SEFIRA

SEFIRA IS A EU FP7 COORDINATION ACTION ON
Socio Economic Implications
For Individual Responses to
Air Pollution policies in EU +27

SEVENTH FRAMEWORK PROGRAMME

European Commission

SEFIRA SCIENTIFIC INTEGRATION REPORT

Work Package deliverable 5.8

By Martin Williams[1], Ben Barratt[1], Eva Valeri[2], Paolo Polidori[2], Vittorio Sergi[2] and Michela Maione[2]

[1] King's College London, United Kingdom

[2] University of Urbino, Italy

1. INTRODUCTION

This report comprises Deliverable 5.8 of the FP7 SEFIRA project and addresses the research question:

Can the process governing the review and implementation of air quality legislation by the European Commission be improved by the introduction of socio-economic resources?

A summary of the elements of the project work is given noting the important results and findings**.** This is followed by some conclusions and recommendations for further work in this area.

2. THE IMPACTS OF AIR POLLUTION IN EU28

Although improvements have been made in air quality in the EU, there are still significant impacts on health and the environment from air pollution emissions as well as problems with legal compliance. For particulate matter (PM_{10}), 22 out of the 28 Member States reported exceedences of the daily Limit Value in the Air Quality Directive with 61% of the urban population of the EU living in areas which exceeded the WHO Air Quality Guideline. For ozone (O_3) 18 Member States reported exceedences of the Directive Target Value with 98% of the urban population living in areas exceeding the WHO 8-hour guideline. Nitrogen dioxide (NO_2) concentrations also remain high with 19 Member States reporting exceedences of the annual mean Limit Value, with 9% of the EU urban population in areas above the WHO Guideline (which is the same as the annual mean Limit Value). For PM2.5, 9% of the urban population were in areas above the Target Value in the Directive, but 87% of the population were in areas above the WHO Guideline.

2.1 Which policies are in place?

The European Union has a mature system of air quality management which has been developed over several decades. A consolidated package was announced in 2013 bringing together the various elements of the system and proposing new initiatives. This was achieved through the 2013 Thematic Strategy on Air Pollution (TSAP), which sets out the overall policy direction including interim objectives for 2030 towards the EU's long-term target and cost-effective actions to achieve those objectives while promotes overall policy coherence. The TSAP included a new Clean Air Programme for Europe with measures to ensure that existing targets are met in the short term, and new objectives for the period up to 2030. The package also includes support measures to help cut air pollution, with a focus on improving air quality in cities, supporting research and innovation, and promoting international cooperation.

The EU ambient air quality Directive, AAQD (2008/50/EC) contains Limit Values which have to be respected everywhere in the EU with a view to provide protection against adverse effects on human health and the wider environment. This has proven to be a challenge for many Member States, particularly for nitrogen dioxide (NO_2) and to a lesser degree PM_{10}. Achieving the air quality standards often requires a combination of national and local

measures addressing particular air pollution hotspots, and reducing background concentrations entering a country by implementing the NECD (see below). The AAQD entered into force in 2010, and was not revised as part of the air policy review in 2013.

For pollutants like PM and ozone, and also for deposited aerosols leading to eutrophication (an excess of nutrient nitrogen) there is a substantial component deriving from transboundary transport of pollution. The National Emission Ceilings Directive (NECD) limits the total emissions from each Member State for a set of pollutants to reduce the transboundary transport of pollution. A proposal for a revision of the NECD was included in the Clean Air Package and at the time of writing (July 2016) it appears that agreement is likely to be reached later in 2016. The Clean Air Package also contained a proposal for a Medium Combustion Plant Directive to cover appliances smaller than those already in the Industrial Emissions Directive and this Directive has also now been agreed and entered into force on 18 December 2015.

There are also a range of other measures at EU, national and international level controlling pollution at the source. Several sector- and source-related EU Directives and Decisions serve the purpose of reducing the pollutant emissions at the source. Source-related standards, such as EU emission limit values for vehicles and industrial installations or quality standards for products and fuels, are regularly adapted to progress in "best available emission control technology". There has been considerable interest in the past few years in the vehicle emission legislation where the testing regime has been shown to be a poor reflection of real-world driving emissions leading to very little improvement in on-road emissions from diesel cars. This will be rectified in future with the introduction of a real-world emissions testing procedure, aimed at being introduced in 2017. In addition, foremost on a national level, a suite of economic instruments, such as energy taxes, funding schemes for clean technologies and pricing of polluting activities exist so as to incentivize less polluting ways of living and doing business.

2.2 What has been achieved?

Emissions of the major pollutants and associated ambient concentrations have fallen significantly over the past few decades as a result of the measures described above and also to some extent due to global shifts in relative fuel prices. Figure 1 shows the development of emissions for the more important pollutants; data for ECE Europe have been used here (ref: CLRTAP Assessment Report, 2016) as the make-up of the EU has changed significantly over the last three decades. The largest decrease has been for sulphur dioxide resulting from stringent emission controls on power plants and more recently on the sulphur content of fuels, coupled with a shift from coal to gas. Reductions in VOCs have arisen from vehicle exhaust emissions standards and also from the regulation of petroleum products production, distribution and sales. NOx emissions have reduced through vehicle controls and measures on power plants. The smallest reductions overall have been for ammonia. Reductions in this pollutant have been much harder to achieve as Member States have been reluctant to agree to more stringent controls on their agricultural sectors. Figure 2 shows more recent detail for the EU.

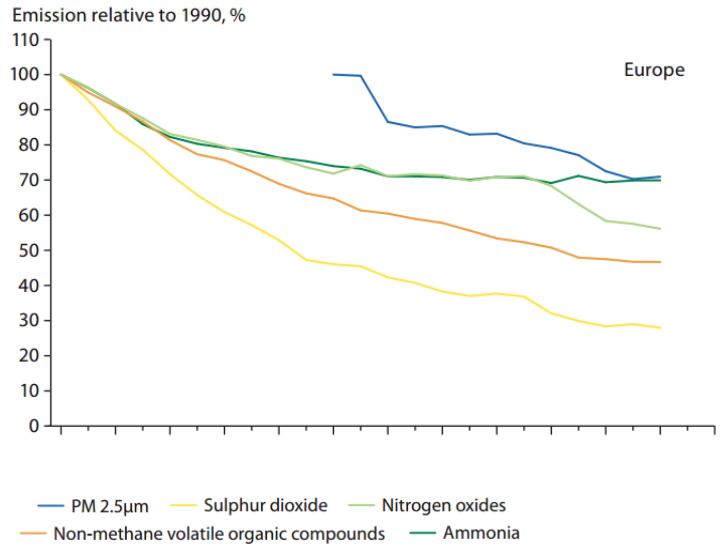


Figure 1. Emision trends in ECE Europe 1990-2013

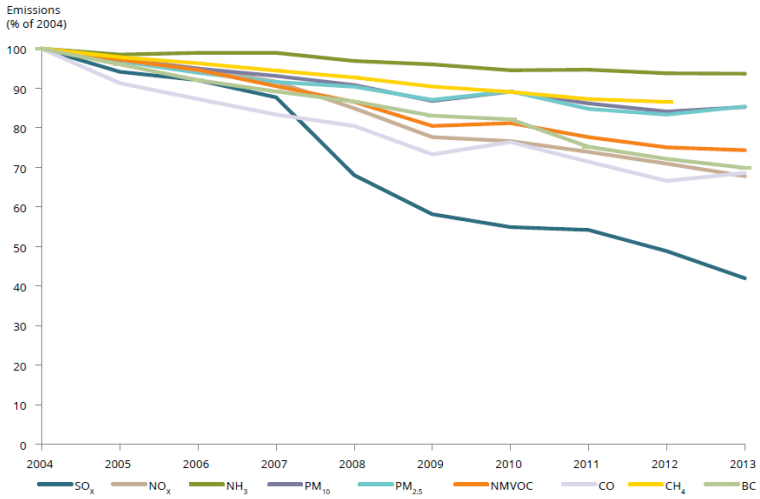
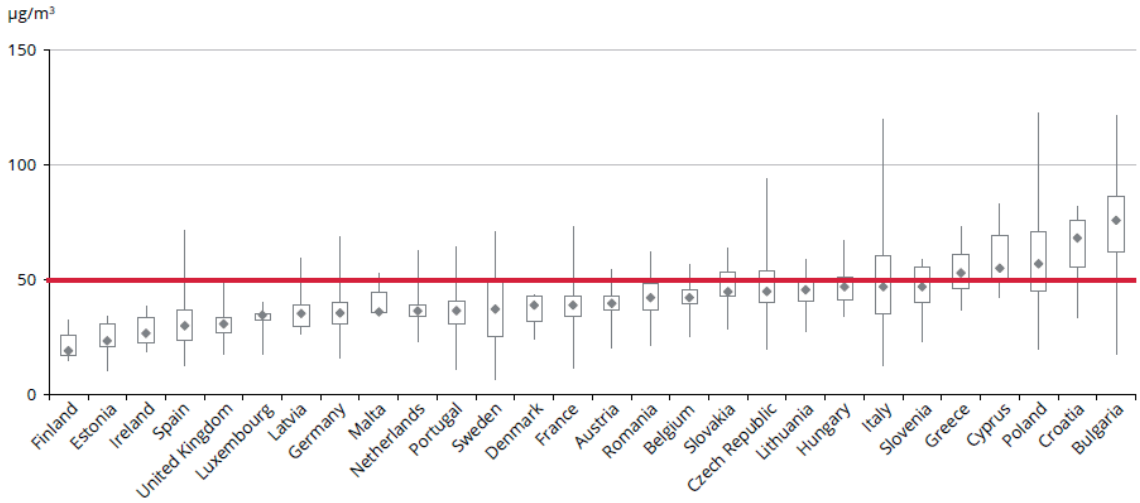


Figure 2. Emission trends in the EU 2004-2013

Even though emissions have fallen, there still remain air quality problems in the EU regarding the attainment of the obligations under the air quality legislation. The attainment situation for the daily mean Limit Value for PM_{10} is shown in Figure 3 below where 22 Member States did not attain the value at one or more stations.

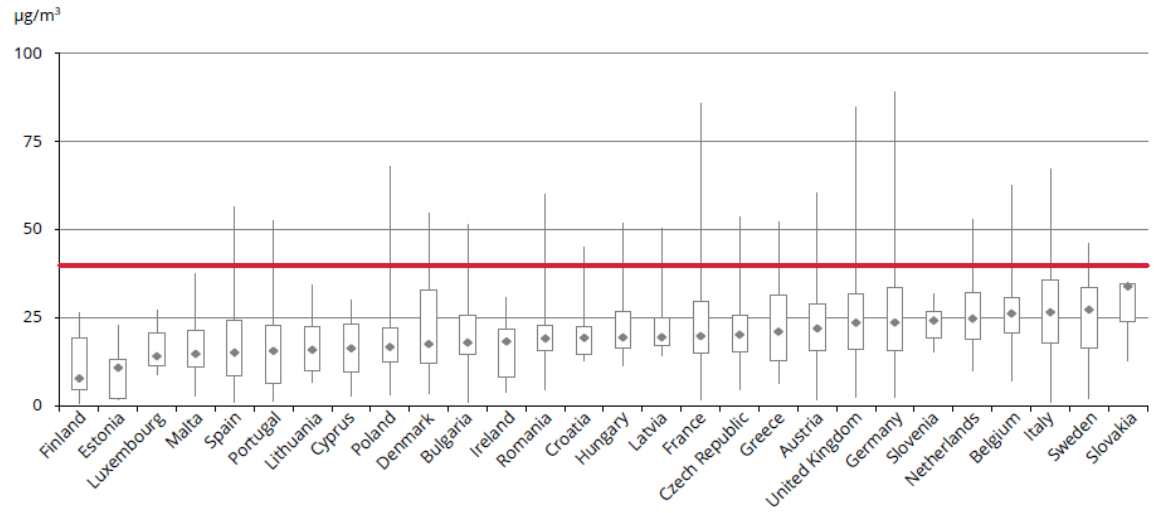


Notes: The graph is based, for each Member State, on the 90.4 percentile of daily mean concentration values corresponding to the 36th highest daily mean. For each country, the lowest, highest and median percentile 90.4 values (in µg/m³) at the stations are given. The rectangles mark the 25 and 75 percentiles. At 25% of the stations, levels are below the lower percentile; at 25% of the stations, concentrations are above the upper percentile. The daily limit value set by EU legislation is marked by the red line.

Source: Based on Air Quality e-reporting database (EEA, 2015a).

Figure 3. Attainment situation for PM10 in the EU, 2013

The situation for attainment of the annual mean limit for NO_2 is shown in Figure 4. Exceedences at one or more stations were reported for 19 Member States, fewer than for PM10 in 2013, but with overall a larger degree of exceedence.



Notes: The graph is based on the annual mean concentration values (calculated from hourly data) for each Member State. For each country, the lowest, highest and median values (in µg/m³) at the stations are given. The rectangles give the 25 and 75 percentiles. At 25% of the stations, levels are below the lower percentile; at 25% of the stations, concentrations are above the upper percentile. The limit value set by EU legislation (equal to the WHO AQ guideline) is marked by the red line.

Source: Based on Air Quality e-reporting database (EEA, 2015a).

Figure 4. Attainment situation for NO_2 in the EU, 2013

Ozone Target Values are also widely exceeded despite significant reductions in peak hourly and 8-hourly concentrations resulting from reductions in VOC and NOx emissions in Europe. Further reductions in ozone levels will require hemispheric and potentially global emission reductions notably of methane.

The situation for PM_{10} (and $PM_{2.5}$) and NO_2 is such that to achieve further reductions to attain the Limit Values, measures beyond technological solutions will be necessary. These measures will potentially embody behavioural changes, encouraged either by fiscal policies or by regulation, or a combination of both. Such measures might include the discouragement of more polluting vehicles by differential fuel duty, or by payments to enter Low Emission/Clean Air Zones and differential parking charges. The success of such measures will depend on their acceptability to the general public and therefore a methodology for the analysis of this acceptability is appropriate. This is the context in which SEFIRA was designed and the project represents the first attempt by the European Commission to develop research in this important and emerging area. The following section gives a brief discussion of the methods and results obtained in this novel approach to a socio-economic analysis of air quality policies.

3. THE SEFIRA APPROACH

The main SEFIRA objective was to support the review and implementation of the air quality legislation, improving its effectiveness and acceptability. This task has been achieved through the coordination of trans-disciplinary scientific and socio-economic resources. Air quality policies are not implemented in a social vacuum; they require a continuous interaction with individuals, often implying significant changes in their lifestyles. In addition, the extent to which people endorse a policy is crucial in determining its effectiveness and success both at national and regional scales.

Within SEFIRA various qualitative and quantitative approaches have been explored. Quantitative methods consisted in the exploitation of Discrete Choice Models that proved to be an effective tool in supporting the decision-making process whenever behavioural changes are involved. Qualitative methods included the analysis of thirty-eight interviews with experts and policy makers from the national to the local scale and the organisation of twelve focus groups involving citizens from four metropolitan areas in Europe (Antwerp, Malmö, Milan and Warsaw).

3.1 Discrete Choice Modelling survey description

An assessment of the use of behavioural modelling and related techniques to evaluate environmental and air quality policies is timely. Policies based on technical measures and technological solutions have been used successfully for many decades, but there is increasing evidence that such measures will not be enough to reduce air pollution concentrations to acceptable levels. One reason for this is that health effect studies are

suggesting that adverse effects on human health can occur even at concentrations which meet existing legal targets. Policies involving non-technical (i.e. behavioural) measures are therefore likely to play an increasingly important role in the future air quality management in Europe. Such policies will inevitably involve behavioural changes, purchasing decisions, and lifestyle changes. Assessing the impacts of these policies and in particular their acceptability and acceptance will require systematic study and the use of proven techniques.

One of the available methods, widely applied in many research fields and used for the SEFIRA pilot survey, is discrete choice modelling (DCM). DCMs offer a quantitative approach with an established worldwide scientific literature in many disciplines facilitating an understanding of what people would do in response to different products, services or policy measures, and to support the decision-making process of public makers at different levels of governance (Ben-Akiva and Lerman, 1985). A description of DCMs using non-technical language is provided in Valeri et al. (2014).

Within the SEFIRA project, using choice experiments we investigated individual preferences for environmental policy drivers in seven European countries (Austria, Belgium, Germany, Italy, Poland, Sweden, United Kingdom), complemented by estimates of elasticity and willingness to pay measures. The selection of the country reflected different socio-economic and political patterns of the society. Preference heterogeneity and the role of socio-economic and attitudinal variables in determining policy preferences and acceptability were explored with a modelling approach.

In order to describe the environmental policies to test in the empirical survey, we carried out several meetings with experts with interdisciplinary backgrounds. This allowed us to consider interdisciplinary aspects within the environmental policy domain. During these meetings, the importance of considering recent and urgent air quality issues impacting on pollution such as individual's habits of mobility and eating and also those affected by pollution such as human health emerged. The importance of these issues is also confirmed by a survey carried out within the SEFIRA project aimed at analysing social network content regarding perceived environmental concerns by the general public in the surveyed countries (Giardullo, 2016).

We characterized each environmental policy based on five key drivers or policy levers:
1. Country-specific cost of the measure implementation.
2. Required changes in the individual's mobility behaviour.
3. Required changes in the individual's eating habits.
4. Reduction of premature deaths due to the atmospheric pollution.
5. Distribution of implementation costs of the measure to the community.

For each choice experiment proposed, the individual was required to choose between two potential environmental policies. Each alternative was characterized by a different combination of the policy drivers' levels as described in Valeri et al. (2016a). Administering the questionnaire in different countries which are characterized by different socio-economic and political profiles has required several adaptations in particular with reference to specific questions (namely, income level and the ‘cost of the measure’ policy driver) to make them

comparable between countries). In particular, *purchasing power parities* were applied to estimate the amount of adjustment needed on the exchange rate between countries, in order to be equivalent to each currency's purchasing power. See further details of the questionnaire in Avataneo et al. (2014).

With a *computer-assisted web interviewing* (CAWI) technique 2,300 interviews for each country have been collected for a total of around 16,100 interviews. Given the SEFIRA research objectives and the policy drivers selected, the target population is defined as people who both use cars/motorcycles for their urban movements and consume meat (beef, pork, lamb, and in some countries, horse) and/or milk or dairy products more than 4 days per month. Since there are no official data available on the spatial distribution of this target population, data on resident population 18+ in each target country were used as a proxy, to set road quotas in terms of age, gender, geographical area crossed by level of urbanisation (the latter variable is based on the new EU classification of NUTS3 into three typologies: 'predominantly rural', 'intermediate' or 'predominantly urban' regions.

3.2 Discrete Choice Modelling Results

Results of the DCM survey are described for the seven countries in Valeri et al. (2016a) and graphically represented in Figure 5, while further in-depth analysis that consider individual's socio-economic and attitudinal data (i.e. environmental concern and intention) for the Italian sample are reported in Valeri et al. (2016b). Overall, they show interesting similarities and differences across and within countries. For instance, for all the countries the annual cost of the policy, the decrease in pollution-related deaths, and the '*polluters pay more*' principle to distribute cost within the community are the drivers with a high impact on the stated policy preferences and acceptability. As a consequence, the policy acceptability will be especially affected by measures having an impact on these policy drivers. On the other hand, the policy drivers which present differences across countries are those related to the changes in mobility and eating habits. They have been found to be not significant for specific countries (Italy and Poland). Designing policies considering policy drivers with a low impact on policy acceptability would contribute to the identification of potential policies which are more likely to be accepted. Using a basic approach in modelling DCMs (i.e. Multinomial logit), Italians and Polish seem more inclined to change their behaviour on eating and mobility habits (the latter only for Poland). It is important to stress that this does not mean that the other policy drivers (those found significant) do not impact on the policy acceptability; conversely, they have the higher impact on the policy acceptability, so any change of these policy drivers produces important behavioural changes in the policy acceptability. However, an in-depth analysis of the Italian sample that exploited better preference heterogeneity demonstrated that there is also an important proportion of Italians sensitive towards personal engagement in term of changes in the mobility and eating habits (Valeri et al. 2016b).

Estimated elasticity measures allowed the further exploration, for each country, of individuals' sensitivity to policy drivers. Across the countries, British and Germans seem more sensitive to changes in the 'per capita annual cost' policy driver, while Swedish seem less sensitive. Swedish and British are more sensitive to changes in the behavioural policy drivers (i.e. mobility and eating habits). Italians and Austrians are more sensitive to changes

in the premature deaths policy driver, and Belgians and Austrians are the most sensitive to changes if the policy costs are distributed according to the principle of '*poor people pay less*'.

Using country-specific willingness to pay measures, the tested potential environmental policies have been classified by the level of preference/acceptability (low, medium and high). An example is included in Valeri et al. (2016a), in which a *cost-based policy* and a *behavioural-based policy* have been simulated and compared in terms of changes in the individuals' preferences/acceptability. DCMs might also be an important instrument to simulate and compare new and potential environmental and air quality policies. An on-going activity of a further extension of the SEFIRA project is aimed at creating and implementing a Decision Support Software (DSS) to allow policy makers the *ex-ante* evaluation of potential air quality policies in term of individuals' acceptability for all the countries and segmenting by socio-economic and attitudinal data of respondents. The prototype (v1.0) is called **SEFIRA-EPPE** (**SEFIRA**-**E**nvironmental **P**olicy **P**references **E**valuation) and a description of the architecture is briefly described in Valeri et al. (2016c).

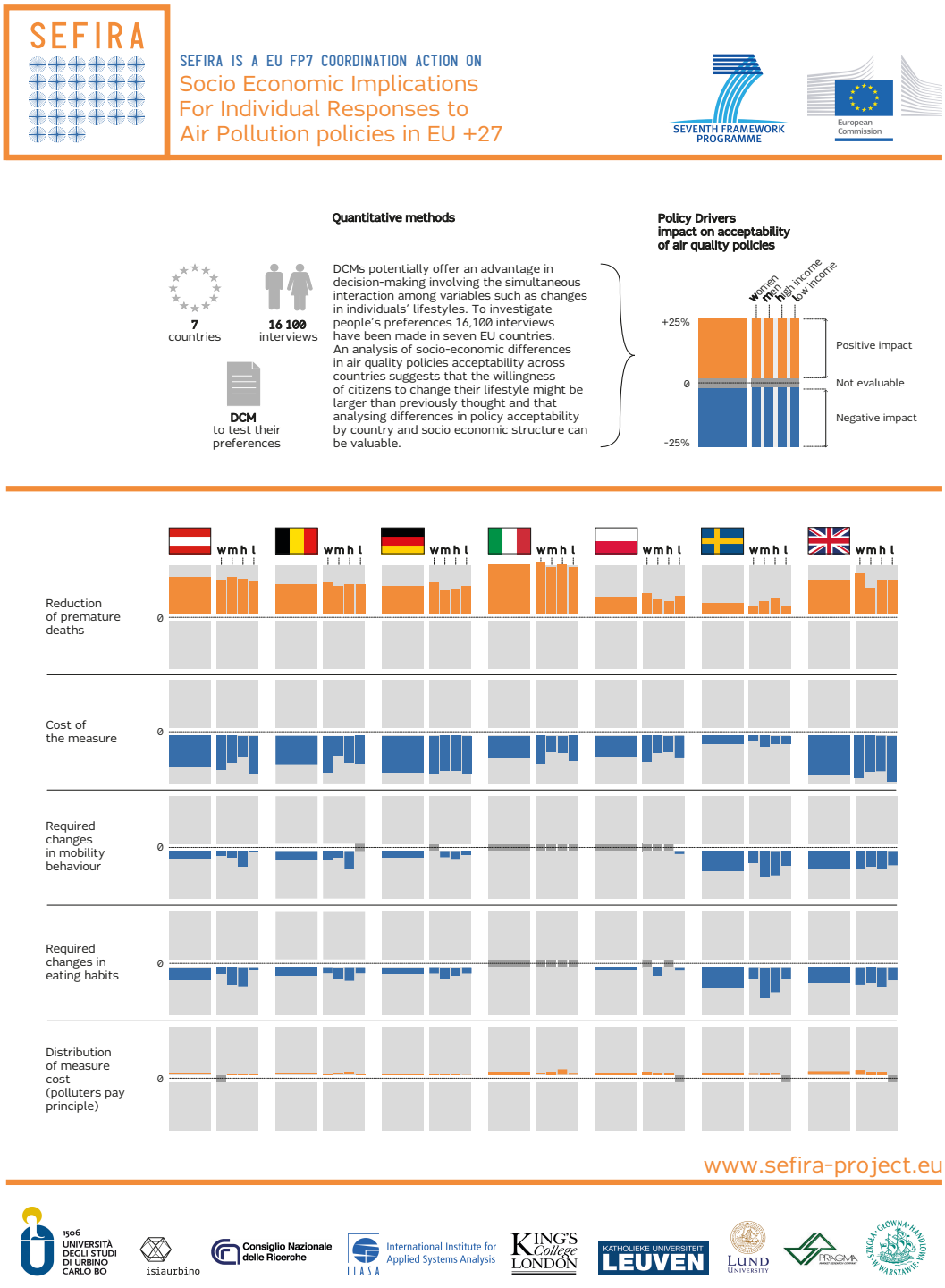


Figure 5. Policy driver impact on acceptability of air quality policies (Valeri et al. 2016a)

3.3 Perceptions from the online survey and from focus groups

SEFIRA investigated the perception of citizens in the four metropolitan areas that have been selected and also covered by the CAWI questionnaire with pilot research involving twelve focus group interviews with citizens affected by (or affecting) local air quality measures. In particular, the research used groups focused on traffic-related air pollution. This is not only because traffic is often the dominant source of emissions in urban environments, but also because many city dwellers are being confronted with policies related to traffic on a daily basis. This more narrow focus allowed us to move beyond the mere exchange of 'opinions' in the direction of a more in-depth understanding of reactions to air quality policies, which also include 'experiences' (Carton et al., 2015).

Focus groups allow us to scan the *diversity* of possible opinions and reactions to the existing air quality situation and the measures intended to address air pollution, and also to try to arrive at *in-depth* insight into perceptions and behaviour with regard to air quality, as well as the reasons and motivations behind acquiescence, resistance or pro-activeness in relation to air quality policy measures and behaviour change. Furthermore, focus groups help to gain insight into the kind of group dynamics that generate social norms or expectations with respect to environmental issues. In other words, the goal is not only to acquire a better understanding of the perceptions and behaviours of individual persons in relation to air quality and related policies, but also to study social interactions and dynamics which arise when air quality becomes the topic of common action and debate. The purpose of this focus group exercise has been to acquire a better understanding of the perceptions and behaviour of individuals in relation to air quality policies.

As the discussion shows, focus group participants appeared to possess a fairly high level of knowledge of air quality issues, as understood in terms of the four categories put forward by Jensen (2002), and seemed environmentally aware more generally as well (though there were some exceptions, particularly for the Warsaw case). Many participants held nuanced and sophisticated ideas in all four of the categories that Jensen (2002) puts forward, namely on the distribution of air pollution in their cities, about its proximate as well as underlying causes, about the kind of actions that were available to them, and about the alternatives they could envisage for the future. The least developed form of knowledge, perhaps, was on the kind of concrete policies that governments had already implemented in order to reduce air pollution. In Warsaw for example, many of the participants pointed out that they had insufficient information about the policies that were being implemented, which they attributed to a lack of information campaigns on the part of the city authorities. Similar concerns were expressed by focus group participants in Malmö.

The way these different levels of knowledge are acquired holds interesting insights for policy makers seeking to instigate behavioural change. In line with the existing literature, it is quite clear that direct sensory experiences play an important role in shaping or confirming opinions of air pollution. These affective associations with air pollution therefore emerge as a potentially powerful avenue through which people could be stirred to action. In fact, from the Antwerp case it is clear that this is exactly the kind of thinking that lies behind the strategies of various action groups. In Ghent for example, the action group "Ghents Milieufront" (the Environmental Front of Ghent) launched the 'operation white sheets',

asking inhabitants to hang white sheets out of their windows. In this way the group managed to construct a visual, affective connection between PM concentrations in the city – which otherwise are rather abstract - and the pollution of the everyday living environment. The blackening sheets are seen as an effective campaigning tool because they constitute a sensorial and physical proxy for what is supposedly happening to people's lungs. Other reportedly successful campaigns, such as a project that analysed pollution concentrations on homegrown strawberries, are based on the same principle, while also mobilizing a large number of people around the topic more directly. Given the awareness-rising power of these affective experiences with air pollution, governments would perhaps do well to play closer attention to these campaigns when developing their own communication strategies, which currently all too often rely on abstract indications of air pollution, such as Antwerp's initiative to place several large displays in the city centre, indicating current pollution levels, or Malmö's air quality website that lists the direct results of air pollution measurements in different locations around the city.

Other ways in which information campaigns could appeal to people include concentrating on the link between air pollution and children's health, since this appears to be one of the most common causes for concern and one of the more frequently mentioned reasons why people undertake adaptive actions. At the same time however, sensory and physical associations with air pollution would seem to be most (though not exclusively) applicable to Jensen's (2002) first knowledge category, and less so to knowledge of causes, actions, or alternatives. Since all four categories are deemed necessary for people to undertake pro-environmental action, other strategies appear necessary as well, including more formal forms of communication or education. In addition to exposure in the media, the work of environmental organisations and action groups seems potentially significant in providing the educational role put forward by Jensen. In the Antwerp case in particular, a lot of the knowledge participants had gained about policy alternatives (e.g. 'Ringland'), about the pros and cons of different actions, and about pollution causes, appears to have come as a direct consequence of civil society initiatives. The general importance that participants in all cases attributed to awareness-raising campaigns underlines the importance of this kind of work.

Participants' reactions to existing policies differed considerably, though some commonalities could be discerned. In all of the focus groups, economic incentives came up as potentially the most effective way to decrease car use and thereby reduce pollution, even though in nearly all cases people also flagged these incentives as problematic because of the socio-economically uneven impacts they would likely entail. At the same time, participants generally immediately added that (economic) measures to reduce traffic would also need to be accompanied by investments in alternative options that are easy, affordable, and widely available. As one of the participants in Malmö put it, governments need to make it easy for people to make the right choices. The respective absence or presence of adequately developed public transport and bicycling infrastructure therefore emerges from our focus groups as a significant factor underpinning people's willingness and/or ability to change their behaviour. This confirms the idea that the active pursuit of infrastructural investments in alternative modes of transport is perhaps one of the most effective strategies that governments can pursue if they want to bring about a change in behavioural patterns, alongside punitive economic measures that discourage car use. This strategy could also help to overcome, to some extent, the obvious political problems with economic and punitive

measures, that is, that the people most likely to be affected by them are unlikely to be very supportive of their introduction.

Another potential benefit of this approach, as one participant in Antwerp noted, is that investing in public transport simultaneously also has advantages in other fields, for example for social cohesion, since people from widely different backgrounds get to meet each other on the tram, bus or train. The concrete actions that participants put forward largely corresponded to the broader alternative visions they formulated: car-free cities, more sustainable forms of city planning, changing commuter patterns, an infrastructural overhaul of the public transport system, and more public involvement in decision-making, to name but a few. These broader visions highlighted perhaps significant finding of this analysis, namely, that people do not tend to think in terms of individual environmental problems. The focus groups clearly show that people reason in more holistic environmental terms and don't necessarily differentiate between actions for air pollution, and, say, actions for mitigating climate change. People tend to change their behaviour in order to reduce their environmental footprint in general, and then assume this has all kinds of ancillary benefits. They generally do not change their behaviour specifically to reduce, say, their NOx emissions. Indeed, in the context of the broader environmental challenges that societies are facing, the question of air pollution can seem quite insignificant to the public of less-polluted countries (e.g. in Sweden). In this context it perhaps makes little sense for authorities to single out air quality as a concrete focus for behavioural change. Instead we suggest the pursuit of strategies that seek to create more synergies between air quality policy and related environmental policy, perhaps particularly so for the mitigation of climate change.

This approach could aim to tag air quality gains onto general improvements in environmental quality, in the expectation, for example, that it would be easier to mobilize behavioural change for reasons other than air pollution reduction. De facto, if somewhat unwittingly, it appears a lot of governments are already pursuing this. Malmö's air quality plan largely reads as a strategy to bring about a modal shift, and is acknowledged by politicians to have been developed for reasons quite separate from the reduction of air pollution. In Antwerp as well, participants noted that a lot of the supposed air quality measures were actually introduced for very different reasons. Care is needed in this regard however as measures to improve air quality and those to mitigate climate change can be mutually contradictory as the example of diesel use and the encouragement of biomass (wood) burning have shown. This issue remains a challenge for policy makers at all levels of governance.

Finally, the SEFIRA focus group exercise clearly shows that environmental knowledge is a necessary but not a sufficient condition for bringing about environmentally beneficial behaviour. In fact, we have to consider that the distance between the representation of the causes of pollution between the citizens and the expert knowledge appears to be very relevant as the following tables show.

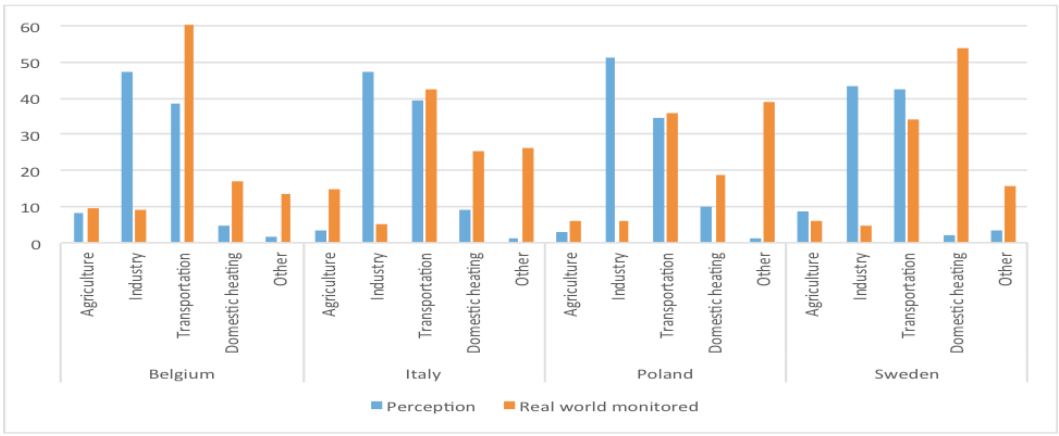


Figure 6. Mismatch between perceived and monitored air pollution

While knowledge of the problem, of its causes, and of the alternatives were commonly declared by citizens, a number of participants hinted at the fact that they would in any case be unwilling to give up their cars. The reasons for this was framed in terms of purely selfish reasons (Antwerp), in terms of contradicting government incentives (the promotion of company cars in Belgium), or in terms of the connection people felt between the use of their cars and the satisfaction of their basic needs (Milan). The importance that people attribute to the need for infrastructural changes and investments in alternative modes of transport thus highlights the imperative for visionary politics, that is, for government policies that is radical in its sustainability aims.

3.4 Conflicts (from stakeholder interviews)

The four case studies selected by SEFIRA, through the analysis of a set of 38 semi-structured interviews with key stakeholders such as policy makers, experts, civil society organizations and academic researchers, showed a very wide range of opinions, practices, discourses and technical solutions that cover almost all the range of air quality policies in Europe. The four cities have many different characteristics in geographical, social and economic terms but also share very important points. Commonalities and differences between policy management within the cities can be dependent on many factors such as institutional, political and cultural practices. The financial crisis has been quoted in all the interviews as the socio-economic background where ecological policies are more difficult to sustain because governments, companies and also citizens under financial stress would be reluctant to spend additional resources on environmental controls (Giardullo et al., 2015).

The interviews researched three main domains:

- the relationship between the sources, the root causes and the domain where measures are planned or already implemented;
- the relationship in terms of processes between institutions and between institutions and other relevant social actors;

- the (mis)match between the applied approach and what should be done in order to reduce air pollution.

We point out a correspondence between the sources of air pollution and the areas of intervention by policy-makers; in each case interviewees assigned importance to the same sectors tackled by the policy measures. Traffic, for instance, the main sector formally tackled by the interventions in all the four case studies, was perceived as the main source by the interviewees. Traffic assumes different nuances but it is considered crucial at each level: national, regional and local. Indeed, the importance of traffic is not only limited to urban areas but it is recognised as important at national and international levels for determining population exposure to air pollution. In Poland the situation differs somewhat because of the importance of old heating systems for a large part of the population making a large contribution to background pollution; however traffic especially because of the older car fleet circulating in the country still represents a significant problem.

For other sectors, there was a perception that some sources could not be controlled properly at national, regional or urban level, without a specific initiative at EU level. This was the case in Belgium and Italy particularly, where complaints have been registered regarding the absence of stricter and clearer norms on emissions; for the former mainly from the EU, while for the latter the issue appears to be at national level where there is an historic lack of co-ordination. These gaps may contribute to the slow development of air quality management, actually limiting the alternatives of intervention to be implemented because of this lack of "legislative support" (the case of Lombardy); further it may drive the adoption of less strict limits (Flanders). In Sweden, where transboundary pollution significantly contributes to background pollution –as in Belgium and Flanders - policy makers recognise the importance of action at EU level for the further regulation of sources which are outside of their territory. These kinds of problems seem not to affect Poland, the country which entered the EU most recently among the four, given the difficulties of ameliorating the worst air quality situation compared to the others.

The aforementioned legislative gaps introduce the second main point which emerged during the analysis: the relationship in process terms between institutions and between institutions and other relevant social actors. According to interviewees from Italy and Belgium, legislative gaps give further room for lobbying activities by big international business groups or to other groups at national and regional level. The relationship with organised stakeholders from the economic – mainly industrial - sector represents an issue for air quality policy, but this is part of a more general problem affecting environmental policy-making (Spaargaren and Mol 2000). What it may characterise more specifically for air quality policy-making as research object is the relationship with the citizens. Indeed, according to the interviewees, policy makers don't want to implement measures that are too strict because these will have a significant impact on citizens.

These issues were noted in all the cases even though they differ from city to city due to the different material and socio-economic situations. On the one hand, we have the Swedish case where, as in Malmö, air quality appears not to be a major issue for the general public; levels of air pollution are already relatively low and the pressure to further improve the values of NO_2 concentrations is limited to local street canyons in the city. This could be done

by deviating traffic or through limiting car use, as for instance banning the oldest most polluting cars; however there is a reluctance to burden people who cannot afford to retrofit their own car or to buy a less polluting one. Similarly in Poland policy-makers are concerned by the problem of equity but the level of such concern is greater for two main reasons: first, air quality situation in Poland and in Warsaw is the worst among the four case studies, giving more pressure to the whole decision making apparatus; second, people contributing the most to air pollution are, in general, the poorest.

This latter issue gives policy makers a warning regarding imposing stricter limits on air quality; a further peculiarity of Poland is that the poorest people are also more likely to use the more polluting fuels for domestic heating. In Italy the concern is not actually meant in terms of equality across social classes, rather it appears to be more a matter of economic competitiveness. Stricter norms in a policy landscape which is not co-ordinated, as mentioned above, may significantly affect companies and consumers in a period of economic crisis; another fear is the that stricter norms may be interpreted as an unfavourable economic condition that could force companies to migrate outside of the borders of the region. In Belgium, the interviewees addresses differently the issue of the consequences for citizens; the public health reasons why more interventions are needed still hold, but in particular what matters is the need to keep a balance between social support and effectiveness of the measures.

We have already partially addressed the third point; there is a general awareness that further interventions are needed and are possible but there are several constraints. Firstly there is the need for social support; this could be a function of awareness and if we except the Masovia (Poland) and Lombardy case, there are few institutional attempts to raise awareness with communication campaigns. Of course it is too early to assess the impact of the efforts put in place in Italy and Poland, and it would go beyond the aims of this WP, however some doubts remain about the long term effects of such attempts. In Malmö, the emphasis appears to be on city liveability and improving soft-mobility as a desirable practice which may also drive to an improvement in air quality; indeed, given the general satisfactory air quality of the Skåne province, even linking the air quality debate to climate change may help to foster a change in behaviour.

Awareness of air quality issues and social support for the measures are part of the problem but there are also other factors; in order to produce more effective measures, interviewees agreed, the economic sectors should be addressed. The economic structure of the countries we explored are extremely influential in decisions over policies for air quality and the actors involved there often offer resistance to modal shifts in transport. Although traffic is the most important factor in many cases it would be unfair not to address other sectors which have been addressed by interviewees. Agriculture for instance has been quoted in Belgium and Italy but, as already noted above, further regulation should come at the EU level. Heating systems have been already cited for the Polish case a key sector; it represents a further domain of intervention also in Lombardy region especially for the case of domestic biomass (wood) combustion which contribute to PM_{10} and $PM_{2.5}$ emission.

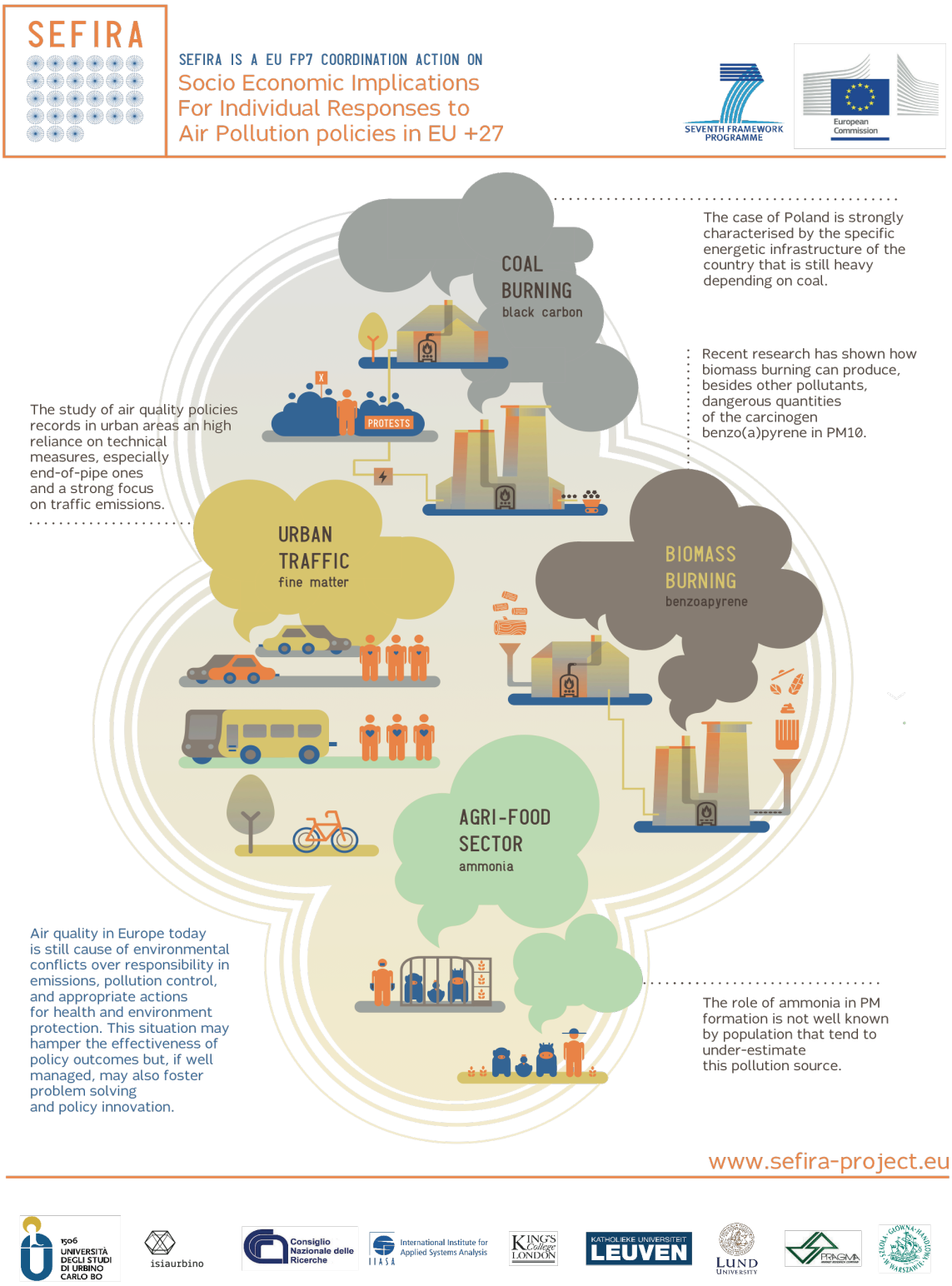


Figure 7. Impacts of different sectors on air quality

4. CONCLUSIONS AND RECOMMENDATIONS

Beginning in June 2013, the SEFIRA project has coordinated some of the best scientific and socio-economic resources to review air quality policies and legislation, working at the interface between environmental, economic and social sciences in order to achieve a deeper understanding of these complex issues. The main fields involved in the action have been atmospheric sciences, environmental and legal sociology, anthropology, geography and economics.

Qualitative and quantitative methods have been applied. An empirical study involving 16,100 European citizens from 7 countries (Austria, Belgium, Germany, Italy, Poland, Sweden, United Kingdom) tested their environmental behaviour and preferences for air quality policies estimating Discrete Choice Models. In addition, a qualitative research in the four metropolitan areas of Antwerp, Malmö, Milan and Warsaw has been carried out, consulting 12 focus group of citizens and 38 top experts and policy makers.

The SEFIRA project is the first attempt by the European Commission to use socio-economic techniques to investigate the public acceptability and preferences of air quality policies with inter- and intra-country comparisons. This pilot study first reviewed the air quality policy framework in the EU and assessed the progress to date in improving air quality. One important conclusion is that with the increasing drive to lower pollution concentrations, behavioural measures will become more important. Whereas the acceptability of technical measures has up to now been assessed by means of 'hard science' methods of cost-benefit analysis, an assessment of the acceptability and preferences of behavioural measures will need socio-economic methods and the SEFIRA project represents a first step in this direction.

Integration between atmospheric and social sciences can improve policy design. The costs of air pollution reductions often lead to conflicts over implementation. The policy review outlined preferences in policy-making highlighting strategies of intervention. All aspects of air quality regulation have been examined through an interview campaign involving experts, stakeholders and policy-makers in four EU countries. Focus groups explored qualitatively several aspects of air quality: awareness, experience and vision about interventions for air quality. Emissions from urban traffic appear as the primary concern but various conflicts over different sources have been described.

The project used Discrete Choice Models which potentially offer an advantage in decision-making involving the simultaneous interaction among variables such as changes in individuals' lifestyles having an impact on atmospheric pollution levels. Our Results show that socio-economic differences in air quality policies acceptability occur across countries and suggest that the willingness of citizens to change their lifestyle might be larger than previously thought and that analysing differences in policy acceptability by country and socio economic structure can be valuable. Even though the sample was one of the largest used in an FP7 project, the conclusions are necessarily tentative and should be read in that light.

Among the tested policy drivers in describing the environmental policy, the annual cost of the policy, the decrease in pollution-related deaths, and the 'polluters pay more' principle to distribute cost within the community are the drivers with a high impact on the stated policy acceptability in all the countries. As a consequence, the policy acceptability will be especially affected by measures having an impact on these policy drivers. The policy drivers which present differences across countries are those related to the reduction in mobility and eating habits. In fact, some of these have been found to be not significant for specific countries, meaning that people are more inclined to change their behaviour on the eating and mobility habits, like in the case of Italy and Poland. In addition, the estimated importance via elasticity measures allowed us to further explore, for each country, the individuals' sensitivity to policy drivers. Across the countries, British and Germans seem more sensitive to changes in the 'per capita annual cost' policy driver, while Swedish seem less sensitive. Belgians and Austrian are the most sensitive to changes if the policy costs are distributed according to the principle of 'poor people pay less'. Finally, as shown in Figure 5, differences have been found according to the socio-economic segmentation of the individual's sensitivity (e.g. women and individuals with a low personal income are the more sensitive to changes in the annual cost of the policy if compared with men and high personal income individuals, respectively).

The project also found a large discrepancy between the public perception of the most important sources of pollution and the actual ones, identified through source apportionment studies carried out in Europe. Transport has been identified by the citizens as an important source, reflecting the actual situation in European Environment. However, the role of industry has been perceived as being much higher than it is in reality. Equally, domestic fuel and combustion choices were perceived as being much less important than they really are, as well as emissions from the agri-food sector. The reasons for this are not clear but possible causes may be the technical complexity of the issue and the complexity of the technical language; the role of mass media in spreading environmental information; the role of public institutions in spreading environmental information which can often be scientifically accurate but not readily understandable.

This work shows the importance of structured knowledge about the dynamics in society that link socio-economic issues with environmental policies. As behavioural measures become more important and more common, socio-economic research of the type carried out in SEFIRA should be considered in the early stages of policy formulation.

This research has suggested a mismatch between public perception of the importance of source sectors (industry, agriculture, residential sources) and the scientific reality. In order to implement policies in these sectors, this mismatch needs to be confirmed and then addressed. A next step could be to understand the relation between communication and dissemination of research results and peoples' perceptions and beliefs. This process would be extremely useful to understand the relationship between public information and policy acceptability.

Our research suggests also that a regular process of socio-economic data collection could be useful in supporting the implementation of policies that have both a positive impact on air quality and that could be accepted by citizens.

This work has shown that quantitative information on socio-economic aspects of air quality policies can be obtained through techniques such as Discrete Choice Models. More research is still needed however to integrate such models with the integrated assessment models currently used to inform air quality policy in the EU and elsewhere

References

Avataneo L., Gatta V., Kazepov Y., Maione M., Polidori P., Sergi V., Valeri E., (2014), Scientific methodological paper on the questionnaire preparation including willingness to pay estimates, Deliverable D.4.2, FP 7 Coordination Project SEFIRA, www.sefira-project.eu.

Ben-Akiva M., Lerman S., (1985), *Discrete Choice Analysis: Theory and Application to Travel Demand*, The MIT Press, Cambridge, London.

Carton W., Marrécau F., Kenis A., Sergi V., Giardullo P., Błędowski, Kobus D. (2015), Citizen responses to urban air pollution: a focus group analysis, Deliverable 2.3, FP7 Coordination Project SEFIRA, www.sefira-project.eu.

Giardullo P., Sergi V., Carton W., Kenis A., Kobus D., Kesteloot C. (2015), The cases of air quality policies in Antwerp, Malmö, Milan and Warsaw in 2014, Deliverable 3.2, FP 7 Coordination Project SEFIRA, www.sefira-project.eu.

Giardullo P. (2016), Social perception of air quality, Deliverable 6.7, FP7 Coordination Project SEFIRA, www.sefira-project.eu.

Jensen, B. B. (2002). Knowledge, Action and Pro-environmental Behaviour. *Environmental Education Research*, *8*(3), 325–334.

Valeri E., Polidori P., Sergi V., Kazepov Y., Maione M., Amman M., Williams M., (2014), The use of DCEs for estimating socio-economic acceptability of air quality policies, Deliverable 4.1, FP 7 Coordination Project SEFIRA, www.sefira-project.eu..

Valeri E., Gatta V., Polidori P., Avataneo L., Maione M., Kazepov Y., Sergi V., Williams M., (2016a), Modelling Individual Preferences for Environmental Policy Drivers for 7 European countries, Deliverable 4.4, FP 7 Coordination Project SEFIRA, www.sefira-project.eu.

Valeri, E., Valerio Gatta, Désirée Teobaldelli, Paolo Polidori, Benjamin Barratt, Sandro Fuzzi, Yuri Kazepov, Vittorio Sergi, Martin Williams, Michela Maione, (2016b), Modelling individual preferences for environmental policy drivers: Empirical evidence of Italian lifestyle changes using a latent class approach, *Environ. Sci. Policy* (2016), http://dx.doi.org/10.1016/j.envsci.2016.05.019.

Valeri E., Gatta V., Polidori P., Maione M., Kazepov Y., Sergi V., (2016c), Discrete choice experiments to inform environmental policy makers: the SEFIRA-EPPE Decision Support System (prototype v1.0), Deliverable 4.5, FP 7 Coordination Project SEFIRA, www.sefira-project.eu.