coordinated goods distribution in city centres: The case of Uppsala - ScienceDirect. *The case of Uppsala shows that coordinated urban logistics can be a key strategy for reducing air pollution, easing traffic congestion, and improving efficiency in city transport. The same principles can be applied to other cities looking to optimize their goods distribution networks while addressing environmental concerns.*

6.3 Transportation and city planning: "Rebuild" measures

6.3.1 Expansion of pedestrian and bicycle infrastructure, cycling network

This measure aims at reducing exhaust emissions of pollutants NOx, PM, PM10, VOC from motorized road transport by achieving a modal shift from private car to walking and cycling. Effects for reduced exhaust emissions will be local and regional. For pedestrian and bicycle traffic to become more attractive, the route needs to be fast, short, and perceived as safe and secure. An attractive cycle path is

[100] Are mobility systems gender-neutral? - Ramboll Group

straight, has good visibility and as few stops and sharp curves as possible – the same traits as those that are asked for by car drivers. It is preferable to design and implement bike lanes as protected and separated as such design has proven significantly safer for all categories of road users, compared to just dividing bikes from other modes with painted lines for example[101].

The route environment is important. A pedestrian or bicycle path too close to routes with high levels of car traffic can be perceived as noisy and with poor air quality, which reduces the attractiveness of cycling and walking there[102]. Preferable is to convert existing lanes for car traffic into dedicated space for pedestrians and protected bike lanes, and to adjust speed limits to calm car traffic in the area. This both reduces the cost for the walking and cycling infrastructure when using already existing road infrastructure instead of investing in new infrastructure and reduces car traffic levels as well when available space for driving and parking decreases and travel time for car journeys in the area increases.

Administrative level:	Local, regional, national (infrastructure investment funding)
Owner:	Local, regional
Socio-economic effects:	In cities that are designed for less car-dependent accessibility, distances are shorter, space and resource consumption for transport is reduced and car dependence is reduced for everyday transport. For low-income households, accessibility by walking and cycling is generally more affordable than car ownership and thus this kind of measure package often has

[101] Marshall, W.E. & Ferenchak, N.N. (2019) Why cities with high bicycling rates are safer for all road users, Journal of Transport & Health, Volume 13, 2019, 100539, ISSN 2214-1405, https://doi.org/10.1016/j.jth.2019.03.004.

[102] Shergold, I. et al. (2016a) The Economic Benefits of Sustainable Urban Mobility Measures. Independent Review of Evidence: In-depth Reviews of Measures.;
Wardlaw, M.J. (2014) History, risk, infrastructure: perspectives on bicycling in the Netherlands and the UK, Journal of Transport & Health, Volume 1, Issue 4, 2014, Pages 243-250, ISSN 2214-1405, https://doi.org/10.1016/j.jth.2014.09.015.
Marqués, R. & Hernández-Herrador, V. (2017) On the effect of networks of cycle-tracks on the risk of cycling. The case of Seville, Accident Analysis & Prevention, Volume 102, 2017, Pages 181-190, ISSN 0001-4575, https://doi.org/10.1016/j.aap.2017.03.004.;
Pucher J, & Buehler R. (2016) Safer Cycling Through Improved Infrastructure. Am J Public Health. 2016 Dec; 106(12):2089-2091. doi: 10.2105/AJPH.2016.303507. PMID: 27831780; PMCID: PMC5105030.

	positive effects for social and economic sustainability Households' financial burden for car ownership and car journeys can then be reduced.
Impact on children:	Positive as children more often than adults are dependent on walking and cycling, and thus benefit from better air quality and improved road safety.
Impact on gender:	Positive as women more often than men are dependent on walking and cycling, and thus benefit from better air quality and improved road safety.

Example: *Several cities in for example Denmark and the Netherlands have implemented top standard bike lanes, called Cycle Super Highways. On these, routes are fast, comfortable and safe, connecting areas with many workers and students to their homes, and to public transportation possibilities to enable fast commuting with bikes. The highways are as direct as possible and with as few stops as possible. Traffic lights can be adapted to give priority for cyclists instead of motorists along main roads and streets, so that cyclists are able to surf a wave of green lights through the city during rush hour.*

Learn more:

- http://www.cykelsuperstier.dk/sites/default/files/Cycle%20Super%20Highway s.pdf
- http://www.cykelsuperstier.dk/concept;
- http://www.aviewfromthecyclepath.com/2009/02/how-groningen-grew-tobe-worlds-number.html ;
- http://www.tfl.gov.uk/roadusers/cycling/11901.aspx

6.3.2 Dedicated lanes for buses

Dedicated bus lanes (DBL) increase accessibility and reduce travel time for buses. Thus, fewer buses are needed, which reduces air pollution from bus transport exhaust emissions of NOx, PM, PM10, VOC. These emissions also decline as total motorized traffic levels are expected to decrease with this measure. Preferably buses should be electric to get rid of exhaust emissions completely.

The measure leads to increased attractivity for bus travel in relation to car travel, and a mode shift from private car to bus. If the buses are electric, mode shift to bus travel from private cars gives substantial reductions in emissions. Travel times by buses should ideally be shorter than for a corresponding car journey. To accomplish short distances and travel times, dedicated bus lanes that are separated

from car traffic have proven successful, together with measures in traffic management (traffic signal programming etc.) that give buses priority over cars.

New lanes and space for buses (as well as for walking and cycling) have proven extra effective when being implemented by converting car lanes into dedicated lanes for walking, cycling and public transport[103]. It is thus preferable to convert already existing car lanes into dedicated bus lanes. Such road space reallocation decreases car traffic in the area by 8-10%. It also reduces the cost for the road infrastructure needed for the bus lanes. See above under 5.2 "Optimize" measures.

In Pristina, the set-up cost was 100 000 euro for planning and 0,5 - 1 million € for investments in the bus lane infrastructure. Preferable is to convert existing lanes for car traffic into dedicated bus lanes, as this both reduces the cost for the bus lane infrastructure when using already existing road infrastructure with smaller adjustments such as paint and signs and reduces car traffic levels when buses are given priority over cars.

Administrative level:	Local, regional
Owner:	Road space manager
Socio-economic effects:	In cities that are designed for less car-dependent accessibility, distances are shorter, space and resource consumption for transport is reduced and car dependence is reduced for everyday transport. For low-income households, accessibility by public transport is usually more affordable than car ownership and thus this kind of measure package often has positive effects for social and economic sustainability as households' financial burden for car ownership and car journeys can be reduced.
Impact on children:	Positive as children more often than adults are dependent on public transport.

[103] Hagen, O. H. & Tennøy, A. (2021) Street-space reallocation in the Oslo city center: Adaptations, effects, and consequences, Transportation Research Part D: Transport and Environment, Volume 97, 2021, 102944, ISSN 1361-9209, https://doi.org/10.1016/j.trd.2021.102944.
Shergold, I. et al. (2016a) The Economic Benefits of Sustainable Urban Mobility Measures. Independent Review of Evidence: In-depth Reviews of Measures.
[103] Litman, T. (2023a) Are Vehicle Travel Reduction Targets Justified? Why and How to Reduce Excessive Automobile Travel. Victoria Transport Policy Institute, 30 October 2023.
Litman, T. (2023b) Comprehensive Transportation Emission Reduction Planning Guidelines for Evaluating Transportation Emission Reduction Strategies. Victoria Transport Policy Institute, 4 January 2023.

Impact on gender: Positive as women more often than men are dependent on public transport[104].

Example: *Network of dedicated Bus Lanes: A solution to increase the accessibility of the urban intermodal transport discusses how dedicated bus lanes can improve urban public transport accessibility, particularly in Bucharest Romania. The study found that implementing a network of dedicated bus lanes (DBL) in Bucharest could significantly improve public transport accessibility, particularly in areas with limited metro and tram connections. Key results include:*

- ***Increased Accessibility**: Only 28% of residents currently have easy access to metro stations, and 49% to tram stations. DBL can help bridge this gap by providing faster and more reliable bus connections to high-capacity transit.*
- ***Reduced Congestion**: Prioritizing buses over cars in strategic road sections can decrease overall traffic congestion, making public transport more attractive.*
- ***Improved Travel Time**: The study suggests that DBL could lead to shorter and more predictable travel times, encouraging more commuters to switch from cars to public transport.*
- ***Potential Trade-offs**: While DBL benefits public transport users, it may reduce road capacity for private vehicles, requiring careful route planning and optimization.*
- *(PDF) Network of Dedicated Bus Lanes: A Solution to Increase the Accessibility of the Urban Intermodal Transport THE EFFECT OF DEDICATED BUS LANE IN A CITY CENTER | Request PDF*

6.4 Transportation and city planning: "New construction" measures

6.4.1 Cleaner municipal vehicles

Replacement of existing municipal vehicle fleet into new vehicles with low/zero emissions will reduce exhaust emissions of NOx, PM, PM10, VOC from this fleet, at local level. With electric vehicles, these exhaust emissions can be eliminated (emissions of PM and PM10 from friction of road surface, brakes, tyres remain).

[104] Are mobility systems gender-neutral? - Ramboll Group

Reduction of emissions from road traffic can be achieved by shifting technology in road vehicles, and by upgrading the vehicle fleet to more modern vehicles with less tail pipe emissions. A shift from fossil diesel and gasoline to electricity gives best result but also a shift to fuels like biodiesel, biogas, hydrogen gas, Compressed Natural Gas (CNG) or Liquefied Petroleum Gas (LPG) can reduce emissions compared to fuels like fossil diesel and gasoline. Upgrading existing vehicle fleet with the latest generation filters or engines with emission standards equivalent to the latest EURO emission standards are measures that are less effective than introducing new and clean vehicles and fuels, preferably electric vehicles, and however also less expensive[105]. Electric vehicles are preferable as they don't emit any exhaust emissions, while vehicles that run on biofuels will still emit air polluting emissions.

Cost for purchase of electric buses in Pristina EBRD - 4 million euro, and cost for purchase of EURO-6 buses EBRD - 6 million EUR. For electric buses, installation of charging infrastructure is needed. When implemented, there will be a fuel cost (electricity cost). Time scale for procurement and installation can be estimated to 2-4 years.

Administrative level:	Local
Owner:	Municipality
Socio-economic effects:	Positive effects for all inhabitants by better air quality.
Impact on children:	Positive as children more often than adults are dependent on walking and cycling, and thus benefit from better air quality and improved road safety.
Impact on gender:	Positive as women more often than men are dependent on walking and cycling, and thus benefit from better air quality[106].

Learn more:

- CosteffectivenessCO2reductionhybridandelectricbuses.pdf
- Impact of bus electrification on carbon emissions: The case of Stockholm - ScienceDirect. This paper examines the decarbonization of Stockholm's public bus transport, focusing on electrification and optimal charger placement using a life cycle perspective. The study finds that while higher battery capacities can

[105] CIVITAS () Cleaner and better transportation in cities. Policy advice notes. Cleaner vehicles and alternative fuels. www.civitas.eu

[106] Are mobility systems gender-neutral? - Ramboll Group

electrify more routes, they don't always reduce total emissions. 120 kWh batteries result in the lowest life cycle emissions. Fuel choice is crucial—certified renewable electricity has the lowest impact, while second-generation biofuels like HVO can rival the Nordic electricity mix. Electrification also reduces local pollutants, but emissions from public transport remain much lower than those from private vehicles.

6.4.2 Expansion of bike lane network

Expansion of bike lane network provides better connectivity and accessibility in the city for cyclists. Through modal shift from private cars to cycling, this measure will contribute to reduced exhaust emissions of NOx, PM, PM10, VOC from private cars. Best impact with regard to reducing car traffic is generally achieved if bike lanes are accomplished by transforming existing car lanes into dedicated bike lanes.

International benchmarking of quality in design of bike infrastructure shows that the design of cycle infrastructure can have a big impact on modal choice. The strongest factors are safety, comfort, and continuity and these will have to be at the forefront of design[107]. In general, it is İmportant is that travel times are short, and ideally shorter than for corresponding car journey.

Another important feature for making cycling attractive is that the bike lanes are separated from car traffic. New lanes and space for cycling (as well as walking and public transport) have proven extra effective when being implementing by converting car lanes into dedicated lanes for walking, cycling and public transport108. The design and maintenance of bike lanes will affect how potential cyclists perceive them as being attractive and safe109. Cost for setup varies

[107] Hull. A. & O'Holleran, C. (2014) Bicycle infrastructure: can good design encourage cycling?, Urban, Planning and Transport Research, 2:1, 369-406, DOI: 10.1080/21650020.2014.955210;
Design Manual for bicycle traffic - CROW
[108] Hagen, O. H. & Tennøy, A. (2021) Street-space reallocation in the Oslo city center: Adaptations, effects, and consequences, Transportation Research Part D: Transport and Environment, Volume 97, 2021, 102944, ISSN 1361-9209, https://doi.org/10.1016/j.trd.2021.102944.
Shergold, I. et al. (2016a) The Economic Benefits of Sustainable Urban Mobility Measures. Independent Review of Evidence: In-depth Reviews of Measures.
[108] Litman, T. (2023a) Are Vehicle Travel Reduction Targets Justified? Why and How to Reduce Excessive Automobile Travel. Victoria Transport Policy Institute, 30 October 2023.
Litman, T. (2023b) Comprehensive Transportation Emission Reduction Planning Guidelines for Evaluating Transportation Emission Reduction Strategies. Victoria Transport Policy Institute, 4 January 2023.
[109] Conventional Bike Lanes | National Association of City Transportation Officials (nacto.org)

depending on design and the setting[110] [111]. Time scale for planning and building is estimated to 2-3 years.

Administrative level:	Local
Owner:	Municipality
Socio-economic effects:	Positive. With improvement of less car-dependent accessibility, car dependence is reduced for everyday transport and households' financial burden for car ownership and car journeys can then be reduced.
Impact on children:	Positive as children more often than adults are dependent on walking and cycling, and thus benefit from better air quality and improved road safety.
Impact on gender:	Positive as women more often than men are dependent on walking and cycling, and thus benefit from better air quality and improved road safety[112].

Learn more: The article *"Effect of Bike Lane Infrastructure on Ridership"* examines how dedicated bicycle lanes influence cycling rates and overall transportation dynamics. It highlights the benefits of bike lanes, such as reducing traffic congestion, lowering greenhouse gas emissions, and promoting non-motorized transport. The study focuses on Metro Manila, where rapid urbanization and rising car ownership have led to severe traffic congestion and air pollution. The research suggests that developing bike lane networks could increase ridership, improve mobility, and offer a cost-effective, sustainable transport alternative. It also discusses safety concerns, infrastructure design, and public perceptions of cycling. https://www.researchgate.net/publication/317185362_Effect_of_Bike_Lane_Infrastructure_on_Ridership

[110] Countermeasure_Costs_Summary_Oct2013.pdf (pedbikeinfo.org)
[111] The Costs of Cycling Infrastructure (ecf.com)
[112][112] Are mobility systems gender-neutral? - Ramboll Group

7 Electricity and heat supply

The following chapter presents the selected measures for the Electricity and Heat Supply sector. Given the nature of these measures, they are categorized as either "Rethink" or "New Construction."

7.1 Electricity and heat supply: “Rethink” measures

7.1.1 Requirements for new buildings

This is a measure to step by step improve the standard of buildings. An example can be requirements that new buildings are connected to central district heating. The pollutants targeted are PM, NOX, SOX, VOCs which are generated through the production of residential heating and electricity. Building developers must commit to have an approved energy source for the new building. After the construction phase a building inspection is performed. This can be administrated at a municipal level and the effect and target scale is primarily local and/or regional. The time scale is dependent on the expected time for construction. This is likely not a quick measure but a way to gradually improve new buildings. The expected lifespan for an apartment building can be estimated to be over 50 years, and thus a building with lower impact on air pollution have an impact for a very long time period. The expected time scale for planning and implementation of this measure is approximately between 1-7 years due to long time frames for planning and construction of new buildings and neighborhoods.

Owner:	Municipality
Socio-economic effects:	Supports the green economy and sustainable energy sector.
Impact on children:	Positive. Improved indoor and outdoor air quality have a positive effect on children. The improvement of the building stock creates a new standard and expectations leading to a change in attitudes.
Impact on gender:	Positive. Cleaner household energy can lead to improved indoor air quality which will have a positive effect on women and children who typically spend more time in the home.
Learn more:	

- Chapter 3 "Sustainable building and construction policies" in Beyond foundations – Mainstreaming sustainable solutions to cut emissions from the building sector. global_status_report_buildings_construction_2023.pdf

7.1.2 Information or subsidy: Replacement of inefficient heating systems in official buildings

Investing in the replacement of inefficient heating systems with modern, energy-efficient, and cleaner alternatives, such as heat pumps, in municipal buildings, targets pollutants like PM and CO. The impact scale is both local and regional. The effectiveness of this measure arises from the reduction in emissions achieved by using cleaner energy sources for heating compared to coal. The estimated timeframe for implementing this measure is between 1-5 years, depending on readiness and available funding.

Administrative level:	Municipality
Owner:	Municipality
Socio-economic effects:	If no subsidies are available from national or regional level, the cost for the municipality will mean savings will be needed in other sectors. On the other hand, socioeconomic benefits occur from less air pollution, better air quality, and less negative health impacts on the inhabitants which will mean savings in healthcare costs etc.
Impact on children:	Positive from better air quality outdoors as children typically spend a lot of time outside.
Impact on gender:	Positive from better air quality outdoors, as women to a larger extent walk, cycle and use public transport compared to men.

Learn more:

- A study of residential heating in a residential area in Slovakia shows that district heating emits less CO and NO2 pollutants than individual heating in each building. The impact of heating systems scenarios on air pollution at selected residential zone: a case study using AERMOD dispersion model. Environ Sci Eur 35, 91 (2023). https://doi.org/10.1186/s12302-023-00798-1.

7.2 Electricity and heat supply: "New construction" measures

7.2.1 Solar panels on municipal buildings

Installing solar panels on municipal building is one way of "leading by example". By installing solar panels on communal buildings, the municipality is setting a positive example by embodying a principle of aiming for sustainable and renewable energy. It is a way of showing commitment as well as contributing to cleaner air and improved health for the inhabitants. Furthermore, the municipality have control over their own properties hence it is good start to begin with the municipal buildings. This measure target pollutants are PM and CO. The target scale for this measure is local. Since the impacts from this type of measure comes from the emissions avoided when using solar energy compared to e.g., electricity generated from coal, impact scale is both local and regional.

In 2021, the municipality of Kavadarci applied for funds from the European Structural and Investment Funds to finance investments of solar panels for municipal buildings. The installation was to cover 10 public municipal buildings with a total capacity of 19.2 kWh/h. The Municipality of Kavadarci is contributing financially with 3,352,981.80 denars, while the remaining funds of 3,489,838.20 denars are provided by the Bureau for Regional Development. Approximately 55 000 EUR from the municipality of Kavadarci and 57 000 EUR provided by the Bureau for Regional Development[113] The estimated timescale for this is 1-3 years depending on available funding etc. Installation of solar panels is also a good

[113] ПЛАН ЗА ПОДОБРУВАЊЕ НА КВАЛИТЕТОТ НА АМБИЕНТАЛНИОТ ВОЗДУХ ЗА ОПШТИНА КАВАДАРЦИ период 2022-2026 , Plan for Improving Ambient Air Quality for the Municipality of Kavadarci, Period 2022-2026, Skopje 2022.

opportunity to examine the status of the roof and identify possible maintenance needs.

Administrative level: Municipality
Owner: Municipality

Learn more:

- Potential air quality benefits from increased solar photovoltaic electricity generation in the Eastern United States - ScienceDirect.[114] .

[114] Abel, A., Holloway, T. Harkey, M. Rrushaj, A. Brinkman, G. Duran, P., Janssen, M. & Denholm, P. (2018) Atmospheric Environment, Volume 175, 2018, Pages 65-74, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2017.11.049.

8 Industry

The following chapter presents the selected measures for the industry sector. Given the nature of these measures, they are categorized as either "Rethink", "Optimize" or "Rebuild". Consequently, there are no measures classified as "Construct" for this sector.

8.1 Industry: "Rethink" measures

8.1.1 Polluter pays fees and environmental inspections

To reduce emissions of NOX from plant chimneys within industry, heating and energy, polluter pays fees can be implemented. Impact will be at local and regional level. Polluters pays principal is based on the concept of those causing environmental damage and pollution are also responsible and implies that polluters should bear the associated costs of polluting. This includes the cost of preventing, mitigation, and remedying. Polluter pays fees may be implemented through various alternatives such as taxes, pollution charges, emission trading systems or liability schemes to create economic incentives to avoid and reduce pollution.

Administrative level:	National, local
Owner:	Plant owner, municipality, national government
Socio-economic effects:	Positive – improved air quality. Initial cost for plant owner for installation of emission monitoring system.
Impact on children:	Positive effects from improved air quality as children often are more dependent on walking and cycling and thus benefit from improved outdoor air quality.
Impact on gender:	Positive effects from improved air quality for both men and women.

Example: *An example is the NO_x charge system in Sweden. Enabling legislation*[115] *came into effect 1992 and stipulates that a charge per kilo emitted is payable on measured emissions of*

[115] Environmental Charge for Emissions of Nitrogen Oxides from Energy Production Act,

nitrogen oxides (NO_x, calculated as nitrogen dioxide, NO_2) from electricity and heat-producing boilers, stationary combustion engines and gas turbines having a measured useful output of at least 25 GWh hours of useful energy per year. A special feature, which has been claimed to be a success factor for this charge, is that the total environmental charge paid into the system is repaid to those liable to the charge in proportion to each production unit's share of total useful energy production. The idea is to reward emissions that are low in relation to energy production (i.e., low specific emissions). Since the charge was introduced, specific emissions at the plants subject to the charge fell by around 40 per cent. The charge has provided an impetus for technological development and more accurate monitoring of emissions, which is essential for fine tuning and adjustments of the charging system so that NO_x emission reductions will be accomplished[116] [117]*. By monitoring, emission levels are visualized which contributes to behavioral change*[118] [119]*. Time scale is estimated to 2-3 years for implementing legislation, 1-2 years for installing emission monitoring system.*

8.2 Industry: "Optimize" measures

8.2.1 Water sprinklers where coal is crushed

A coal mine is a primary source of suspended particles, especially an open pit mine. To reduce emissions from this sector one potential measure is crushing of coal in an enclosed spaces equipped with water sprinkler system. This is a type of dust suppression which prevents particles on the ground from being airborne or settles down already airborne particles (fugitive coal dust) back to the ground or material bed. Other similar ways of achieving this is by making use of foggers or foam generation systems.

However, sprinkling of water is the most cost-effective method[120]. The sprinklers are typically positioned at loading areas, along haul roads, and at unloading points within the mining area. Additionally, water-spraying systems are used at washeries, coal handling plants, feeders, crushers, belt conveyors, and coal stock areas.

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[116] https://www.naturvardsverket.se/globalassets/media/publikationer-pdf/5300/978-91-620-5335-3.pdf
[117] https://www.iea.org/policies/1198-nitrogen-oxides-nox-charge
[118] https://www.sciencedirect.com/science/article/pii/S0959652623041392
[119] https://www.ivl.se/press/nyheter/2018-04-17-atta-framgangsfaktorer-for-att-lyckas-med-en-beteendeforandring.html
[120] Ray R (2019) Coal dust control, Power Engineering. https://www.power-eng.com/2013/07/15/coal-dust-control/. Accessed 10 April 20224

Reduced fugitive coal dust has other benefits besides health impacts and climate and environment, e.g., decreased cost for machinery maintenance. The target pollutant of this measure is PM, and the target and impact scale is local and regional. It is a relatively low-cost setup. Water sprinkler systems is considered a low- cost and cost-efficient method to reduce fugitive coal dust. Timescale for implementation is approximated to 1-5 years.

Owner:	Municipality, Industry owners
Socio-economic effects:	Job creation and water resource management. Installation and maintenance of water sprinkles can create job opportunities for local businesses. Dust suppression using water requires proper management of water resources, depending on the availability of water in the region. Increased demand or water can impact other industries, communities, and agriculture dependent on the same water resource.
Impact on children:	Children are particularly sensitive to air pollution and are thus beneficiaries of reduced emissions. Children living in areas with coal industries will thus most likely experience improvements in air quality and health, both short- and long-term perspective.
Impact on gender:	Traditionally, it's men who predominantly hold jobs within the coal industry so the improvement of roads within that sector will therefore benefit men. Nonetheless, everyone working at coal mine will benefit. Furthermore, particles spread with the wind, primarily affecting those living near the industry who will benefit from this measure.

Learn more:

- Study of reduction in dust density in open cast coal mine. https://www.neuroquantology.com/open-access/Study+of+Reduction+in+Dust+Density+in+Open+Cast+Coal+Mine_12811/

8.3 Industry: "Rebuild" measures

8.3.1 Asphalting roads used by heavy vehicles

Paving roads with asphalt can significantly reduce emissions of air pollutants and greenhouse gases in several ways. Firstly, it can lower fuel consumption for

vehicles traveling on the road due to the smoother surface, which reduces rolling resistance and therefore fuel use. Secondly, asphalted roads generate much less dust compared to gravel or dirt roads, thereby reducing the amount of airborne particulate matter released into the environment. This measure can notably improve air quality and decrease health risks for people living or working near these roads.

In addition to reducing emissions, asphalted roads enhance traffic safety by providing better driving conditions, especially during inclement weather or on slippery surfaces. The primary targeted pollutant with this measure is particulate matter (PM), with the local impact scale being both local and regional. While the exact timeframe for implementation is difficult to estimate, paving roads is a relatively quick measure and, with adequate funding and planning, could be initiated within 1-3 years.

This measure is relevant for all roads frequented by heavy vehicles. In the coal industry, wind erosion of unpaved roads significantly contributes to airborne dust and particulate matter, which then disperses into surrounding communities. According to the Air Quality Plan for the Municipality of Pljevlja, this measure has the potential to reduce emissions by over 90%[121].
However, asphalt is itself a major source of emissions of particulate matters and air pollution, especially in sunny and hot places[122]. Reducing traffic levels in total and thus reduce the need for expanding road surface, is therefore an important part of air pollution mitigation.

Administrative level:	Municipal
Owner:	Municipality, industry owner
Socio-economic effects:	Improved transportation infrastructure and job creation. This includes jobs in construction, road maintenance, and associated services contributing to local economic development.
Impact on children:	Children are particularly sensitive to air pollution and are thus beneficiaries of reduced emissions. Children living in areas with coal industries will thus most likely experience improvements in air quality.
Impact on gender:	Traditionally, it's men who predominantly hold jobs within the coal industry so the improvement of roads within that

[121] Air quality plan for the municipality of Pljevlja (2023)
[122] Asphalt on roads may soon be greater source of air pollution than cars | New Scientist

sector will therefore benefit men. However, particles spread with the wind, primarily affecting those living near the industry who will benefit from this measure.

9 Miscellaneous

The following chapter presents measures that did not fit in with the other sectors. The selected measures are categorized as either "Rethink" or "Optimize". Consequently, there are no measures classified as “Rebuild” "Construct".

9.1 Miscellaneous: "Rethink” measures

9.1.1 Restrictions on celebratory burning, fireworks

Restrictions on celebratory burning of e.g., large bonfires and fireworks aim to promote public health, reduce adverse environmental impact, reduce fire hazards etc. The restriction can be designed in way that prohibits the use of firework and bonfires without permission from the municipality. Or only allowing celebratory burning and fireworks on specific dates and times. An age limit for handling fireworks can also be applied. Targeted pollutants are PM, NOX, SOX, and CO. The target and impact scale are local.

As an alternative to fireworks, it has become increasingly more common to substitute with LED light drone shows creating patterns and shapes in the sky. Benefits include reduced risk of fire, risk of damage and injury[123].

Administrative level:	Municipality
Owner:	Municipality
Socio-economic effects:	The scale of impact depends on the design of the restriction. Restriction on fireworks can impact the fireworks industry, reduced revenue, and potential job losses within the industry. Fireworks and bonfires are often part of cultural celebrations and festivals, and restriction can affect the attractiveness of those events.
Impact on children:	Limitations and restrictions can contribute to raising awareness about safety and environment. It can also

[123]CBS News (2023). *These cities are having drone shows instead of fireworks displays for Fourth of July celebrations.* https://www.cbsnews.com/news/fireworks-displays-drone-shows-4th-of-july-celebrations/

encourage innovation around celebrations without fireworks or bonfires.

Learn more:

- Fireworks regulation, air pollution, and public health: Evidence from China - ScienceDirect
- The Diwali festival: short-term high effect of fireworks emissions on particulates and their associated empirically calculated health risk assessment at Bhubaneswar city | Environmental Geochemistry and Health

9.2 Miscellaneous: "Optimize" measures

9.2.1 Remediate illegal waste dumps

Illegal waste dumps pose serious air quality concerns due to the unregulated release of harmful gases and potential exposure to hazardous materials. In areas where illegal burning of waste is common, these dumps can become significant local sources of air pollution. Burning waste at these sites, or the dispersion of dust from uncovered waste piles, releases particulate matter (PM) into the air. This PM can contain a variety of harmful substances, including heavy metals and toxic compounds, posing serious health risks when inhaled.

Recommendations for illegal waste dumps include but are not limited to the following: Strengthen legislation and enforcement. Laws and regulations related to waste disposal must be updated and illegal dumping should be met with deterring penalties. Municipality, region, and country must provide proper waste management infrastructure. Increase monitoring and enforcement to detect illegal activities. Sites prone to illegal dumping should be regularly inspected. Enforcement has been shown to be crucial for successful abatement of illegal waste dumping, as more stringent waste policy can have adverse effects than intended, and actually increase illegal disposal of waste. Deterrence might only result after a relatively high level of controls is implemented[124].

[124] D'Amato, A., Mazzanti, M., Nicolli, F. & Zoli, M. (2018) Illegal waste disposal: Enforcement actions and decentralized environmental policy. Socio-Economic Planning Sciences, Volume 64, 2018, Pages 56-65, ISSN 0038-0121, https://doi.org/10.1016/j.seps.2017.12.006.Illegal waste disposal: Enforcement actions and decentralized environmental policy - ScienceDirect.

Remediating illegal waste dumps requires collaboration among government agencies, environmental experts, contractors, and community members to achieve effective and sustainable cleanup outcomes. The cost setup for this measure can contain several steps, each with their own financing needs. The cost for regular cleaning of illegal dumps and establishment of sites for disposal of waste (vehicles, construction debris, bulky waste etc.) was estimated to 33 000 EUR annually in the air quality plan of Kumanovo[125]. Target and impact scale is local, regional for this measure.

Administrative level:	Municipality
Owner:	Municipality
Socio-economic effects:	Public health benefit, property value enhancement, tourism development, job creation.
Impact on children:	Reduced health risk due to improved air and water quality. Cleaning up waste dumps enhances recreational spaces providing more opportunities for outdoor activities.

Learn more:

- Environmental Pollution from Illegal Waste Disposal and Health Effects: A Review on the "Triangle of Death" - PMC

[125] Plan for improving the quality of ambient air for the municipality of Kumanovo 2022-2026 (ПЛАН ЗА ПОДОБРУВАЊЕ НА КВАЛИТЕТОТ НА АМБИЕНТАЛНИОТ ВОЗДУХ ЗА ОПШТИНА КУМАНОВО за период 2022-202)

10 Annex A

10.1 Designing information campaigns

Campaigns aiming to change lifestyle and consumption patterns should typically be organized in small "steps", where members of the target group have the opportunity to adopt slowly to a change. For instance, a first step that pays attention to the matter itself ("Did you know that bad air could be dangerous to your health…") could be followed up later by a second step providing more information ("In our city, X premature deaths per year are caused by exhausts from the traffic…").

A third message, provided after a suitable time lap, could tease the willing of making a change ("By commuting by tram instead of car, you make a great contribution to the general health of our school kids…"). This step prepares for the action wanted, which in turn could be supported by some kind of incitement ("Sign up for a free trial month on the tram line…").

Finally, a fifth step could be made to verify that the person addressed is satisfied with the change of habit and to establish it for long time ("As our new Star Commuter, you will receive a reward…").

In between these steps, it is important with feedback options, i. e. possibilities for the person to respond to the messages, and proofs that the change is in the right direction. If, for instance, one part of the campaign is to collect e-mail addresses or mobile phone numbers, it is possible to communicate progress ("As you commuted by tram on 16 days of the last month, you saved our common air by X kg NOx…"),

10.2 Target groups for information campaigns

Different kinds of information suit different groups of people. In successful campaigns, some groups will respond strongly to what is said and suggested. Meanwhile, other groups maybe don't pay any attention to what is informed.

When planning an information campaign, a basic step is to select and carefully define the group of inhabitants that should be reached, often labeled the "target group". That group is generally a smaller part of "the general public", sharing common economic, social, cultural, or other conditions, and have similar abilities to

perform a change in for instance consumption or lifestyle. A campaign organizer should carefully examine what groups within society that are most likely to make a change as a response to the campaign. Every target group should be addressed in ways that is relevant and attractive for the people within the group. Defining and getting to know specific target groups for different campaigning issues also means that less effort is spent in reaching other groups within society that are less likely to make a change. Hence, a campaign that is designed to reach "the general public" is likely to fail, since the target group is too broad.

People who will give a quick and positive response to a campaign are often called "early adopters". Maybe they represent just a small fraction of the entire population, but their changed consumption or lifestyle might set off a more general movement later. This is one reason why advertisers often give away several of their products for free. If, for instance, a group of early adopters are offered electric stoves in a neighbourhood where such are rare or absent, it is likely that curious neighbours later will invest in the same kind of equipment. Summing up, the cost of giving away (or subside) stoves will be well worth its money.

Example: The offer of a free bus ride trial period to car drivers, has proven to contribute to a behavioural shift in the longer term, as many of the test persons tend to stick to the new bus commuting habit also after the end of the trial.

10.3 "The Dialogue Stair" – one of many appropriate models

There are numerous models for communication planning. Some of them are basic and general and could function as inspiration or checklists for un-trained staff, while others are more advanced and resource demanding, but highly efficient.

"The Dialogue Stair" is a fairly simple model, easy to keep in mind. It develops from the dichotomy between information and communication mentioned above, and details different levels of engagement and involvement from the audience, or rather the selected target group.

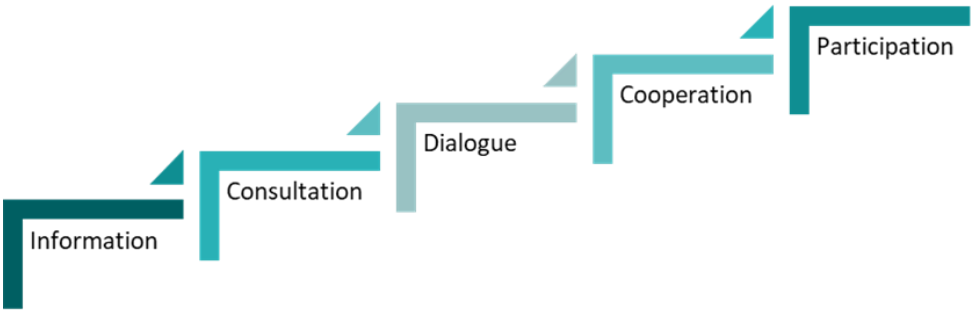

Figure 5 A schematic illustration of "the dialogue stair" starting with the one-way communication (Information). At the top of the stair, we find cooperation and participation, steps characterized by more involvement of all participants and an exchange of views.

Information is, as mentioned above, a one-way communication. The sender states a message, and maybe the receivers pick it up or not. Whether the receiver is affected or not, or willing to change mind and behaviour, remains unknown. It might be good enough in some cases but have a low impact on habitual change.

Consultation involves an exchange of experience and knowledge between the sender and the receiver(s). The receivers are involved in the process, but merely as advisors or information sources.

Dialogue is the level where sender and receiver are on equal terms, speaking on impact on the process for change. Contributions from the receiver are of same importance as those from the sender. Cooperation means both parts contribute to the work, for instance the development of a new traffic plan, but still represent two different categories, maybe with differing values and priorities.

Participation, finally, is the level where all parts involved in a process are contributing on the same premises, and it might be hard to identify any major differences in responsibility, values, or priorities.

The higher step in the stair, the more involvement could be expected by the participants, and so the engagement in fulfilling the change and maintaining the new standards of behaviour. That doesn't mean that all communication should end up in full participation processes: Sometimes lower degrees of involvement are just what is needed or wanted to make appropriate changes. Skilled communicators could give good advice on what involvement level and communication strategies will bring the best probability of the change wanted.

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This report has been reviewed and approved in accordance with IVL's audit and approval management system.

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