ClairCity - Citizen Led Air pollution Reduction in Cities

Deliverable 3.1
Review of Social Science in Air Quality and Carbon Management

October 2017 (Updated in April 2018)

Executive Summary

This report consists of a review of the extent to which the academic disciplines of social science have interacted with the issue of air quality management (AQM): either through using AQM processes as the subject of research, or through AQM policies and practices being grounded in social science.

This document consists of six main sections briefly described below.

1. An introduction to the nature and context of the report
2. Results and conclusions from a formal literature review that sought evidence on the extent and nature of social science research relating to air pollution along with indications of its uptake within policy;
3. A review of EU funded projects and research outcomes on air quality management from the CORDIS database;
4. A review of a selection of air quality policy and plan documents at a national and regional level;
5. An overview, examining the role of the citizen with regard to air pollution from a practitioner point of view;
6. A second overview of the role of 'civil society' and non-governmental institutions within the air quality management processes.

Overall, there is little active role identified for the public within the way that AQM is carried out. There is evidence to suggest though, that particularly since the failure of the Euro Standards vehicle emissions strategy to significantly reduce emissions, there has been an increasing interest in the role of the public, however to date there has been little air pollution specific work on which to provide support to policy in this area. From the reviews there tend to be three core ways in which the public have, to date been designated a role in relation to AQM. These are:

1) As relatively passive receptors of pollution;
2) As recipients of information about pollution concentrations, on the basis of which they will change their behaviour in order to reduce their exposure;
3) As approvers of public policy, through assessments of their willingness to pay for cleaner air.

The evidence gathered points to a lack of direct attention to the social science domain by air quality management directly: the measures included in the plans are disproportionately technical in nature and aim at tackling specific sectors, for instance transport or delivery of goods, or industries. Even where AQ plans attempt to go beyond command-and-control measures and aim at changing citizens' behaviour they are predominantly limited to infrastructural investments and subsidies to less polluting vehicles and domestic appliances. However, The Cleaner Air for Scotland plan, seemed to show more ambition than the others acknowledging a need to look beyond individual circumstances and choices and understand what determines these people's choices, including not just material barriers but also norms and expectations. Although there has been considerable behavioural research in the areas of transport and energy consumption, there is little direct involvement of air quality management processes with the basic evidence base. Where more behavioural transport measures are taken up into air quality management plans, this appears to have been done from selecting a set of off the shelf measures rather than a greater involvement and understanding of the social science evidence and research behind it.

The latter part of this review presents overviews of how, in practice, both citizens and civil society have come to play roles in air quality management and environmental protection more broadly. These sections demonstrate, that even without a clear formal structure to incorporate them within governance processes, there is a clear push, and a need for them, to be included in the processes of policy and practice.

For many years, policy has assumed that clean air and carbon reductions could be largely achieved through technological measures, leaving behaviour to remain Business As Usual (e.g. by introducing cleaner cars, but allowing traffic flows to continue increasing). Now, however, despite great successes at the end of the last century, the process of cleaning up (particularly light duty) vehicles has been shown to have problems, locking in relatively new but poorly performing cars into vehicle fleets for a decade or more. Thus it is becoming increasingly evident that we will need changes to both behaviour and lifestyles in order to achieve our environmental goals, not just in terms of air pollution, but also co-benefits in terms of greenhouse gases, noise, public space and so forth.

To date AQM has created a world populated by chimneys and vehicles, analysed through forecasting and models built upon average usage characteristics and emission factors, and consisting of polluting machines and objects but with very little consideration of the people and the social frameworks which lead to them. The failure to date to find a significant role for social science in air quality management is therefore a concern that needs to be addressed.

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Review of Social Science in Air Quality and Carbon Management

"These proposals seem not to take account of the many and complex reasons for vehicle use by the residents of Easton, presenting a picture of a seamless transition to an urban idyll where everyone has ample time to stroll to school or shops and still get to work on time, and everyone's job is local and easy to reach. In reality most peoples' schedules and the demands of their lives necessitate independent transport; simply taking steps to massively inconvenience them doesn't really seem to be engaging with the broader reasons behind vehicle use and ownership."

Local Residents Group Response to Proposed Council Traffic Management Plans in Bristol, United Kingdom

http://www.eastonvoice.org.uk/detailed-response-to-proposals/

1 Introduction

The quote above is taken from a local resident's group response to council proposals for a set of local traffic calming measures. We provide it here as an introduction to this report in order to provide an example of how air quality management has failed to get to grips with the fact that polluting emissions are not just a consequence of polluting technologies, but also how these technologies are used and incorporated into the everyday lives of our societies and citizens (whether this relates to motor vehicles, domestic heating and cooking appliances or other ways in which the activities of citizens cause pollution). With 3-.7-4.2 million deaths from ambient pollution a year worldwide (Landrigan et al., 2017) and over half a million per year in Europe alone (EEA, 2017) work on combatting air pollution should be inherently people centred. However, given this public health core to air quality management the degree to which people and their actions is considered in the policy processes is often remarkably low.

This document presents a review of work in the academic, policy, research and practice domains on air quality management (AQM) with the aim of identifying where and how social sciences have considered, or been considered by the processes of AQM. By 'social science' we mean the scientific study of human society and social relationships (Oxford English Dictionary), and the 'social sciences' to include, but not be limited to economics, political science, human geography, demography, management, psychology, sociology, anthropology, archaeology, jurisprudence, history, and linguistics. In particular, in line with the theoretical approaches set out and described in ClairCity Deliverable D3.3 ('Framing Reports') the interest of the project lies in those social sciences that focus on 'the social' as opposed to 'the individual', and on the everyday lives of citizens as opposed to the policy realm. However, no specific effort has been made to target these at the exclusion of other work.

1.1 Why a social science approach to AQM may be important

It can be argued that one of the key reasons why efforts to improve air quality have not been more successful across Europe has been the failure to elicit more political support from the

public at both national and local levels. This can be seen as being due, in no small part, to a failure to capture significant public engagement to create the democratic mandate for significant action on air pollution and thus create the political will for the substantial amount of action required. This has happened for a number of reasons, not least the success in achieving legislation, through the Air Quality Framework and Daughter Directives (96/62/EC) and subsequent EU and national policies, a set of numeric "$\mu g/m^3$" limit and target values, which whilst based on health evidence, have led to approaches to management based on abstract numbers, rather than real-world impacts.

A second reason for both a lack of civic engagement and an absence of social solutions to air quality problems may lie in the absence of 'people' in models and scenarios used to estimate and predict air pollution concentrations. For example, these models represent the flows of cars along roads, and it requires a great leap of imagination to link these to the reasons for actual journeys that people make. The modelling of emissions sources, not the human activity that results in them, leads to a bias in policy that focuses on mitigating emissions through technological change, not through human behaviour; and a reliance on technological innovation not social innovation.

In order to support this argument, this document provides an overview of the current and historical ways in which social science research has:

a) Considered air quality management (AQM&CM) as an area of study;
b) Been taken up and used within AQM&CM policy and practice.

1.2 Structure of the report

This document consists of five main sections briefly described below.

1: Results and conclusions from a formal literature review that sought evidence on the extent and nature of social science research relating to air pollution along with indications of its uptake within policy;

2: A review of EU funded research and projects on air quality management from the CORDIS database;

3: A review of a selection of air quality policy and plan documents at a national and regional level;

4: An overview, examining the role of the citizen with regard to air pollution from a practitioner point of view;

5: A second overview of the role of 'civil society' and non-governmental institutions within the air quality management processes.

1.3 A background to the History of Air Quality Management

1.3.1 Air Quality and Carbon Management

AQ&CM is understood here in the context of the ClairCity framing set out in Deliverable D7.1, The Scenario Reporting Framework. This is that the incorporation of climate change and carbon within the project view of AQ&CM is only so far as carbon emissions *"are from sources that are also relevant to air pollution and only as far as these sources can be*

influenced through citizen behaviour and/or their organizations and local authority's policies". As such, this report primarily focusses on conventional air pollution rather than greenhouse gas emissions, and although the application of social science to climate change is sometimes referred to, due to the very different (and much greater) issues involved (across both adaptation and mitigation), the aim of this document is not to focus on this. Further work discussing the intersection of climate change and air quality management can be found in Tiwary et al. (2013) and Baldwin et al. (2009). Future work of WP3, including the next Deliverable in M24, will consider how the project has been designed around some of the latest social science in the causative domains of transport and domestic energy consumption (some of this has already been discussed in Deliverable D3.3 within the framing reports).

Very little work has been identified that clearly links air quality and carbon management within the reviews presented here, therefore the overall emphasis of the report ends up simply being on AQM. Unless work has specifically identified a clear linkage to efforts to also manage carbon emissions through achieving win:wins (or at least minimising win:lose situations) then we simply refer to AQM within this report.

1.3.2 The conventional 'PTEM' approach

To date, the predominant approach of air quality management (as a practice with fairly global reach) can been seen as following what has been referred to in the energy efficiency domain as the PTEM (Physical-Technical-Economic-Model) approach (Lutzenhiser, 1993; Guy, 2006).

The following quote describes the PTEM view of the energy system:

"*The PTEM represents a marriage of strong paradigms. At its core is an engineering view of the world and its energy efficiency potentials. This is a world populated by buildings and devices that are connected to electricity grids and natural gas pipelines. It is most clearly depicted in demand forecasting models of the type managed by the CEC* [California Energy Commission]*. This bottom-up model consists of populations of millions of appliances that have average usage characteristics that can change in aggregate over time. Its "saturations" of equipment can vary. It also contains "building stocks" that consist of dwellings of various sizes, types, and vintages. It considers the effects of weather on buildings and HVAC systems, as well as population growth effects on stocks and saturations. It produces aggregate projections and it has no people, per se, except as are found in assumed average appliance usage rates and temperature settings, and in technology adoption (saturation) rates. It is a world of machines and objects envisioned from afar, in which the technological outcomes of aggregate choices are as close as we can come to actual households and behaviors.*" (Lutzenhiser et al., 2009, p.12 – underlining added)

It takes little imagination to apply this quote to the way that AQM has tended to be undertaken. AQM has created a world populated by chimneys and vehicles, analysed through forecasting and models built upon average usage characteristics and emission factors, and consisting of polluting machines and objects but with very little consideration of the people and the social frameworks which lead to them.

The dominance of this PTEM view is perhaps best exemplified by assessing the overall balance in achieving Limit Values through reliance on improved vehicle emission standards as opposed to road traffic reduction. So far, research on air pollution policy and management has put most of the effort on designing and implementing technical measures to reduce

emissions; for example, by strengthening emissions standards for vehicles, or reducing emission from point sources through developing new “Best Available Technologies”. This approach has placed little emphasis on people’s role in generating emissions and on possible ways to reduce them.

In other words, if we consider the classical way of calculating emissions:

Emissions = Activity x Emission Factor

the predominant effort has always been put on reducing the Emission Factor whilst maintaining, or often (especially in the case of traffic growth) allowing or encouraging activity to increase. This reports sets out to assess the extent to which study of the activity of human society has been integrated into the way that air AQM has been approached. In doing this we don’t simply consider ‘activity’ as measured in km driven or kWh of energy consumed, but considered in a way that is meaningful to citizens, by looking at the purpose of journeys, the need for heating in their homes to achieve comfort, or to use fuels to cook their food and heat their water.

On a theoretical level, this trend towards focussing on more technical aspects of the air pollution problem has meant that there is now still a limited understanding of the deeper roots and of the societal factors that are linked to excessive air pollution levels. Half a century ago Siegel (1967) already highlighted that, before designing and implementing technological solutions, research needs to understand the broader conditions and the political environment in which they are implemented. In particular, he pointed out that even the effect of technological solutions should be evaluated and ”interpreted in the light of political, social, and economic behaviour; governmental structure and other factors” (Siegel, 1967, p. 1104). For this reason, he called for the development of a social science framework that could account for the socio-economic and political side of the air pollution problem.

However, whilst (non-environmental) work on both transport and domestic energy use has paid a lot of attention to people’s behaviour (through economic, psychological and sociological accounts), it has made little impact on environmental regulation and policy, particularly in the field of air quality. In this regard, Shove (2010) has argued that the overwhelming majority of social science research on environmental issues or climate change assumed models of behaviours rooted in economic thought and price mechanisms (Shove, 2010, pp. 284-285) and that these shaped policymaking. The adoption of behavioural approaches in social sciences research and policymaking in the environmental and climate change sectors became well established and gradually unquestioned. As Shove puts it: ‘since there is only so much intellectual energy to go around, these points of concentration draw resources away from projects for which readers do not already exist, and from those in which making the case for social science is itself an important task” (Shove, 2010, p. 285). This, she argued, resulted in an intellectual lock-in that restricted the scope of social science research’s contribution, and in particular of social theory, to environmental debates (Shove, 2010, p. 285). Instead, social science should be able to put forward alternative and more radical approaches that policy makers should be able to access and that potentially could change current practice: ‘what might climate change policy look like if it was *not* anchored in simple accounts of attitude, behaviour, choice and change?’ (Shove, 2010, p. 285).

1.3.3 Air Quality Management vs. Air Pollution Control

Whilst this report focuses primarily on 'Air Quality Management' this is a technical/policy term that is not likely to have particular resonance and meaning outside of particular professional circles. Therefore, this report also covers the interaction of social science with the broader topic of 'air pollution' (a phrase which will have much wider public understanding). For this reason it is worth noting that although indoor air pollution is not considered to be within the scope of either this report or the wider ClairCity project, the absence of a clear non-expert boundary between these issues, means that this topic is occasionally referred to.

It is important, however, to make a distinction between two separate historical phases/approaches to reducing air pollution/improving air quality: "Air Pollution Control" (APC) and "Air Quality Management" (AQM). We describe these briefly below, however a longer discussion of the move from APC to AQM can be found in Longhurst et al. (2009).

Air Pollution Control – This generally refers to the control of *emissions* from discrete point sources. This can be considered as the 'traditional' method of attempting to reduce air pollution, and can be found in legislation dating back to the 1900s (for example the UK 1863 Alkali Act and subsequent legislation where "control was exercised primarily through emission controls for individual plant using the concept of Best Practicable Means (BPM)" (Longhurst et al., 2009, p.64).

Air Quality Management – This tends to refer to a set of regulations and practices developed at the end of the twentieth century, and characterised in particular by the 1996 European Framework Directive on Air Quality Assessment and Management (96/62/EC) and subsequent European and national legislation. AQM is distinct from APC through its focus, not on emissions, but on *ambient concentrations* of pollutants. AQM can be considered to have arisen due to the widespread success of APC in controlling emissions from discrete, gross, industrial emitters. However, as industry became cleaner and less problematic (both through the application of BPM (or similar) and through dilute-and-disperse measures such as tall chimneys, it became clear that air pollution still continued to be a problem in certain places and at certain times. Much of this problem arose from small, diffuse sources, particularly road transport, but also domestic emissions from boilers and solid-fuel burning. By establishing air quality standards/objectives/limit values that proscribed maximum levels for ambient concentrations of various pollutants, it was possible for legislation to force relevant governmental bodies to attempt to meet these targets using any means necessary (sometimes caveated by a requirement for technical or economic feasibility, sometimes not).

This new AQM concept provided a framework for assessing the cumulative impacts of a myriad of diffuse sources, not just in terms of consequent air pollution concentrations, but also in terms of their impacts on human health (particular variants of AQM such as the UK system, specify that AQ Objectives can *only* be exceeded where there is relevant public exposure over the relevant averaging time (HM Gov, 2000, 4(2)). However, due to the varied and multiple causes of air pollution exceedences, the AQM process, unlike APC, is unable to set out specific remedies for tackling these, as was done under BPM and similar standards for industrial processes.

Whilst the differences between these approaches may appear fairly academic from a technical point of view, it becomes fundamental when taking a social science approach that focuses on people as citizens. Under a traditional APC approach, citizens primarily relate to

air pollution as a receptor, whilst industry is the main target of policy and interventions. Under AQM however, citizens (for example as the driver of private motor vehicles) also become an important source and therefore the target of policy.

Within the transition from APC to AQM, another important thing happened with regard to how AQM was viewed. The development of AQM followed on from some of the major air pollution concerns of the 1980s around long-range transport of pollutants and acid rain, and linking to the growing interest in the global atmosphere with respect to climate change. This led air quality management to become an 'environmental' issue, its study being an issue of environmental science, and at least in the UK, being managed at a local scale by 'environmental health' departments. This approach set up a false boundary within the risk/threat being treated as an external issue, separated from a passive human receptor who was simply exposed to this harm. What this meant, was that it was not treated as a *public health* issue where the behaviour of the population is seen to be intimately connected to the risk of harm.

1.4 Some words on Social Science(s)

There are a wide number of social sciences, and there is often a fine and unclear dividing line between these and humanities subjects. A current EU Horizon 2020 platform SHAPE ENERGY (Social Sciences and Humanities for Advancing Policy in European Energy http://shapeenergy.eu) lists these as including: Business, Communication Studies, Demography, Development, Economics, Education, Environmental Social Science, Gender, History, Human Geography, Law, Philosophy, Planning, Politics, Psychology, Science and Technology Studies, Sociology, Social Anthropology, Social Policy, and Theology. Within this review, we have not directed our concerns to any particular branch of the social sciences, instead we have tried to identify research and policy which has focussed on the role of citizens as 'everyday people' in relation to exposure to or mitigation of air pollution. We have, therefore, tended to exclude work (or not examine it in close detail) from policy and political studies that has simply analysed the institutional processes around air pollution, except where they could be considered to have a social dimension that reflects the day-to-day lives, behaviour, activities and practices of citizens. The consideration of behaviour within ClairCIty however is not just limited to that of the citizens, but also to the experts, practitioners and decision makers (in the words of ClairCIty Associate Sea Rotmann, "attempting to change the behaviour of the behaviour changers") Therefore the issue and analysis of governance processes will play a greater role in later stages of the project.

2 Social Science Literature Review

The aim of this review is to substantiate the argument that, so far, what academic research has been undertaken on air quality management has put most of the effort on controlling the emission factor (e.g. g/km of PM emitted from road vehicles, or NOx emitted per kWh of gas combusting for heating) not the activity side. Furthermore, this has had two main implications. Firstly, on the policy side, national and local governments over-relied on techno-centric innovation to tackle air pollution problems. Therefore, to a large extent, this can be seen as proposing a "Low-Emission Business As Usual" future, where everyone behaves as they do now but just using low-emissions technologies. However, so far, these solutions have proved to be inadequate for ensuring that emissions and/or concentrations are kept within legal limits. It has been estimated that between 3.7 million (GBD, 2015) and 4.2 million (Prüss-Üstün et al., 2016) died prematurely as a result of air pollution worldwide in 2012 (cited in Landrigan et al., 2017), with over 500,000 deaths in Europe alone in 2014 (EEA, 2017). There has been little

In light of this, through a literature and policy review, this paper aims at answering the following research questions:

Research perspective: to what extent has research in air quality management included the study of "people" from a social science perspective? Or, conversely, where has social science specifically focussed on the issue of air pollution emissions?

Policy perspective: has there been an uptake of (people focused) social science recommendations in air quality policy/management? And, where there has been a policy uptake, have these policies worked for air quality policy/management?

Appendix 1 provides details of the review methodology. In summary 104 papers were identified from a literature search, and these could be divided into four main groups:

1) Economic investigations of "Willingness To Pay" (45 papers);
2) Analyses of Emission Trading Schemes (5 papers)
3) Issues of justice and inequality, primarily gender, race and poverty (29 papers); and
4) Papers dealing with generic socio-political factors in relation to air quality (36 papers).

2.1 Willingness to pay

Willingness to Pay (WTP) is an economic concept that assesses the strength of people's preferences for goods and services (including environmental goods such as clean air or rises in global temperature below 1.5^0 C). It does this through assessing how much they would be prepared to pay in order to achieve that end (generally through a set of survey questions). The WTP method has been used to inform public policy by evaluating how much citizens are willing to pay in monetary terms to procure a positive or avoid a negative change (Atkinson et al., 2008). The concept of WTP is grounded within the standard cost-benefit analysis technique (CBA), which accounts for all the benefits and the costs occurring in a certain area following the implementation of a public policy (Atkinson et al. 2008, p. 420-421). In order to also capture the value of intangible goods, WTP (or conversely Willingness to Accept (WTA)) has been applied to assess the value of environmental services, including

air quality, using methods such as contingent valuation (CV), hedonic prices, or, life satisfaction or happiness studies (Atkinson et al., 2008).

As Wang and Zhang point out, WTP and CV methods have been widely used to value environmental services in developing countries (2009, p. 1023) but more recently there has been an increase in WTP studies focussing on Chinese cities, probably reflecting the growing concerns about air pollution and its consequences in this country (Wang & Zhang, 2009, p. 1022). Overall, WTP studies show mixed evidence about the degree to which people would be willing to pay for improved air quality and what factors are most important in determining citizens' preferences. Most studies indicated that people are generally willing to contribute financially to improve air quality (Alberiniet al., 2006; Ara & Tekeşin, 2016; Carlsson & Johansson-Stenman, 2000; Du & Mendelsohn, 2011; Filippini & Martínez-Cruz, 2016; Gonzalez et al., 2013; Sfendoniset al., 2017; Sun et al., 2016; Wang, K. et al., 2015; Wang & Zhang, 2009; Zhang, X. et al., 2017). However, some reported low levels of WTP (Chu et al., 2017; Liu et al., 2016; Parry Dziegielewska & Mendelsohn, 2005; Pythagore et al., 2014). Consequently, this means that there are also examples of WTP studies that do not support more radical actions to improve air quality. Arguably, this is because economic development and air quality are still widely considered as conflicting goals by the population. For example, Parry Dziegielewska & Mendelsohn (2005) valued air quality in Poland and concluded that "if development follows an optimistic fast growth path, Poland should agree to reach EU (air quality) standards quickly. In contrast, if development proceeds more slowly, Poland should be given more time to harmonize its pollution regulations" (Parry Dziegielewska & Mendelsohn, 2005, p. 148).

Low levels of WTP are mostly linked to relatively lower economic development (Parry Dziegielewska & Mendelsohn, 2005; Pythagore et al., 2014) and low income household (Parry Dziegielewska & Mendelsohn, 2005; Wang K.et al., 2015; Wang Y. & Zhang, 2009). Nonetheless, Ndambiri et al. (2016) found substantial support for improved air quality in Nairobi, Kenia, and positive WTP in 85% of the whole sample. Moreover, positive WTP was also found in Turkey (Ara & Tekeşin, 2016), Mexico (Gonzalez et al., 2013), and Sao Paulo (Arigoni Ortiz, et al., 2009).

In order to provide some explanations behind different attitudes to air quality, WTP studies broke down differences between stated preferences and WTP based on individual characteristics (other than income), but these studies showed very mixed results. For example, in most studies higher education levels are correlated with higher WTP (Ara & Tekeşin, 2016; Carlsson & Johansson-Stenman, 2000; Chao-jun, et al., 2010; L. Zhang et al., 2014). However, this is not always the case as Alberini et al. (2005) reported lower WTP amounts among highly educated respondents for a public program for the preservation of a lagoon, beach and infrastructure in Venice. Interestingly, WTP does not always reflect the level of awareness of air pollution: for instance, Liu et al. (2016) found that while female employees have better awareness of urban air pollution, they are much less willing to pay for improvement in air quality. Ara and Tekesin (2016) found that women and households in Turkey that use coal as main source of heating and cooking were willing to pay less. Also, whilst most studies found that WTP decreases with age, Alberini et al. (2006, p. 252) found no evidence that older people display a lower WTP.

Although WTP studies disproportionately focus on the characteristics of individual participants, a comparative study of three EU countries (UK, France and Italy) by Alberini et al. (2006) have argued that WTP can be influenced by country-specific factors (cost of living,

cultural factors, etc.) as well as by individual characteristics (mainly income). For example, they found that at a constant level of household income, French and Italian respondents were more willing to pay for improved air quality than their UK counterparts (Alberini et al. 2006, p. 255). As the authors report, these findings confirm Ready et al.'s argument that "preferences differ across countries in ways not related to observable characteristics" (2004, p. 77).

Another division in WTP studies is whether citizens see air quality as a government matter or as a community matter– hence, whether citizens should be responsible for improving air quality or not, and therefore whether they are willing to pay more or less for improvements. For instance in Ji'nan, China, respondents regarded air quality as a government responsibility and more than 40% of respondents were not willing to bear the cost for achieving better air quality (Y. Wang & Zhang, 2009). By contrast, in Zhang et al.'s (2014) study, 98% of the respondents in Nanchang, China agreed that improving air quality is the responsibility of every citizens.

An important factor that seemed to be linked to higher WTP is whether the air quality improvements are hypothetical or real, and whether respondents had been personally affected by air pollution or not. Du and Mendelsohn's study (2011) found that Beijing residents are willing to pay much more to maintain the actual improvement experienced during the Olympic Games than previous studies on hypothetical improvements had indicated. Furthermore, most studies showed that people that have had a personal experience with air pollution-related illnesses (Ara & Tekeşin, 2016) or that are aware of the health-related risk of pollution (Bayer et al., 2009; Filippini & Martínez-Cruz, 2016; Hazar, et al., 2014; Sfendonis et al., 2017) tend to be more willing to pay, as well as being more responsive to educational and public awareness campaigns (K. Wang et al., 2015).

In terms of exploring differences in WTP, Valeri et al. (2016) applied a behavioural model based on latent class analysis (Vermunt and Magidson, 2004) to evaluate non-technical air quality measures. Their findings indicated that Class 1 respondents were particularly concerned with costs and showed a stronger support towards the "polluters pay more" principle (Valeri et al., 2016, p. 70). Instead, Class 2 and 3 respondents expressed more interest towards personal engagement and positive attitude towards changes in eating and mobility habits. However, Class 2 respondents perceived potential changes as negative in terms of personal utility and only Class 3 respondents saw habitual changes as producing environmental and health benefits (Valeri et al., 2016, p. 71).

WTP research on air quality paints a complex picture of different and contrasting results. So how can we make sense of the mixed results? As has been emphasised, some studies hinted at the existence of underlying societal factors that affect people's attitude and responsiveness to air quality policies. However, WTP studies do not deal with unstable preferences and do not explain under what circumstances they can change. In other words, these studies do not aim to tackle the factors that affect people's preferences or what policies can best fulfil those preferences, nor do they explain what determines the translation of preferences into actual behaviours and habits. WTP studies can offer guidance about people's preferences, particularly in terms of quantifying benefits and cost of certain policies. For example, in the UK Department of Environment, Farming and Rural Affairs' (Defra) 2015 report *Assessing wider impacts of air quality policy,* WTP was used to estimate the external costs of accidents and noise, which were assumed to reflect people's willingness to pay (DEFRA, 2015, p. 21). Similarly, in the European Commission's 2005 *Thematic Strategy on*

Air Pollution, WTP was used as a consultative methods and used as a baseline to make the case for better public information on air pollution related risks (EC, 2005, p.12). Indeed, the monetisation of benefits and costs and the consideration of citizens' WTP features in many (if not all) public policy projects. However, CBAs normally constitute only one of many considerations in decision-making processes, as policymakers normally have to take into account more than just respondents' willingness to pay (Tesler & Zweifel, 2002).

Finally, as the study of WTP in Poland shows (Parry Dziegielewska & Mendelsohn, 2005), where these approaches do show a strong WTP value, this does not necessarily result in better and/or more ambitious policies for air quality. Indeed, as Damonte et al. (2017) put it "research on policy ecologies is often descriptive: we know about the policy mix and how governments have chosen this or that mix, but much less about the effects produced by the particular configuration of policy instruments in a country or group of countries, at a given time or across time" (Damonte, et al., 2017, p. 74).

In sum, we can conclude that while WTP approaches have had an impact on policies, specifically by providing a method for attempting to evaluate intangible costs and benefits of policies, they have generated little impact on the broader society in terms of improvements in air quality and changes in social practices.

2.2 Pollution trading schemes

There is extensive and influential academic research on market-based instruments and, among these, emission trading has gained broad support both from governments and industries (Drury et al., 1999). On the back of growing criticisms towards traditional command-and-control regulatory approaches, market-based instruments were put forward in order to incentivise polluters. Tradable permits are based on Coase's theorem that if trade in an externality is possible and there are no transaction costs, bargaining will lead to an efficient outcome regardless of the initial allocation of property rights (Anderlini and Felli, 2006, p. 223). Although this approach has been applied more often for controlling and reducing greenhouse gases to mitigate climate change (see for instance, the EU Emission Trading Scheme), there are trading schemes specifically aimed at conventional air pollutants, such as the Los Angeles' Regional Clean Air Incentives Market (RECLAIM) scheme (Drury et al., 1999; Kamieniecki, et al., 1999; Lejano & Hirose, 2005; Lents & Leyden, 1996; Zerlauth & Schubert, 1999)[1]. This program started in 1993 and was aimed at reducing emissions from all major NOx and SO_2 sources. It allowed business to achieve emission reductions either by reducing their own pollution or by buying emission credits for each facility in the area. Drury et al. explain that each faciilty could: 1) use all the credits and pollute at the highest allowed level; 2) reduce emissions and sell other credits; 3) pollute more than initially allowed and buy credits from other facilities (Drury et al. 1999 p. 247-8). Reportedly, it received large support by the government and by the business sector but was opposed by local environmental groups (Lents & Leyden, 1996). The introduction of this market-based scheme meant the weakening of the existing command-and-control regulation

[1] Another known scheme of relevance similar to a trading scheme, but that has not been the subject of study to date, is the South African policy that allows industrial emitters to 'offset' emissions by supporting reductions elsewhere under the National Environmental Management Act 1998. See Guidelines from the http://www.naca.org.za/uploads/NEMAQAAirQualityOffsetsGuideline.pdf

on air quality that was deemed to be too costly and not attractive for business (Lents & Leyden, 1996, p. 199). However, despite the great expectations, scholars have expressed mixed views about the success of these schemes.

On the one hand, Stavins (1998, p. 144) argued that market-based instruments, including RECLAIM, contributed to reducing emissions faster than other approaches could have done. Furthermore, Kamieniekcki et al., (1999), concluded that the shift to a more privatised form of pollution reduction introduced by RECLAIM delivered the expected results in terms of emission reductions and, in addition, stimulated the creation of constructive partnerships between government and industry (1999, p. 120). On the other hand, Lejano and Hirose warned that ”the degree to which a program can succeed is not tied to the elegance of the underpinning model, but the ability of the agency to adapt it to the dynamics, characteristics, and unique phenomena of places” (2005, p 375).

More decisively, Drury et al. contested that pollution trading schemes are more efficient in reducing pollution (1999, p. 275) and argued that, compared to command-and-control regulation, the enforcement and the monitoring of market-based programmes is more difficult and make it easier for company to report progress on paper rather than real emission reductions (1999, p. 280).

Furthermore, Drury et al. (1999) argued that these schemes, including RECLAIM, create in effect the right to pollute, which can be problematic from a moral point of view (1999, p. 270), but can also undermine the effectiveness of the scheme. In this regard, Zerlauth and Schubert, while highlighting the RECLAIM’s strengths such as its flexibility and the reduction of red-tape, also stressed that ”the whole program is influenced by one fact: in order to reach maximum consensus, the initial endowment of credits was consciously set at a very high level above actual emissions” (1999, p. 280). In addition, Drury et al. (1999) were also very critical of other effects created by pollution trading, particularly in terms of environmental injustice. They pointed out that:

> *“The Los Angeles experiment shows that emissions trading programs can exchange small reductions in widespread pollution for increased exposure to concentrated, and often more toxic, pollution in the neighborhoods surrounding large industrial facilities. The resulting exposure to low-income communities of color make this a matter of environmental justice”* (1999, p. 272).

Other scholars (Farrell & Lave, 2004) denied that the RECLAIM programme created geographical and temporal pollution hot spots. Nonetheless, this aspect becomes particularly problematic if the government does not put in place adequate safeguarding measures to protect the interests of more vulnerable communities and if affected communities are not given a meaningful say over the trading scheme. As Drury et al. put it “ any proposed pollution trade that will result in an increase or continuation of toxic chemical emissions in a given community should first be subjected to a public comment and review period, including notification to the affected communities” (1999, p. 285).

To conclude, research on market-based instruments and pollution trading in particular, strongly grounded in economic theories has had a strong impact on policymaking as governments and business showed enthusiasm and willingness to invest in this type of schemes. Conclusions over their effectiveness are mixed and concerns have been raised about effects on affected communities as well as in terms of the creation of ‘a right to pollute’. In any case, policymakers that have to tackle air pollution cannot over-rely on

pollution trading programs because, even assuming that they work and that adequate safeguarding measures are in place to protect affected communities and ensure proper implementation, monitoring and enforcement, they can only tackle part of the emissions (i.e. emissions coming from the business sector). Instead, the scope of the problem is much wider: every citizen potentially contributes to increasing air pollution and over-relying on market-based measures that tackle individual sectors is not enough. In other words, this research is not people-focussed. For this reason, and considering that there are mixed judgements about the effectiveness of pollution trading, it can be argued that social science research that focussed on these mechanisms has had an influence on policy-making but its contribution to tackling the wider air quality problem has been limited.

2.3 Air quality and inequality (poverty, race and gender)

Building on environmental justice legal cases, much air quality social science research has focussed on the relationship between air pollution and disadvantaged groups et al., 2002; Brunt et al., 2016; McLeod et al., 2000; Pless-Mulloli et al., 1998). The evidence from these studies point to a strong association between poor air quality and low socio-economic background or BAME (Black And Minority Ethnic) background, and these results are consistent across countries. For instance, Maantay (2007) found that people living near noxious land were not only more likely to be hospitalized for asthma, but also more likely to be poor or a in minority ethnic group (2007, p. 53). Similarly, Bell et al. (2005) showed that persons with lower socio-economic status face higher risk from polluted air and that this may result from elevated exposure but also from other factors, such as indoor pollution or limited access to health care. In addition, Jephcote et al. (2014) suggested that exposure to detrimental socio-environmental factors might increase the risk of respiratory incidents, and Mennis & Jordan (2005) also confirmed many environmental activists' claims that certain minority neighbourhoods bear a disproportionate burden in terms of environmental pollution.

As well as in the US, European countries have been found to show a similar pattern of environmental inequality in relation to air pollution and its effect. Branis and Klinhartova's analysis (2012) pointed that environmental hazards are unevenly distributed among the urban population in the Czech Republic. A study in the UK by McLeod et al. (2000) demonstrated that there is a strong link between social class and pollution in England and Wales and concluded that "reducing air pollution would improve equity as it would selectively favour the poorer districts" . Moreover, Brainard et al. (2002) modelled environmental equity and access to air quality in Birmingham, UK. They found that there was a striking relationship between modelled emissions and poverty indicators and ethnicity. Interestingly, although they underline that the effects of poverty and ethnicity are difficult to separate, there is strong evidence that these two factors operate independently. In 2003, Mitchell and Dorling also undertook work in the UK looking at justice issues relating specifically to car ownership and emissions resulting from their use (Mitchell and Dorling, 2003) through a spatial analysis. They found that significant inequalities existed with regard to links between greater exposure to pollution for poor areas and for certain age groups. Conversely, through an examination of levels of car ownership and estimations of emissions, they found that poorer areas were potentially contributed less to ambient pollution levels. More recently, Barnes and Chatterton (2017) reproduced the work using better quality data over a decade later. This work indicated that the patterns of inequality found in earlier work were still evident and likely to be stronger than previously thought (see F. This was in part due to an

overturning of assumptions regarding the likelihood of poor households driving dirtier vehicles, but also due to the fact that car owners in poor areas drove significantly less and overall emissions were linked more to distance driven than to emission factor of vehicles.

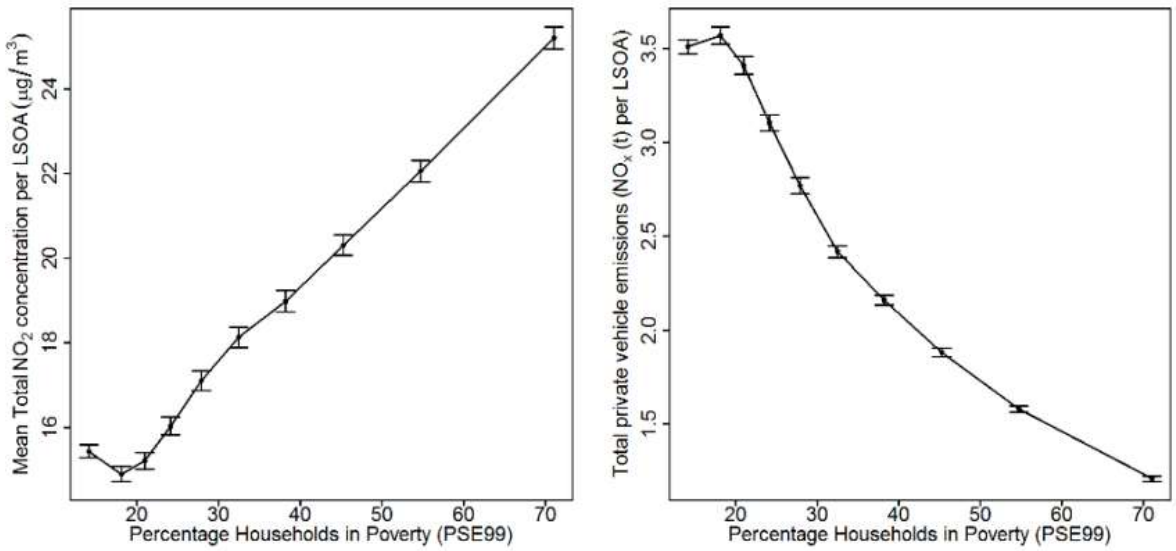


Figure 1: Relationship between levels of poverty and exposure to ambient air pollution and responsibility for emissions from private vehicles (from Barnes and Chatterton, 2017)

An extension of this work to examine patterns of emissions and exposure on the basis of a wider range of socioeconomic and demographic characteristics (Chatterton and Barnes, 2016) found evidence of very strong social and structural relationships with pollution (see Figure 2)

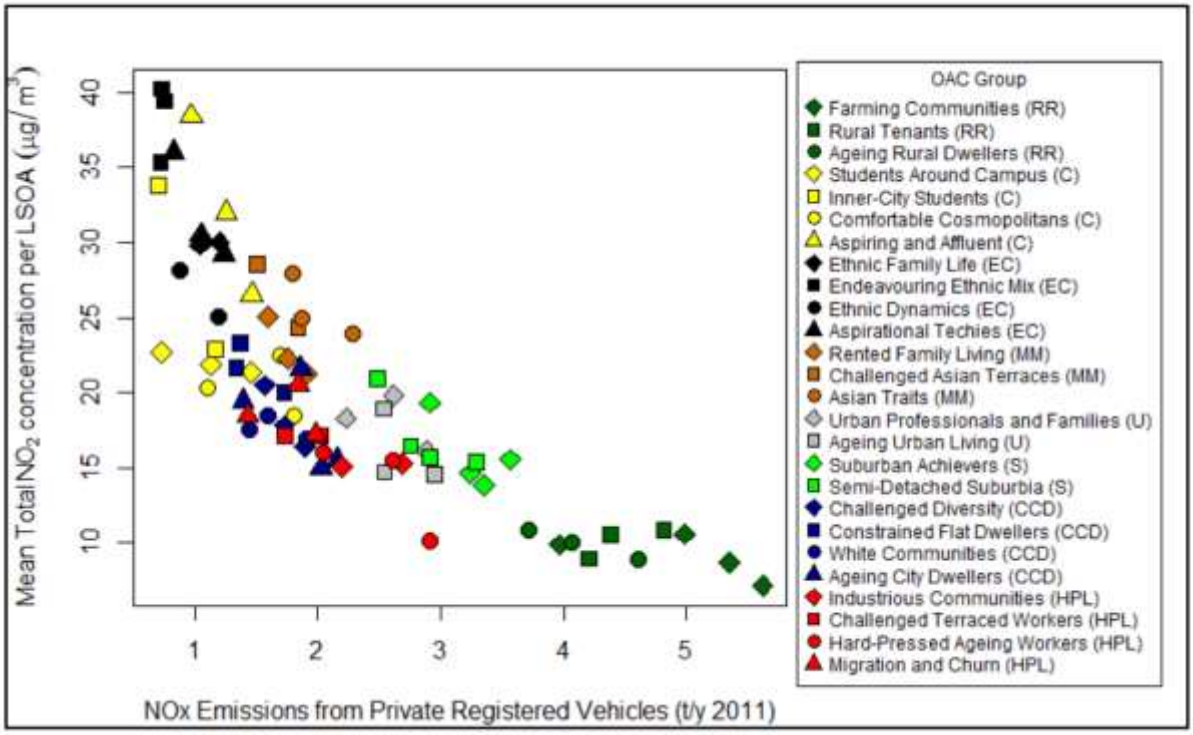


Figure 2: Relationship between responsibility for emissions from vehicles and exposure to ambient pollution by 76 socio-demographic types (from Chatterton and Barnes, 2016)

Other studies on inequality and air pollution focussed on differences in perceptions of environmental risks. For example, Howel et al. (2003a & 2003b) found that the strongest influences on air pollution perceptions were living in proximity to industry, and, to a lesser extent, age and illness status, thus suggesting that neighbourhood characteristics play an important role in shaping public perceptions of air quality. In line with this, Day found that "the differences in these feelings about the air were in part at least related to the different levels of satisfaction with the areas in a wider sense", thus showing that wider impacts of air pollution are mediated by perceptions of place at different levels (2007, p. 255). This conclusion might partly explain the discrepancies registered among WTP studies that broke down WTP according to individual characteristics.

Furthermore, in this regard it has to be underlined that Simone et al. pointed out that "the immediate physical, social, and cultural landscapes in which respondents live and interact may influence their perceptions of neighbourhood problems more than any kind of information based evidence" (2012, p. 242). In other words, "respondents' everyday experiences would influence their perceptions of air quality" (2012, p. 253). This study draws interesting parallels between the perception of air pollution among respondents living in industrial areas and those living in slums:

" Through a historical presence of industry leading to citywide stigmatization, internal perceptions [of residents living in industrial areas] would be in part shaped via external views. But they may choose to see differently as past study of slums have shown that residents defined them as home and their levels of family and social interactions may lead to positive perceptions, even if environmental quality is poor" (2012., p. 254)

In line with this, Johnson (2002, 2011) studied the relationships between air pollution perception and cultural characteristics the US and found that concerns and familiarity with air pollution increased with time spent in the US while beliefs in overregulation that pollution in New Jersey was getting better, increased with time in the nation of origins. Johnson concluded that while societies can benefit from diversity in terms of reduced groupthink and different approaches to managing risk, diversity can limit consensus on risk, government's intervention and self-protecting behaviours (2002, 2011). In other words, while neighbourhood characteristics are the strongest element to help understanding environmental hazards, perceptions, personal experiences of neighbourhoods and deeper cultural aspects are also an important part of the picture.

Other scholars focussed on the relationship between air quality and gender. On one hand, Aliyu and Ismail's (2016) findings indicate that "although the effect of poor air quality on adults is found to differ between genders, such difference is not statistically significant" and that, therefore, "air pollution effects, on average, are similar between genders in the African countries" (2016, p. 21288) By contrast, when looking at perceptions about indoor pollution, Kim et al. (2013) reported that female occupants" satisfaction levels were consistently lower than male occupants, and Stenberg and Wall' s analysis of "sick building symptoms" concluded that: "the results from the clinical examination indicate that the excess symptom prevalence among females is real and not a reporting artefact" (1995, p. 491).

Interestingly, gender roles have been also the focus of some research and provided interesting insights. For example, Cupples et al. (2007) analysed home-heating habits in Christchurch, New Zealand, a city virtually lacking of central heating systems. Here, households' favourite form of home heating is open fires, log burners or electrical heaters, which in winter contribute substantially to air pollution. These scholars explored the citizens' reluctance to change behaviours and concluded that, other than reluctance to invest in new home-heating systems, cultural and national identity, strongly grounded in the masculine pioneer heritage established during colonial periods, plays a substantial role in preventing change.

Finally, Bickerstaff and Walker (2002) conducted a discourse analysis on public understanding of air quality and found that even individuals who expressed a level of concern and accepted some responsibility for dealing with the problem, justified the low level of personal commitment through the use of passive language. In particular they concluded that "responsibility shifts to 'The Other' become increasingly important rhetorical resources with which to justify and excuse personal lifestyle and behavioural commitments which society (or society's institutions) deems morally suspect" (2002, p. 2188).

The contribution of these studies to policymaking is difficult to track and to measure. The impact of studies on air quality and socio-economic inequality should be evaluated in policies that are place-based and that tackle socio-economic factors as well as air pollution (i.e. air quality policies should be integrated into other sectors, like transport, housing, health, education, etc.). Cultural and gender-based studies, on the other hand, could provide invaluable insights into designing public engagement and communication campaigns.

However, rather than being tailored to specific groups or communities in a way that can resonate with them, current communication and educational campaigns are generally based on the information deficit model. The information deficit model starts from the assumption that "providing new knowledge [alone] produces new behaviour" (Marteau et al., 2002). This generates the expectation that, once complete information is provided, the responsibility lies on households for changing their individual behaviour. However, this approach does not take into account other factors that can affect the effectiveness of scientific communication in changing individual behaviours (for example campaigns to reduce energy consumption while policies try to keep prices as low as possible, thus going against the logic of pricing mechanisms). Furthermore, research has shown little evidence of air quality information measures having a significant impact (Bickerstaff & Walker, 1999; Owens & Driffill, 2008) or their evaluation have been patchy (Steg, 2008). One trial (Lyons et al, 2016) of an information system (AirAWARE) found that it was associated with a 4-fold increase in hospital admissions for respiratory conditions and a near doubling of emergency department attendance. Far from being effective in preventing health problems, the system appeared to exacerbate problems, or at least perceptions of them and the researchers concluded that "evidence from this evaluation questions the benefits of implementing near real-time personal pollution alert systems for high-risk individuals." (p1184).

Having said this, it has to be stressed that these studies offer interesting insights that could be useful in designing communication or public engagements campaigns (as part of wider policy initiatives). However, a fully post-structuralist approach cannot account for the aforementioned neighbourhoods effects and for the evidence of environmental inequality that characterises the air pollution problem[2].

2.4 Other social science research

In conducting this review, only one paper by Giardullo et al. (2016) attempted to explore social constraints influencing air quality governance. The evidence from the EU SEFIRA project (http://www.sefira-project.eu discussed in the Review of EU projects section) points to the fact that lack of awareness among citizens alone cannot account for the failure to meet EU requirements for air quality and that social forces must be taken into account.

2.5 Research on the effectiveness of air quality policies on the ground

The analysis of how air quality policies have worked on the ground, although quite limited, definitely points to the fact that policy instruments remain largely business-as-usual as far as societal activities go i.e. policies seek to make activities less polluting rather than addressing

[2] Interesting insights in relation to the difficulties in changing households' practice and habits come from Whitehead's study (2008). This study pointed out that, while technologies (and particularly smoke abatement exhibitions) sought to create a more engaged female citizenry, they were not supported by the creation of new socio-political opportunities for women. This is suggestive of the fact that air quality policies or public engagement campaigns cannot be isolated from the broader context and must take into consideration wider societal and political factors.

the activities themselves. For example, in analysing transport policies aimed at improving air quality in big EU cities, Dablanc (2008) showed that environmental considerations, including on the negative effects of air pollution, do not influence local actions on freight transport of urban goods (Dablanc, 2008, p. 265) . In particular, while legal and policy tools used in urban freight activities attempted to pursue economic, social and environmental goals, they did so in a conflicting way. Moreover, they usually resulted in *routine* measures, because they were "motivated by the same concerns over street congestion as the first by-law on freight deliveries, which appeared in France 47 years ago" (Dablanc, 2008, p. 264).

Murray (2013) analysed the evolution of atmospheric environmental policy and argued that many developed countries have abandoned a true political leadership and as the leadership role of governments has been partially eroded, governments are more reliant on persuasion and diplomacy in their relations with stakeholders. As a consequence, "governance arrangements have become more complex, multilevel and polycentric" (Murray 2013, p. 115). In this regard, Gollata and Newig (2017) studied the policy implementation of EU air quality directives in Germany and found that the multilevel governance model in air quality showed limited success: "in particular, sub-national policy-makers use their new planning competencies but struggle to implement functional governance layers" (2017, p1466).

2.5.1 Work of the Air Quality Management Resource Centre at University of the West of England, Bristol

Aside from the work identified in the main thematic review above, it is worth mentioning a substantial body of work on air quality and carbon management that has been undertaken by the Air Quality Management Resource Centre at UWE, Bristol. This very substantial body of work focuses strongly on the governance processes of air quality management in the United Kingdom, with extension of learning and comparative studies with other countries (Chatterton et al. (2008,2009).

There is a range of work regarding public engagement (Dorfman et al.; Leksmono et al., (2010); Hayes et al. (2013)). The work also makes efforts to link the AQM agenda with carbon management (in particular the work of Bailey et al., and Baldwin et al.), with transport policy (Olowopokuku et al.) and with public health agendas (Brunt et al.).

Whilst it is difficult to fully categorise most of this work under a formal social science heading due to the absence of a clear theoretical stand point (the work mainly consisting of straight forward policy analysis), this work does provide a significant account of air quality management processes, and their failings, over a long period of time (references for on papers on AQM governance from the group since 2000 are listed in the references in section 8.2.2). Increasingly, some the work of the group has been adopting a more candidly social science approach, particularly by making increasing links to the transport and energy sectors where the behaviours that lead to air pollution are a more conventional subject of study (Allen and Chatterton (2013), Chatterton et al. (2015;2016;2017), Morton et al. (2017), Mattioli et al. (2017)) as well as the specific application of theoretical work on behaviour to these issues (Wilson and Chatterton (2011); Chatterton and Wilson (2014), Chatterton (2017), Ahern et al. (2017), Spotswood et al. (2015)).

2.6 Discussion and conclusion

From the review presented here, it is apparent that AQM research has disproportionately focused in analysis through the physical sciences (e.g. modelling and monitoring) and on aspects of technological innovation (particularly fuels, vehicles and heating systems); Examples of social science research in AQM based on survey methods have been informative to a limited extent, but the policy impact seems to be limited to CBA applications. Whilst influencing policy, there is little evidence that they have generated impact on the broader society in terms of improvements in air quality and changes in social practices, or indeed that citizens are given any real choice in everyday life about an opportunity to pay for clean air. There seems to be little research on the effectiveness of air policy instruments and in the real-world AQM is still largely based on business-as-usual policy tools.

Other efforts within the broad discipline of social science that tackled AQM issues explored pollution trading schemes or borrowed from social science research in transport behaviour and domestic energy use. While these studies generated a policy impact, this was not necessarily effective, nor always necessarily good for AQM. The Los Angeles' pollution trading scheme created pollution hotspots and was criticised for being immoral and unjust because it put additional burden on more vulnerable communities (Drury et al., 1999).

There is very little evidence that AQM policy and practice has significantly interacted with the realm of social science in the area of behaviour. Where this was considered it tended to be from psychological and economic perspectives, and the effectiveness of these approaches in terms of sustained change and improved air quality was found to be questionable. For instance, the nudge approach that characterises the UK transport policy proved to be short-term and not likely to deliver radical changes (Goulden et al., 2014). Very little social science research in the AQM sector appears to have taken into account broader socio-economic and political factors (despite this having been raised by the US Environmental Protection Agency (Siegel) in 1967).

When research was identified in the review that considered the socio-economic and political context, thus going beyond simple behavioural approaches, generally it was not concerned with AQM issues. For instance, Owens & Driffill (2008) explored behaviours in the context of energy as practice but they did not consider air quality. Within this context, the work of the AQMRC at UWE, and particularly its development through the ClairCity project forms a very notable exception in terms of a consistent focus on the study of governance processes and the development of specific social science led approaches to the management of air quality and carbon, particularly in relation to the drivers of pollution within the energy and transport domains.

3 EU Air Quality Projects

To support the analysis of interactions between social science and air quality management an structured review was undertaken of EU R&D funded projects that focus/focussed or considered air quality management as a core component. A total of 45 objects were identified relating to Air Quality Management in the CORDIS database through an open text search on the term 'air quality management'. These were then reviewed at several levels of detail to identify whether they had a significant social science component, whether or not this focussed on citizens, and whether or not they considered citizens only as a potential point of exposure or if they considered their behaviour as a critical element to consider within Air Quality Management processes. This process is described in further detail in Appendix 2, where all objects identified on the CORDIS database are listed, and summary descriptions provided for projects that passed the first screening stage.

Out of the 45 objects identified and reviewed, only nine were found to have a significant relationship with areas of social science, these are described below. It is notable that only two of these nine projects (G-FORS and SEFIRA) were found to have a substantial contribution from the social sciences, as opposed to simply using an information deficit model with regard to providing citizens with air pollution data, using non-theoretical approaches to issues of 'governance', or treating people as a blackbox that was only relevant to AQM as (for example) the driver of a vehicle, or as the receptor point for air pollution exposure.

3.1 Projects explicitly dealing with social science areas (people/citizens and governance)

THE ISSUE (Traffic- Health- Environment. Intelligent Solutions Sustaining Urban Economies)

http://www.theissue.eu/en/Project-outputs

THE ISSUE project was primarily sustainable transport project that saw is main focus on facilitating a transfer of new and emerging technologies in the ICT sector into the intelligent mobility and sustainable transport sectors.

The main outputs of THE ISSUE Project were:

- A Roadmap for the application of ICT and Downstream Space Data Products & Services to improve the economic, environmental and social health of cities & regions
- A pioneering and state-of-the-art Programme of Innovation Actions: Supporting Sustainable Transport and Intelligent Mobility in Cities & Regions across Europe (2014-2020).
- A new legal entity, THE ISSUE Meta-Cluster, a new European Special Interest Group in transport-health-environment.
- A new dynamic for university-industry-government relationships in promoting innovation in the transport and urban mobility sectors.
- A major new publication: "Space and ICT Applications Supporting Smart, Green, Integrated Transport and Urban Mobility".

- New perspectives on future patterns of urban mobility and the challenges these could present for future research and technological development programmes.

Citizens are considered in a relatively passive role within the project framing.

The project overall sought to improve the safety and security of citizens, whilst the the Programme of Innovation Actions seeks to develop ”a common vision for the future traveller experience that meets expectations of user groups and citizens”. Notably, the project makes considerable use of the term “triple-helix” by which it refers to “Science, Business and Local Authorities” or ”University/Industry/Government”.

The projects’ primary focus is on the issue of mobility. Air quality is considered to be just one of the key adverse impacts, alongside safety/security, greenhouse gas emissions. In general, the role of people/citizens within the project is simply that of ‘traveller’ or as pollution receptor.

THE ISSUE Website http://www.theissue.eu/

THE ISSUE Final Report: http://www.theissue.eu/en/a/PROJECT-FINAL-REPORT

PASODOBLE (Promote Air Quality Services integrating Observations – Development Of Basic Localised Information for Europe)

http://cordis.europa.eu/result/rcn/141390_en.html

The PASODOBLE project sought to collate and analyse user requirements for air quality assessment, monitoring and forecasting services, as well as providing “health community support services” for a wide variety of users – primarily organisations, but also vulnerable citizens. Within the final report, it poses its aspirations high in terms of the relevance of air pollution information to specific groups of citizens, asking “*Imagine families with children, a cyclist or a hiker planning a day trip. Wouldn’t it be perfect to guide them to where the air is cleanest? Wouldn’t it be perfect for sportsmen or people suffering from hay fever or asthma to have information that shows highly resolved and integrated information on physical, chemical and biological weather?*”

Under PASODOBLE, various information systems were developed, such as the UK airTEXT system which was expanded to include forecasts of air pollution, maximum temperature, grass pollen and UK-radiation. A large amount of the project focus appears to have been on the technical delivery of information, both in terms of the forecasting and the delivery of information. Work was undertaken to develop a standard prototype user interface for receiving air quality information services, and some evaluation of services was done with users – however, for the most part these seem to have been done with organisational users rather than citizens.

In general, the project and its components can be seen to have taken a simple information deficit model of citizen behaviour, with the provision of clear, understandable information on air quality being sufficient to trigger relevant action on the part of the recipients. The project offers little clear discussion of how citizens actually engage with the information and what they (are expected to) do on receipt.

N.B. Project website www.myair.eu is no longer available

PASODOBLE Final Report: http://cordis.europa.eu/docs/results/241557/final1-pasodoble-final-publishable-summary-report.pdf

APPRAISAL (Air Pollution Policies foR Assessment of Integrated Strategies At regional and Local scales)

The main focus of the APPRAISAL project was looking at reviewing Integrated Assessment Methodologies at various local and regional scales. As part of this, Health Impact Assessments played a key role, and thus citizens played a tacit part, even as just passive receptors of pollution.

Citizens were also present to some extent as 'Drivers' of pollution, however this explicitly focussed on "action resulting from or influenced by human/natural activity or intervention, in particular referring to variables describing traffic, industries, residential heating, etc.". This framing specifically promotes the classical notion of emission activity as something that can be measured in terms of, for example, road flows, kilometres travelled, gas consumption etc. and does not look behind the activities to pay attention to what behaviours or practices were leading to this 'activity'

APPRAISAL Website: www.appraisal-fp7

APPRAISAL Final Report (Layman's) http://www.appraisal-fp7.eu/site/images/download/Laymansreport_D58.pdf

SEFIRA (Socio-economic implications for individual responses to Air Pollution Policies in EU +27)

http://cordis.europa.eu/result/rcn/189380_en.html

SEFIRA is only one of two EU air quality management projects that specifically incorporated significant work on social science (the other being G-FORS). The project also made citizens a central element of the project, with the SEFIRA survey received over 16,000 responses from citizens across seven European countries in order to undertake a discrete choice analysis exercise.

There was a specific workpackage on "Individuality, Law, Society and Environmental policies" which attempted to "integrate multidisciplinary approaches from social sciences in order to collect evidence on the implementation of environmental policies and legislation regarding air and noise pollution at EU and national level". The project used political geography and social studies of governance in general (including sociology, anthropology, psychology and economics) to analyse the acceptability and implementation of air quality legislation for citizens and other stakeholders.

The final project report strongly concludes that "Integration between atmospheric and social sciences can improve policy design."

Some conclusions from the project that are particularly relevant to note in this review include:

"The Commission will be looking for Member States to put into place local measures and that these measures are likely to be 'non-technical'. Alongside this is a proposal to

enhance public information on the performance of products, and the success of national and local air quality action, by developing public-oriented indicators." (SEFIRA Policy Briefing 1)

"The criterion for 'success' in catalogues of (non-technical) measures to address appears tends to be based on public acceptability rather than on a quantitative assessment of the effectiveness of the measure in reducing pollution. This highlights a difficulty inherent in many if not most non-technical measures, namely the difficulty of quantifying their effectiveness. This generally stems from the difficulty of predicting the response of populations to measures which encourage behaviour change or which offer new choices. In many cases too it is fair to say that some non-technical measures are likely to offer marginal benefits to air quality, when compared with technical measures such as the Euro standards which offer the prospect of widespread improvements, if they deliver their initial promised reductions. This difficulty of quantification can prove a barrier to take-up of such measures, particularly where administrations require cost benefit analyses before they will act." (SEFIRA Policy Briefing 2)

"The focus [of AQM] on traffic may be partially explained by the centrality of urban environment in opinion making and civic engagement and activism that has a direct connection with policy making and accountability to stakeholders. The role of civil society actors is crucial in order to improve the policy agenda, having they the capacity to foster social support for behavioural change." (SEFIRA Policy Briefing 3)

"A change toward a sustainable system of production, distribution and mobility in contemporary daily life seems an ambitious objective but it is also the only option to really curb noxious pollution from cities. An ecological transition may take an indefinite time, while the impact of air pollution is already compromising life expectancy with an average loss of three years for each European citizen exposed to harmful air pollutants." (SEFIRA Policy Briefing 3)

"Mismatch between scientific description of air quality and the public social representation of urban air pollution is a concrete risk today. This outcome of scientific applied research can be avoided with the integration of social sciences at all level of environmental research and policy making. Environmental policies for air quality need to be re-scaled socially and geographically in order to improve the ecological integration of policies, economic activities and individual behaviour." (SEFIRA Policy Briefing 3)

From the quotes above, it is clear that the SEFIRA project clearly recognised and advocated the need for the incorporation of citizens within the air quality management policy process. However, the project comes very much from an economic/psychology perspective. The main social science focus of the work on discrete choice modelling can be seen to be a very limited approach to developing a fully social approach to air quality management. In the words of the SEFIRA Common Glossary document "Discrete choice models are a statistical tool that have application in specific disciplines such as biology to study animal behaviour. However, such models can be used to test anthropogenic interactions between humans and the natural world. However, the application of economic models such as willingness to pay (see earlier section on academic literature review), to natural resources is seen by many as controversial, as individuals often struggle to put value on something so rarely bought." This quote highlights that, the main tool, being derived from looking at animal behaviour, is unlikely to be able to (in the words of the introductory quote) "*take account of the many and*

complex reasons for vehicle use". In fact the framing of the discrete choice analysis is around public acceptability of measures (via willingness to pay assessments). As such, this frames the role of the citizen as being the receptor of a policy, someone who has a policy done to them, rather than being fully included in the development of solutions.

SEFIRA website http://www.sefira-project.eu/

SEFIRA Common Glossary http://www.sefira-project.eu/ad/wp-content/uploads/2013/11/SEFIRA_D-5.3.pdf

SEFIRA Discrete Choice Model results paper http://www.sefira-project.eu/ad/wp-content/uploads/2013/11/SEFIRA_D4.4.pdf

APNEE (Air Pollution Network for Early warning and on-line information exchange in Europe)

http://cordis.europa.eu/project/rcn/57858_en.html

The APNEE project attempted to take a slightly more advanced version of the traditional information deficit model of air pollution communication with citizens. However, as the project ran between 2000 and 2001, little of the project is of significant relevance today, as it was undertaken in a world where "Most publishing approaches are limited to mere tables, and there is no approach addressing early warning and dynamic information providence. " (Rose et al., 2002). Therefore the more advance methods of communication have now, to a large extent, become common practice, and the processes advocated by the project largely taken up, or been superseded by those considered within projects such as PASODOBLE (see above).

The project took what it described as a 'citizen centred' approach to information provision (rather than an 'expert view'). It recognised that that" the public should not be treated as a one-piece monolithic body, but that the multiple identities and profiles of each individual user should be considered carefully" (Rose et al., 2002). However, there is little or no evidence in the information around the project about the extent to which variations in user preference and responses to information and mode of information were actually explored).

APNEE website http://www.faw.uni-ulm.de/apnee No longer available

APNEE Final Report Untraceable

Rose, T. H., Peinel, G., Sedlmayr, M., & Karatzas, K. (2002). Citizen-centred dissemination of air quality information on multi-modal information channels: the APNEE project. In SATURN* EURASAP workshop proceedings: urban air quality management systems. Munich: EUROTRAC ISS (Vol. 103, p. 110).
https://www.researchgate.net/publication/228794989_Citizen-centred_dissemination_of_air_quality_information_on_multi-modal_information_channels_the_APNEE_project

MIRACLES (Multi-Initiatives for Rationalised Accessibility and Clean, Liveable Environments)

http://cordis.europa.eu/project/rcn/86853_en.html

The MIRACLES project was a transport project that placed reduction in air pollution (and other 'transport related environmental impacts at the local-level') as one of its main aims, alongside: increasing accessibility, improving transport management and improving citizen's quality of life.

These aims appear to have been sought to be achieved through a mixture of relatively conventional measures, such as the provision of "pre-trip" and "on-board" information for public transport users, new park and ride services, quality bus partnerships, cleaner vehicles, new and improved cycling facilities etc. As such, the project gave little attention to people/citizens other than in terms of being service users, and being the target of better information or infrastructure. There is little evidence of consideration being made to their decision-making processes beyond simple information deficit or economic rationality models.

TRIMIS webpage for MIRACLES https://trimis.ec.europa.eu/project/multi-initiatives-rationalised-accessibility-and-clean-liveable-environments

MIRACLES Final Report
https://trimis.ec.europa.eu/sites/default/files/project/documents/20090917_163228_19121_MIRACLES%20-%20Final%20Report.pdf

INTEGAIRE (Integrated Urban Governance and Air Quality Management in Europe)
http://cordis.europa.eu/project/rcn/61296_en.html

The INTEGAIRE project was an FP7 project involving 6 research/policy organisations and 11 partner cities. The aim of the project was to review current good practice in air quality management from a governance perspective across Europe. As such, the project covered a very wide range of issues, and it collated examples of best practice within an online and CD-ROM based database (link below). These were then structured under four headings of Governance; Legislation; Assessment; and Planning and Measures. Given the focus on Governance, which led to a significant emphasis on policy and regulation, as well as the general technical focus of AQM to be technocentric, it is perhaps not surprising that the vast majority of database content contained little that related significantly to citizens in detail. However, there were some specific issues/topics of relevance. These are listed below under the main headings (N.B. each title is hyperlinked to the relevant page for the Issue or Topic in the database for further information).

Governance

Participation of Stakeholders

- Informing the public
- Consultation and Participation
- Active public involvement in relation to LA21

Legislation

Implementation of EC Air Quality Directives

- How should the public be informed about the Air Quality situation?

Assessment

Air Quality Assessment, Tools and Methods

- How to develop scenarios for Air Quality in the future?

Planning and Measures

Traffic Measures: Improvement of Travel Demand

- The potential of Mobility Management
- Taxation regimes
- How can telematics help in improving air quality?
- Tele shopping – Tele working – Home delivery
- Is car sharing effective to improve urban air quality?

Land Use Measures: Land Use Change

- Residential Areas
- Regeneration and Newly Developed Areas
- Existing Land Use Planning Policies including LU & TR relationships
- Pedestrianised areas
- Relocation of business activities

Whilst the range of measures and considerations identified in AQM practice clearly indicates a recognition of a role for citizens and a need (both practical and legislative) to engage with citizens, none of the elements involves what might be recognised to be a significant relationship to a clear social science informed approach, or research to support it. As has been found in AQM in general, there are a range of easily recognised approaches that are recommended, however there is little in the way of a strong evidence base, or theoretical explanation as to why and how these should be implemented

INTEGAIRE website www.uwe.ac.uk/integaire

INTEGAIRE Final Reports (incl. reports to CAFÉ and research community) http://www.uwe.ac.uk/integaire/Project.html

INTEGAIRE Good Practice Database http://www.uwe.ac.uk/integaire/database-new/gpdb.html

LENVIS (Localised ENVironmental and health Information Services for all: User-centric collaborative decision support network for water and air quality management)
http://cordis.europa.eu/project/rcn/87602_en.html

The LENVIS project was aimed at providing improved information on environmental issues and heatlh risks to a range of local stakeholders to improve their decision making (creating a "decision Support Network" as opposed to just a system). Air quality was a major focus of the project alongside water quality. Citizens played a key role in the project, however, it appears that they were defined (as User-Peers) fundamentally in terms of their relationship with the information system as opposed to considering them within any significant social or personal context. There was an overall focus on users as organisational representatives as opposed to the general public (i.e. public agencies, municipalities, health services, environment related software companies and research centres).

Project webpage www.lenvis.uk Untraceable

Final project report Untraceable

Webpage on project at partners site http://www.francescoarchetti.com/?page_id=101

Evaluation report http://cordis.europa.eu/docs/projects/cnect/5/223925/080/deliverables/001-D83aValidationItalyFinalreportpdf1.pdf

G-FORS (Governance for Sustainability)

http://cordis.europa.eu/result/rcn/47695_en.html

The G-FORS project was the only AQM related project that was identified as coming from a clear social science led perspective. The project examined how new structures and patterns of governance might and should be formed in response to the increasing development of a 'knowledge society'. The problem of air quality management (specifically with regard to particulate matter) was chosen as one of three study areas (alongside emissions trading and strategic environmental assessment).

The project particularly identified how the European Union policies had been establishing new multi-level governance arrangements, and that new approaches to policymaking and implementation are likely to be necessary in order to properly establish and activate key economic, social and political roles of sub-national actors.

G-FORS identified three particular 'knowledge bundles' that represented different groups of actors (or different modes of actors). These were:

- Scientific/expert/professional knowledge (bundle 1);
- Steering/institutional/economic knowledge (bundle 2);
- Everyday/milieu/local knowledge (bundle 3). (Atkinson and Klausen, 2011)

The project concluded, that within AQM, bundles 1 and 2, overwhelmingly dominated the implementation of policy and practice. That is to say that institutional actors (or actors acting in institutional roles) dominated the processes, thereby tending to exclude citizens from both the perception of the problem and of the solutions. This finding is exactly what is reflected in the quote from the residents group that was used in the introduction (and the full text of which has been included as a postscript to this document). The tendency of each bundle is to focus on their own expertise and level of influence, and thus actors within bundle 1 tend to focus on the technical aspects of problems, and actors within bundle 2 or procedural elements. This is not just with regard to proposed solutions to problems, but to the definition of the problems in the first place. As such the analysis of the G-FORS project makes it clear how, as evidenced in so much of this review, little work on AQM to date has put a clear identifiable role for citizens, both in terms of the problem or in terms of the solutions.

GFORS Final Report http://cordis.europa.eu/docs/publications/1243/124376951-6_en.pdf

Atkinson, R., & Klausen, J. E. (2011). Understanding sustainability policy: Governance, knowledge and the search for integration. *Journal of Environmental Policy & Planning*, *13*(3), 231-251. http://dx.doi.org/10.1080/1523908X.2011.578403

3.2 Conclusions

The results of the search on the CORDIS database have identified only two projects that approached the issue of air quality management from a strong and overt social science perspective. The first of these, SEFIRA, used a Willingness to Pay type methodology of stated preference surveys over a very large sample (n>16,000) in order to assess the acceptability of air pollution measures. Whilst notable as one of the few projects to consider social science approaches, as identified in the academic literature review section, WTP is not particularly novel, and it has been used extensively to date in CBA aspects of AQ policy development. Also, being a primarily economic approach, it does not come close to attempting to tackle the complex social and structural factors that underlie vehicle usage and home heating.

Whilst a number of projects considered governance processes within air quality (e.g. INTEGAIRE), only one project (G-FORS) approached this from a clear social science perspective. The conclusions of this project clearly reflect some of the arguments made in this report regarding the bias within AQM towards scientific and institutional knowledge and away from the everyday knowledge and experience of citizens.

4 Review of air quality policies and plans

This section reviews some of the existing air quality policies, position papers, and plans in order to explore the ways in which policymakers have tackled the issue of air quality in the EU, since the adoption of the Ambient Air Quality Directive 2008/50/EC (and related legislation). In line with what emerged from the review of the academic literature, the analysis of policies reveals that, so far, there has been a limited attention to social sciences in efforts to reduce air pollution. The next section illustrates the theoretical framework for the policy analysis. This review selected a sample of policies from Italy and the United Kingdom to provide an overview of policies and plans in two quite distinct governance structures, the UK being tightly centralised, whilst Italy has a strongly devolved regional structure. The policies analysed focussed on Italy's national and regional air quality plans and the UK (six quality plans for Urban Areas published by the Department for Environment, Food and Rural Affairs (but based on local plans), and the Scottish Government's Cleaner Air plan). The overall review indicates that very few plans explicitly consider citizens' behaviour and the deeper socio-economic aspects of the air quality issue.

4.1 Issue framing and measures adopted

Cairney defined 'issue framing' as the definition of policy's image (how an issue is portrayed and categorized). There is extensive research in political science and public policy on the effects that issue framing has on policies (Cairney 2012, pp 175; Carter 2007). Already in 1972, Downs introduced the idea that the public attention towards an issue follows a cycle along which an issue moves up or down the political agenda (Carter 2007, p. 191).

Moreover, other authors have pointed out that issue frames influence the policy cycle beyond the agenda setting stage and that they "influence ensuing policy dynamics over the long run to the extent that the specific representation and delineation of policy issues shapes the formation of substantive interests and at times restructures political constituencies" (Daviter 2007, p. 655; Pierson 1993). In other words, the way policy makers frame the issue at the policy formulation stage influences the policy itself, its scope and implementation.

In light of this, this section looks at the extent to which policy makers frame the air quality issue: whether they frame it as a crosscutting issue or a narrow issue. In particular, the review explores whether the problem is defined in narrow terms within the governance system or whether there is an understanding that the management of the problem should not be restricted to a single domain or specific sectors (Candel & Biesbroek, 2016, p. 219). Moreover, it looks at the measures (already adopted or, in some cases, suggested) and explores the extent to which they build on social science approaches.

4.1.1 Italy

The analysis of the Italian plans showed that they overwhelmingly tend to consider air quality in the narrower sense, and not as a crosscutting societal issue. This means that they identify specific sectors to tackle and focus on reducing the emissions from each of them individually. This means that the contributions to air pollution are treated as separated from the wider social context. In other words, the social dimension of the air quality issue plays a very limited role in the framing of the air quality problem.

The 2015 Italian national plan brings together the data, the measures and the results from individual regional plans and describes its strategic aims in terms of legal compliance and measures to reduce emissions. The document focuses on the technical assessments of the emissions and concentrations and, consequently, the measures (p.20) focus on the key polluting sectors and are disproportionately command-and-control and technical in nature. Citizens' behaviour is taken into consideration only insofar as interventions can encourage citizens to use more sustainable transport or choose more energy-efficient domestic appliances, mainly through subsidies.

According to the national plan, regions' AQM efforts concentrated primarily on Mobility (74%), followed by Domestic and Commercial activities (13%), Industry (2%) and Agriculture (2%) and Agriculture (1%). Examples of measures include (p. 62):

- Replacement of old vehicles with newer, more efficient vehicles
- Improved public transport, including improved infrastructure for trains, trams, metro lines
- Speed limits and limited traffic zones in urban areas
- Stricter regulation of goods deliveries in urban areas
- Car sharing; taxi sharing initiatives

Moreover, while all the plans included a section on information and public participation, these referred to consultations during the preparations of the plans, and information was only mentioned as a way to raise citizen's awareness regarding the effects of certain pollutants (such as PM_{10} or $PM_{2.5}$) on health, thus following the information deficit model.

Furthermore, the almost tokenistic nature of information awareness campaigns as a way to reduce emissions is exemplified in the Valle d'Aosta regional plan. Interestingly, the plan identifies the need to increase citizens' knowledge about the status of air quality in the region but it predicts low-to-middle effectiveness potential (hence, priority) to communication and information campaigns.

A few exceptions to this included the regional air quality plan of Puglia (2008), Umbria (2013) and Liguria (2006). These plans stand out compared to the other Italian regional plans that were analysed as they explicitly state that air quality represents a challenge that requires the active contribution of citizens. Therefore, in these plans, the framing of the issue is a crosscutting problem that concerns everyone and so the whole approach to developing plans and strategies encompasses the consideration of citizens' behaviour.

However, while these plans point to the need to change citizen's lifestyle, they offer limited solutions and generally still over-rely on infrastructural improvements. For example, the Puglia regional plan (2008) aimed to integrate cycle paths and train stations in order to encourage the use of more sustainable means of transport.

According to the plan, the measures to reduce the contributions from the transport/mobility sector in Puglia (p.153) can include:

- Command-and-control measures such as bans for more polluting vehicles in urban areas and, particularly, historical centres;
- Paid parking zones, including for mopeds
- Congestion charges
- More buses/trains
- Integration of parking spaces for bikes or bike-sharing and bus/train stations

- More and better cycle paths
- Car pooling and car sharing

Similarly, the Umbria plan (2013), despite stating at the very beginning (p.1) that air pollution is a responsibility of all citizens, it offers only very limited advice about options to use (pp. 45-49):

- Installation and maintenance of adequate wood-burners and use of adequate wood/fuel
- Adequate and appropriate use of domestic heating systems and of energy-efficient domestic appliances
- Cycling and public transport as main mode of transport, and eco-driving (including the use of electric cars or electric bikes)
- Preference for locally produced food
- Awareness raising campaigns regarding fires, particularly in woods or forests.

Finally, the Liguria plan (2006) goes a bit further and focuses on lifestyle changes and takes into account the overall quality of life of citizens. The plan pushes for an integrated and synergistic approach between all the key stakeholders, public authorities, NGOs, professional associations, and civil society to reducing emissions and raising awareness among citizens, with particular reference to schools and universities. Nonetheless, the measures in the plans follow the traditional sector-specific and techno-centric approach that characterises the other plans and, thus, miss out on acting upon the social variables that determine lifestyles and choices.

4.1.2 United Kingdom

Compared to the Italian plans, the UK air quality plans deal more explicitly with citizens and the measures aim more directly to changing citizens' behaviours. Furthermore, in the UK plans there is a much more explicit recognition of air pollution as a threat to human health and as a crosscutting societal issue. The plans do not consider changes in the way people travel as "desirable" or "secondary" compared to the more prominent command-and-control measures that characterise the Italian plans. For example, in the 2017 Greater Manchester Air Quality Plan, the increase in number of people travelling actively (p. 16) as a result of a cultural and lifestyle change is considered as a necessary outcome, not a secondary one.

As a consequence, in the UK plans, the focus is more on citizens' preferences and mobility choices and therefore more directly targets behaviours. In particular, the UK plans are more specific than the Italian plans in spelling out measures to encourage active travelling. For example, in the 2017 West Midlands Air Quality Plan, the measures that target behaviours include personal travel planning, thus suggesting the need to consider individual needs and specific circumstances in parallel to a more generic and top-down intervention to encourage transport behavioural changes.

With regard to information campaigns, the measures mentioned in the UK plans are not limited to generic awareness raising of the effects of pollutants on health; rather they go a bit further in that they include communication and alerts to citizens (through texts, media and social media) during high and very high pollution episodes (for example, the plan for the 2017 Greater London Urban Area). This means that although citizens are treated as information recipients, the assumption is that then they can act immediately and change their behaviour immediately once the information is gathered. However, the behavioural change

envisioned by the alerts is likely to be only temporary and limited to the occurrence of isolated pollution events, rather than longer-term lifestyle changes linked to the ongoing air pollution problem. In other words, even if citizens are considered in more active terms in this model of information campaigns, the overall policy approach is still very much reactive rather than proactive.

The social dimension somewhat features in the 2017 plan for the Greater London Urban Area, which acknowledges the existence of vulnerable people (children, older people or hospital patients) that are disproportionately affected by pollution. Disappointingly though, vulnerable people feature in the plan only as air pollution receptors, whose exposure to emissions has to be minimised or more strictly monitored.

By contrast, the 2015 Cleaner Air for Scotland plan is the policy document that makes the most of social science inputs into trying to understand the root causes of the air pollution problem. In terms of issue framing, air quality is not only positioned as a crosscutting societal challenge, but also a problem in terms of social and health *inequalities* (thereby linking into a separate social agenda that is concerned beyond simple net health benefits/disbenefits). This is reflected in the overall plan, which demonstrates more ambition than the other plans analysed for this review. Indeed, the plan includes not only a dedicated section about citizens' behaviour (p. 40), but it also mentions more advanced methods for citizens' engagement, such as citizen science approaches to promote air quality to young people (p. 71). Moreover, the social science component is clear in the section on changing personal behaviour. Indeed, the plan recognised the importance of providing information that helps people to understand the effects of pollution on them, but it also acknowledges that this is not enough:

"*However, simply raising concerns about air pollution and health without providing any solutions or practical alternatives to enable personal change, is likely to be counterproductive and result in a negative, resigned attitude to the issues*" (p. 41).

According to the Scottish policymakers, in order to effect change, communication needs not only to take into account individual personal factors, but also the wider context, such as the social context (norms, expectations, etc.) and more generally material issues. For these reasons, the plan calls for local agencies, authorities, local NHS boards to work together to tackle the air quality issue.

4.2 Concluding remarks

To conclude, the review focussed on Italian national and regional air quality plans and on UK local air quality plans, including the Scottish national plan. The evidence gathered points to a lack of attention to the social science domain: the measures included in the plans are disproportionately technical in nature and aim at tackling specific sectors, for instance transport or delivery of goods, or industries. Even the few plans that attempted to go beyond command-and-control measures and aimed at changing citizens' behaviour were predominantly limited to infrastructural investments and subsidies to less polluting vehicles and domestic appliances. The Cleaner Air for Scotland plan, seemed to show more ambition than the others in that it considers the wider implications of air quality in terms of health inequality, and acknowledges the limitations of the existing approaches, including the information deficit model. Positively, the plan recognises that if policymakers want to

encourage and effect behavioural changes, they need to look at individual circumstances and understand what determines people's choices, including not just material barriers but also norms and expectations.

5 The role of citizens in improving air quality and reducing carbon footprints

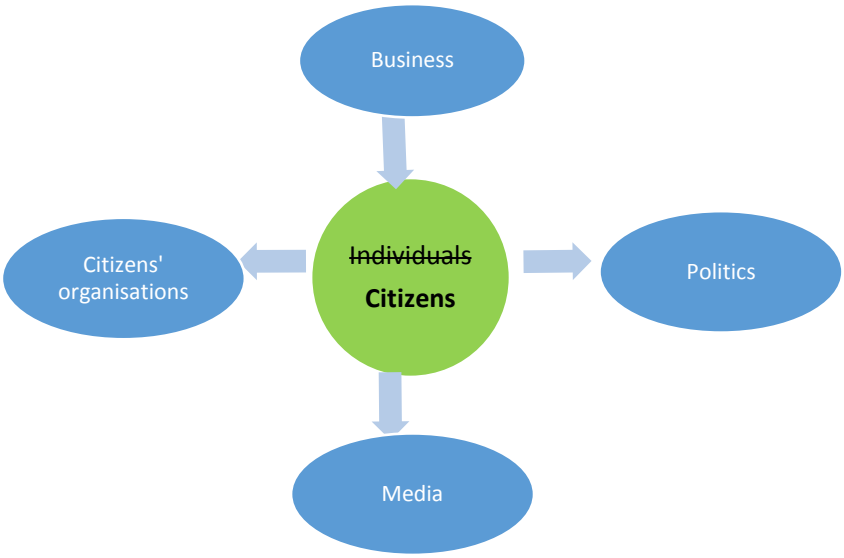
Following the formal, structured reviews undertaken by the University of the West of England, and presented in Chapters 2 to 4, the following two chapters present a practitioner perspective. The Regional Environmental Center for Central and Eastern Europe (REC), an international organisation with a mission to assist in addressing environmental issues, write this section. The REC fulfils this mission by promoting cooperation among governments, non-governmental organisations, businesses and other environmental stakeholders, and by supporting the free exchange of information and public participation in environmental decision-making.

Having found little evidence for a formal role for citizens in social science literature or policy, this chapter presents a pragmatic perspective on the current inclusion of citizens within the AQ&CM processes.

5.1 State-of-the-art analysis

Citizens have rather unique dynamics with regard to the improvement of air quality and reducing carbon footprints. In contrast to citizens' organisations (i.e. NGOs, see related analysis) – they do not act in an organised way, in fact, each person has their own approach, opinion and way of acting in relation to this topic. Citizens tend to 'stay in the background', and only when larger groups of people get concerned or motivated about a particular issue do they move to the next level and act in an organised way. This process can occur spontaneously (e.g. air pollution gets so bad that people start acting about it), but it can also be stimulated. This stimulation can occur through raising the awareness of people about air quality, carbon footprints and public health, and then motivating them to act by giving them innovative tools to use.

Although the "general population" cannot be considered as a proper, well-defined, target group suitable for any specific action or project, citizens do play a central role through their interactions with key stakeholder groups. Citizens contribute to air pollution and carbon emissions through their consumer behaviour, through their political engagement (e.g. participation in public referendums and political voting), through their levels of awareness and through their active self-organisation. The following simple diagram illustrates these linkages with the four biggest stakeholder groups.



As, was highlighted by the ECN 'Sustainable Lifestyles 2050' report (Backhaus et al., 2012), most people in Europe tend to be aware of the main environmental and health challenges. However, it is easy to underestimate the ramifications of personal behaviour. One example is active travel. Cycling, walking and other forms of active travel have extensive positive effects on the level of individual (e.g. better health, cost saving) and on a societal level (e.g. less noise, better air quality, reduced external costs). When approaching the issue of air pollution in a holistic way (e.g. also tackling issues of health, employment, societal issues, spatial planning, lifestyle and a lot more), there is a vast potential to improve air quality and to reduce carbon emissions. The main beneficiaries of such an improved living environment are certainly the citizens themselves – and at the same time, they are also the ones that demand further improvements.

One important current tool for involving people in solving societal and environmental problems is community planning. This is especially important in the area of spatial and neighbourhood planning: bringing in people to the street infrastructure planning from the very beginning, through a series of community planning workshops. One example of the move towards far more participatory approaches in planning is the Sustainable Urban Mobility Planning (SUMP) process (Wefering, 2013). In an urban context, a large number of domains which impact on air quality (e.g. mobility, space heating, consumption & production etc.) can be first tackled through appropriate spatial planning (Rydin, 2010). Spatial planning has considerable implications for air quality (e.g. compactness of cities, distances driven, types and sizes of dwelling, positions of point sources in the urban fabric, wind channels etc.). By involving citizens in the planning process multiple objectives can be met in a single process: the quality of planning may increase (citizens are often the best experts of their own neighbourhood), the public acceptance of implemented measures can improve, and costs can be saved (citizens very often prefer low-cost, neighbourhood level interventions over and above costly infrastructure works).

Finally, one must draw the attention to the importance of behaviour. This is also one of the main findings of the EU's CONCERTO demonstration projects (http://www.ecolife-project.eu/TheConcertoInitiative.html). The CONCERTO initiative provides a platform for the exchange of ideas and experiences between the 45 CONCERTO demonstration communities, and other cities that are committed to introducing similar strategies.

Communities participating will benefit from the shared expertise of Europe's most advanced communities, active in the field of energy sustainability.

It is not enough to establish an energy-saving, low-emissions built environment, to minimise energy consumption, it is equally important for citizens/building occupants to behave in an energy efficient manner. A number of research projects indicate that buildings' energy-efficiency and emissions-levels are significantly influenced by the behaviour of human occupants (e.g. Janda, 2011). One particular example of this arising in the ClairCity demonstration cities/regions is either the retro-fitting of wood burning appliances in houses which already have modern, relatively clean central heating, or the use of particularly dirty fuels (including waste) within existing solid fuel fireplaces and stoves

5.2 ClairCity societal target segments

The fabric of our societies is complex. It varies considerably between geographical locations in terms of age profiles, cultural background, economic status etc. Therefore, it is important to be aware of the social composition of each demonstration city when designing ClairCity activities to engage the public. The following table collects some of these aspects and indicates those social segments where the project can most effectively involve citizens.

Table 1: Matrix of ClairCity's targeted social segments and their behaviour characteristics
(=some relevance, ** = medium relevance, ***=high relevance). Developed by REC.*

Social segment	Main characteristics	Vulnerability to air pollution	Needs external support or push to change	Most contribution to local[1] air pollution	Likeliness to change behaviour	Most important for ClairCity citizen engagement
Children	Open-minded, quick learners	***	***	N/A	***	***
Working age	Economic driver	**	*	***	**	*
Pensioners	Has time, influences others, difficult to change	**	*	*	*	***
Low income	Focus on economic aspects	**	**	**[2]	*	**
Middle income	"Consumer society"	*	**	**	***	**
High income	1. Most intense consumers. 2. Can afford expensive low emission technologies	*	**	**[3]	**[4]	*
Healthy	Ready to act	*	*	**	**	**
Disabled or with health problems	Most vulnerable to air pollution or climate disasters	***	***	*	**[5]	**
Active in community	Opinion leaders	**	*[6]	*	***	***
Passive in their community	Don't care about change, difficult to influence	**	***	**	*	N/A[7]
Well informed	Focus on actions	**	*	*	***	**
Not well informed	Needs to be aware of problems	**	***	**	**	***

[1] In ClairCity we are not considering e.g. overseas flights or consuming products that cause air pollution elsewhere.
[2] For example burning low-quality fuel.

[3] High contribution due to high level of consumption. (E.g. big house, big car, high car mileage)
[4] If behaviour change means cutting back on their consumption levels – it is more difficult. If it is about switching to eco-technologies (e.g. demanding no real behaviour change) – it should be easier.
[5] If it is about changing behavior to positively impact their health – behavior change is more likely. If, on the other hand, health issues prevent desired behavior change, then it is more difficult.
[6] They may need guidance and professional support.
[7] They need significant levels of external push to change behaviour. For ClairCity this target group's relevance is limited as in the first place we want to convert those who *can* be converted.

5.3 Specific advice for ClairCity activities

Based on the identification and analysis of the targeted ClairCity sub-groups this section provides specific advice, which will be used in the detailed development of the ClairCity workshops, the app and the game. As (directly and indirectly) changing behaviour is a consideration of ClairCity, it is important to build on the findings of latest research in social dynamics as well as in relevant European demonstration projects. The following list contains such recommendations.

- Pick low-hanging fruits: focus on those segments that are open to change (e.g. car drivers ready to shift mobility mode or children) (Wefering, 2011; BAMBINI 2012)
- Target high emitters: These may come from very different social strata: e.g. can be high-income segments with high consumption rates, as well as low-income or low-educated segments, with very detrimental behaviour in some European cities (e.g. burning household waste). (Krakowski Alarm Smogowy, 2016)
- Engage those segments that are most vulnerable for air pollution and climate change effects (e.g. children, low-income groups, elderly). (AENEAS, 2011; BAMBINI, 2012)
- Select the most important air-quality issue of each ClairCity and build actions around those.
- Assure sustainability of actions by involving a number of stakeholders all throughout the process (e.g. local municipality, schools, business, media, social institutions, NGOs etc.) (Vink at al., 2008; ÖGUT 2007). Links ideally need to be maintained after the end of the ClairCIty project and so emphasis is being put on recognition of the value for the city/region that these links can provide so that there is interest in maintaining them after ClairCIty funding has ended
- Measure both change and results/outcomes (e.g. not just the number of households switching fuel or number of people changing mobility form, but also changes in energy use, in traffic flows, and ultimately changes in atmospheric pollutant levels) and in health outcomes. Figures and trends need to be recorded in the first instance, and then change communicated through media and other means. (Sang-Hoon at al. 2012; Laurent et al., 2005)
- Engage opinion-leaders, i.e. identify those persons in the local community who have progressive thinking and are active in public making them 'champions' that can be utilised in the campaign. (Valente & Pumpuang, 2007)
- Communicate, communicate, communicate. There should be extensive coverage of the issue in local media, social networks etc.: people should be aware of the problem itself, know that action is in progress, and should learn about results. (Tonc, 2002; Leiss et al., 2005)
- Use well proven marketing techniques of the consumer world to tell people that there is a problem and what action they should take. (Leiss et al., 2005)

- Keep things simple. The key message should be simple, the methodology of citizen involvement should be clear, the design of the game should be self-explanatory etc. (Kapp et al., 2012)
- Overcome cost and time barriers. ClairCity actions should not require any significant cost or time investment (travelling to venue, infrastructure modifications in households, time slot of actions etc.).
- Make the evidence relevant to people and their behaviour / daily activities

There are many good example case studies in the networks of sustainable cities and healthy cities that explore the different needs, roles and responsibilities of the population. These include examples of the targeting of both high polluters and also vulnerable groups of citizens (children, old people, disabled people, etc.) who need both additional support to change behaviour both to reduce their impacts, but also to reduce their exposure (for a summary of many of these see Carmichael et al., (2017)).

5.4 Conclusion

From the practitioner point of view, this chapter demonstrates that there is clear potential for much greater formal integration of citizens within air quality management processes. The ability to distinguish between different groups of citizens indicates a need for a much more nuanced approach to the inclusion of the public(s) than simply treating the as identikit 'individuals'. There is considerable work that has been done in the transport sector on formal segmentation of people in order to be able to target policies and engagement strategies appropriately (see for example Anable, 2005). However, many of these approaches have, to date, focussed more on psychological factors, such as attitudes and preferences, than on their interlinkages with social and structural conditions.

Within the wider scope of environmental/sustainable planning, there is a clear experience base of public engagement within community planning. However, as the rest of this document shows, there is little evidence that these approaches have successfully made their way into general air quality management practices to any great degree.

6 The role of civil society and NGOs in improving air quality and reducing carbon footprints

As with the last chapter on citizens, this chapter presents a practitioner perspective from the Regional Environmental Center for Central and Eastern Europe (REC) on the role of civil society and its component organisations within the current air pollution domain.

6.1 Introducing 'civil society'

The term 'civil society' term was not frequently used fifty years ago. Today policy makers in Europe know the great potential of working with civil society and establish mechanisms to work with them in air quality, climate change mitigation and public health improvement. Key questions regarding the role of civil society are:

- ”How can governments better work with civil society for clean, healthy and sustainable societies and cities keeping in mind the future challenges towards 2050?”; and
- “What are the overall context and instruments for the cooperation of civil societies and local governments to reach the sustainable development goals and targets?” (Greer et al., 2017)

6.1.1 Civil society definition:

Civil society has been defined as “the aggregate of non-governmental organisations and institutions that manifest interests and will of citizens” and therefore can be seen to consist not of *individual* citizens but coordinated group[s] of them (Greer et al., 2017).

The World Bank (http://www.worldbank.org) interacts with thousands of Civil Society Organisations (CSOs) throughout the world at the global, regional, and national levels. These CSOs include NGOs, trade unions, faith-based organisations, indigenous people’s movements, and foundations. These interactions range from CSOs who critically monitor the Bank’s work and engage the Bank in policy discussions, to those which actively collaborate with the Bank in operational activities. There are many examples of active partnerships in the areas of forest conservation, AIDS vaccines, rural poverty, micro-credit, and Internet development.

In UNDP’s (http://www.undp.org) guided process CSOs are no longer restricted to the role of service delivery but are increasingly influential in policymaking and performing watchdog functions. Among its potential CSO partners, UNDP includes intermediary non-government organisations (NGOs), cooperatives, trade unions, service organisations, community-based organisations (CBOs), indigenous peoples' organisations (IPOs), youth and women's organisations, academic institutions, policy and research networks, and faith-based organisations. UNDP engages with CSOs that work towards inclusive globalisation, promoting accountability, increased political participation and linkages between the grass roots and the national policy arenas.

For FAO (http://www.fao.org) civil society refers to all groups outside government such as community groups, non-governmental organisations, labour unions, Indigenous Peoples' organisations, charitable organisations, faith-based organisations, professional associations and foundations. Civil society expresses the interests of social groups and raises awareness of key issues in order to influence policy and decision-making. In recent decades, Civil Society Organisations (CSOs) have been successful in shaping global policy through advocacy campaigns and mobilisation of people and resources Good example is the Sustainable Development Goals global agenda and its implementation. Good examples of the participation of civil society in the sustainable development process globally (SDG) and the environment and health process in Europe have been well documented by the WHO (Carmichael et al., 2017)

In the European Union one of the main reasons for this increased interest on the part of the European Union is the need to enhance social cohesion in the construction of a multicultural Europe. Achieving social cohesion in a multicultural Europe (Council of Europe, 2006)

Civil society organisations - that is to say those created by and for citizens - are seen as best placed to favour sustainable cohesion in a multicultural context. In addition, the much-vaunted move to a so-called knowledge society has shifted attention to non-formal ways of

learning; in particular based on personal experience. Here again, it is those informal organisations closest to citizens that are seen as best placed to be the places where non-formal learning can take place in an on-going way. (Greer et al., 2017).

6.2 Civil society in current time with future challenges:

Civil society in general, and CSOs/NGOs as recognised organisations in particular, are already actively contributing to improving air quality and reducing carbon footprints in a number of ways. The following analysis will provide a summary of these activities in a European context. The term 'civil society' is used here to mean an aggregate of citizens and their organised interest groups ('NGOs') in order to represent specific interests (in this case primarily those of health and environment.) While the terms 'civil society' and 'NGOs' are often used along one another, the main focus of this analysis is primarily on NGOs (i.e. non-governmental, non-profit organisations, also called civil society organisations "CSOs".) The reason is that these are interest groups with clear missions and way of working, therefore relevant subjects of such an analysis.

Although in policy, air pollution has often been treated as a standalone subject (see for example Olowoporuku et al., 2012), from the civil society gaze, air pollution is usually becomes just one issue amongst many within a more holistic approach that focusses on environment, health and liveable cities. Liveability and/or sustainability are increasingly being linked to the agenda of 'smart cities'. However, it should be noted that this term ('smart') can be considered an empty or floating signifier that potentially means everything and nothing (or 'all things to all people' without having a clear agreed upon definition. Smart cities initiatives tend to be heavily focussed on upgrading infrastructure with a heavy/primary concern on competitiveness, innovation, efficiency, ITC etc.

Where used in a holistic manner, the smart city agenda may actively promote urban development where a high quality of life is achieved through a balanced, integrated and energy-efficient development of the local economy, natural and human resources, and built environment. The Amsterdam Smart City network is one example (https://amsterdamsmartcity.com). The goals of this action program Smart Mobility contribute to the goals of the Executive agenda Mobility and Agenda Sustainability: improving the safety, accessibility, quality of life and attractiveness of Amsterdam.

A number of seemingly new roles of civil society organisations are being pointed to as essential to society at large especially in the new SDG agenda 2030 (www.sustainableBrands.com, 2016). One such role is that of promoting social cohesion. Taking part in civil society organisations can serve as an ongoing apprenticeship for an open attitude towards diversity and at the same time, contributes to strengthening local culture and identity. Such a role, however, is not necessarily in the forefront of the aims and preoccupations of most local organisations.

Another role is that of lifelong learning. As a response to ever increasing speed of change and the complexity of the modern world as well as the cut throat competitiveness that drives many activities forward, politicians and educationalists have come up with the idea of lifelong learning. Although this lifelong learning effort is often seen from the perspective of institutionalised, formal education and training, there is a growing awareness of the importance of tacit knowledge based on personal experience (Ross, 2017). In seeking ways and means of enhancing such non-formal learning, public authorities are turning to civil

society bodies as potential relays. The theory is that associations, being closest to the everyday life of citizens, are best placed to encourage a "learning attitude" and to create a suitable context in which such learning can take place. Now, although there has been a tradition of training and the development of competencies in certain civil society organisations, there is less of an overt tradition of exchange of experience with a view to learning, except possibly in organisations catering for a particular professional sector (Ross, 2017).

The dilemma on the part of public authorities is how to support such roles without intervening directly in the life and activity of civil society organisations. The underlying concern is that direct intervention on the part of authorities or their mandated organisations could well be counter-productive in developing tacit knowledge (reflective, experience based) or an active attitude to social cohesion (Matthew & Sternberg, 2009). The generally accepted solution is to create a favourable context in which such civil society activities can flourish. This might entail modifying existing legislation, providing financial assistance, organising general training schemes. But is also requires an openness and a willingness to allow and to encourage groups of citizens to take an increasingly active part in the life and decision-making of the community (Greer, et. 2017)

6.3 Civil society for reduced air pollution and carbon footprint

Air pollution is a subject where the so called ‘cocktail effect’, i.e. the aggregated effect of different pollutants from various sources combine to create a synergistic impact (Kienzle et al, 2014). This requires air quality management (which focuses on the ambient concentration and health risks rather than specific emissions from specific processes) to have to deal with a very wide range of sources (and which ones are most important varies greatly between different locations). For example, in some places the largest source of $PM_{2.5}$ emissions (as much as 75% in winter) comes from non-industrial combustion sources, mainly from transport and households burning wood according to the report of the Norwegian Meteorological Institute (EMEP, 2014). Road transport is responsible for almost half of all NOx emissions; and up to 40% of SOx emissions come from industrial sources in Europe (EMEP; 2014). For this reason, this analysis looks at different sources of pollution, of which the most relevant ones for ClairCity include transport, households and industry.

NGOs play a very important role in awareness raising about environmental and health challenges. Although most organisations act on national and/or sub-regional levels, some well-established, nationally or internationally active NGOS also mobilise citizens to put pressure on decision-makers. NGOs may also play an important role even in global processes, such as the UNFCC COP (Conference of Parties) or the TTIP (Transatlantic Trade and Investment Partnership) negotiations. In fact, their pressure played an important role for achieving a relatively strong agreement at the Paris climate change negotiations in December 2015. (http://www.un.org/sustainabledevelopment/cop21)

Civil organisations are very active in shaping the climate change policies of the countries and push them to reach higher decrease of emission. Around the world there are a few climate change lawsuits. In 2015 for the first time ever, judges accepted human rights arguments for demanding a country make deeper greenhouse gas emissions cuts in the Netherland (http://www.climatechangenews.com).

Most civil society initiatives are concerned with national and neighbourhood-level problems and local quality of life. Therefore, they also support local environmental decision making (for example in cities) through the encouragement of citizen participation, data transparency, accountability and by sustaining the values of the Aarhus Convention (https://www.unece.org) (http://ec.europa.eu/environment/aarhus). This tool is used in Europe and beyond to reduce the burden of environmental impact on health and wellbeing.

One burden issue is the increasing levels of domestic wood burning for space heating is a growing threat to local air quality (EMEP; 2014). This is true for whole Europe, and especially to new EU Member States where increasing fossil fuel prices have motivated large segments of the population to change fuel (RCP, 2016). Education plays a key role here: many citizens are not aware of the very harmful effects of burning low-quality wood or combustible debris. What is worse, illegal burning of household waste has become the single largest source of toxic air pollutants in many economically and socially disadvantaged locations.

It is important to pay particular attention to two European NGOs working on health and wellbeing: The EuroHealthNet (http://epha.org/) and European Public Health Alliance (EPHA http://epha.org/). From health point of view, EuroHealthNet is a not-for-profit partnership of public bodies working from local to regional, national and international levels across Europe to promote healthier communities and tackle health inequalities within and between European States. As the communication leader of the EuroHealthNet said the organisation achieves this through its partnership framework by supporting members' work in EU and associated States through policy and multi-sector project development, networking and communications (http://www.eurohealthnet-magazine.eu). EuroHealthNet has a research arm, the European Centre for Innovation, Research and Implementation in Health and Wellbeing (CIRI). It aims to promote evidence-based approaches to health and wellbeing across all groups in society. Members include leading health centres of research and public health in Europe (http://epha.org/) who are committed to improve the uptake of evidence in policymaking processes. The cooperation of the health centres is key in the change on European and local level. The EPHA is regarded as a Europe's leading NGO advocating for better health. A member-led umbrella organisation made up of public health NGOs, patient groups, health professionals and disease groups that work to improve health and wellbeing. Besides that this health organisation is committed to strengthen the voice of public health in Europe and reduce the burden of environmental impact.

6.4 Overview of NGOs covered by the analysis

The following table collects those organisations and initiatives, which relate to ClairCity activities. It is not the intention of this table to record all relevant organisations and initiatives due to the very large number of relevant organisations. Its aim is to give some examples, and an overview of the kind of organisations and initiatives relevant to ClairCity.

Table 2: Examples of NGOs covered by the analysis and broader ClairCity work

	Health	Air Pollution	Transport	Energy	Society and Environment
National	UKPHA (UK)	EPUK (UK) Clean Air Action Group (Hungary) Croatian Air Pollution Prevention Association Association pour la Prévention de la Pollution Atmosphérique (France) Comitato di Studio per l'Inquinamento Atmosferico dell'Associazione Termotecnica Italiana (Italy) Swedish Clean Air Society	Sustrans (UK) Low Carbon Vehicle Partnership (UK)	Energy Savings Trust (UK)	Bund für Umwelt und Naturschutz (Germany)
European	EPHA EuroHealthNet	EFCA	European Mobility Week (EMW) Traffic Snake Game campaign		
International	WHO Healthy Cities Network	CAI-Asia	SlowCAT		Greenpeace Friends of the Earth Transition Network
Virtual			Route4you		fixmystreet.com

Although the overwhelming majority of NGOs are small in size and therefore focus on national and sub-regional level problems, the largest ones included in this table do take an active part in European (and even global) policy formulation and civic control of international processes such as EC Air Quality Directive development or the COP process. In other words, although very often NGOs receive most attention when they oppose something, these professional organisations can provide extremely valuable input to shaping these processes. On one hand this is due to their members' large pool of knowledge and expertise, and on the other hand it is because of their well close collaboration and information exchange with the citizens they represent.

National or local initiatives. Case studies are provided for their activities, such as those that aim to improve local air quality and improve health (e.g. the Traffic Snake Game campaign[3] of an energy efficiency EC project, or the employment of "mobility managers" which aim to improve the health of citizens while improving local air quality through fostering more optimal mobility patterns.

Smart cities. This emerging concept does devote significant attention to NGO and civil society involvement. More specifically, the smart cities themes "Smart environment", "Smart people" directly cover citizens & civil society. Examples for such "Social innovations" include:

Cargonomia (where locally grown vegetables and fruits are delivered to the neighbourhood by cargo bikes), urban gardening (where empty or run-down urban areas are regenerated),

Route4you (a crowdsourcing app, helping the sustainable mobility of wheelchair and pram users to plan their local mobility) or

fixmystreet.com (and on-line platform to report neighbourhood level problems) (Howaldt and Schwarz, 2016)

EU Sustainable Energy week. Among other stakeholders NGOs and consumers can also voice their input through this European campaign, hence contributing to lower energy-related emissions and better health.

Green Week. There are different green week programs and activities organised by civil society, governments and business organisation in Europe One of them is hosted by EC on yearly basis in May focusing on specific important environmental, social and economic topics. https://www.eugreenweek.eu**.** EU Green Week in May 2018 will explore ways in which the EU is helping cities to become better places to live and work. Showcasing policy developments on air quality, noise, waste and water management, it will promote participatory approaches to urban development, networking schemes, and tools for sharing best practices, engaging local authorities and citizens, and encouraging them to share their vision of a sustainable future.

European Mobility Week (EMW) Civil society involvement through the MOBILITYACTIONS campaign. The all year round MOBILITYACTIONS campaign is an 'add-on' to embellish the 'primary' EMW campaign which runs from 16-22nd Sept (the

[3] This is a European campaign developed to encourage walking and cycling to school, see http://www.trafficsnakegame.eu/

last of which is Car Free Day). It is a platform enabling NGO's, citizen groups, employers etc. to promote their local mobility actions at any time of year, and hence contribute to the overall objective of emissions reduction. So far, 200 have been registered since autumn 2015[4].

Sustainable Urban Mobility Plans (SUMPs). This planning methodology is on its way to become the 'de-facto' standard for progressive mobility planning in the European Union. Citizen and civil society involvement is an integral part of the SUMP planning cycle and in every main planning phase there is a dedicated task for this. In fact, more and more often neighbourhood level urban planning goes beyond the minimal requirements of good governance and puts citizens to the driving seat. Good cases are shown in the reference document from cities in Belgium, Germany and UK. (Wefering, 2013)

Cooperation with Healthy Cities Network of WHO Europe. This network aims to create and improve our physical and social environments in cities in close collaboration with local authorities. This network also aims to put health high on the political agenda of cities and to build a strong movement for public health at the local level. It promotes principles of equity, participatory governance and solidarity, inter-sectoral collaboration and action to address issues relating to human health. The concept of the WHO Healthy Cities Network was inspired and supported by the WHO European Health for All strategy and the WHO Health21 targets. (http://www.euro.who.int/en/health-topics/environment-and-health) Civil society actively participates in shaping the agenda of European cities and bring Health 2020 agenda in the planning process (Greer, 2017).

Collaboration with stakeholders and sectors: The Healthy Cities Network approach is a good example for collaborating among public, private, voluntary and community sector organisations. This way of working and thinking includes involving local people in decision-making, requires political commitment and organisational and community development, and recognizes the process to be as important as the outcomes. This design of collaboration fits well to the ClairCIty project's approaches also.

Another innovative network for cities is the Covenant of Mayors. Cities who joint to the Covenant of Mayors network (http://www.covenantofmayors.eu) share experiences on adaptation to climate change which can bring benefit for cities' sustainability. The role of the Covenant of Mayors initiative, and similar city networks will be explored in much greater detail in ClairCity Deliverable D6.3)

General summary of the benefits of civil society engagement: empowerment, commitment, service deliverer, flexibility, participation in policy and credibility today and in the future agenda toward 2050 (Marmot and Bell, 2012) (Hicks et al., 2012).

All of the listed aspects and examples are important for efficient and democratic cooperation of civil society and local governments in different regions and cities in Europe towards healthy and clean cities towards 2030 (Dyakova et al., 2017)

[4] See full list of registered actions and organisations: http://www.mobilityweek.eu/registered-actions

6.5 Conclusions

This chapter has provide an overview of the wide range of civil society organisations that operate in the domains of environmental protection and health. There is generally no clear, formal role for them within air quality management processes, except potentially as consultees. The huge diversity of organisations that exists means that it may be difficult to set out clear and specific roles for. However, as identified in the previous chapter, the situation and views of citizens are many and diverse, and they tend towards identification within certain groups (either through self-perception or by others). Thus the role of civil society organisations can be to give citizens a stronger, more coherent voice in policy processes. However, for this to be the case, then experience suggests that the policy realm needs to both open up policy processes for real engagement with civil society and its organisations, and to actively support the development of a strong and vibrant civil society that has the capacity to participate in these processes in an informed and constructive manner.

7 Conclusions

The formal literature review demonstrates that there has been little academic focus on the processes of air quality management and air pollution control, and indeed little on the broader issues of citizens/people and air quality within a social context. What research there has been has predominantly taken one of two stances. Firstly, economic and psychological approaches to the issues considering willingness to pay, or emission trading schemes, or secondly looking at air pollution as a justice issue, which whilst recognising a richer societal context to pollution around inequalities of exposure, often tends to view the citizen as a passive receptor of pollution. We can conclude that while WTP approaches have had an impact on policies, specifically by providing a method for attempting to evaluate intangible costs and benefits of policies, they have generated little impact on the broader society in terms of improvements in air quality and changes in social practices. With regard to emissions trading, research has tended not to be people-focussed. For this reason, and considering that there are mixed judgements about the effectiveness of pollution trading, it can be argued that social science research that focussed on these mechanisms has had an influence on policy-making but its contribution to tackling the wider air quality problem has been limited.

The review of EU projects has demonstrated the extent to which the vast majority of EU research projects have focussed on technical aspects of air quality management. Where citizens have been a significant consideration in the project work, this has tended to be as passive receptors of pollution exposure, or as economic actors whose behaviour can be addressed through the provision of more and/or better information, or correct pricing. Only two projects were identified (G-FORS and SEFIRA) that made a significant effort to address air quality management problems with overt reference to social science.

The policy analysis again finds that air pollution very much tends to be dealt with as a stand-alone, technical issue with little attempt to approach it as a cross-cutting societal issue that is linked to many other issues. The evidence gathered points to a lack of attention to the social science domain: the measures included in the plans are disproportionately technical in nature and aim at tackling specific sectors, for instance transport or delivery of goods, or

industries. Even the few plans that attempted to go beyond command-and-control measures and aimed at changing citizens' behaviour were predominantly limited to infrastructural investments and subsidies to less polluting vehicles and domestic appliances. The Cleaner Air for Scotland plan, seemed to show more ambition than the others in that it considers the wider implications of air quality in terms of health inequality, and acknowledges the limitations of the existing approaches, including the information deficit model. Positively, the plan recognises that if policymakers want to encourage and effect behavioural changes, they need to look at individual circumstances and understand what determines people's choices, including not just material barriers but also norms and expectations.

The practitioner overviews however, demonstrate that there is clearly a social dimension to AQ&CM that appears to have been overlooked and unaccounted for by both social science researchers and the policy domain. There is a strong body of community planning community planning within civil society, and yet its application to air quality issues appears to date to be limited. Within the formal evidence reviews presented in this document there was little significant evidence of studies considering the role of civil society organisations of the inequality domain, and here reporting suggests that NGO participation tends towards 'activism' that lies outside of more formal processes rather having access to or providing a formal voice for citizens within governance processes.

From the evidence set out in this report, there is little in extant practice of AQ&CM on which a more social approach to air quality might be founded. However, ClairCity has identified both mobility and energy consumption as key factors in determining air pollution. Within the domains of mobility and energy consumption there is however, a range of work from the social sciences, much of which is used to influence and develop policy. The previous ClairCIty deliverable (D3.3 on Framing Reports) has already outlined some key theoretical perspectives (Social Practice Theory and Institutional Theory/New Institutionalism) being used within the mobility and energy domains that go beyond treating the citizen simply as a passive receptor, a target for information, or whose active role is at best to "accept" policies and interventions. These approaches will be explored further in the project, in order to better recognise and understand the roles that citizens, societal structures and civil society organisations might play in a broader and more social rewriting of how we achieve clean air and low carbon futures in our cities.

7.1 Postscript

To address comments from readers of draft versions of this report, we will take this opportunity to address two concerns which regarding issues that have not been dealt with in detail within this final copy of the report: Citizen science and Eco-Labelling.

7.1.1 Citizen science

Whilst it may seem an obvious interlinking of 'social science' and 'air quality management', an analysis of the increasing trend towards encouraging the participation of citizens within air pollution monitoring projects has not been incorporated in this report. This is on two main counts. Firstly, there are few examples where this sort of citizen science project has been effectively incorporated into the air quality management process. With many of these

schemes organised by NGOs and other civil society organisations, as discussed in Chapter 6, these schemes often lack a formal integration within the AQM processes. Secondly, even where there are examples of these sorts of schemes that are well linked and integrated with policy processes (such as in Sheffield, UK http://www.sheffieldeastend.org.uk/MonitoringLeafletDec06.pdf) there has been little if any social science or theory applied to these schemes to understand how they work, their role and how they might fit in to the wider AQM governance picture. Most of the projects identified tend to employ a basic information deficit model regarding the mechanisms for achieving benefits from the schemes. The absence of work on this has now been recognised though, and particularly with rising interest in this area, the ClairCity project hopes to pay specific attention to these schemes within Workpackage 3.1 on the Sub-task looking at the role of citizens.

7.1.2 Eco-labelling

Another area of work on air pollution that was expected to arise from the review process was with respect to eco-labelling of vehicles and appliances with respect to atmospheric emissions of pollutants. As with citizen science, the work generally identified within the review process failed to meet the criteria for inclusion for a number of reasons. Firstly, there is little clear integration of eco-labelling within air quality management processes in a way that is significantly informed by social science. The basic model is one of information deficit, with little in depth analysis of how eco-labelling of atmospheric emissions works in practice. It is interesting to note that in general understanding of eco-labelling, the greatest impact has been on changing the goods that manufacturers offer for sale (resulting in the move towards A+++ ratings regarding appliances) rather than through pushing changes in consumer choices directly. Secondly, there is very little published work specifically on eco-labelling with regard to conventional air pollutants as opposed to greenhouse gas emissions, or fuel efficiency (in relation to vehicles). One particular report which did deal specifically with eco-labelling with respect to conventional air pollutants was a Deliverable from the EU AirUse project and interested readers are directed towards this for an overview of this issue (http://airuse.eu/wp-content/uploads/2014/02/2016_AIRUSE-B8_06-Eco-label-vehicles-CNE.pdf).

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8.2.1 General literature review

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Appendix 1: Literature Review Methodology

Methodology

This review aims to cover both a research and a policy perspective. Firstly, in order to identify the areas in which social science research specifically focussed on the issue of air pollution emissions, a systematic review was conducted, with a special focus on socio-economic and political factors. Secondly, a review of policies and policy papers followed more purposeful search criteria, given the time and resources constraints for this project. For the academic literature review, *Scopus* was used as database as it allowed for a multidisciplinary overview and breakdown of the air quality research area. When the Ambient Air Quality Assessment and Management Directive (96/62/EC) came into force, it defined the concept of air quality management as we know it. For this reason, the searching timespan was restricted to the years 1996-2016 (although 2017 articles were later included as well). Only documents under the category of "Article or Review" were considered. Although an initial overview of documents included all the disciplines, for the actual identification of articles to be included in the review the subject area was restricted to "Social Sciences and Humanities". The search string developed for this review was developed based on the following keywords: "air quality" OR "air quality policy" OR "air quality management". Other articles were later retrieved by adding the keywords "social factors", "political factors", "gender", "poverty" and "willingness to pay".

Selection criteria

The search was conducted in August 2017. The first search returned 23,388 documents, of which 19,567 from the Environmental Sciences area (56.8%); 8,510 from Earth and Planetary Sciences (24.7%); 5391 from Medicine (15.6%); 5,330 from Engineering (15.5%); and 2,813 from the Social Sciences (8.2%). Figure 3 shows a breakdown of the documents by subject area. The initial search gave an idea of the proportion of social sciences articles in relation to other disciplines.

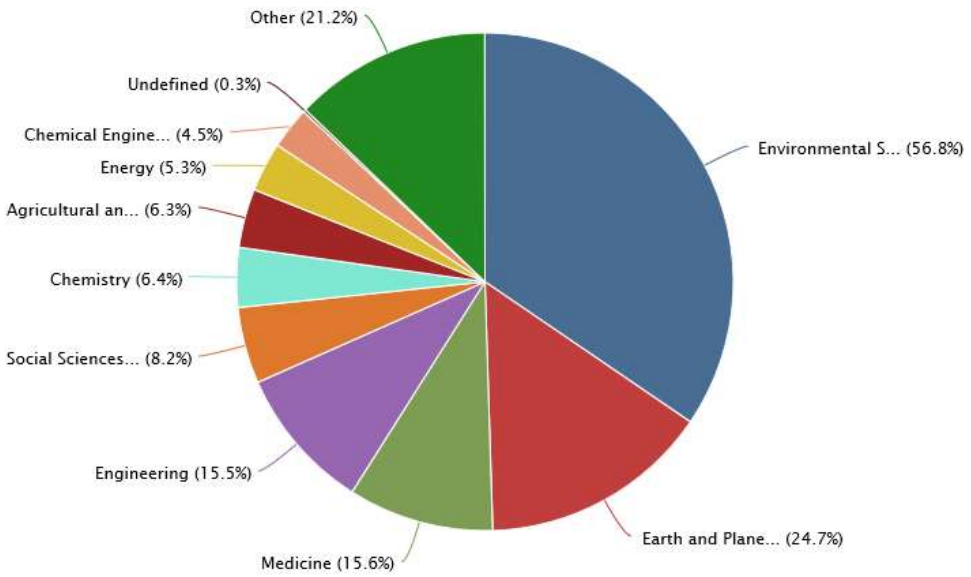

Figure 3: Documents by subject area

As we can see from the graphs, published social science research in air quality is still rather limited compared to other disciplines. Nonetheless, the interest of the social sciences in the topic has been steadily increasing as the number of outputs per year indicates (

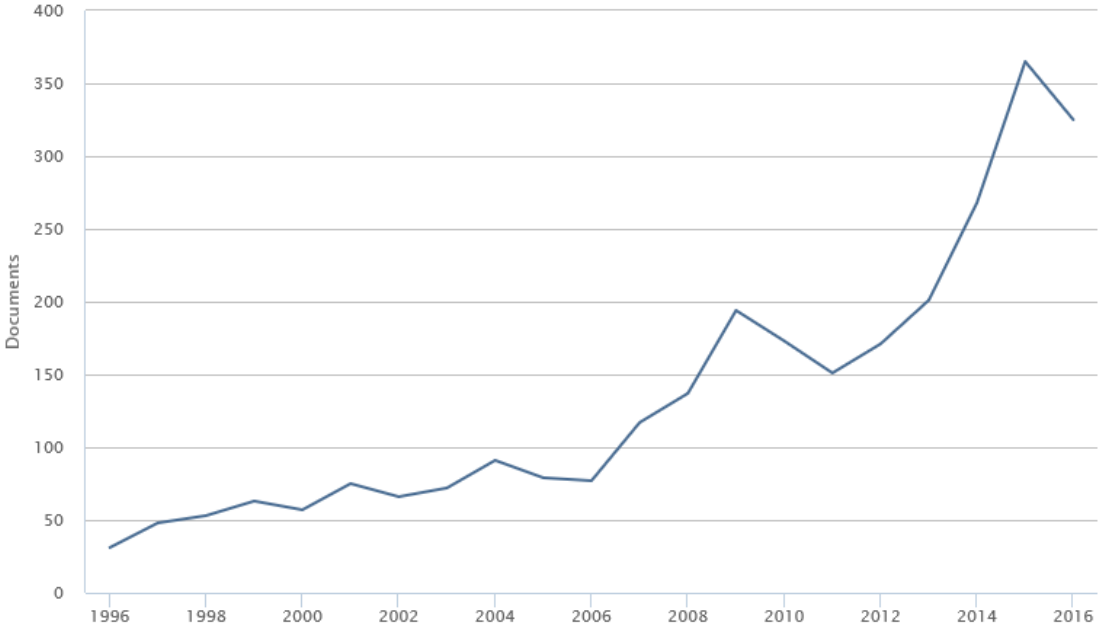

Figure 4)

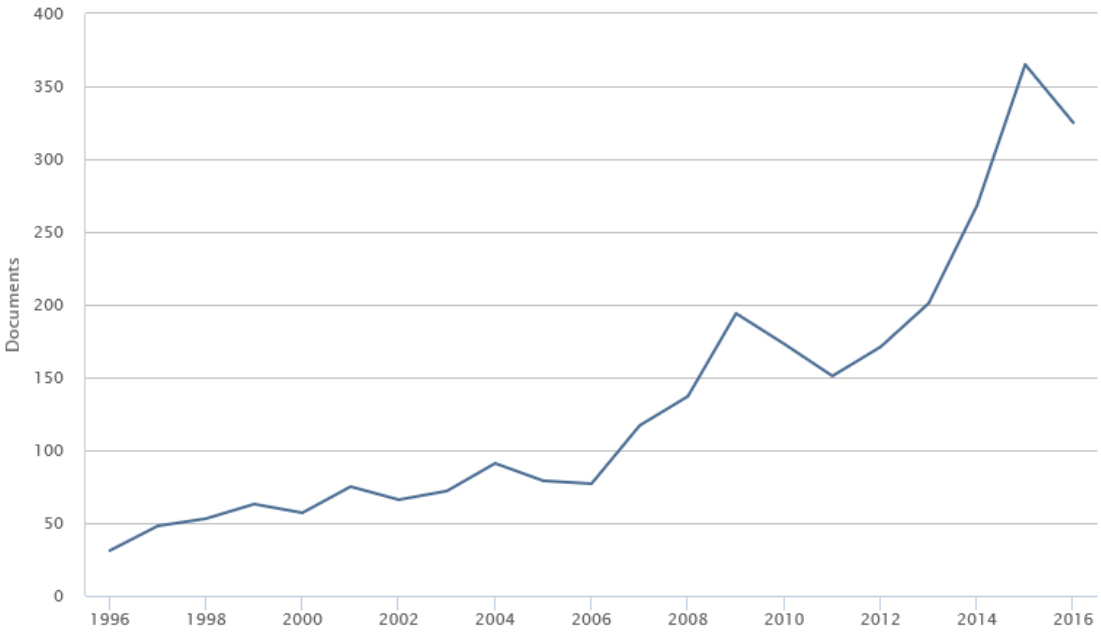

Figure 4: Documents per year - social sciences subject area

From an initial screening of the titles and abstracts, all the papers that were irrelevant for the purposes of this research were excluded, particularly those that were explicitly dealing with emissions modelling. The first filter left a pool of 96 documents. After reviewing the abstracts of this initial pool, the review suggested that there were three predominant areas of social science research on air quality involved people's willingness to pay for clean air; gender and

race issues; and poverty/inequality issues. For this reason, during the second stage of the review, other articles were added to the list.

As Figure 5 shows, in total, 104 documents were identified, of which 6 dealt with issues of gender and race, 23 dealt with poverty, gender and race, 45 dealt with willingness to pay, and 36 dealt with generic socio-political factors in relation to air quality.

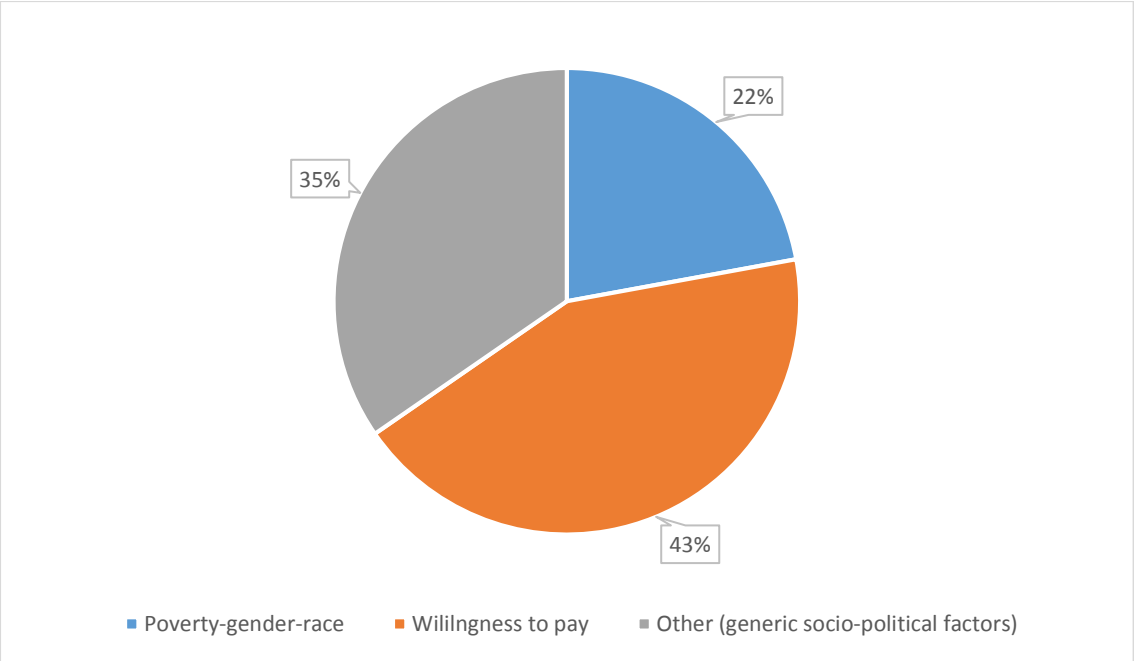

Figure 5: Selected papers retrieved from Scopus

Appendix 2: Description of EU Project Review Procedure

Methodology

45 projects or documents were identified on the CORDIS Database using a Free Text search on 'air quality management' (no other restrictions regarding dates or types of content were specified).
http://cordis.europa.eu/projects/result_en?q=%27air+quality+management%27+AND+%28contenttype%3D%27project%27+OR+%2Fresult%2Frelations%2Fcategories%2FresultCategory%2Fcode%3D%27brief%27%2C%27report%27%29&num=100

These documents represented 28 projects and 17 project reports (each of which related to a listed project). Table A2 provides a list of these objects along with brief details and the results of the following screening stages

These were given a cursory screening of the object summaries to identify which of them was likely, in any way, to have the potential for a significant social science component. 17 of the 45 objects were passed at this stage. Descriptive text for these objects from the database are provided below.

These 17 objects then underwent an analysis of the information available on CORDIS in order to identify whether the objects described the works:

- Considered people or citizens as opposed simply to social science aspects of policy and governance;
- Considered the exposure of citizens;
- Examined the provision of information and or communication with citizens;
- Considered the behaviour of citizens in any detail;
- Considered citizens and their activities as a source of pollution that required specific addressing within air quality management.

Only nine of the objects were found to relate significantly to people as significant objects of research or policy. These were:

THE ISSUE (Traffic- Health- Environment. Intelligent Solutions Sustaining Urban Economies)

PASODOBLE (Promote Air Quality Services integrating Observations – Development Of Basic Localised Information for Europe)

APPRAISAL (Air Pollution Policies foR Assesement of Integrated Strategies At regional and Local scales)

SEFIRA (Socio-economic implications for individual responses to Air Pollution Policies in EU +27)

APNEE (Air Pollution Network for Early warning and on-line information exchange in Europe)

MIRACLES (Multi initiatives for rationalised accessibility and clean, liveable environments)

INTEGAIRE (Integrated Urban Governance and Air Quality Management in Europe)

LENVIS (Localised ENVironmental and health Information Services for all: User-centric collaborative decision support network for water and air quality management)

G-FORS (Governance for Sustainability)

Further information on these projects has been identified via project websites (where still available) and project deliverables (especially the final reports). These have been used to provide more description and discussion in the main text of the report

Screening table for EU Air Quality Management Projects

Table A2:1: Analysis of Air Quality Management projects and outputs from CORDIS (Yellow indicates that document passed initial screening stage. Green indicates that document passed secondary screening stage and is analysed within Chapter 3)

Name of Project/ Output	Funding Programme	Potential Social Science Component	Topic	Consideration of People or Citizens	Exposure	Information/ Communication	Behaviour	People as Emissions Contribution	Notes
THE ISSUE (Traffic- Health- Environment. Intelligent Solutions Sustaining Urban Economies)	FP7-REGIONS	Y	Transport	Y					
AIRLOG (Integrated Platform for Intelligent Indoor Air Quality Audit Management)	FP7-SME	Y	Indoor Air Quality	N	-	-	-	-	
PASODOBLE (Promote Air Quality Services integrating Observations – Development Of Basic Localised Information for Europe)	FP7-SPACE	Y	Monitoring and Information	Y	Y	-	N	N	airTEXT
BRIDGE (sustainaBle uRban plannIng Decision support accountinG for	FP7-ENVIRONMENT	Y	BioScience and Planning	N	-	-	-	-	Creation of socio-economic indicators

urban mEtabolism)									
APPRAISAL (Air Pollution Policies foR Assesement of Integrated Strategies At regional and Local scales)	FP7-ENVIRONMENT	Y	Modelling and Impact Assessment	Y	Y	-			Only through Health Impact Assessment treating citizens as passive receptors
Air pollution policies under the microscope	FP7-ENVIRONMENT	Y	OUTPUT OF APPRAISAL	N	-	-	-	-	
SEFIRA (Socio-economic implications for individual responses to Air Pollution Policies in EU +27)	FP7-ENVIRONMENT	Y	Air Quality Policy	Y		-	Y		Contribution of socio-economic dimension to policy
Integrated Computational Assessment of urban air quality via Remote Observation Systems NETwork	FP5-IST	N	Remote Sensing	N	-	-	-	-	
INTASENSE (Integrated air quality sensor for energy efficient environment control)	FP7-ENVIRONMENT	N	Monitoring	N	-	-	-	-	

APNEE (Air Pollution Network for Early warning and on-line information exchange in Europe)	FP5-IST	Y	Monitoring and Information	Y					
Innovative and efficient air quality management system for a healthy, comfortable and safe in - vehicle environment	FP5-GROWTH	N	In-Vehicle Pollution	N	-	-	-	-	
ALP-AIR (Atmospheric flux-measurements of precursor-gases for air-quality and climate research)	FP7-PEOPLE	N	Atmospheric Science	N	-	-	-	-	
CLEANRCAB - Cleaning up the air inside our vehicles	FP5-GROWTH	N	In-Vehicle Pollution	N	-	-	-	-	
Properties of various electrostatic air cleaning techniques	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Air quality assessment in	FP5-GROWTH	N	OUTPUT OF	N	-	-	-	-	

vehicle environment by field inspection			CLEANRCAB						
Improving air quality in vehicles	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Catalytic formulation able to oxidize, in post-plasma location, VOC pollutants, CO and to eliminate ozone	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Plasma catalysis for in-vehicle air quality	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Performance of plasma/catalysis on other (than vehicles) applications	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Elaboration of a test bench at laboratory scale (1-3 l/mn) with on-line analysis	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Inventory of air pollutants in vehicles	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Demonstration of the efficiency of VOC removal by plasma-	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	

catalyst system, at laboratory and real scale									
Elaboration of a test bench at real scale (100-200 m3/h) with on-line analysis	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Elaboration of a predicting model of the behaviour of the plasma-catalyst system	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Performances of plasma in VOC destruction in vehicles	FP5-GROWTH	N	OUTPUT OF CLEANRCAB	N	-	-	-	-	
Improving the spatial resolution of air emission inventories using earth observation data	CSC	N	Remote Sensing and Emissions	N	-	-	-	-	
OSCAR - Combining measurements of air quality and traffic congestion in Madrid roads	FP5-EESD	N	Monitoring	N	-	-	-	-	
MIRACLES - Multi initiatives for rationalised accessibility and clean, liveable environments	FP5-GROWTH	Y	Sustainable Transport	Y		Y	Y	N	Impacts of raising transport awareness and smarter travel choices http://cordis.euro

									pa.eu/result/rcn/43731_en.html The benefits of improving multi-modal traveller information http://cordis.europa.eu/result/rcn/43732_en.html
The benefits demonstrating cleaner vehicles to businesses	FP5-GROWTH	Y	OUTPUT OF MIRACLES	N	-	-	-	-	
Results from cleaning up public vehicle fleets	FP5-GROWTH	Y	OUTPUT OF MIRACLES	N	-	-	-	-	
Lessons learned from vehicle emissions monitoring trials	FP5-GROWTH	Y	OUTPUT OF MIRACLES	N	-	-	-	-	
URBAN-AEROSOL - Development of know-how and technology on indoor air quality monitoring and inhalation dosimetry assessment.	FP5-EESD	N	Indoor Air Quality	N	-	-	-	-	
INTEGAIRE - INTEgrated urban Governance and AIR quality	FP5-EESD	Y	Sustainable Governance	Y	Y	Y	N	N	Database

management in Europe									
JAKFISH (Judgement and Knowledge in Fisheries including Stakeholders)	FP7-KBBE	N	Fisheries	N	-	-	-	-	
CITAIR - Stationary Sources of Air Pollution in Urban Areas	IC-COST	Y	Clean Technologies and Techniques	N	-	-	-	-	
VIVALDI - The city centre clear zone in Bristol (UK)	FP5-GROWTH	Y	Interventions	Y	N	Y	Y	-	Travel Planning "he quality of the free Travel Plan work secured through the UK Government's Transport Energy Best Practice Programme was mediocre. Coming at an early stage in the process, this may have had a demotivating effect and contributed in part to lower levels of participation than were originally hoped for"
PANDA - PArtnership with	FP7-SPACE	N	Remote Sensing	N	-	-	-	-	

chiNa on space DAta									
ADA - Advance Distributed Architecture for telemonitoring services	FP5-IST	N	Monitoring	N	-	-	-	-	
LENVIS - Localised environmental and health information services for all: User-centric collaborative decision support network for water and air quality management	FP7-ICT	Y	Monitoring and Information	Y	Y	Y	-	-	Not just air -. Sought "enhanced capacity to assess population exposure and health risks and better management of the concerned ecosystems."
BIOSMHARS (Biocontamination specific modeling in habitats related to space)	FP7-SPACE	N	Indoor Air Quality	N	-	-	-	-	
HRMODURB - High resolution models for flow and pollutant dispersion in urban areas	FP7-PEOPLE	N	Modelling	N	-	-	-	-	
Enhancing security of large buildings	FP7-SECURITY	N	Terrorism	N	-	-	-	-	

G-FORS (Governance for Sustainability)	FP6-CITIZENS	Y	Sustainable Governance	Y	N	Y	Y	N	Used AQM as case stufy
Facilitating good governance for our future	FP6-CITIZENS	Y	OUTPUT OF G-FORS	N	-	-	-	-	
Application of fuzzy control in indoor air quality management	FP5-GROWTH	N	Indoor Air Quality	N	-	-	-	-	

Summaries of projects that passed first screening stage

THE ISSUE (Traffic- Health- Environment. Intelligent Solutions Sustaining Urban Economies)

http://cordis.europa.eu/result/rcn/174123_en.html

THE ISSUE (Transport, Health and Environment: Intelligent Solutions Sustaining Urban Economies) Project was a three year “Coordination & Support Action” that received funding through the EU’s Seventh Framework Programme “Regions of Knowledge” Initiative. The Project was launched in December 2011 by a Consortium of 13 core partners in four European regional ‘triple-helix’ research-driven clusters and supported by 22 associate partners in 8 additional European regional clusters. The Project successfully completed its work programme at the end of November 2014.

THE ISSUE Project focussed on fostering cooperation, development and collaboration between European regional ‘triple-helix’ research-driven clusters, involving partners from industry, research institutions and government in each region. Its aim was to realise the potential for technology transfer from applications of ICT and Downstream Space Data Products & Services into the intelligent mobility and sustainable transport sectors to develop new research-based and innovation-driven solutions that will help improve the economic, environmental and social health of cities and regions.

The Project’s key output was the preparation of a pioneering and state-of-the-art “Programme of Innovation in Sustainable Transport and Intelligent Mobility (2014-2020)”. The Programme identifies 46 innovation actions that address a series of strategic objectives in six challenge areas. Each challenge area reflects one of the highest priorities in the transport and urban mobility sector where THE ISSUE identified that innovation and exploitation of newly-emerging and existing ICT and Space Technologies could offer major advances towards the operational implementation and market growth of innovations in intelligent traffic management and urban mobility. Each innovation action is based on a strong evidence of user-need within urban and regional transport authorities and capable of being supported through harnessing RTD activities and competencies within THE ISSUE Consortium. Many of the innovation actions are already sufficiently mature to be the subject of proposals for funding aimed at demonstrating their market readiness through pilot studies, demonstration programmes and pre-operational roll-out. The recommended funding route for these actions is through European programmes such as Horizon 2020.

AIRLOG (Integrated Platform For Intelligent Indoor Air Quality Audit Management)

http://cordis.europa.eu/result/rcn/169286_en.html

While ambient air pollution is being successfully monitored throughout the EU, the situation for indoor air pollution is not nearly as positive. This is of particular concern, as a much wider range of air pollutants are found at higher levels indoors than outdoors. Indoor air quality is a major concern to businesses, building managers, tenants, and employees because it can impact the health, comfort, well-being, and productivity of building occupants, as most Europeans spend up to 90% of their time indoors and many spend most of their working hours in an office environment.

Studies conducted by the U.S. Environmental Protection Agency (EPA) and others show that indoor environments can sometimes have levels of pollutants that are actually higher than levels found outside. In spite of the obvious need to better control and manage the quality of indoor air, no European legislation or standard currently defines indoor air quality auditing and management systems, leaving it to the member states' responsibility to define air quality targets and risk levels, certification procedures and audit management processes.

AIRLOG (www.iaq-airlog.eu) proposes a web-based Indoor Air Quality (IAQ) Audit Management platform that will save specialized SMEs up to 40% of the cost of performing audits, helping auditors improve their audits and clients better understand the IAQ process. AIRLOG's Decision Support System will learn from past experiences and propose the most effective Best Practice mitigation actions to ultimately improve IAQ control and healthier conditions in EU buildings. The link between sustainable building design, energy-efficient management and green procurement will be actively fostered by AIRLOG, through the development of a unique knowledge base at the EU level on successful indoor air management practices for various building types in various EU areas.

PASODOBLE (Promote Air Quality Services integrating Observations – Development Of Basic Localised Information for Europe)
http://cordis.europa.eu/result/rcn/141390_en.html

At current levels healthcare costs, associated with poor air quality in the EU27, are estimated to reach at least €189 billion per year by 2020. Considering the adverse health effects of air pollution, monitoring, assessing and forecasting of air quality are fundamental to increase the quality of life and prosperity in Europe.

Within the frame of the European Earth Observation Programme GMES/Copernicus, PASODOBLE has considerably improved information and tools on air quality in more than 30 regions and cities throughout Europe. This has been achieved by developing a portfolio of innovative and sustainable Myair services in coordination with local stakeholders and agencies (www.myair.eu). From 2010 to 2013 existing user requirements were analysed in order to design and implement improved air quality monitoring, assessment and forecasting services. A consortium of 21 partners joined forces to realize the portfolio by combining space-based data, in-situ measurements, modelling and information technology. In close collaboration with over 50 users from 18 countries, multiple follow-ups on service demonstration, use and assessment were successfully applied with respect to fitness-for-purpose and business planning.

PASODOBLE has been providing health community support services for hospitals, pharmacies and people at risk, public air quality forecasting services, traffic scenario assessment services for cities, compliance monitoring support for regional environmental agencies on particulate matter and finaly model evaluation support for a wide spectrum of users. PASODOBLE has augmented the supply of relevant information for policy and decision makers. Events like the Olympic Games in London in 2012 benefitted from these developments. The results and their evaluation have clearly demonstrated the necessity for services at high spatial resolution in addition to the Copernicus Atmosphere Service.

Furthermore, PASODOBLE has worked towards a harmonized European framework for air quality services. By developing a generic and modular technical infrastructure, including ready-to-use tools, modern interfaces, simple data access together with applied quality

management, which takes also INSPIRE-compliance into account, the project has significantly increased interoperability and implementation efficiency. This will facilitate the service transfer into new regions and cities.PASODOBLE has worked both at local level and broader scale, resulting in advanced European harmonisation by integrating and promoting best practice tools. The technical interface to Copernicus atmosphere products will be transferred to MACC-II for operational sustainability.

BRIDGE (sustainaBle uRban plannIng Decision support accountinG for urban mEtabolism)

http://cordis.europa.eu/result/rcn/196169_en.html

Urban metabolism considers a city as a system and distinguishes between energy and material flows. "Metabolic" studies are usually top-down approaches that assess the inputs and outputs of food, water, energy, etc. from a city, or that compare the metabolic process of several cities. In contrast, bottom-up approaches are based on quantitative estimates of urban metabolism components at local scale, considering the urban metabolism as the 3D exchange and transformation of energy and matter between a city and its environment. Recent advances in bio-physical sciences have led to new methods to estimate energy, water, carbon and pollutants fluxes, but the knowledge exchange between end-users, such as planners, architects and engineers and biophysical scientists is still poor.

BRIDGE is a joint effort of 14 Organizations from 11 EU countries aimed at illustrating the advantages of considering environmental issues in urban planning. BRIDGE did not perform a complete life cycle analysis or whole system urban metabolism, but rather focused on specific metabolism components: energy, water, carbon and pollutants. BRIDGE integrated the development of numerical tools and methodologies for the analysis of fluxes between a city and its environment with its validation and application in terms of future development alternatives, based on environmental and socio-economic indicators for baseline and extreme situations. Helsinki, Athens, London, Firenze and Gliwice have been selected as case study cities.

A Decision Support System (DSS) combining integrating the bio-physical observations with socio-economic issues was developed to allow end-users to evaluate several urban planning alternatives based on their initial identification of planning objectives. In this way, sustainable planning strategies can be analysed based on quantitative assessments of energy, water, carbon and pollutants fluxes. The project uses a Community of Practice approach, which means that local decision-makers were involved in the project from the beginning, exchanging knowledge and experience with scientist. CoPs were developed in all five BRIDGE case aiming at continuing the interaction and communication after the end of the project.

The methodology adopted in BRIDGE and incorporated in the DSS is based on sustainability objectives defined for components of urban metabolism (environmental, social and economic). A set of criteria associated to the objectives and indicators were used to demonstrate the level of achievement of each criterion, in a quantified manner. Indicator values are either calculated by numerical modelling or are given as data attached to planning alternatives, in the case of socio-economic indicators. The BRIDGE DSS evaluates how planning alternatives can modify the physical flows of the above urban metabolism components, using a Multi-Criteria Evaluation (MCE).

Different types of models from mesoscale air quality models to urban canopy models were used in BRIDGE, adapting a cascade modelling technique from large to local scale. This approach allowed estimating energy, water and carbon and pollutant fluxes associated to varying geographical extents of urban development scenarios. State of the art meteorological and chemical models were adapted using urban and canopy parameterization. Several local scale models were implemented for different purposes (computational fluid dynamics models, traffic models, turbulence schemes models).

A Foresight Exercise was also performed during BRIDGE involving end-users from BRIDGE Case Studies and experts from the academic and private sectors to analyse how decision-making priorities change in response to different future strategic scenarios. The Foresight Exercise focused on macro dimensions, such as climate change, energy supply and economic performance and different possible futures were discussed. Based on the outcomes of Foresight Exercise, analysis of planning alternatives considering strategic scenarios was

APPRAISAL (Air Pollution Policies foR Assesement of Integrated Strategies At regional and Local scales)
http://cordis.europa.eu/result/rcn/176582_en.html

Air quality in Europe is still facing a continued wide-spread of exceedances, particularly regarding PM, NOx and O3. In case of non-compliance the 2008 Air Quality Directive requests Member States (MS) to design local and regional plans and assess their impacts on air quality and human health. MS have therefore developed and applied a wide range of modelling methods to cope with these obligations. Today, with the revision of the EU air quality policy pending, there is a need to consolidate and assess the research results in the field of Air Quality and health Impact Integrated Assessment and make them accessible to policy makers.

In this context, the APPRAISAL project aims at:

1. Undertaking on overall review of the Integrated Assessment methodologies used in different countries at regional and local scale, from the simple (scenario analysis) to the more comprehensive (cost-benefit, cost-effectiveness analysis). This includes evaluating both top-down and bottom-up approaches to systematically analyse their strengths and weaknesses and to identify key areas to be addressed by further research.

2. Designing an Integrated Assessment Modelling framework, based on the information collected during the review process, for different policy-maker requirements, model capabilities and levels of data completeness.

3. Drawing guidelines on how to implement the defined Integrated Assessment System framework, based on identified strengths and weaknesses and best practice examples among the Integrated Assessment Systems in place within MS.

4. Communicating with key stakeholders and in particular to policy-makers the state-of-the-art scientific knowledge on emission abatement assessment.

APPRAISAL includes 15 highly experienced groups working on both air quality and health impacts assessment. Partners come from all over Europe to guarantee the review process representativeness. A group of stakeholders are closely connected to the Consortium to ensure a direct line of communication with key policy makers. APPRAISAL contributes to

improve knowledge on regional and local IA methodologies and supports the revision of EU air quality policies.

SEFIRA (Socio-economic implications for individual responses to Air Pollution Policies in EU +27)
http://cordis.europa.eu/result/rcn/189380_en.html

SEFIRA had the objective of creating a European coordination of transdisciplinary scientific and socio-economic resources in order to support the review and implementation of air quality legislation by the European Commission (EC) led by DG Environment. The EC has now given increased attention to the socio-economic dimension of air quality policies in order to improve their effectiveness and acceptability. SEFIRA has coordinated some of the best scientific and socio-economic resources in Europe to review air quality policies and legislation at the interface between environmental, economic and social sciences with the final aim of achieving a deeper understanding of such complex issues.

Individual behaviours and choices have been analysed in a socio-economic context ranging from the local to the European level.

The main fields involved in the action were atmospheric sciences, environmental and legal sociology, anthropology, geography and economics.

The integration of disciplines, the relationship with the most relevant stakeholders and an effective coordination between the SEFIRA consortium and other European projects in the same field has been achieved. The project strategy supported the development of a new European appraisal of problems and resources in the field, deployed a pilot survey and a test of policy implementation by innovative models of individual choices analysis. The relevant stakeholders have been involved from the beginning of the project in a process of dialogue and cooperative problem solving in order to ensure relevance and robustness as the work progressed from the local to the European level.

Project Context and Objectives:

The main objectives of SEFIRA at the start of the project were:

1. To integrate scientific and technical knowledge on air quality with the socio-economic aspects of national, regional and EU wide implications of air pollution policies;

2. To explore ways to better integrate the socio-economic dimension in those policies, especially with respect to preferences, behaviours and responses of individuals, stakeholder groups and civil society, to obtain a better understanding of the feasibility and acceptability of the implementation of those policies;

3. To develop a specific analytic method based on discrete choice models that integrate quantitative and qualitative data on European population attitudes and actions toward air quality regulations;

4. To provide specific reports in support to the on-going revision and implementation of the EU air policy.

5. To produce an integrated transdisciplinary synthesis report to DG Environment and peer-reviewed papers.

APNEE (Air Pollution Network for Early warning and on-line information exchange in Europe)

http://cordis.europa.eu/project/rcn/57858_en.html

APNEE's objective is to establish services for human centred management of cities by building a geographic information portal for urban air quality. APNEE will serve citizens as well as professionals, European Authorities (Local and Regional) and relevant European institutes. This portal will provide online visualisation means about real-time air pollution, and special features like discussion boards, online newsletters and early warning systems. Dissemination of information will be based on highly sophisticated technology standards like WAP, GSM, SMS, WEB and GIS. The Project will serve requirements specified in EU-directives relating to citizen information on health threatening air pollutants. APNEE provides an interface to air pollution management systems and facilitates dissemination of appropriate information to affected groups of citizens. The prime focus is on air pollution management, rather than air pollution measurement, forecasting or alert systems. Once APNEE is in place, there will be a dedicated information service to inform citizens on the potential impacts of their behaviour. Rather than broadcasting alarms on air quality (through news media), APNEE aims to increase citizen's ongoing knowledge of air quality and how their behaviour can influence it.

Objectives: The APNEE project aims to increase the knowledge of citizens on air quality and develop the exchange of information both on a local level in European cities and at normal & regional levels among European institutions. Dissemination of quality information will take place by implementing new communication lines such as mobile telephone functionality, multimedia, electronic panels and the Internet. The APNEE project will integrate new information technologies as additional management modules in existing Air Quality Management Systems in European cities.

Prime objectives are to:

- implement an interface to available information on air pollution and design a harmonised classification methodology;
- implement user-friendly information services for citizens, public and private organisations, and business communities;
- develop the exchange of information among professionals, local and regional authorities across Europe, and relevant European institutions;
- introduce and facilitate forecasting of pollution and data modelling.

APNEE services aim to become the reference portal for topical and real time environmental air quality information.

MIRACLES - Multi initiatives for rationalised accessibility and clean, liveable environments

http://cordis.europa.eu/project/rcn/86853_en.html

There is a need to act locally both to improve urban quality of life and to contribute to resolving global problems of pollution and oil dependence. The MIRACLE sites respond to this challenge with measures that:

1. Provide effective co-ordination between the demonstration sites and the networks coming from the accompanying measures for evaluation and dissemination to be established by the Commission;

2. Develop and demonstrate the introduction of radical integrated sustainable urban transport policy strategies, supported by innovative technological infrastructures in real urban situations with large-scale application of innovative technology.

For this, measures need to be organised into implementable groups of actions (ie: it is neither practical nor innovative to implement 7 measures and then evaluate each one).Goals are investigated by actions for defined demonstrations areas.

There are 4 proposed goals:

G1. A significant reduction in emissions

G2. Up-take of targeted types of clean vehicles (esp. electric scooters)…

(no more text available on CORDIS summary)

MIRACLES Report: The benefits demonstrating cleaner vehicles to businesses
http://cordis.europa.eu/result/rcn/43734_en.html

Key Findings:

- Prior to each trial businesses were asked which factors would influence their decision to purchase a clean vehicle.
- The three most important factors were operating costs, reliability and purchase cost.
- After the trial 82% rated the vehicle as generally good, 55% thought it was generally better than their usual fleet vehicle and 65% stated they were likely to purchase a clean vehicle in the future for business use.
- Businesses tend to renew their company vehicles at set times over cycles of several years. Therefore, the effect of the trial in encouraging businesses to purchase clean vehicles may not be evident for a number of years. However, one business and three employees did purchase alternative fuel vehicles following the trials. In all cases the trial had been a major influence.
- Emissions savings from the alternative fuel vehicles were estimated. For the petrol/hybrid vehicle, CO2 emissions reduced by an average of 40%, CO by 20% and HC+NOx by 70%. There were also energy reductions of 37%. For the LPG/petrol vehicles, average CO2, CO, and HC+NOx emissions reductions ranged from 9-18%, 30-78%, and 58-74%, respectively. The energy reduction was in the rage of 1-5%.
- The electric vehicles produced no tailpipe emissions, and therefore resulted in emission reductions of 100%.
- In terms of fuel cost per km petrol hybrid vehicles and LPG/petrol dual fuel vehicles provided average savings of about 40% and 20%, respectively.
- It should be emphasised that the analysis only compared usual business vehicles that were five years old or less, as no emission figures are available for older vehicles. If all vehicles had been included the emissions and fuel savings would have been greater.

INTEGAIRE (Integrated Urban Governance and Air Quality Management in Europe)
http://cordis.europa.eu/project/rcn/61296_en.html

INTEGAIRE aims to explore solutions to key challenges for urban governance and air quality management throughout Europe. The principal objectives are: - The first focuses on urban

governance and concerns the development of the existing weak and poorly specified interface between, on the one hand, air quality assessment, management and monitoring tools developed in relation to the urban environment, and on the other hand, tools for sustainable urban governance at the urban level. The aim is to encourage the development of a strongly integrated model and appropriate tools linking air quality science and technology to the needs of end users at the urban level, and thereby optimise local decision making. The second horizontal objective concerns the development of a coherent and comprehensive network and framework of network activities that facilitates the identification of RTD gaps and future RTD priorities in the field of urban air quality management and urban governance. These initiatives will assist the development, and provide a sound basis for, the new research agenda, that will be pursued via the 6th Framework Programme and the European Research Area.

CITAIR - Stationary Sources of Air Pollution in Urban Areas
http://cordis.europa.eu/project/rcn/21911_en.html

COST 617 Action "Stationary Sources of Air Pollution in Urban Areas" forms, together with COST 615, COST 616 and COST 618, the COST CITAIR Programme "Science and Research for Better Air in European Cities". COST 617 has following objectives:

- to promote scientific research co-operation between various parts of Europe, based on specific experience already gained with respect to clean technologies and techniques in domestic and industrial use,
- to develop research capacities for adaptation of technologies and techniques to local conditions as a prerequisite for their faster implementation in less economically advanced European countries,
- to exchange experience regarding the effects of regulations and other incentives aimed at reducing the consumption of energy in wealthier countries, where economic progress has led to scarce resources being, used to a degree, negligently.

VIVALDI - The City Centre Clear Zone in Bristol (UK)
http://cordis.europa.eu/result/rcn/41038_en.html

84 new clean vehicles in the Council and Dial-a-Ride fleets, and the retrofitting of exhaust treatment equipment to 63 diesel buses. Access control and management systems included 3 new bus priority measures, a bus lane enforcement trial and the investigation of new access management measures. New orbital bus service provides an improved frequency, accessible, high quality service linking key city centre sites. Cycle Resource Centre (CRC) providing secure parking, showers, lockers, cycle repair/maintenance and information.

Freight Consolidation Scheme (FCS) commenced operation in May 2004 and has progressively grown in scale to include over 50 retailers with an encouraging reduction in the number of delivery trips. Travel Plans (TP) for city centre leisure sites including new cycle parking and lockers for staff, a cross-harbour ferry service and improved pedestrian signing and route finding. New TravelBristol Info Centre provides information and ticketing for commercial bus services, and the Council providing a range of other travel and transport information. Travel Information provided by the Info Bus (mobile information vehicle), I+ information kiosks (on-trip information) and real time bus information displays.

LENVIS - Localised environmental and health information services for all: User-centric collaborative decision support network for water and air quality management
http://cordis.europa.eu/project/rcn/87602_en.html

The main goal of the LENVIS project is to develop an innovative collaborative decision support network for exchange of location-based environmental and health services between all stakeholders, for enhanced capacity to assess population exposure and health risks and better management of the concerned ecosystems. LENVIS will include health indicators as integral part of the environmental management.

There is a growing demand for real time and integrated environmental and health risk information. Provision of such location-based services linked to the state of the environment at particular geographical locations (addresses) is necessary for improving the quality of life of all people. This is essential for mitigation of environmental-related health threats associated to water quantity and quality, and outdoor air pollutions.

LENVIS project aims to fill the existing gap between environmental management and the health management systems. This will be done by developing a generic ICT solution that combines service-oriented-architecture (SOA) and user-centric approach (peer-to-peer network, P2P) by fusion of location-based environmental and health data, information and modelling services. This novel collaborative peer-to-peer network, as an integral part of the Single Information Space for the Environment in Europe, will be validated through test cases on fresh surface water and outdoor air quality in the Netherlands, Portugal and Italy.

LENVIS project will facilitate collaboration between different stakeholders, such as environmental protection agencies, health institutions and service providers, policy makers, citizens in general and environmental communities in Europe.

G-FORS (Governance for Sustainability)
http://cordis.europa.eu/result/rcn/47695_en.html

The objective of G-FORS is to develop an innovative analytical model for the study of governance for sustainability with a particular emphasis on how knowledge was drawn upon and utilised in practice in the so called knowledge society. These issues are of vital importance for policies addressing the environment and sustainability where levels of uncertainty and disagreements over how to formulate and implement policy are particularly high.

The G-FORS team developed this analytical model, focusing on the synergy between new governance modes and different forms of knowledge, taking into account the rapid changes in the knowledge society. For this purpose, GFORS identified a range of different forms of knowledge and analyse how they may interact in the context of particular governance arrangements to produce 'reflexive knowledge' and contribute to a more legitimate understanding of sustainability. Point of reference is 'the problem of ignorance': taking decisions against a background of risk. This was and still is especially crucial for environment and sustainability policies. From this point G-FORS team investigated the interplay of governance arrangements and knowledge and analyse the problem solving capacities of specific arrangements / arenas. The G-FORS team identified the three areas: emissions trade, air quality management/particulate matter and strategic environmental

assessment, and their implementation at local level. These areas have been chosen because they involve different governance modes in a multi-level context that illustrate the positive interactions and potential tensions between certain governance arrangements, different forms of knowledge and sustainable development. Benchmark indicators have been identified that can appraise the effectiveness of current political, economic, administrative and organisational processes and institutional settings in developing economically, socially and environmentally sustainable policies.

Proceeding from the empirical research, the research team assessed how the engagement of a range of actors in new multi-level governance arrangements can be activated to tackle any future threats of democratic deficit and to promote participation and sustainable development. In particular, G-FORS demonstrated the key economic, social and political roles of sub-national actors. The first year of the project mainly addressed the elaboration of the new conceptual frame and its preparation for the application. This fusion of concepts on governance arrangements and knowledge scenarios will be analysed by discourse analysis as a primary methodological tool.

The crucial insight of the conceptual discussion was a different understanding of policy outcomes. Based on discussion about the impact of knowledge on problem construction and solving, policy outcomes are understood as aggregated effects of governance and knowledge in the context of sustainability. Sustainability is more about experience-based learning processes on causal assumptions, while institutional change and the generation of new knowledge are more concerned with causes and effects. Policies developed to promote sustainability are partial and ineffective unless they effectively incorporate a range of knowledge forms.

G-FORS Output Facilitating good governance for our future

http://cordis.europa.eu/result/rcn/87774_en.html

The concept of sustainability cannot be applied to our societies if it isn't accompanied by good governance. Understanding knowledge gathering to enhance governance has become crucial in enhancing sustainability.

Sustainability has become perhaps the most important issue of the 21st century that ensures the well-being and continuity of society and ecosystems on our planet. The EU-funded project 'Governance for sustainability' (G-FORS) studied how knowledge was acquired and exploited in the 'knowledge society' to govern sustainability. It looked at how policies regarding the environment and sustainability are drafted and implemented.

G-FORS analysed new government modes, different forms of knowledge and evolution of a knowledge society. It looked at the different forms of knowledge and their interaction in understanding sustainability, with particular focus on decisions vs. risks. Researchers looked at problem-solving capacities and policy implementation related to the areas of emissions trade, air quality management and strategic environmental assessment.

The project also articulated indicators to measure political, economic and administrative processes to help develop sustainable policies in environmental, social and economic spheres, among others. It assessed the key economic, social and political roles that sub-national actors could play in governance. G-FORS examined the concepts of sustainability

and policymaking in this regard, noting that the three dimensions of sustainability (consistency, comprehensiveness and aggregation) were difficult to reconcile. This often led to dominance of one dimension or certain policy incoherence.

The project's strategy involved gathering information about target audiences, creating a database and establishing a website for the project. All workshop results and project findings were disseminated to stakeholders, fostering good practice in sustainable governance across Europe.