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# Mitigation strategies for reducing air pollution

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## Abstract

Today, it is increasingly recognized that air pollution hurts human health. Consequently, efficient mitigation strategies need to be implemented for substantial environmental and health co-benefits. A valid approach to reducing the air pollution effects on the environment and human health is proposed. Specific guidelines have been elucidated by differentiating them on the base of the final stakeholders (citizens, enterprises, and public authorities), of the emission sources (transport, household energy, industry, and energy generation sector, agriculture, and shipping area), and of the field of implementation (urban and extra-urban context). This paper can provide useful information for governments for the implementation of a strategic plan focused on emphasizing multi-pollutant emission reductions and overall air pollution-related risk.

**Keywords** Air pollution · Mitigation strategies · Human health · Environmental impact · Air quality · Guidelines

## Introduction

Today, air pollution is the main responsible for environmental quality worsening in many cities all over the world, with adverse outcomes on people's health (Vlachokostas et al. 2011). According to the last World Health Organization (WHO), more than 80% of people living in the urban context are subjected to air quality levels above the emission limits regarding air pollution. The primary atmospheric pollutants are carbon monoxide (CO), particulate matter (PM), nitrogen oxides (NO<sub>x</sub>), volatile organic compounds (VOC<sub>s</sub>), polycyclic aromatic hydrocarbons (PAH<sub>s</sub>), ozone (O<sub>3</sub>), and sulfur dioxide (SO<sub>2</sub>). The increase in emission amounts of these pollutants is due to the rapid industrialization and urbanization of developing countries (Fu and Chen 2017).

The worsening of air quality in urban environments has considerable interest in the scientific community and public

opinion due to the strong relationship between air pollution exposure and increased harmful short- and long-term effects on human health (Masiol et al. 2014). Recently, significant epidemiological studies in the literature have found that air pollution contributes to increased morbidity (especially at respiratory and cardiovascular levels), premature mortality, and finally, cancer (Brancato et al. 2018). Figure 1 summarizes the different area of diseases: neuronal (Dales et al. 2009) (Power et al. 2015) (Power et al. 2016) (Levy 2015) (Block and Calderon-Garciduenas 2009), respiratory (Brugha and Grigg 2014) (Guan et al. 2016) (Kurmi et al. 2010) (Goss et al. 2004) (Fajersztajn et al. 2013), cardiovascular (Zanobetti and Schwartz 2005) (Anderson et al. 2012) (Maheswaran 2016) (Yang et al. 2017), and oncology area (Raaschou-Nielsen et al. 2013) (Crouse et al. 2010). Each disease is affected by own pollutant exposures (PM, NO<sub>2</sub>, SO<sub>2</sub>, CO<sub>2</sub>, O<sub>3</sub>) with the corresponding level of risk. Human exposure to air pollutions is strongly affected by the lifestyle and by the prevailing life environment (Buonanno et al. 2014). In their work, Buonanno et al. (2012) demonstrated that essential contributions to children exposure are due to the time spent at home for cooking/eating as well as for the time spent in traffic jams moving to or from school (Buonanno et al. 2012). In addition to human health risks associated with gases and particles inhalation, urban air pollution also causes damages at an environmental level, for example, by increasing the corrosion and deterioration of materials and damaging historical monuments and buildings (Vlachokostas et al. 2011). The effects of air pollution have been studied on many assets of the

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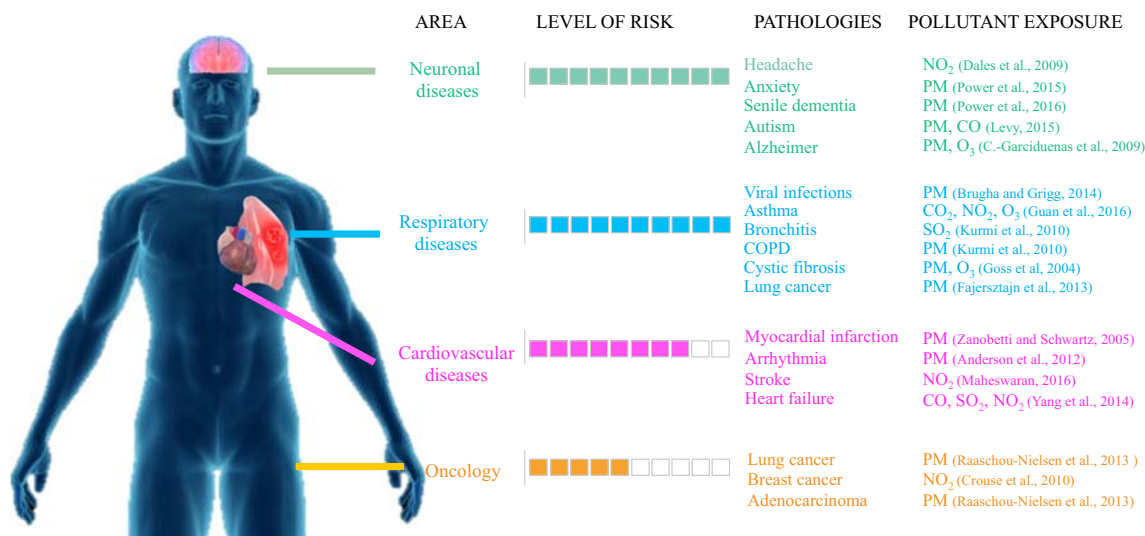


Fig. 1 Different areas of diseases in the human body

Italian artistic heritage Depending on where they are located; it was possible to verify the effects of the typical pollutants of the context itself. Sulfur dioxide reflecting the severe air pollution of this very large city can be dangerous for stone monuments as the marble Arch of Titus in Rome (Metallo et al. 1995); the particulate matter and the heavy metals as Pb and Zn can damage monuments like the Vittoriano Monument in Rome that is exposed to intense road traffic (Barca et al. 2014). The exposure to air pollution can influence also the stability of public utility buildings such as bridges as occurred in Genoa during 2018 when, due to the aggressive environmental condition that corroded the strands, the Polcevera Bridge collapsed causing 43 deaths and more than 5000 evacuated people (Invernizzi et al. 2019).

To tackle these problems, efficient long-term air pollution mitigation strategies need to be identified and implemented (Rodriguez de San Miguel 2019). For this reason, the role of the management to improve the current situation becomes critical (Werner et al. 2015). It is, therefore, crucial to define a strategic plan with some actions in compliance with the relevant directives in the field of air quality (Vlachokostas et al. 2011). These actions strongly depend on local policy and economy, on available technologies, and on public opinion (Harlan and Ruddell 2011).

**The aim of this work**

This paper aims to contribute to the existing knowledge on environmental pollution literature by investigating how people, companies, and committees can contribute to reducing pollution effects by engaging in pro-environmental behaviors. We firmly believe that if these proposed behavioral recommendations are pursued, positive environmental impacts and health co-benefits are very likely to occur. Among the policies that we intend to propose, the promotion of active transport

and sharing mobility, the reduction of energy use in the household environment, the urban planning, the provision of benefits in favor of bio-fueled (Sofia et al. 2013), and the use of electric vehicles are included.

**Recommendations for citizens**

To mitigate the air pollution problem, many efforts have to be taken with the aim to decrease the pollutants emissions coming from people. Each citizen may contribute to the mitigation of air pollution through behavioral changes in their lifestyle as the reduction of energy consumption in transportation, households, and supply.

**Public and active transport**

Transportation is the central investigated sector for public health benefits obtained after air pollution reduction (Sarigiannis et al. 2017) (Lindsay et al. 2011). It is well known that vehicular transport produces about 70% of environmental pollution since exhaust fumes from motors are a source of several pollutants (CO, NO<sub>2</sub>, VOC, and PM) (Xia et al. 2015). Consequently, programs aiming at changing travel behaviors are essential (Guersola et al. 2017). Each citizen should use public transports (bus, tram, subway, train) as much as possible and possibly travel actively (walking and cycling). The shift to active transport by reducing the use of owned cars entails significant benefits for human health and environment (Rabl and de Nazelle 2012) (Maizlish et al. 2013) (Xia et al. 2015). Recently, several studies have shown that the increase in physical activity reduces the incidence of several diseases, especially at cardiovascular level (coronary heart disease, stroke), hypertension, and diabetes (Mueller et al. 2015) (Scheepers et al. 2014). Furthermore, in this

way, significant reductions of colon and breast cancer and the improvement of mental health can be achieved (Rabl and de Nazelle 2012). Of course, benefits from physical activity are obtained by minimizing exposure to atmospheric pollution; therefore, the outdoor activity has to be carried out in the environment with healthy air (Rabl and de Nazelle 2012). Furthermore, commuters should be encouraged to use low-cost public bicycle sharing systems to combine benefits concerning health and air pollution reduction (Rojas-Rueda et al. 2011).

### Household sector

Nowadays, household air pollution is attributed to the residential use of the solid fuels from cooking activities (Stabile et al. 2014) and space heating systems (Stabile et al. 2018), leading a significant hazard for the health of exposed populations (Gao et al. 2018). Accordingly, actions to reduce energy use by households and buildings are essential because of their great contribution to gas emissions (Datta et al. 2017). One of the appropriate strategies is the improvement of combustion efficiency of solid household fuels (Venkataraman et al. 2010). Generally, traditional fuels have low combustion efficiency producing accordingly large amounts of products due to incomplete combustion, with consequences for both environment and human health. In their work, Marchetti et al. (2019) demonstrated how the particles deriving from the combustion different fuels (pellet, wood, charcoal) could activate toxicological pathways, finally producing cytotoxic effects on human health (Marchetti et al. 2019). The fuel toxicity is dependent on the chemical composition of the particulate matter characterizing the quality of the combustion and fuel. The energy generated from renewable sources (biomass) should lead health benefits for citizen because of a cleaner environment with low emission production (Harlan and Ruddell 2011) with respect to the traditional fossil fuel used.

Nevertheless, more stringent regulations are required to guarantee high-quality biomass fuels and safer combustion technologies (Marchetti et al. 2019). On their side, each citizen has to adopt some behavior actions to reduce energy consumption and emissions deriving from home heating. Another essential structural adaptation is the introduction of new technologies to reduce energy use in new buildings (Ruparathna et al. 2017). Porritt et al. (2012) showed how limited changes in building are able to eliminate overheating during heat wave periods and reduce space energy use for internal climatization, such as external wall insulation, solar reflective coatings (external shutters), and painting of the outer walls in lighter colors (Porritt et al. 2011) (Porritt et al. 2012). Furthermore, green roof technologies can help to reduce local outdoor temperatures and improve the appropriate cooling inside buildings (Harlan and Ruddell 2011).

### Aeration

Despite efforts to reduce particle emissions deriving from outdoor activities, most of air pollution is related to indoor microenvironment (Buonanno et al. 2017). The air quality inside buildings is affected by the air circulation, the construction materials, the use of cleaning products, and the habits of occupants (smoking). A vast range of pollutants can concentrate in indoor environments produced by individual activities in addition to outdoor concentrations (Settimo 2015). As a consequence, air exchange with particle filters, ventilating (Debnath et al. 2017), and air-conditioning systems are a distinct way of reducing air pollution in indoor spaces, like homes or shared communities (offices, schools, hospitals, sport facilities, restaurants, cinemas, and public transport) (Kwong et al. 2019). Among public buildings, school is one of the worrisome indoor environments since children represent a susceptible population to air pollution due to their age (Mainka et al. 2015).

### Healthy diet

Beyond mitigation strategies to reduce air pollution, each citizen can adopt some eating habits that can influence own health status (Biesbroek et al. 2014). It was well demonstrated that the increased intake of antioxidants in foods could hinder and reduce the adverse effects of atmospheric pollution (Kelly et al. 2003). Precisely, the antioxidants are substances able to neutralize free radicals generated by some air pollutants (ozone and nitrogen dioxide). In this way, injury to respiratory tract like asthma can be avoided after their oxidant exposure (Romieu et al. 2002). Therefore, it is necessary to reduce the consumption of food deriving from animal source by promoting a healthy diet with higher consumption of fruit and vegetables.

### Recommendations to small, medium, and large enterprises

Globally, one of the main contributors to emissions of atmospheric pollutants and a significant user of energy is the industrial sector (Conti et al. 2015). The pollutants deriving from industrial activities are transported into the urbanized areas. Consequently, the development of strategies to reduce air pollution is crucial. In this section, possible measures relating to industrial, agriculture, and shipping sector are introduced such as energy reduction (Pask et al. 2017), advanced technologies and process performance promotion (Contreras-Zarazúa et al. 2018), improvement of the efficiency of livestock farming and manure management, and electrification of the port docks.

## Industrial sector

Even today, the primary source of energy are fossil fuels, responsible for the production of some pollutants notably particulate matter (PM) (Salehi et al. 2015), nitrogen oxides ( $\text{NO}_x$ ), and sulfur oxides ( $\text{SO}_x$ ) (Chao 2008). The reduction of power generation from fossil fuel sources (coal, oil, gas) imply health benefits by reducing local air pollutants, especially micronic and submicronic particles (Karka et al. 2017). Recently, several initiatives to replace fossil fuels with alternative renewable fuels have been taken into consideration (Ribeiro et al. 2015). Among the various technologies for energy production from renewable sources, the biomass combustion can represent a valid alternative technology of fossil fuels (Sripada et al. 2017) (Giuliano et al. 2018a). Shrestha and Shakya (2012) showed that the implementation of the cost minimization energy system MARKAL, based on the market allocation framework, reduces the local pollutant emissions, improving the efficiency of the national overall energy consumption. This strategy includes energy supply, conversion and process technology, end-use service demand, and environmental emissions promoting the use of renewable energy resources (Shrestha and Shakya 2012). In this way, cities will have benefits if they will move toward low carbon technologies (Ren et al. 2012).

Among the various industrial sectors, one of the primary sources of the main pollutants (VOCs, toxins, PAH) is the chemical industry (Lee and Cho 2003). As a consequence, proper air pollution control techniques have to be applied to reduce the negative environmental impact (Contreras-Zarazúa et al. 2018). Another mitigation strategy to reduce air pollution from the industrial sector is the implementation of advanced technologies in the industrial process (Babar and Shareefdeen 2014). For example, clean coal technologies (CCT) can treat and use coal in an efficient way without a substantial environmental impact (Giuliano et al. 2018b). Besides, it was demonstrated that retrofitted technologies such as catalytic converters and desulfurization reduce only local air pollution.

On the other hand, the benefits of integrated environmental strategies are higher than the ones given by air quality management plans and measures for GHG reduction. This result is highlighted in the study of Chae and Park, who demonstrated that using compressed natural gas and an efficient heating and cooling systems, both local and global air pollution reduction can be achieved (Chae and Park 2011). Furthermore, the best available techniques (BAT) are promoted to reduce the environmental impacts deriving from industrial activities since they operate minimizing costs (Ibáñez-Forés et al. 2013). This technology has to be “available” that means usable to the operator and economically and technically feasible. Additionally, it has to be “best” that means provide a high level of environmental protection as a whole (Liu and Wen 2012). As a consequence, plant owners of different industrial

sectors have to select the BAT that is appropriate for their conditions.

Finally, the change in average working hours in a very efficient way that could have a good impact on consumption and related environmental pressure (Bergh et al. 2011).

Even if the literature available is still low, some studies demonstrated that changing the times of going to work, shifts, brackets, rationalizing home-office travel times, and the rigidity of schedules can reduce traffic congestion and  $\text{CO}_2$  and fine dust emissions, PM10, and PM2.5 as well as employee stress with a positive return on the quality of work and the competitiveness of businesses (Ge et al. 2018). Furthermore, it is possible to improve air quality by promoting online work, avoiding not strictly necessary car moving. Another example is to support the vertical part-time (fewer days a week but more hours a day), halving the mowing toward the workplace.

## Agriculture and food sector

The majority of fine particulate originates not only from combustion processes in traffic, power plants, industry, and household energy use but also from sources related to agriculture (Martins et al. 2015). One of the particulate precursors is ammonia ( $\text{NH}_3$ ) after the reaction with the sulfuric and nitric acid (Erisman and Schaap 2004). It has been estimated that about 80% of  $\text{NH}_3$  entering in the atmosphere is produced by agricultural activities in Europe (Velthof et al. 2012). In agriculture, the main sources responsible for  $\text{NH}_3$  production are the excretion of urine by livestock and the manure storage (Velthof et al. 2012). There are many specific changes to mitigate  $\text{NH}_3$  emissions in agriculture (Giannadaki et al. 2018). These imply the improvement of the technology and the management of agricultural productions, but also include the reduction of food wastes combined with human diet optimization (Zhao et al. 2017). In fact, the  $\text{NH}_3$  emission levels depend on the animal typology, with higher amounts for beef and sheep, and a lower amount for pigs and poultry. Four strategies are identified in this study to reduce  $\text{NH}_3$  by focusing mainly on livestock:

1. Improvement in livestock farming efficiency: The livestock farming efficiency can be improved by supporting local farmers' markets and community gardens, in order to reduce the traveled distances of transported goods. Agriculture and land use increases the demand for deforestation, increasing the levels of atmospheric  $\text{CO}_2$  produced promoting climate change (Younger et al. 2008).
2. Manure management optimization: Besides  $\text{NH}_3$  emission, livestock manure contributes to other substances, mainly methane ( $\text{CH}_4$ ) and nitrous oxide ( $\text{N}_2\text{O}$ ). These emissions derive from various phases in the use of manure ranging from the handling and storage to the application as a fertilizer to soils (Mohankumar et al. 2017). Some

abatement options need to be developed like lowering the dietary crude protein content, external slurry storage via acidification, frequent removal of manure, and covers of straw or artificial films (Mohankumar et al. 2017) (Hou et al. 2015).

3. Reduction in the use of fossil fuels: Another revolution in agricultural sector concerns the reduction of dependence on non-renewable energy. Oil is also used to produce nitrogenous fertilizers (McMichael et al. 2007).
4. Reduction in the production and consumption of foods from animal sources: It is necessary to promote more healthy diets with low consumption of foods from animal sources (Friel et al. 2009).

### Shipping sector

Nowadays, the shipping sector provides low-cost and reliable delivery services in the economic field (Arunachalam et al. 2015). Nevertheless, shipping-related activities have a considerable impact on air pollution, especially in coastal areas but also globally (Buccolieri et al. 2016). The primary air pollutants are PM, VOCs, NO<sub>x</sub>, O<sub>3</sub>, SO<sub>2</sub>, and CO (Bailey and Solomon 2004). As a consequence, a wide range of options toward “greener” seaports is needed (Bailey and Solomon 2004). Some of these measures are easy to adopt such as the regulation of fuel quality (by using low-sulfur alternative fuels), the speed reduction (Lack et al. 2011), and the use of alternative transportation equipment (Lai et al. 2011).

Furthermore, a variety of technical strategies for reducing ship emissions have to be adopted. NO<sub>x</sub> and SO<sub>x</sub> emission reduction strategies consist in lowering combustion temperature, switching to lower sulfur marine fuels and using seawater scrubbing (Han 2010). In addition, it is essential to operate in modifying the entry and the docking of ships in the harbor to reduce local emissions. A precautionary approach includes the dock electrification that means the shore-side power for docked vessels to avoid the motor power on during the stop (Dhupia et al. 2011).

### Recommendations to local/provincial/regional/national authorities

Rapid industrialization, as well as urbanization in developing countries, has led to an increase in air pollution with adverse effects on human health. As a consequence, the development of city action plans that includes mitigation and adaptations strategies to emphasize pollutant emission reduction is an important step toward the better well-being of life. Therefore, the responsibility for urban areas such as governance bodies (local/provincial/regional/national authorities) is involved in

planning the correct strategies aimed at improving air quality. In this section, more comprehensive management measures focused on emphasizing pollutant and emission sources reductions at both local and regional levels are proposed to mitigate the air pollution issue. The options include the implementation of new regulations, urban planning reorganization, and promotion of hybrid vehicles with low emissions.

### New regulations

Air quality management policies have to fix new air quality standards that maximize overall population benefits, reduce illness related to air pollution and gas emissions from industrial, urban, or domestic activities (Fann et al. 2011). It is essential to identify effective structural and exceptional measures throughout the national territory.

### Advisory and prevention

Frequently, acting with mitigation strategies after critical levels of pollution does not solve the pollution emergency. For this reason, it is necessary to move toward a “preventive approach to the emergency” by promoting effective measures before reaching critical levels of pollution (Bandyopadhyay et al. 2014). In this context, the authorities should support new technologies for air pollution monitoring (Mishra et al. 2015). Air pollution monitoring networks offer the possibility to measure the spatiotemporal distribution of air pollution in the urban environment for the health and safety of citizens (Singla et al. 2018) (Sofia et al. 2018a). For example, sensor networks offer the potential to focus on air pollution monitoring reflecting high spatial and temporal variability in pollutant levels (Knox et al. 2013) (Sofia et al. 2018b). In this way, if a particular pollutant exceeds the target limit, efficient strategies should be adopted to mitigate the air pollution issue and find the pollution sources. Furthermore, air quality prediction models are another way to make a rational decision by political leaders (Vicente et al. 2018). The combination of air quality monitoring and modeling is a valid approach for regulatory purposes (Vlachokostas et al. 2011).

### Urban planning

Rapid urbanization has involved significant challenges in urban areas with dramatic consequences in air quality. The primary source of atmospheric pollution is vehicular traffic (Pospisil and Jicha 2017). The emissions from vehicles are different throughout the day with a maximum concentration during the more congested hours (Kumar et al. 2016). Therefore, policymakers have to support the implementation of strategies and actions aimed at reducing air pollution in urban areas while promoting economic growth and higher quality of life (Vranckx et al. 2015). In this context, the

concept of “smart city” has emerged as a way to respond to the inhabitants’ needs more efficiently and sustainably. In urban planning, smart mobility represents a crucial factor. Since a major part of pollutant emissions in cities are due to traffic, an appropriate transport design in the urban area is needed (Cariolet et al. 2018). Political leaders have to promote changes in travel behaviors by supporting public transport (Sellitto et al. 2015) and the sharing of mobility. The strong inclination toward traffic congestion reduction promoted by policymakers is not always conformed to health promotion. Appropriate safety interventions must be proposed to have health benefits, especially for cyclists and pedestrians (Rojas-Rueda et al. 2016).

Regarding public bicycle sharing, it is now spreading in different countries in Europe, Asia, and America as a healthier transport system in the urban context (Rojas-Rueda et al. 2011). In addition, the reduction in private car use can be reached only ensuring public transport availability, cycling infrastructure, and green spaces (Panter et al. 2016). Currently, many cities in the world are moving toward mobility solutions implementing car-free days, strengthening the infrastructures and public transport (Nieuwenhuijsen and Khreis 2016). The objective is to reduce the traffic-related air pollution and provide strong opportunities to increase free spaces that can be used to improve the urban green with parks and open areas or attractive places (public squares, shops) for citizens and tourists (Nieuwenhuijsen and Khreis 2016). Furthermore, the reduction in vehicular traffic will certainly lead other human health benefits like the reduction of road accidents (Nieuwenhuijsen and Khreis 2016). All these mitigation measures have to be promoted in the long-term to

obtain significant changes in emission reductions and human health benefits. In fact, in evaluating the effects of commonly adopted mitigation strategies such as car free-days in a large city of Po Valley (Northern Italy), Masiol and their colleagues (Masiol et al. 2014) did not find significant changes probably due to the very short time of mitigation procedure (Masiol et al. 2014).

In addition, the reduction in private cars use promotes the increase in public space for vegetation and retail goals. Roadside vegetation barriers can be a potential mitigation strategy for near-road air pollution (Isakov et al. 2017). In their work, Tong et al. (2016) demonstrated that a wide vegetation barrier combined with a solid barrier reduces pollutant concentrations significantly (Tong et al. 2016). Urban vegetation impacts our ecosystem positively by filtering airborne particulate matter, providing a scenic public landscape and reducing flooding consequences (Al-thani et al. 2018).

### Promotion of hybrid vehicles

It is well known that vehicle emissions (NOx, HC, O<sub>3</sub>, VOC, CO, and PM) contribute to air pollution (Wu et al. 2017). In this scenario, besides the implementation of increasingly stringent standards for vehicle emissions, the most effective policy is the promotion of the zero-emission vehicle (Perez et al. 2015). In particular, by using alternative fuels, respect to the traditional fossil ones, like electricity, bio-fuels, liquefied petroleum gas (LPG), natural gas (CHG, LNG), and, methane, this kind of cars can produce lower concentrations of pollutants (Qiu et al. 2016).

**Fig. 2** The mitigation strategies or strategic measures proposed that can be adopted by different stakeholders to obtain public health co-benefits with air pollution reduction

		Short - term	Long-term
<b>Final speaker</b>	<b>Citizens</b>	<ul style="list-style-type: none"> <li>• Change in urban mobility (public and active transport, car sharing)</li> <li>• Hour change in outdoor activity (walking, cycling)</li> <li>• Aeration of indoor environment during the hours of the day with less pollution levels (no morning between 8 and 9)</li> <li>• Use of photocatalytic paints for domestic walls</li> </ul>	<ul style="list-style-type: none"> <li>• Installation of domestic purifiers</li> <li>• Choice in living in less polluted area</li> <li>• Adoption of a diet rich in antioxidants</li> </ul>
	<b>Enterprises</b>	<ul style="list-style-type: none"> <li>• Promotion of renewable alternative fuels</li> <li>• Low environmental impact heating/cooling systems</li> </ul>	<ul style="list-style-type: none"> <li>• On-line work and vertical part-time promotion</li> <li>• Implementation of new innovative technologies</li> <li>• Interventions in agricultural sector (ammonia reduction)</li> <li>• Interventions in shipping sector (dock electrification)!</li> </ul>
	<b>Public authorities</b>	<ul style="list-style-type: none"> <li>• Urban traffic management</li> <li>• Urban planning</li> <li>• Improvement of public transport and infrastructure</li> <li>• Smart mobility promotion</li> <li>• Promotion of electric vehicles</li> </ul>	<ul style="list-style-type: none"> <li>• New regulations of air quality</li> <li>• Promotion of preventive systems (air quality monitoring systems)</li> <li>• Urban green addition</li> <li>• Incentives on the renewal of heating and energy saving systems</li> <li>• E-mobility incentives</li> </ul>

With the rapid industrialization, the hybrid electric vehicle (HEV) technology is a valid alternative to the fuel prices rising and to satisfy the more effective environmental policies (Xia et al. 2015) (Sabri et al. 2016). The combination to active travel with zero-emission vehicles can reduce the cases of ischemic heart disease (Woodcock et al. 2009). The government has to make a series of laws aimed at encouraging electric mobility such as tax incentives and lower prices for usage or parking (Leurent and Windisch 2011).

## Conclusions

This study summarizes the mitigation strategies that can be adopted by different stakeholders (citizens, companies, and committees) to obtain public health co-benefits with air pollution reduction. In particular, specific guidelines were provided in various sectors: transportation, industry, household, energy generation, agriculture, and shipping sector. These guidelines can be considered a basis for governments for the implementation of a strategic plan focused on the reduction of multi-pollutant emission, as well as of the overall air pollution-related risk. Individuals can also adopt environmental friendlier behaviors that together with mitigation policies, can obtain health and environment co-benefits. The strategic measures proposed, differing for the stakeholder (citizens, enterprises, and public authorities) on the application kind (direct/indirect measure), for the emission sources (transport, household energy, industry and energy generation sector, food, and agriculture) and for the area of implementation (urban and extra-urban context) that can be reassumed by Fig. 2.

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