Something in the Air

The forgotten crisis of Britain's poor air quality

Simon Moore
Edited by Guy Newey

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Policy Exchange

About the Authors

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All errors, of fact and interpretation, are the author's.

Executive Summary

Air pollution is Britain's forgotten environmental and public health crisis. Each year, around 29,000 deaths are attributable to man-made fine particulate air pollution in the UK, at a cost to the economy of £15 billion a year. Other pollutants cause further damage to our health and our economy.

In 1952, it was believed The Great Smog had killed around 4,000 people in London and catapulted concerns about poor air quality to the top of the political agenda. It led to landmark legislation that improved the quality of the air in Britain's cities. Only much later, after the new legislation had been adopted, was it discovered that the final death toll from the Smog may have been three times as high. In 2010, a study commissioned for the Mayor of London estimated that long-term exposure to fine particulate emissions in London had an impact on mortality of 4,267 deaths in London in 2008. Sixty years on from The Great Smog, the problem of air pollution today is less visible than it was in 1952, but it is still deadly.

It is easy to see how air pollution became a neglected public health story. Unlike smoking, alcohol abuse or obesity, there is no direct link between personal behaviour and personal consequence. Unlike climate change, there is no lurking threat of catastrophe. It is usually an invisible problem, with many and diffuse causes. This makes it different to other air pollution problems which have been successfully tackled. Sulphur dioxide that caused acid rain, or CFCs in aerosols, which spurred concerns over the ozone layer had concentrated groups of major polluters that regulators could target. Defra has legal responsibility for improving air pollution, though many of the required measures fall under the control of other departments or local governments to implement.

The summer of 2012 will see London come under intense international scrutiny with the city hosting the Olympic Games. Previous host cities have had to deal (sometimes drastically) with air pollution in the run up to the Games. London is not in the same position as Beijing was for harmful particulate pollution, but nitrogen dioxide levels are as bad in London as they are in Beijing.

This report aims to highlight the seriousness of the problem of air pollution in the UK. It notes deficiencies in public awareness of air pollution and its costs, and considers policies that can reduce pollution levels.

Pollutants

A number of key individual pollutants have different impacts and with differing policies in place to address them. Table ES1 outlines them.

Table ES1: Characteristics of key pollutants

Pollutant	Composition	Sources	Effects	Policies and effectiveness
Particulates	PM_{10} is particulate matter smaller than 10 micrometres (µm, or 0.001mm) in diameter. $PM_{2.5}$ is that smaller than 2.5 µm. PM_{10} is considered the threshold below which particles can be drawn into the lungs. Smaller $PM_{2.5}$ is considered an even greater health risk due to being able to get deeper into the lungs and bloodstream.	Particulate matter is made up from a wide range of substances. It has both man-made and naturally occurring sources. In central London, road vehicles are responsible for around 80% of PM_{10} and $PM_{2.5}$.	Strongly linked to health problems, including asthma, lung cancer and cardiovascular illness. Day to day variations in particulate pollution levels are strongly associated with variations in daily deaths, hospital admissions for respiratory and cardiovascular diseases and asthma.	Technical emissions controls have begun to reduce PM emissions from exhausts. However, few improvements have been made with tyre and brake materials. Other measures have been introduced to reduce the PM released by activities such as construction, including the use of different materials and the adoption of methods that reduce the production of PM or its release into the air.
Oxides of nitrogen	NO_x refers to the combination of NO and NO_2 (nitrogen monoxide and nitrogen dioxide).	Around half NO_x in Greater London comes from road transport. In central London, workplace gas use dominates. In outer London, domestic gas use is a major contributor in outer, more residential parts of the city.	NO_2 has been strongly linked with emphysema, bronchitis, and heart disease. Though there is some evidence that hospital admissions are related to concentrations of nitrogen dioxide, it has not yet been considered robust enough to quantify the effect. Overloading of nitrogen has also been connected with the degradation of sensitive habitats and deteriorating biodiversity.	More NO_2 is being emitted, as a proportion of NO_x, because numbers of diesel vehicles have increased. Technologies being developed such as 'selective catalytic reduction traps' (SCRT) are becoming available for larger vehicles with high replacement cost (such as buses and lorries), but, at around £10,000 per vehicle, are as yet unlikely to see wider use in family cars. Tackling NO_2 pollution means tackling the use of diesel, especially in cities.

Vehicles account for about 80% of particulate matter (PM) emissions and about half of the emissions of oxides of nitrogen (NOx) in London, (for comparison, 42% of emissions of PM and about half of emissions of NOx are caused by vehicles in Manchester, where there are more industrial emissions of PM). Of the exhaust emissions from vehicles in London, 91% of $PM_{2.5}$ and 95% of NO_2 come from combustion of diesel. Diesel vehicles are the worst contributors to harmful air pollution in London.

Many other pollutants are controlled in the UK (ozone, sulphur dioxide, lead, arsenic, benzene, carbon monoxide amongst others). Restrictions on these substances have been largely effective in reducing harmful emissions levels. This report will focus its attention on particulates and nitrogen dioxide, which are the cause of the biggest current public health concerns.

Quantified effects of air pollution

Air pollution has effects on both morbidity (illness) and mortality (deaths).

- There was "an effect on mortality in 2008 equivalent to nearly 29,000 deaths in the UK at typical ages." In other words, 29,000 deaths occurred that year that were attributable to man-made particulate pollution.[1]
- This averages out to a "loss of life expectancy from birth of approximately six months" for every UK resident.
- In London, the average loss of life expectancy from birth is closer to nine months for every resident, 50% higher than the national average.
- 15–30% of all new cases of asthma in children and chronic obstructive pulmonary disease and coronary heart disease in adults 65 years of age and older, and 15–30% of exacerbations of these illnesses could be attributable to air pollution.
- The costs to the UK of 2008 $PM_{2.5}$ levels is in the range of £8–17 billion per year (with a central estimate of £15 billion).

London and air quality

The effects of Britain's bad air are not evenly spread around the country. Those living in London are the worst affected. 86% of the worst areas in the country for nitrogen dioxide pollution, and 87% of the worst areas in the country for particulate pollution are in London. As a result, tackling air pollution requires a strong focus on London-based policies. Studies assessing European cities' air quality have highlighted the scale of the air pollution problem in London.

- The monitoring site at Marylebone Road, London, is fourth worst of more than 2,000 sites across Europe for NO_2 pollution (and the worst of any capital city) in 2010.
- A 2011 report by Soot Free Cities for the European Environmental Bureau ranked London 14th of 17 major European cities for its policies to tackle black carbon PM, giving the city a lowest-possible F rating.

Socioeconomic impact

Our research found that it is often the most vulnerable and deprived communities who suffer the worst effects of air pollution.

We took the most polluted areas in London (the worst 10% of London for NO_2 and PM_{10} concentrations) and compared them to London-wide socioeconomic indicators. We found that, for example, in the worst 10% of London for particulate pollution:

- 5–10 year old children are 41% more likely than the London average to be eligible for free school meals.
- Residents are 27% more likely than the London average to be on income support.
- Residents are 11% less likely to continue in post-compulsory education than the London average.

1 Mortality impacts are challenging to conceptualise and communicate. There is no group of deaths that "are directly (and solely) caused by, or attributed to, air pollution" because exposure to pollution acts in conjunction with other risks to cause earlier death. Rather, the figures should be considered as the difference in mortality between two scenarios, one with higher pollution (and thus a higher mortality rate) than the other. Deaths are postponed if air quality improves, so in a specified year, x lives could be saved – these people will live longer.

In the worst 10% of London for NO_2 pollution:

- 5–10 year old children are 47% more likely than the London average to be eligible for free school meals.
- Residents are 26% more likely than the London average to be on income support.
- Residents are 14% less likely to continue in post-compulsory education than the London average.

Our analysis has also uncovered that more than 320,000 children (including more than 180,000 children under the age of 11) attend schools in London within 150m of roads carrying more than 10,000 vehicles per day. This is the level of traffic that has been found to increase risk of developing or exacerbating asthma in children.

Recommendations

Air pollution undeniably presents a difficult policy problem. Tightening government budgets and the difficulty of identifying politically-acceptable policy measures combine to prevent action, even as evidence on the scale of the problem strengthens and targets risk being missed. Because of this, there is scope for well-designed policy experimentation that can identify effective solutions. Moreover, it is crucial that perverse incentives which encourage polluting vehicles and technologies are removed. Finally, policymakers should clearly focus on the most cost-effective policies that deliver the greatest environmental benefit for a limited set of resources.

Reduce perverse incentives for polluting technologies

- **The London Mayor's office should look at reducing or removing exemptions from the congestion charge from those vehicles (mostly small diesel-engined cars) which come under the CO_2 emissions threshold, but which cause considerable localised air pollution. This may be accomplished by tightening the criteria for the Greener Vehicles congestion charge exemption, as part of the environmental legacy the Mayor has said he wants the Olympic Games to leave behind.**
- **Diesel vehicles should be subject to the same small surcharge under Vehicle Excise Duty as they are under the Company Car Tax regime** (though we do not have sufficient evidence to judge what size of surcharge would be needed to affect these decisions). This would help ameliorate the current, arguably perverse, encouragement of diesel vehicles and bring consistency to the treatment of private and company cars.
- **So far as is practicable, the Renewable Heat Incentive and other small-scale renewable energy support programmes should support non-biomass technologies in cities. Local authorities should be cautious about renewable energy pledges, such as the Merton Rule, that, in practice, lead to biomass installations in built-up areas where they increase risks to public health from poor air quality.**
- **Smoke control and air quality management rules should not be weakened as government attempts to promote renewable energy in homes and businesses, and if necessary should be strengthened to ensure that local authorities have discretion to determine whether biomass installations are right for their area.**

Technology and policy innovation

- **The Department for Transport, Defra and local authorities should continue to develop a wider network of Low Emissions Zones to cut emissions in locations where limit values for NO_2 are being breached.**
- **Test differentiated parking permit charges based on emission of vehicles. Local authorities in Camden and Kensington & Chelsea have both introduced parking charges for residents partly based on the emissions level of the vehicle. It is imperative that these small-scale programmes are designed in such a way that their success can be rigorously assessed.**
- **Defra should encourage a Local Authority to consider piloting a Berlin-type system in their city, where cars have to display colour-coded visible road tax permits based on the emissions levels (where, for example, a low polluting car would display a green sticker and high polluting one a red). Again, any pilot should be designed so that the behavioural impact of such a 'nudge' can be rigorously assessed.**
- **A strategy for reducing pollution concentrations should not rely on pollution suppression methods until more is known about their potential. If, after testing has been carried out, the technologies prove effective, they should be deployed in sensitive areas for public health, such as near schools and hospitals, whenever pollution levels are elevated. If they prove ineffective, they should be stopped, and resources used for alternatives.** The Mayor's office has publicly agreed with this approach, saying such initiatives form only a small part of their overall pollution reduction plan. However, they have also stated that use of these local measures will help achieve compliance at the most sensitive pollution monitoring hotspots. The Mayor's office needs to clarify its position on the extent of their reliance on local spot-treatments to comply with limit values. As well as demonstrating whether suppression can reduce pollution at kerbsides, Transport for London must also demonstrate that a beneficial effect can be detected as one moves further from the road.
- **In London, public money would be better spent on reducing the NO_2 emissions from buses by retrofitting buses with SCRT pollution filtering systems, rather than relying on the slow and expensive process of replacing the fleet with 'New Buses for London' (commonly referred to as 'Boris Buses' or 'New Routemasters') to improve air quality.** 'New Buses' would remain available for TfL and their bus operations contractors as they expand their fleets or replace existing vehicles as there are other motivations (aside from air quality) behind their development.
- **Transport for London should consider introducing a tighter localised Low Emission Zone around Heathrow airport.**

Improved public awareness

In their reports on air quality in Britain, the House of Commons Environmental Audit Committee repeatedly recommended the establishment of a government campaign to inform the public about the harms of air pollution. Although air pollution is a similar scale of public health problem to obesity and alcohol, and is only surpassed by smoking, the government spends little on increasing public awareness of the problem. However, without the identification of a clear 'ask' – something you can encourage people to do to improve the situation – there are

serious limits to what such a programme could achieve. Nevertheless, there are areas where communication, both of the scale of the problem, and especially of steps people can take to reduce their contribution to it, can be improved.

- **The government, or the private sector, could establish a competition to build a website that improves on existing resources by clearly and accurately portraying air pollution, including criteria for health, cost, and geography.** It would be a low-cost method of improving the communication of the problem. Both the contest process, and the resulting website, would provide a boost to public awareness of the problem.
- **Local authorities and institutions such as schools should start, or continue, awareness programmes around relevant behaviours such as engine idling, or encouraging cycling and walking.** If possible these should be done in a way where the impact of the programme can be assessed. For instance, if a school is near to an air quality monitoring station, pollution data from before and after the campaign can be compared to determine if it is an effective way of lowering pollution concentrations.

1
Background

Introduction

In December 1952, an anticyclone weather system, common for the time of year, settled over London. Cold, windless air sat over the city, held in place by a 'lid' of warm air high in the atmosphere. Coal burning power stations in central London and hundreds of thousands of household chimneys were releasing huge quantities of pollutants into the sky, which could not escape. The air in London was so noxious that people reported a stinging sensation to their eyes and sinuses, while visibility was reduced to just a few yards.

At the time, it was believed 4,000 people had died because of the Great Smog of 1952.[2] Landmark legislation, including the 1954 City of London Act and the 1956 Clean Air Act was enacted, to reduce short-term air pollution in London and around the country. Those Acts helped drive the technology changes that eventually saw natural gas replace coal and coal gas (also known as town gas) in the energy system, and saw many more polluting industries forced to clean up their production methods or move out of urban areas. Only much later, after the new legislation had been adopted, was it discovered that the final death toll from the Smog may have been three times as high.

In 2010, a study commissioned for the Mayor of London estimated that long-term exposure to fine particulate ($PM_{2.5}$) emissions in London "had an impact on mortality equivalent to 4,267 deaths in London in 2008" (see Box 1.1).[3] December 2012 will mark the 60th anniversary of the Great Smog. The stinging sensation is long gone, and the problem of air pollution today is less visible than it was in 1952, but it is still deadly.

Box 1.1: Attributable deaths

Mortality impacts are challenging to conceptualise and communicate. There is no group of deaths that "are directly (and solely) caused by, or attributed to, air pollution" because exposure to pollution acts in conjunction with other risks to cause earlier death. Rather, the figures should be considered as the difference in mortality between two scenarios, one with higher pollution (and thus a higher mortality rate) than the other. Deaths are postponed if air quality improves, so in a specified year, χ lives could be saved – these people will live longer. With reductions in pollution, larger populations live longer as more people survive each year.[4]

Each year, man-made $PM_{2.5}$ pollution at 2008 levels "is associated with an impact on mortality equivalent to nearly 29,000 deaths", at an assessed cost to the economy of £15 billion a year.[5] Yet, in recent years, government and NGOs have

2 Met Office; 'The Great Smog of 1952'; http://web.archive.org/web/20110719205353/http://www.metoffice.gov.uk/education/teens/casestudy_great_smog.html

3 Within a range of 756 to 7,965. Dr Brian Miller; *Report on estimation of mortality impacts of particulate air pollution in London*; Institute for Occupational Medicine; 2010; http://www.london.gov.uk/sites/default/files/Health_Study_%20Report.pdf

4 Miller; ibid and Committee on the Medical Effects of Air Pollution; *The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom;* London; 2010; http://www.comeap.org.uk/images/stories/Documents/Reports/comeap%20the%20mortality%20effects%20of%20long-term%20exposure%20to%20particulate%20air%20pollution%20in%20the%20uk%202010.pdf

5 Committee on the Medical Effects of Air Pollution; *The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom*; London; 2010; http://www.comeap.org.uk/images/stories/Documents/Reports/comeap%20the%20mortality%20effects%20of%20long-term%20exposure%20to%20particulate%20air%20pollution%20in%20the%20uk%202010.pdf

devoted much of their attention to higher-profile environmental problems, like climate change. With the Olympics bringing unprecedented scrutiny on London – the epicentre of the UK's air pollution problems – Britain's poor air quality should be higher up the agenda (see Box 1.2).

It is easy to see how air pollution became a neglected public health story. Unlike smoking, alcohol abuse or obesity, there is no direct link between personal behaviour and personal consequence. Unlike climate change, there is no lurking threat of catastrophe. It is an often invisible problem, with many and diffuse causes. This makes it different to other air pollution problems which have been successfully tackled. Sulphur dioxide that caused acid rain, or CFCs in aerosols which spurred concerns over the ozone layer, had concentrated groups of major polluters that regulators could target. Defra has legal responsibility for improving air pollution, though many of the required measures fall under the control of other departments or local governments to implement.

In many cases, policies that can help air quality are also beneficial for other reasons. Fuel-efficient engines can improve air quality, reduce greenhouse gas emissions, and save their owners money. Sometimes, though, there are trade-offs between air quality and other objectives. There may be economic trade-offs – the cost of replacing a vehicle fleet with newer models, or of charging people to enter town centres – or environmental tradeoffs – diesel vehicles are moderately better in terms of greenhouse gas emissions but far worse for air quality.[6]

But just because poor air quality is not obvious, and solutions to it are not easy, does not mean it is not important. It is a policy area where government needs to combine implementation of some known responses with well-designed experimentation as additional effectual and affordable solutions are sought. Air pollution remains one of the most under-addressed public health problems. This report aims to highlight the seriousness of the problem of air pollution in the UK. It notes deficiencies in public awareness and understanding of air pollution and flaws in government action to tackle the problem, but also highlights the opportunities to improve public health by addressing the problem more thoroughly and proposes policies that can reduce pollution levels.

Box 1.2: The Olympics

The summer of 2012 will see London under intense international scrutiny with the arrival of the Olympic and Paralympic Games. Previous host cities have had to deal (sometimes drastically) with air pollution in the run up to the Games. London is not quite in the same position as Beijing was for harmful particulate pollution, but nitrogen dioxide levels are as bad in London as they are in Beijing (and the highest of any European capital city).[7]

Increased demand for transport, alongside parts of the road network being restricted to official Games traffic, has led to concerns over transport congestion leading to increased air pollution. During the months that the Olympic and Paralympic Games are taking place, businesses are being encouraged to alter their delivery patterns, have employees work from home or change how they commute – anything to alleviate the pressure on transport systems. The extent to which this will affect congestion and pollution levels is difficult to predict.

6 In response to a parliamentary question from Karen Buck MP, Norman Baker estimated that the average diesel saloon emits about twice as much NO_x and about 22 times as much PM_{10} as the average petrol saloon. http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm111003/text/111003w0001.htm#1110033001281

7 Campaign for Clean Air in London; "Beijing 2008 and London 2012"; http://cleanairinlondon.org/wp-content/uploads/CAL-166-Exhibit-6_Nitrogen-dioxide_Beijing-London-Olympics_Draft-130112.pdf

Pollutants

Air pollution has effects on morbidity (illness) and mortality (deaths). Impacts can be short-term and long-term. Much more research is needed to understand the degree of overlap between the health impacts of different pollutants, and between long-term and short-term exposures. A number of key individual pollutants have different impacts and with differing policies in place to address them. Table 1.1 outlines them:

8 Expert Panel on Air Standards; 'Airborne particles: What is the appropriate measure on which to base a standard? A discussion document' DETR; 2001

9 Fuller, Gary; *Air Quality in London – briefing note to GLA Environment and Health Committee;* Kings College London; July 2012

Table 1.1: Characteristics of key pollutants

Pollutant	Composition	Sources	Effects	Policies and effectiveness
Particulate matter (PM)	Conventionally characterised by the size of the relevant particles, PM_{10} being particulate matter smaller than 10 micrometres in diameter (µm, or 0.001mm), $PM_{2.5}$ being particles smaller than 2.5 µm. PM_{10} is considered the threshold below which particles can be drawn into the lungs; smaller $PM_{2.5}$ is considered a greater health risk due to being able to get deeper into the lungs and bloodstream. Some studies indicate that the $PM_{2.5}$ subset may be responsible for all or most of the health effects of all PM_{10}.[8]	Particulate matter is made up from a wide range of substances. It has both man-made and naturally occurring sources. In central London, road vehicles are responsible for around 80% of man-made PM_{10} and $PM_{2.5}$ emissions (see Figures 1.1 and 1.2). Road vehicles release particles from exhausts after fuel combustion, and by friction wear of brakes and tyres.	Strongly linked with a number of health problems, including asthma, lung cancer and cardiovascular illness. Day to day variations in particulate pollution levels are strongly associated with variations in daily deaths, hospital admissions for respiratory and cardiovascular diseases and asthma symptoms.	Technical emissions controls have begun to reduce PM emissions from exhausts. However, despite efforts to improve their durability, few improvements have been made with tyre and brake materials. Other measures have been introduced to reduce the PM released by activities such as construction, including the use of different materials and the adoption of methods that reduce the production of PM or its release into the air near ground level.
Oxides of nitrogen	NO_x refers to the combination of NO and NO_2 (nitrogen monoxide and nitrogen dioxide). NO_2 is largely a secondary pollutant with concentrations being determined by a combination of emissions of both NO and NO_2 and the capacity of the atmosphere to convert NO to NO_2. For this reason concentrations of NO_2 cannot be understood without considering the total concentrations of NO and NO_2, termed NO_x.[9]	Around half of the NO_x in Greater London comes from road transport. The sources of the remainder vary according to place. Workplace gas use dominates in central London, whereas domestic gas use is a higher contributor in outer, more residential parts of the city.	NO_2 has been strongly linked with emphysema, bronchitis, and heart disease. Though there is some evidence that hospital admissions are related to concentrations of nitrogen dioxide, it has not yet been considered robust enough to quantify the effect. Overloading of nitrogen has also been connected with the degradation of sensitive habitats and deteriorating biodiversity.	More NO_2 is being emitted, as a proportion of NO_x, because numbers of diesel vehicles have increased. Technologies being developed such as 'selective catalytic reduction traps' (SCRT) are becoming available for larger vehicles that are expensive to replace (such as buses and lorries), but, at around £10,000 per vehicle, are as yet unlikely to see wider use in family cars. Tackling NO_2 pollution means tackling the use of diesel, especially in cities.

Many other pollutants are controlled in the UK (lead, arsenic, benzene, carbon monoxide amongst others), with restrictions on these substances being largely effective. This report will focus its attention on particulates and nitrogen dioxide, which are the cause of the biggest under-addressed public health concerns (Table 1.1).

Figures 1.1 to 1.5 show the sources of PM and NOx emissions in London and Manchester. They show that vehicles account for about 80% of PM emissions and about half NOx in London, and 42% of PM and about half NOx in Manchester. Of the exhaust emissions from vehicles in London in 2009, 91% of $PM_{2.5}$ and 95% of NO_2 came from diesel vehicles (Figures 1.6 and 1.7). Diesel vehicles are by far the most significant contributors to harmful air pollution in London.

Figure 1.1: PM_{10} emissions from all sources in central London in 2008[10]

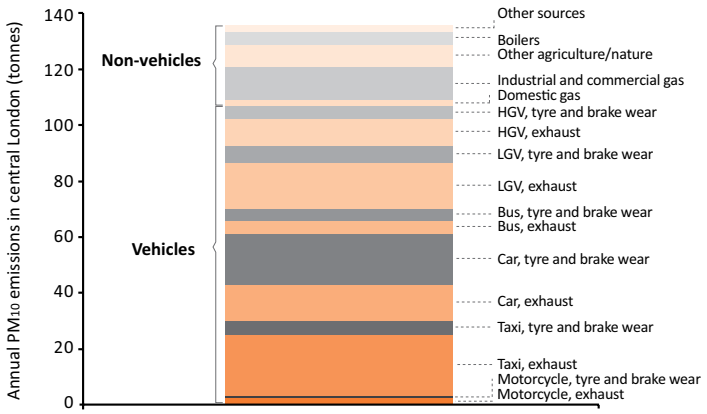
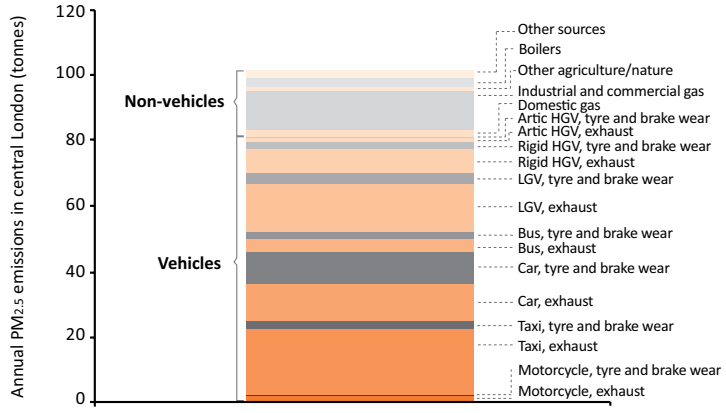


Figure 1.2: $PM_{2.5}$ emissions from all sources in central London in 2008[11]



10 Mayor of London; Clearing the Air; http://www.london.gov.uk/sites/default/files/Air%20Quality%20Strategy%20v3.pdf; p. 40

11 Ibid; p. 42

Figure 1.3: NO_x emissions from all sources in Greater London in 2008[12]

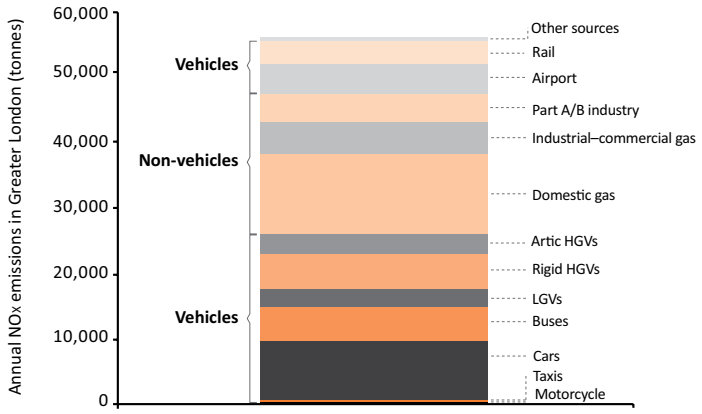


Figure 1.4: NO_x emissions from all sources in Greater Manchester in 2005[13]

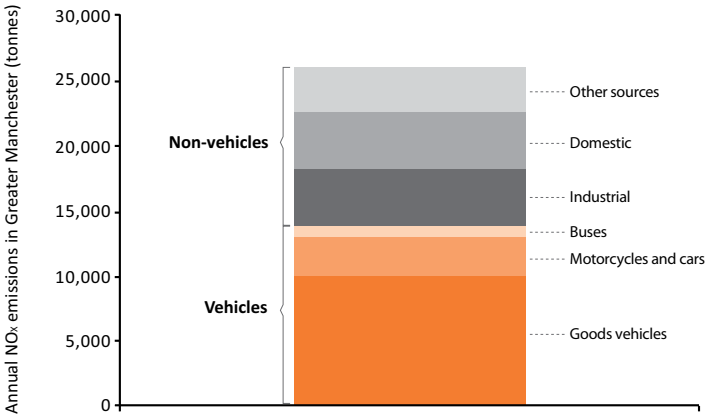
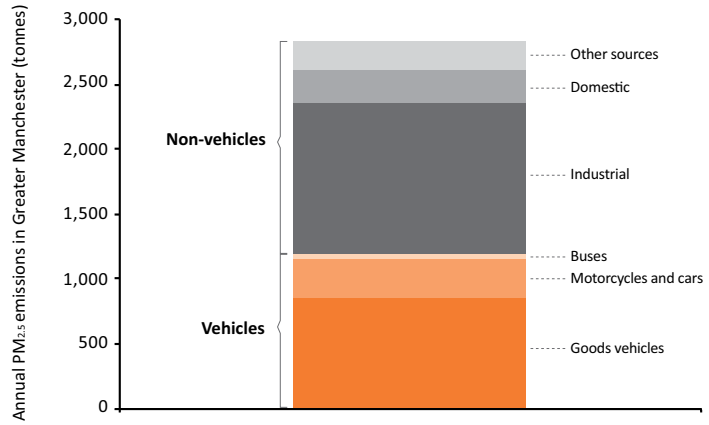


Figure 1.5: Estimated $PM_{2.5}$ emissions in Greater Manchester in 2004[14]



12 Ibid; p.45

13 *Greater Manchester Air Quality Action Plan*; 2006; https://cms.manchester.gov.uk/download/14851/greater_manchester_air_quality_action_plan-2004; pp. 16–17

14 Ibid

Figure 1.6: Proportion of emissions from vehicle exhausts from petrol and diesel vehicles ($PM_{2.5}$)[15]

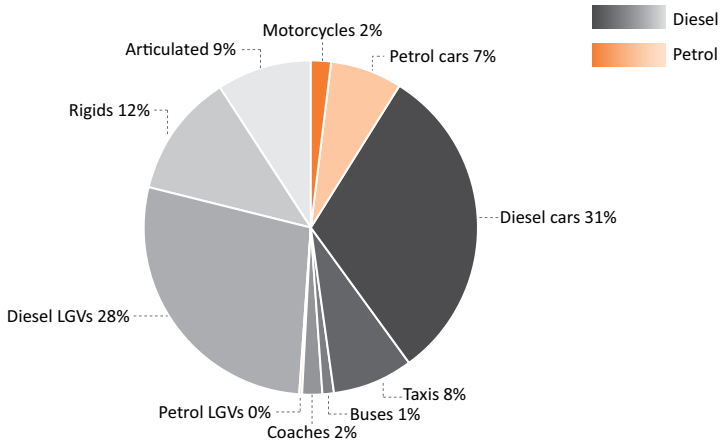
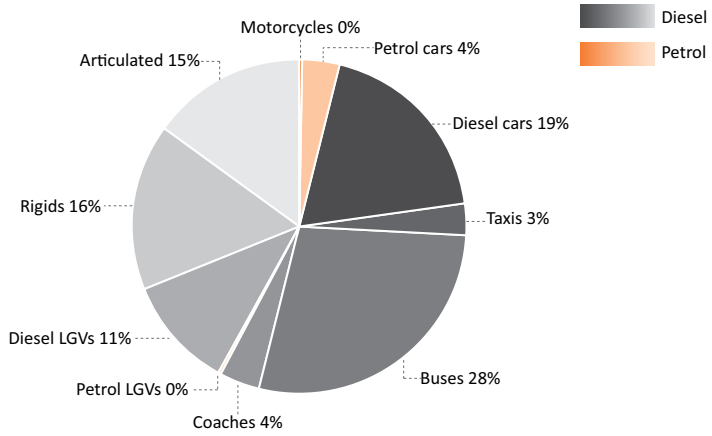


Figure 1.7: Proportion of emissions from vehicle exhausts from petrol and diesel vehicles (NO_2)[16]



Quantifying health impacts

Air pollution is among the most serious public health threats in the UK.

The Committee on the Medical Effects of Air Pollution (COMEAP, an independent committee of public health experts set up to advise government agencies and departments) assessed the 2008 burden of man-made $PM_{2.5}$ particulate pollution to be "an effect on mortality in 2008 equivalent to nearly 29,000 deaths in the UK at typical ages." In other words, 29,000 deaths occurred that year that are attributable to man-made particulate pollution. This averages out to a "loss of life expectancy from birth of approximately six months" for every UK resident.[17] COMEAP has speculated that it is "reasonable to consider that air pollution may have made at least some contribution to the earlier deaths of up to 200,000 people (the number dying of cardiovascular causes)". In other words, they argued that air pollution contributes in some amount to every death from cardiovascular causes in the UK.[18]

15 Data from Kings College London, Environmental Research Group

16 Ibid

17 Committee on the Medical Effects of Air Pollution; *The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom;* London; 2010; http://www.comeap.org.uk/images/stories/Documents/Reports/comeap%20the%20mortality%20effects%20of%20long-term%20exposure%20to%20particulate%20air%20pollution%20in%20the%20uk%202010.pdf

18 Committee on the Medical Effects of Air Pollution; *The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom*; London; 2010; http://www.comeap.org.uk/images/stories/Documents/Reports/comeap%20the%20mortality%20effects%20of%20long-term%20exposure%20to%20particulate%20air%20pollution%20in%20the%20uk%202010.pdf

Because air pollution is not evenly geographically distributed, those living in the most polluted areas would expect a far greater reduction in life expectancy.[19] In London, COMEAP estimates the average loss of life expectancy from birth at around nine months – 50% worse than the national average.[20] Those living in the most polluted parts of London would expect an even greater reduction in life expectancy than the London-wide average.

> "In 2012, the International Agency for Research on Cancer classified diesel fumes as a 'known carcinogen', alongside tobacco, alcohol and asbestos"

In 2010, Defra estimated the costs to the UK of 2008 $PM_{2.5}$ levels to be in the range of £8–17 billion per year (with a central estimate of £15 billion).[21] These estimates were based on earlier work commissioned by Defra to assess people's willingness to pay to reduce the health impacts of air pollution.[22] Those health impacts carry a cost to the economy, both through financing the NHS and in productivity lost when people are unable to work. The Mayor of London has suggested that in London alone "the economic cost of the health impacts of poor air quality could be as high as £2billion".[23] Money spent to reduce pollution reduces the need to spend money in the health system to deal with its consequences.

COMEAP has been cautious about making equivalent estimates for the impact of NO_2 pollution, as the scientific knowledge is not yet sufficiently developed. Its view is that it is "possible that NO_2 could be playing some part in the associations of respiratory effects with exposure to traffic-related air pollution found in epidemiological studies".[24] Work carried out for the Department for Health has found that "Increases in deaths from all-causes were associated with increases in NO_2 concentrations both for all-ages combined and for those over the age of 65 yrs… The main cause-specific mortality outcomes studied were cardio-respiratory, cardio-vascular and respiratory diseases… Estimates show[ed] positive and statistically significant associations with increases in NO_2 concentrations."[25] The relative shortage of quantified evidence on NO_2 harms has meant NO_2 policy has been weakly justified, despite government having signed up to legally binding limits. Cost benefit analyses (for example, in the various Clean Air Strategies) may understate the benefits of some policies if they underestimate the harm of unabated NO_2.

Further research has attempted to quantify associations between particular illnesses and pollution levels. Work by Aphekom (a pan-European air quality research network) "concluded that those living near main roads in cities could account for some 15–30% of all new cases of asthma in children and chronic obstructive pulmonary disease and coronary heart disease in adults 65 years of age and older [and] that 15–30% of exacerbations of these illnesses are attributable to air pollution."[26] In 2012, the International Agency for Research on Cancer, a part of the World Health Organisation, classified diesel fumes as a "known carcinogen", alongside tobacco, alcohol and asbestos.[27] Because this work suggests air pollution may cause, not just exacerbate, health problems, it estimates a burden of air pollution substantially higher than previous work had estimated. Estimates of the costs of air pollution also do not incorporate costs that are not related to public health. Ecosystems are also sensitive to air pollution.

19 Ibid

20 Ibid; p. 9

21 Department for Environment, Food and Rural Affairs; *Air Pollution: Action in a Changing Climate*; London; 2010; p. 7

22 Chilton, Susan et al; *Valuation of health benefits associated with reductions in air pollution;* Defra; London; 2004; http://archive.defra.gov.uk/environment/quality/air/airquality/publications/healthbenefits/airpollution_reduction.pdf

23 Mayor of London; *Clearing the Air*; 2010; pp 14–15

24 Correspondence with COMEAP secretariat

25 Anderson, HR et al; *Quantitative systematic review of short term associations between ambient air pollution (particulate matter, ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide), and mortality and morbidity*; London; 2007; http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/@ps/documents/digitalasset/dh_121202.pdf; pp. 24–25

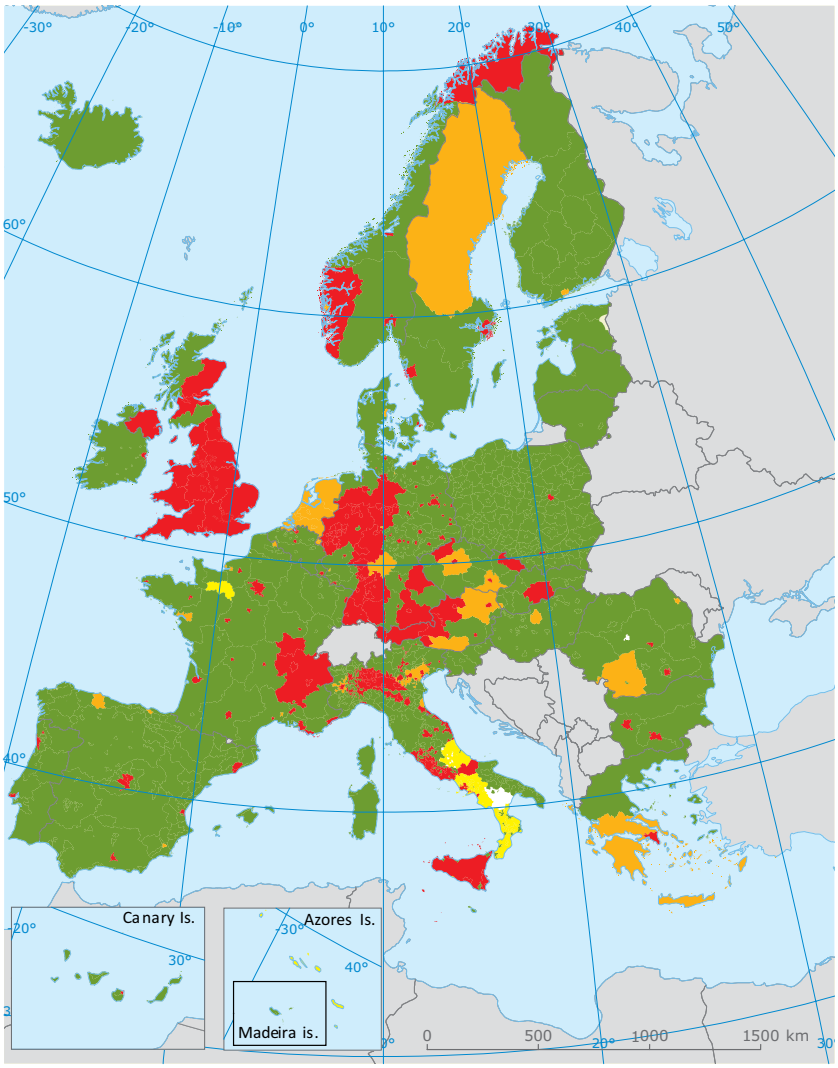
26 Aphekom; *Summary report of the Aphekom project 2008–2011*; http://www.aphekom.org/c/document_library/get_file?uuid=5532fafa-921f-4ab1-9ed9-c0148f7da36a&groupId=10347

27 International Agency for Research on Cancer; 'IARC: Diesel Exhaust Carcinogenic'; http://press.iarc.fr/pr213_E.pdf; 12 June 2012

Box 1.3: London compared with other European cities

Studies assessing European cities' air quality have highlighted the scale of the air pollution problem in London.

Annual limit values for NO_x, 2009[28]



Nitrogen dioxide 2009
Annual limit value for the protection of human health

- ≤ limit value
- > margin of tolerance
- Area not designated
- Outside data coverage
- Limit value – margin of tolerance
- Zone designated, data missing
- Geospatial information missing

The map shows locations where annual limit values for nitrogen dioxide were breached in 2009. The industrialised and densely populated band, which links London to the west, through the Netherlands to north-western Germany has particularly severe NO_2 concentrations.

- The monitoring site at Marylebone Road, London, is the fourth worst of more than 2,000 sites across Europe for NO_2 pollution (and the worst of any capital city) in 2010.[29]

28 European Environment Agency; 2011; http://www.eea.europa.eu/data-and-maps/figures/nitrogen-dioxide-2007-annual-limit-values-for-the-protection-of-human-health-3

29 European Environment Agency; Airbase data; 2012

- A 2011 report by Soot Free Cities for the European Environmental Bureau ranked London 14th of 17 major European cities for its policies to tackle black carbon PM, giving the city a lowest-possible F rating.[30]

These rankings show how far London has to go to match many of its counterparts in Europe. They should serve both as a spur, to show politicians how their performance ranks alongside other countries, but also as an example – that it is possible to do much better. The Soot Free Cities campaign highlighted measures that have been taken in different European cities to improve air quality. These include Low Emission Zones and congestion charges; public procurement of clean vehicles; improving traffic management; promoting public transport, walking and cycling; and improving communication and transparency around air quality issues. We will consider these in more detail later in the report.

Ecology costs

While most of this report relates to the costs of air pollution to human health, there are also wider environmental impacts of poor air quality in the UK. According to testimony given to the House of Commons Environmental Audit Committee by the Countryside Council for Wales, Natural England and Scottish Natural Heritage, 60% of sensitive habitats exceed the critical load for nitrogen, and levels of airborne nitrogen pollution are compromising current conservation commitments.[31] As Policy Exchange has recently argued, the economic value of biodiversity is poorly understood, though Defra has undertaken a major work programme to try to better capture the value of nature in policy decision-making.[32] Putting an exact figure, or even a cost range, around the harm pollution causes is a very difficult task, due to uncertainties about the scale of the interaction between atmospheric nitrogen and natural environments. Here, as elsewhere, there is a significant chance that the cost of air pollution is systematically underestimated.

Most polluted places

Forty out of 43 zones for assessing nitrogen dioxide around the UK exceeded limits (plus a 'margin of tolerance' allowed for member states in certain circumstances) in 2009, worse than any other EU member state.[33] But the effects of Britain's bad air are not evenly spread around the country. It is often the most vulnerable and deprived communities who suffer the worst effects. Those living in London are, perhaps unsurprisingly, the worst affected.

86% of the worst areas in England for nitrogen dioxide pollution, and 87% of the worst areas in England for particulate pollution are in London.[34] As a result, there is a strong emphasis on London-based policies in addressing air pollution. Maps 1.1 and 1.2 show the other cities where the 5% worst local areas for NO_2 and particulate pollution are located, which include Birmingham, Leicester and Southampton.

Research carried out by Policy Exchange for this report found that it is often the most vulnerable and deprived communities who suffer the worst effects of air pollution.

30 http://sootfreecities.eu/city

31 Written Evidence Joint Nature Conservation Committee, Countryside Council for Wales, Natural England and Scottish Natural Heritage to the Environmental Audit Committee; *Air Quality: A Follow Up Report*; 2011; Volume II, pp. 8

32 Newey, Guy; *Nurturing Nature*; Policy Exchange; 2012. Also Defra; National Ecosystem Assessment; 2011

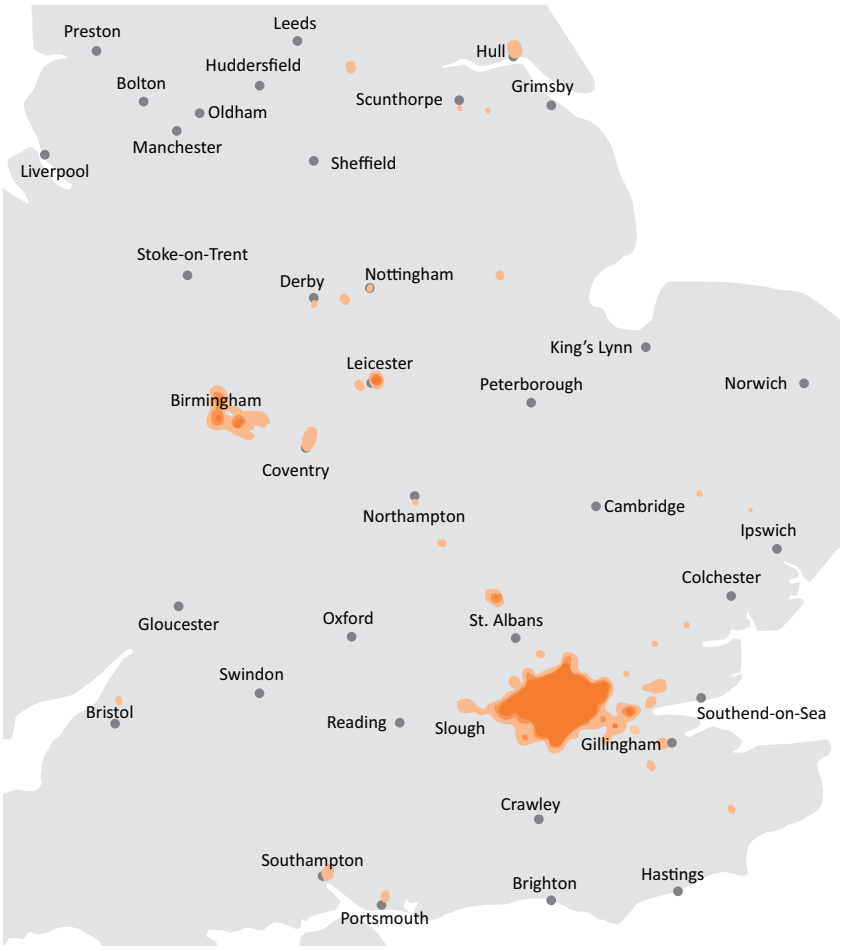
33 Proportion of the 5% worst 'Local Super Output Areas' for those pollutants that are in Greater London.

34 Campaign for Clean Air in London; 'London has the highest levels of nitrogen dioxide in Europe'; 2012; http://cleanairinlondon.org/london-has-the-highest-levels-of-nitrogen-dioxide-in-europe/

Box 1.4: European drift?

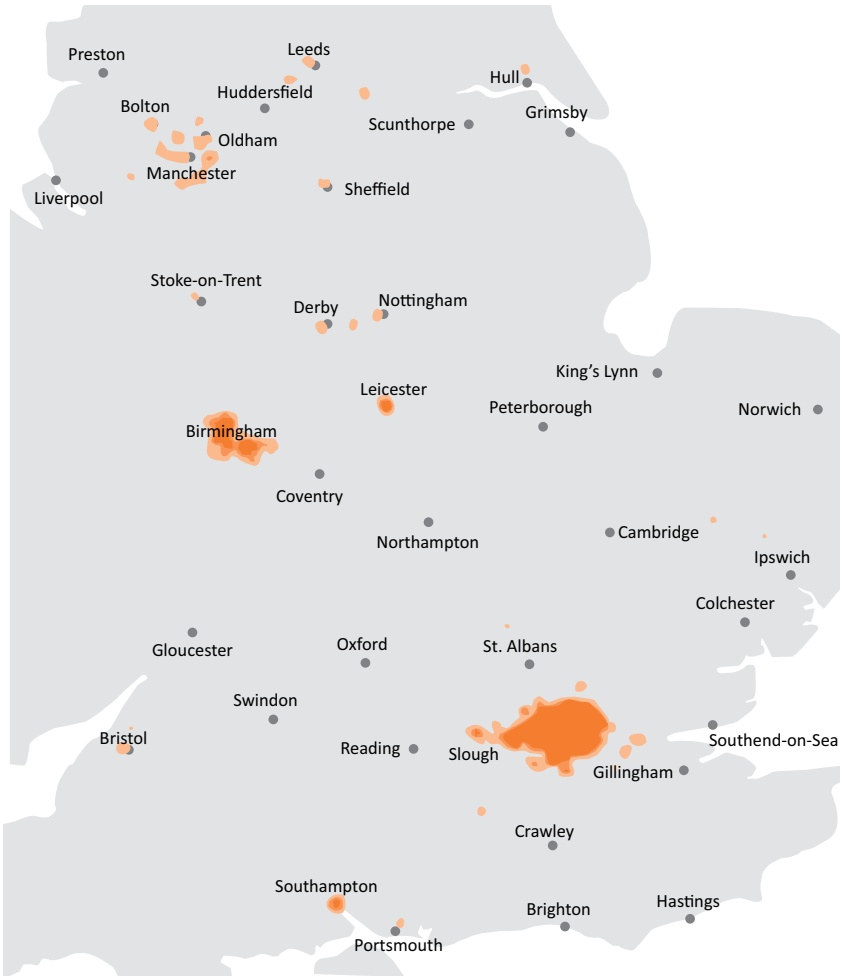
One of the pervasive claims about air pollution in London and southeast England is that pollution drifting across the English Channel from continental Europe is to blame – arguments that Mayor Boris Johnson has used to defend occasions where pollution exceeded target levels, with consequent risks for public health.[35] However, while not entirely inaccurate, the Mayor's comments overemphasise the influence of continental drift. Winds blowing pollution from the continent are less common than winds heading the other way, taking British pollution east. Though anticyclone weather patterns bringing European pollution towards Britain can also create conditions leading to elevated pollution levels, domestic emitters are by far the main contributor. Though continental emissions may marginally reduce the margin for error when targets are in danger of being breached, they are very much diluted compared to regional and locally emitted pollution. It also serves to distract attention from emissions from UK sources that migrate into London.

Map 1.1: Locations of worst 10% of LSOAs for particulate concentrations (England)



35 Johnson, Boris; *Mayor Answers to London*; Question number 0811/2011; 23 March 2011; http://mqt.london.gov.uk/mqt/public/question.do?id=35358

Map 1.2: Worst 10% of LSOAs for NO_2 concentrations (England)



The Department for Communities and Local Government and the Office for National Statistics divide the country up into sub-ward level areas with populations of around 1,500 people. These areas are known as Local Super Output Areas. We compared the average for a selection of socio-economic indicators in the worst 10% of LSOAs in London for NO_2 and PM_{10} concentrations (477 LSOAs out of 4,766 in London) with the London averages for those indicators in 2010.[36] We found that, for example, in the worst 10% of London for PM_{10} particulate pollution:

- 5–10 year old children are 41% more likely than the London average to be eligible for free school meals.
- Residents are 27% more likely than the London average to be on income support.
- Residents are 11% less likely to continue in post-compulsory education than the London average.

36 Using data from the Department for Communities and Local Government; *Indices of Standard Deprivation* and the London Datastore; http://data.london.gov.uk. p(worst 10% average ≥ London average)<0.001 for all listed findings

In the worst 10% of London for NO_2 pollution:

- 5–10 year old children are 47% more likely than the London average to be eligible for free school meals.
- Residents are 26% more likely than the London average to be on income support.
- Residents are 14% less likely to continue in post-compulsory education than the London average.

These correlations between air pollution and other aspects of social deprivation are in line with the findings of Goodman et al on the associations between air pollution and other indicators of deprivation, and with findings from other similar countries such as the Netherlands.[37] Air pollution "hits the poorest hardest" yet is rarely considered to be a 'fairness' issue.

Table 1.2: Worst 10 LSOAs for particulate and NO_2 pollution in 2010[38]

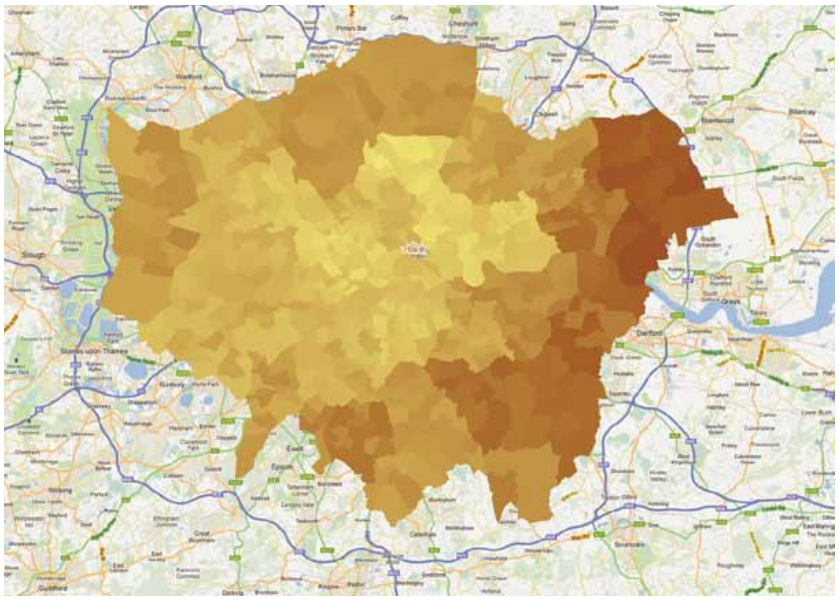
$PM_{2.5}$	NO_2
• **Barking and Dagenham** – New Road and Heathway	• **Camden** – Gower Street and Tottenham Court Road around Goodge Street Underground station
• **Barking and Dagenham** – New Road and Ballards Road	• **Camden** – Euston Road and Fitzroy Square
• **Barking and Dagenham** – Rylands Estate	• **Westminster** – Trafalgar Square, The Strand and Charing Cross Road
• **Camden** – Gower Street and Tottenham Court Road around Goodge Street Underground station	• **Westminster** – The Strand, Aldwych, Kingsway and the Victoria Embankment
• **Camden** – Euston Road and Fitzroy Square	• **Westminster** – Oxford Street, Charing Cross Road and Soho Square
• **Westminster** – Oxford Street, Charing Cross Road and Soho Square	• **Camden** – Gower Street, Russell Square and Upper Woburn Place
• **22 LSOAs equal for 7th place**	• **Camden** – High Holborn and Kingsway (east side)
	• **Camden** – Theobald's Row, Guildford Place and Great Ormond Street Hospital
	• **Camden** – High Holborn and Kingsway (west side)
	• **Camden** – High Holborn, Shaftesbury Avenue and Charing Cross Road

Map 1.3 shows the geographic distribution of deaths in London attributable to $PM_{2.5}$, as calculated by the Institute for Occupational Medicine in a report for the Mayor of London. It shows how pollution levels interact with population density and socioeconomic factors – the parts of east London with the highest numbers of attributable deaths have serious pollution levels and low socioeconomic indicators, leading them to display higher proportions of attributable deaths per 100,000 population than the most severely polluted though richer central areas.

37 Goodman, Anna et al; 'Characterising socio-economic inequalities in exposure to air pollution: A comparison of socio-economic markers and scales of measurement' in *Health & Place* (17, 2011); pp. 767–774. Fischer, Paul et al; *Associations Between Small Area Levels of Air Pollution and Socio-economic Characteristics in the Netherlands and England*; 23rd Annual Conference of the International Society of Environmental Epidemiology; Barcelona; 2011; http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.isee2011

38 Data from the Department for Communities and Local Government; *Indices of Standard Deprivation*

Map 1.3: Geographic distribution of deaths in London attributable to air pollution in 2008[39]



Map © 2012 Google

Attributable deaths due to $PM_{2.5}$ (6pc coeff)

30 attributable deaths each year per 100,000 population at conc coef 6% per 10 micrograms per cubic metre $PM_{2.5}$

100 attributable deaths each year per 100,000 population at conc coef 6% per 10 micrograms per cubic metre $PM_{2.5}$

London schools

A growing body of literature has found that living or attending school in close proximity to busy roads can cause or exacerbate childhood asthma. A health impact assessment study in 25 European cities found that living close to high-traffic roads could be responsible for 15–30% of new asthma cases in children.[40] Earlier work conducted in California suggests a causal link – "that air pollution exposure contributes to new-onset asthma", and that pollution levels at schools, as well as at homes, "may both contribute to the development of asthma".[41] This evolving understanding of the effects of air pollution has implications for London.

Data gathered under a Freedom of Information request by the Campaign for Clean Air in London identified 1,098 schools and nurseries in London within 150m of roads carrying more than 10,000 vehicles per day.[42] Analysis of the data by Policy Exchange shows that more than 320,000 children (including more than 180,000 children under the age of 11) attend those schools in London within 150m of a road carrying more than 10,000 vehicles per day.

Since 2011, London has instituted rules about the construction of schools, as well as other sensitive buildings such as hospitals and old people's homes "in locations where they will be affected by existing sources of air pollution (such as road traffic and industrial processes)."[43] However, this does little for the hundreds of thousands of schoolchildren who attend schools in close proximity

39 O'Brien, Oliver; Centre for Advanced Spatial Analysis, University College London. Data from Dr Brian Miller; *Report on estimation of mortality impacts of particulate air pollution in London*; Institute for Occupational Medicine; 2010; http://www.london.gov.uk/sites/default/files/Health_Study_%20Report.pdf.

40 Aphekom; *Summary report of the Aphekom project 2008–2011*; http://www.aphekom.org/c/document_library/get_file?uuid=5532fafa-921f-4ab1-9ed9-c0148f7da36a&groupId=10347

41 Jerrett, Michael et al; 'Traffic-Related Air Pollution and Asthma Onset in Children: A Prospective Cohort Study with Individual Exposure Measurement' in *Environmental Health Perspectives* (October 2008); pp. 1433–1438 and McConnell, Rob et al; 'Childhood Incident Asthma and Traffic-Related Air Pollution at Home and School' in *Environmental Health Perspectives* (July 2010); pp. 1021–1026

42 Data from Transport for London via the Campaign for Clean Air in London, and Department for Education *School Census*. The Campaign for Clean Air in London's press release quotes a higher figure of 1,148, but this total includes a small amount of duplication, and several higher education establishments which would not have children attending. However, since the CAL data also appears not to include institutions without the name 'School' in their title (anything called, for instance, X College, Y Academy, or Z Nursery is not captured in the CAL data), this number is likely to be an underestimate of the true total.

43 Mayor of London's office; *The London Plan;* July 2011; http://www.london.gov.uk/sites/default/files/The%20London%20Plan%202011.pdf; p. 230

to harmful traffic pollution. To improve conditions at those schools requires the similar measures to reduce pollutant concentrations (especially by reducing traffic volumes and emissions from diesel vehicles) as are desirable to reduce the broader health burden of air pollution. Other local authorities outside London should follow the lead of the *London Plan* in issuing specific planning guidance to avoid building schools or other sensitive buildings in highly polluted areas.

2
Prioritisation

One of the most prominent criticisms made by the Environmental Audit Committee (EAC) when it investigated the government's record was the relative low prioritisation given to air quality. "The Committee found that… air quality was not seen as a priority across Government, which as a result was failing to meet a range of domestic and European targets."[44] Comparing the costs to society, and the loss of life due to air pollution (just from $PM_{2.5}$) and other public health problems shows that air quality is either similar to, or more serious than most other public health issues. In terms of deaths, only smoking has more deaths attributable to it than fine particulate pollution. Overall costs to society are similar to those for alcohol and obesity, (although precise calculations for this type of statistic are difficult and have wide bands of uncertainty around them). Deaths attributable to particulate air pollution (approximately 29,000) are more than ten times the number of people killed in road traffic accidents (2,222 in 2010). In the last year for which statistics are available, 289 people were killed because of drink or drug driving incidents.

Public awareness and understanding

The harm from air pollution is largely invisible. A faint haze over the city may be an indication of a high pollution episode – frequently it is even less obvious than that. Unlike the consequences of smoking or obesity, there is not a direct correspondence between a particular behaviour or action and the health problem which follows.

As a result, public awareness and understanding of the issue is very low. In 2006 Defra convened a 'Citizens' Jury' (a representative panel of members of the public asked to look at a controversial topic in detail) to gauge public awareness of air pollution. It summarised:"An initial brainstorming session revealed that air pollution is not a 'top of mind' environmental issue. With respect to air quality there was an awareness that quality (measured by smell) varies and that this variation was most likely to be caused by traffic. However, there was no understanding of how air quality is measured scientifically or that action can be taken by individuals to improve it. Neither was there a sense of what 'good' quality air is. *Most participants admitted that they had not thought about air quality explicitly* [emphasis added]."[45]

The lack of public awareness of the extent of the air pollution problem limits the extent to which politicians can intervene to tackle the problem. It is difficult to persuade people to change their behaviour if they do not know they are at risk, or possibly contributing to the problem.

44 Environmental Audit Committee; Air Quality – A Follow-up Report; London; 2011; http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1024/102405.ht

45 Defra; *Articulating public values in environmental policy development;* October 2007; http://uk-air.defra.gov.uk/reports/cat09/0711011358_report-summary.pdf

Increased public awareness of air pollution would have a number of potential implications. Better informed about the harm to health air pollution causes, people could better protect themselves against exposure to pollution (although there are obvious limits to this kind of response). They could also limit the impact of polluting activities, such as driving, by using more fuel-efficient driving techniques, reducing time spent with the engine idling, or reducing journeys made. Less directly, it could also lead to an increase in pressure on politicians and policymakers to tackle the issue (making an awareness policy a way to rally public support about other policy actions in the future). For example, the EAC linked low public awareness of the harms of air pollution to the comprehensive rejection in a referendum of a congestion charge in Manchester (by 78.8% to 21.2%) – a situation where the costs of the policy in the form of increased costs or barriers to transport were clear, but the benefits in terms of improved air quality and consequently health were not. There is of course no guarantee that the public of Manchester, fully informed of both sides of the argument, would have chosen differently.

> "The lack of public awareness of the extent of the air pollution problem limits the extent to which politicians can intervene to tackle the problem. It is difficult to persuade people to change their behaviour if they do not know they are at risk"

Contributing to the lack of public awareness or policy action may be the absence of a strong lobby for clean air action. Industrial opportunities in the area seem limited. Even the big environmental NGOs have been relatively quiet, focusing their attentions on other issues like climate change, leaving the field to smaller, less well-resourced organisations. Meanwhile haulage and industrial lobbies can be powerful advocates against changes to road use rules or increasing taxation on diesel. These aspects are likely to be self-reinforcing – public apathy means NGOs and politicians focus their attention elsewhere, which means public awareness is unchanged and apathy continues.

While Defra, as well as other organisations, publish information on air quality, it is not particularly user-friendly. Efforts at outreach are improving with the recent addition of air quality information to Met Office weather forecasting, and the recent establishment of a dedicated Twitter feed, but even with these recent improvements, the clarity or breadth of information provided is limited, in contrast to Hong Kong's respected (though unofficial) Hedley Index. A direct comparison may be slightly unfair – the Hedley Index[46] covers a more smaller and more homogeneous (in terms of pollution) area in Hong Kong than the UK-AIR site has to cover. Nevertheless, the information provided on financial costs and accumulating hospital bed-days and doctor visits is far more striking than Defra's simple summary of current and forecast pollution levels.

The information the Hedley Index provides (Figure 2.2) – a counter of premature deaths and hospital bed-days calculated from pollution concentrations, a counter ticking up the economic loss to the Hong Kong community from air pollution, in addition to information about current and anticipated pollution hotspots and recommended actions to take – is far more user-friendly than Defra's site (Figure 2.1). In estimating the costs of air pollution, both financially and in terms of health impacts, in real time, it goes a step further than the civil society groups in the UK who have established air quality reporting sites (such as the London Air Quality Group).

46 http://hedleyindex.sph.hku.hk/home.php

Figure 2.1: Defra's UK-AIR website

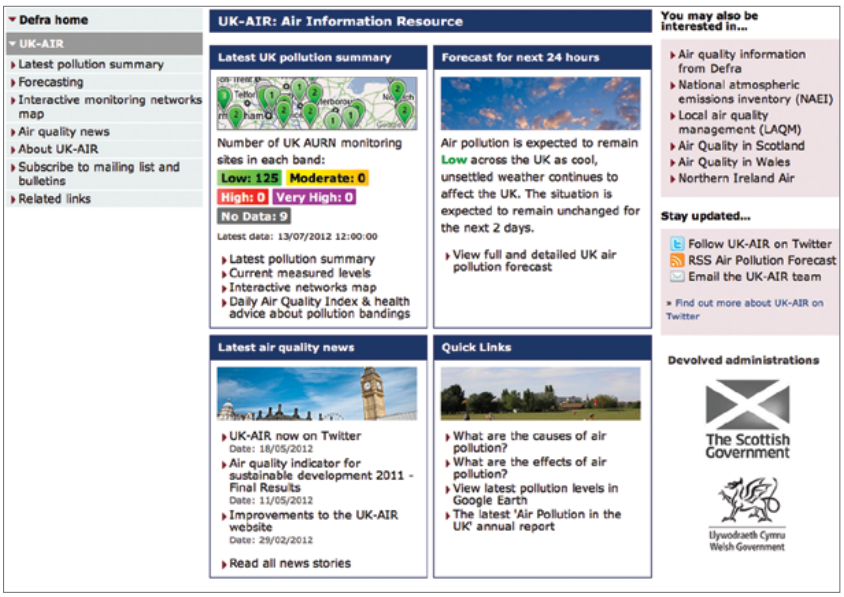
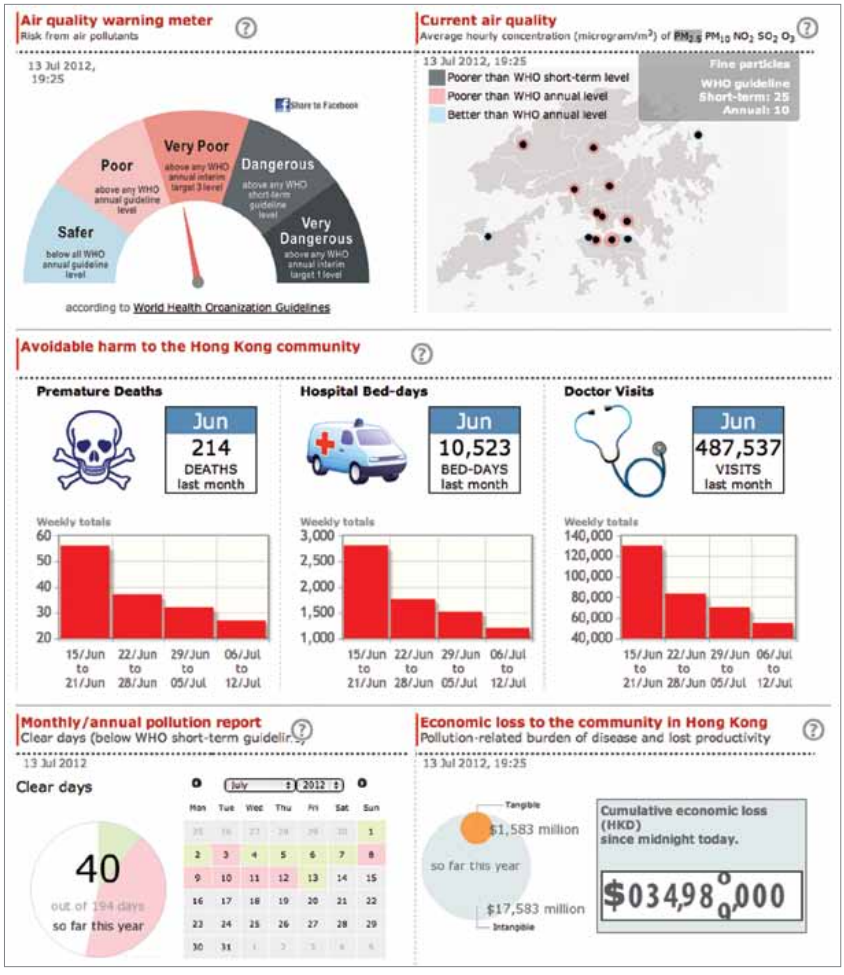


Figure 2.2: The Hedley Index



Recommendation:The government, or the private sector, could establish a competition to build a website that improves on existing resources by clearly and accurately portraying air pollution, including criteria for health, cost, geography. *It would be a low-cost method of improving the communication of the problem. Both the contest process, and the resulting website, would provide a boost to public awareness of the problem.*

As can be seen from Table 2.1, although air pollution is a similar scale of public health problem to obesity and alcohol, and is only surpassed by smoking, the government does not spend any money on increasing public awareness of the problem. The reason for that is relatively straightforward. With drinking, smoking, and obesity there is a direct connection between the actions an individual takes and his or her exposure to the health risk of it. With air quality, the risks are much more socialised – the actions of many people affect each individual's health risk.

The Environmental Audit Committee has repeatedly recommended educating the public about the health risk from poor air quality and how they can limit their exposure and improve air quality in its reviews of air quality policy.[47] The government response so far, however, has been noncommittal. Defra has "given some preliminary consideration to such a campaign and will continue to keep it under review." Defra and the Department of Health have held preliminary discussions to see whether a public information campaign would be a good use of the available budget, and how it might work. One of the main hurdles is identifying an 'ask' – some practical step that people can take that would help with the problem. Warning people of the scale of the problem is of limited use if they feel helpless to act on the information. More targeted messages may be more useful than scary-but-impractical warnings about numbers of pollution-linked deaths. One that is being trialled is a radio and poster campaign to encourage drivers stuck in traffic to turn off their engines, resulting in reduced air pollution, reduced climate impact and savings on drivers' fuel bills. In other areas, schools have sent a similar message to parents waiting to pick up children, encouraging them to turn off their engines – a message that could be adopted by more schools and local authorities. Encouraging people to cycle, walk, or use public transport rather than driving can likewise deliver wins for air quality, climate and (usually) cost.[48]

Recommendation: Local authorities and institutions such as schools should begin or continue awareness programmes around relevant behaviours such as leaving engines running when vehicles are stopped ('idling'), or encouraging cycling and walking. *If possible these should be done in a way where the impact of the programme can be assessed. For instance, if a school is near to an air quality monitoring station, pollution data from before and after the campaign can be compared to determine if it is an effective way of lowering pollution concentrations.*

Air pollution compared with other public health problems

This report compared how spending aimed at improving public awareness of air quality compared with other public health issues. Because, in many of these areas, cost estimates and savings estimates are uncertain, and many policies may be only partly targeted at the headline problem, such estimates are inevitably crude. In other areas, the division of responsibility between many different authorities and programmes means what data does exist is highly fragmented and a comprehensive estimate is not available. Table 2.1 shows how air pollution compares to other prominent public health problems.

47 Environmental Audit Committee; Air Quality; 2009 and Air Quality – a follow-up report; 2011

48 NGO Sustrans has carried out interesting work through its TravelSmart campaign on providing customised information to people to encourage cycling and walking rather than driving. http://www.sustrans.org.uk/what-we-do/travelsmart

Table 2.1: Comparing health impacts, financial costs and government spending on public information campaigns for public health problems

Problem	Estimated health impact	Estimated financial cost	Government public information spend (£ m)[49]			
			2008–9	2009–10	2010–11	2011–12
$PM_{2.5}$ pollution	29,000 attributable deaths per year 340,000 life years lost for those 29,000	£15bn (in 2008)[50]	0	0	0	0
NO_2 pollution	Unknown	Unknown	0	0	0	0
Alcohol	8,790 deaths (2010)[51] 15–22,000 deaths (2008)[52]	Cost to NHS £3.3bn (2006–07)[53] Estimated cost to society £21bn annually[54]	4.77	4.65	0	0.98
Smoking	87,000 deaths/year (2008)[55]	Cost to NHS £3.3bn (2006–07)[56]	23.38	14.6	0.46	3.16
Obesity	Approximately 9,000 deaths (2007)[57]	Cost to NHS of £4.2bn in 2007, rising to £6.4bn in 2015 and £8.3 bn in 2025[58]	7.69	N/A	N/A	N/A
Drink and drug driving	289 deaths (2010)	Not estimated	3.8	5.7	0.5	0.6

Table 2.2: Comparison of the benefits of reducing $PM_{2.5}$ by 10µg/m^3 (equivalent to eliminating man-made $PM_{2.5}$ in 2005), the elimination of motor vehicle traffic accidents and the elimination of exposure to passive smoking[59]

	Reduction in $PM_{2.5}$	Elimination of road traffic accidents	Elimination of passive smoking
Expected average gain in life expectancy	7–8 months	1–3 months	2–3 months
Estimated equivalent gain in life years in England and Wales from 2005–2110 for the whole population (including people born during that time)	39,058,000	8,126,000	13,194,000

49 Air pollution nil spend confirmed in communication with Department for Health Information Service and Defra. Spend on alcohol and tobacco public information campaigns from Anne Milton; Hansard; 24th April 2012; 'Health Education'; Column 864W. http://www.publications.parliament.uk/pa/cm201212/cmhansrd/cm120424/text/120424w0004.htm#12042485000162 and on obesity from Simon Burns; Hansard; 10th January 2011; 'Departmental Publicity'; Column 168W (Change4Life); http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110110/text/110110w0006.htm#1101119000041. Drink/drug driving expenditure from Department for Transport Freedom of Information response.

50 Defra; *Action in a Changing Climate*; http://www.defra.gov.uk/publications/files/pb13378-air-pollution.pdf

51 Office for National Statistics; *Alcohol-related deaths in the United Kingdom 2010*; 26 January 2012; http://www.ons.gov.uk/ons/dcp171778_254061.pdf

52 Department of Health; *Health Inequalities*; 2008

53 Scarborough, Peter, et al; 'The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006–07 NHS costs'; *Journal of Public Health* 11 May 2011; http://jpubhealth.oxfordjournals.org/content/early/2011/05/11/pubmed.fdr033.full.pdf+html

54 Home Office; *Alcohol Strategy* 2012

55 Department of Health; *Consultation on the future of tobacco control*; 2008

56 http://jpubhealth.oxfordjournals.org/content/early/2011/05/11/pubmed.fdr033.full.pdf+html

57 Department of Health; *Health Risks and Costs of Obesity*; 2007

58 Foresight Team, BIS; *Tackling Obesities: Future Choices*; 2007

59 Environmental Audit Committee; Air Quality; p. 8 http://www.publications.parliament.uk/pa/cm200910/cmselect/cmenvaud/229/229i.pdf

Table 2.2 compares the benefits that would result from interventions that led to the elimination of man-made particulate pollution, the elimination of road traffic accidents, and the elimination of passive smoking. The scope for improving public health (in terms of life-years) is more than twice as large for reducing $PM_{2.5}$ pollution as for reducing passive smoking or road traffic accidents.

Furthermore, there is plenty to suggest that the assessments of the harm caused by air pollution underestimate the problem. The costs in Table 2.1 omit serious pollutants, most significantly NO_2, and quantify only mortality (deaths), not morbidity (illness). It also takes no assessment of the impacts on the environment.

3
Institutions

Governments have sought to mitigate air pollution problems using a variety of regulatory interventions aimed at technology and behaviour change, directed from different tiers of government. These different tiers bear responsibility for different parts of the architecture of UK air pollution policy.

Tiers of government

Global

The UK is a signatory to the United Nations Convention on Long-Range Transboundary Air Pollution and the 'Gothenburg Protocol' to Abate Acidification, Eutrophication and Ground-level Ozone.[60] Both of these agreements aim to establish critical loads (i.e. atmospheric concentrations) that signatory governments will not exceed, and emissions ceilings both for countries, and for specified sources (e.g. factories and power stations). These objectives have been incorporated into the UK and EU limits discussed below.

EU

The European Union sets air pollution limits for its member states. These are legally enforceable limits to the number of days, or hours, particular pollutants may exceed particular limit values in a given year. There are also limits set for average pollutant concentrations over the course of a year. Citizens are able to use legal mechanisms, via the European institutions, to ensure their governments take actions necessary to comply with the specified limits.

Several EU directives guide UK emissions controls of particular industries, such as power generation, waste disposal, and chemicals, steelworking, and other heavy industries.

The EU also plays a role in products policy which is of significance to overall air quality policy, for example by setting standards for acceptable levels of pollutants emitted from vehicles.

The EU has no implementation body to implement measures to meet the targets directly; member states hold responsibility for implementation. However, the EU does have a limited enforcement capability in the form of the infraction or infringement process, a process for fining member states who fail to comply with EU Directives. Because the decision to pursue a member state for infraction of a Directive is inherently a political one, however, the use of the mechanism is relatively scarce compared with the number of breaches of Directives that occur.[61] Such a heavy fine would be unprecedented (in any area of EU policy).

60 United Nations Economic Commission for Europe; http://www.unece.org/env/lrtap/lrtap_h1.html

61 For further detail see Transport for London; London Low Emission Zone Variation Order – Supplemental Information; 2010; http://www.tfl.gov.uk/assets/downloads/roadusers/lez/LEZ/LEZ-VO-Supplementary-Information-May-2010.pdf; p. 22 and Treaty on the Functioning of the European Union; Article 258; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:083:0047:0200:EN:PDF

The possibility of such a fine should be given appropriate weighting in the policy process. However, the purpose of policy should not simply be to avoid a large fine.

The European Union is launching a 'Year of Air' campaign in 2013, which will be aiming to focus public attention on the problem of air pollution, and conducting a comprehensive review of air quality policy. In coming years, new binding targets for $PM_{2.5}$ are due to come into force. However, the difficulties European governments have faced complying with the existing targets has seen increased lobbying to weaken any future limits, especially for NO_2 which have proven the most difficult limits to reach.[62]

Central government

The UK government is responsible for implementation of clean air laws, although the Coalition government is seeking to devolve more responsibility in this area to local authorities. It remains the major source of finance for clean air policy, both for national policies and, through the funding of local authorities, policies handled at the local level.

Within central government, several departments bear some responsibility for clean air policy. Defra has overall legal responsibility for air quality. The Department of Health deals with the consequences of pollution on public health. The Department for Transport plays a significant role, with transport being a big contributor to air pollution. With the increased emphasis on localism and local authorities' budgets, the Department for Communities and Local Government (DCLG) is increasingly prominent. The contribution of energy systems to air pollution, and the interactions between air quality and climate policy brings the Department for Energy and Climate Change (DECC) into play. The Department for Business Innovation and Skills (BIS) has a similar connection, regarding industrial emissions and businesses' response to policy interventions. HM Treasury plays a pivotal role by setting departmental budgets and tax structures. The Environmental Audit Committee (EAC) recommended that the Cabinet Office should lead implementation of an action plan to show "how air quality is to be considered in policy development across government, to encourage co-benefits with other policies, to discourage policy conflicts and to assess the impacts of consolidating air quality regulations."[63] Defra currently chairs a board with similar objectives.[64] Co-ordination of this array of stakeholders makes air quality policy a difficult political challenge.

Devolved governments

The devolved administrations in Scotland, Wales, and Northern Ireland each share responsibility for environmental (including air quality) policy and legislation in their respective territories with the UK government.

Regional and local governments

The government's Localism Act has sought to transfer more responsibility for air quality from central government to local authorities, especially attempting to make them potentially liable for a share of EU fines. The EAC characterised that approach as "to encourage and guide local authorities rather than require particular actions".[65] Where an area is set to exceed pollution limits, "Local

62 Other EU countries unlikely to meet the NO_x target are Austria, Belgium, France, Germany, Ireland, Luxembourg, Malta, Slovenia, Spain and Sweden. From European Energy Agency, www.eea.europa.eu/highlights/europe-to-exceed-air-pollutant/nec-directive-2009-preliminary-data

63 Ibid

64 HM Government; *Air quality – a follow up report: Government response*; http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1820/182005.htm#a5

65 Environmental Audit Committee; *Air Quality – A follow up report;* http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1024/102406.htm#a8

authorities must designate those areas as air quality management areas (AQMAs) and take action, along with others, to work towards meeting the objectives."[66]

This has been a mixed blessing. Local authorities are closest to the problem, and can better take account of local factors when considering the implementation of policies such as congestion charging or urban Low Emission Zones. However, local authorities do not have the ability to influence all the factors which influence air quality, and as the EAC identified, "local politicians tend to accord air quality a low priority" (although arguably so do national ones).[67] In straitened financial times, raising air quality up the agenda in town halls is particularly difficult, with budgets squeezed, environment departments being cut back, and little public pressure on officials to act. Fears about the potential impact of more aggressive actions to tackle air quality (such as Low Emission Zones) on economic growth are also an impediment to local authories leading on air quality matters.

Box 3.1: Health and wellbeing boards

The establishment of 'health and wellbeing boards', as part of the reorganisation of the NHS, aims to raise the prominence of air quality at a local level. These boards are meant to ensure "more joined-up services from the NHS and local councils." Public health matters – including air quality – fall under their remit. They are intended to enable more joined-up thinking between traditionally separated functions of local council environment officers and decision makers within the health service. It remains to be seen how this will work out in practice – with both the NHS reform process and the localism agenda at fledgling stages of development there is not yet any record of performance to assess.

In other ways, local authorities are more constrained as to what they can do. For example, as will be discussed in more detail in Chapter 5, a tax structure that favours diesel vehicles is not something a local authority can alter – only central government has that power. In evidence to the Environmental Audit Committee, Richard Kemp of the Local Government Association explained the problem,

> *"At the moment it seems to me there is a lot has just been devolved to local government, but frankly, if you are Warrington Council and you have two major motorways intersecting in the middle of your town, and you have another one on the fringe and you are not far from Manchester Airport, there are some things that you could and should do but there are some things that are clearly outside your control.We need to split who should be doing what so there is clarity between us."*

As yet, there is not even clarity about how to reach a decision on that split, let alone what its final form should be.

That is not to say that local authorities have no tools available to them to help with the problem. These range from high-impact projects like Low Emission Zones in cities to very small items like the provision of secure cycle storage

66 Defra; *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*; 2007. A full list of local authorities with AQMAs can be found at http://aqma.defra.gov.uk/list.php

67 Environmental Audit Committee; *Air Quality – A follow up report;* http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1024/102406.htm#a8

equipment. Many basic local authority functions – from planning and waste management, to regulation of buses and providing transport for schoolchildren and vulnerable communities – have links to air quality. Taking air quality into account when making all these routine decisions will require a significant culture shift among local councillors, but is one that the government is eager to encourage as is demonstrated both by delegation of increased powers, and with the threat of passing down responsibility to pay EU fines.

Planning powers alone give local authorities significant influence over air quality.[68] These occasionally manifest themselves very visibly (for example in debates over energy from waste incinerators, which have tended to provoke strong reactions from communities on pollution grounds, despite being regulated with equivalent stringency to other types of industrial facility). Most of the time, however, they are a component of wider debates about the suitability of any planned project.

68 "Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan." – Department for Communities and Local Government; *National Planning and Policy Framework*; 2012; para. 124, p. 29; http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.pdf

4
Limits

The UK signed up to European legislation that obliges it to achieve a range of limits for different pollutants. The targets were based on World Health Organisation guidance and, in the years since they were set, evidence about the health harm associated with air pollution has strengthened. The targets are summarised in Table 4.1. It notes those targets that are at risk of being breached, or where the UK government has requested, or is in the process of requesting, extensions to the deadline. Targets for PM_{10} and nitrogen dioxide are both subject to ongoing legal action involving clean air campaign organisations, the UK government and the European Union.

Other pollutants, including ozone, sulphur dioxide, benzene, carbon monoxide and lead have been controlled by older UK and EU environmental legislation, which demanded widespread installation of pollution-control technologies and procedures. Concentrations of those pollutants are now below limit values.

The government has argued that current targets for NO_2 are essentially unachievable in some parts of the country (at least using measures they have assessed to be cost-beneficial) before 2020. However, it acknowledges that the costs, particularly of NO_2, but also of air pollution more broadly, are poorly understood.[69]

The government seems to be trying to have it both ways with regard to meeting air quality limits. On one hand, the Coalition Agreement pledged to "work towards full compliance with European Air Quality standards" and has expressed a desire to continue tightening EU limits in the future.[70] However, it also says of EU limits that, "there was never an intention for any of the deadlines to force measures that would impose disproportionate costs on society. Deadlines for attainment of limit values must reflect both the availability of measures and the affordability of implementation relative to the benefits".[71] It has shown, though, that there are measures that the deadlines force that are not disproportionately costly. For example, the 2007 *Air Quality Strategy* identified gains from £30 million to £1.12 billion per year from a suite of measures including increasing uptake of low emission vehicles, incentivising early adoption of new EURO vehicle emissions standards and reducing emissions from shipping. It also found small net costs to road pricing, low emission zones, retrofitting diesel vehicles and reducing emissions from small combustion plants. We will review these options in Chapter 5. However, the *Strategy* also concluded that it was unlikely that these measures (alone or combined) would lead to meeting the 2015 NO_2 limit value. But Defra also assessed that: "the costs to government if all measures required to achieve the limit value [for NO_2] by 2015 were implemented are likely to

69 See Committee on the Medical Effects of Air Pollutants; *Statement on the Quantification of the Effects of Long-term Exposure to Nitrogen Dioxide on Respiratory Morbidity in Children;* 2009; http://www.comeap.org.uk/images/stories/Documents/Statements/COMEAP_statement_on_quantification_of_effects_of_long-term_exposure_to_nitrogen_dioxide.pdf Krzyzanowski, Michal and Cohen, Aaron; *Update of WHO air quality guidelines; World Health Organisation*; 22 February 2008

70 HM Government; *The Coalition: Our Plan for Government*; p. 17

71 HM Government; Air quality: A follow-up report: Government Response to the Committee's Ninth Report of Session 2010–12; p. 6

be significant and in cost benefit terms particular measures or combinations of measures might appear at best to be neutral and in some cases negative."[72] As the *Air Quality Strategy* showed, there are several cost-effective policy options to work towards compliance with limit values. Beyond those options which have already been identified, and where implementation is the next step, there is also scope for experimentation to test the effectiveness in reducing pollution, and the cost of other policy options.

72 Vaughan, Robert; *UK Approach to its Application for Time Extension Notification to Nitrogen Dioxide Limit Value deadline*; Defra; 2009; p. 25

73 Krzyzanowski, Michal and Cohen, Aaron; *Update of WHO air quality guidelines; World Health Organisation;* 22 February 2008

Table 4.1: Statutory targets for key pollutants

Pollutant	European Limit Values	World Health Organisation Guideline limit values[73] (*where tighter than European values)	Deadline for compliance with European limit values	Notes
PM_{10}	An annual mean of 40 µg/m^3 24 hour average of 50 µg/m^3 not to be exceeded more than 35 times a year	An annual mean of 20 µg/m^3* 24 hour average of 50 µg/m^3 not to be exceeded more than 35 times a year	Deadline extended from March to June 2011	At time of writing, limits in parts of London appeared set to exceed limits on more than 35 days in 2012, which would put the UK in breach of the target. At time of publication limits had been exceeded 46 times at the (unofficial) Neasden Lane, Brent monitoring station, 36 times at Upper Thames Street, City of London and 29 times at Marylebone Road, Westminster.[74] A legal case has also been brought by air quality campaigners over the process by which the government obtained the deadline extension, and, separately, on whether a breach of the limit occurred in 2011 at Neasden Lane, London (on the London North Circular road, close to the end of the M1). The case is currently going through the 'EU Pilot' rapid resolution process, with the outcome due to be decided in summer 2012.
$PM_{2.5}$	Annual mean of 25 µg/m^3 Target of 20% reduction in concentrations at urban background from 2010 to 2020	Annual mean of 10 µg/m^3*	2015 and 2020	Non-binding target in place from 2010, will become enforceable limit in 2015. Urban background concentration targets unlikely to be met barring a major breakthrough.[75]
NO_2	An annual mean of 40 µg/m^3 1 hour average of 200 µg/m^3 not to be exceeded more than 18 times a year	An annual mean of 40 µg/m^3 1 hour average of 200 µg/m^3	The government has sought to delay the deadline for meeting targets from 2010 to 2015	The government argues that rather than formally requesting a delay of the deadline until 2015, it can propose plans to meet the target in the "shortest possible time" that would not require it to come under the limits until 2020 in most of the UK, and 2025 in London. In 2010, 40 out of 43 UK air quality assessment zones did not meet the required annual mean, and three zones exceeded the limit for hourly mean. Defra's best case scenario envisages 17 zones still not having achieved compliance by 2015.[76] In June 2012, the UK was denied permission by the commission to delay air quality improvements in 12 areas – Aberdeen and north-east Scotland; Belfast; Birkenhead; Brighton; Bristol; Liverpool; Preston; Sheffield; south-west England; south Wales; Swansea and Tyneside. At time of publication, a judgement had not yet been reached on government plans to delay meeting NO_2 standards in major cities until 2020 – or in the case of London, 2025.

5
Policy Choices

Many different policies have been introduced or proposed to tackle emissions. This chapter aims to describe and evaluate some of the major policy options, as well as suggesting smaller-scale initiatives that could be piloted.

Regulations on transport

'EURO' vehicle manufacturing standards

Road vehicles emit the majority of particulate pollution and around half of the NOx pollution in London. Ownership of the vehicle fleet is very diffuse which makes targeting policy particularly challenging. The greatest gains can be achieved by replacing older, more polluting vehicles with newer, more efficient ones, but turnover of the vehicle fleet is a slow process. (According to the Society of Motor Manufacturers and Traders, about 7% of the UK vehicle fleet is replaced each year.) Upgrades to the vehicle fleet entail an upfront cost – for either replacement or refurbishment of vehicles. Asking the owners of the commercial vans and lorries that contribute to most NOx pollution in other cities outside London to bear the costs of these upgrades, especially at a time of wider economic difficulty, with little direct benefit to them, is challenging. As the cost of fuel has risen, fuel efficiency has motivated some improvements because the owner can realise a long-term cost saving. But as those fuel savings are captured, further improvements such as exhaust catalysts, that reduce pollution but do not necessarily reduce fuel consumption, carry expense without commensurate savings. Therefore, regulations governing vehicle emissions are among the most important policy instruments for constraining air pollution. Vehicle regulations are determined at the European level. Manufacturers need to comply with one set of rules for the whole of the EU rather than having to deal with a diverse set of national rules.

'EURO' regulations for vehicle emissions were first introduced in 1992. Each iteration has limited emissions more tightly. The current iteration is the fifth (EURO V), with EURO VI due to come into effect in 2014. The EURO regulations are generally considered to have dealt well with particulate emissions from vehicles. The case of NO_2 pollution, especially from diesel vehicles, has been more troublesome. Although NOx emissions have steadily decreased, the technology used to control PM emissions has also meant much more NOx is being formed as harmful NO_2. This problem is amplified by the increasing use of diesel vehicles, which have much higher NO_2 emissions.[77] As a result, improvements in NOx and PM being driven by EURO regulations are being undercut by increasing NO_2 emissions.

74 London Air Quality Network, Kings College London; Air Quality Strategy Objectives Generated for the 12 month period commencing 1 Jan 2012; http://www.londonair.org.uk/london/asp/advstatsaqobjresults.asp?site1=BT5&site2=CT8&site3=MY1&site4=MY7&sday=1&smonth=jan&syear=2012&Submit=View

75 The UK target is for a 15% reduction in annual mean $PM_{2.5}$ at background locations across the major urban areas, while the EU target will be 10–15% (still to be determined, once monitoring results for the three years 2009–11 are available). These represent reductions in annual mean concentrations of around 1.5–2 µg/m^3 over the ten years between 2010 and 2020. If these reductions are to be achieved from the local sources that give rise to the urban background enhancement of around 3–6 µg/m^3, then these urban source contributions would need to be reduced by some 25–67%. On the other hand, if the whole of the reduction were to be achieved by reducing the secondary PM contribution, which accounts for ~30–50% of urban background $PM_{2.5}$ (around 4–6 µg/m^3), then the required reduction of this secondary PM would be some 25–50%. In either case the reductions required to meet what appears to be a small target reduction, are substantial. If both are tackled equally the percentage reductions would essentially be halved, but would still remain challenging." SNIFFER (Scotland and Northern Ireland Forum for Environmental Research; *PM2.5 in the UK*; http://www.sniffer.org.uk/Webcontrol/Secure/ClientSpecific/ResourceManagement/UploadedFiles/PM25%20Report%20Final%20%2820Dec10%29.pdf; p. v

76 Defra; *Air Pollution in the UK 2010 – Compliance Assessment Summary*; 2011; http://uk-air.defra.gov.uk/library/annualreport/air_pollution_UK_2010_Compliance_Assessment_Summary.pdf

77 Potočnik, Janez; *Towards Making 2013 a Year of Air;* Brussels; 22 March 2011; http://www.aera-alcotra.eu/upload_docs/SPEECH-11-203_EN%5B1%5D.pdf

Upcoming EURO VI regulations are aiming to make much more dramatic reductions to NO_2, by getting manufacturers to use different technical systems for reducing NOx emissions. Regulators hope that more widespread use of 'selective catalytic reduction' systems will not drive up NO_2 emissions in the way previous NOx and PM abatement technologies have.[78] However, until vehicles meeting the new specifications enter service, we will not know for sure how well they can cut vehicle NO_2 emissions.

Public transport vehicles

Black cabs and red buses are two of London's most iconic symbols. Unfortunately, they are also serious polluters. In London, cleaning up public transport vehicles needs to be part of the approach to improving air quality. Taxis account for about 21% of the miles driven in central London, and buses around 5%. About 24% of PM_{10} emissions and 28% of $PM_{2.5}$ emissions in central London from vehicles in 2008 came from taxis' exhausts, tyres and brakes. Buses contributed a further 8% of PM_{10} and 8% of $PM_{2.5}$ emissions from vehicles. But buses account for around 39% of NOx emissions from vehicles in central London, far exceeding their proportion of miles driven.[79]

The Mayor's Air Quality Strategy contains a number of measures aimed at reducing pollution from these sources. Recent rules have been introduced that mean taxis more than 15 years old are no longer eligible for a licence, while any new taxi must comply with EURO V standards (see above). It also contains an ambition for an affordable zero-emission taxi to be available by 2020.[80] Driver behaviour is also being targeted, with schemes introduced to discourage engine idling, and introducing a mandatory 'eco-driving' course for new taxi drivers.

Ultimately, the development of zero-emissions cabs is the most desirable from a climate and air quality perspective. And London is not the only city pursuing such a breakthrough, meaning manufacturers have plenty of incentive to solve the technological problems that are keeping costs elevated. The technology is not ready yet, though. The other steps outlined above represent sensible interim measures.

Mayor Johnson has also focused a lot of attention on buses. Upgrading buses is among the most cost-effective ways of cutting NO_2 emissions. Withdrawal of the 'bendy bus' and the introduction of the 'New Bus for London' (also known as 'Boris buses' or 'new Routemasters') was a key pledge in his election campaign. The New Bus adds to the already existing hybrid fleet – TfL aims to have 300 hybrids by the end of 2012.[81]

The Mayor's office is also supporting the retrofit of old buses to meet EURO IV standards for NOx by the end of 2015. The fleet of EURO <IV buses has already been fitted with particulate traps to cut particle pollution. NOx however remains a challenge (indeed, one side effect of the particulate traps can be an increase in NO_2 emissions – fitting particulate traps which do not drive up NO_2 or are combined with 'selective catalytic reduction' (SCR) technology (forming 'SCR-Trap' or 'SCRT') would be a helpful step). Retrofitting older buses with NO_2 reducing technology (such as SCRT) is a far cheaper and far faster method for bringing down NOx pollution than waiting for the replacement of the fleet with new buses (or, indeed, New Buses). Accelerating the refit programme, while less visible than the New Bus programme, can deliver more immediate and more cost-effective results for air-pollution. Roughly 20 SCRT retrofits could be bought for the cost of one of the New Buses.[82] Transport for London has confirmed in an email conversation with the

78 At EURO V and earlier standards, the methods for constraining NOx emissions were principally based on the timing and rate of fuel injection, and recirculation of exhaust gases, all of which required precise calibration. Manufacturers concentrated on calibrating the engines for performance in the test conditions, rather than 'real world' operations. The Department for Transport believes it is "likely that this is the primary reason" for underperforming diesel vehicles.

79 Mayor of London; *Clearing the Air*; http://www.london.gov.uk/sites/default/files/Air%20Quality%20Strategy%20v3.pdf; pp. 40–47

80 Transport for London has been in discussions with at least three taxi makers since 2009 about the possibility of developing full or plug-in hybrid electric taxis. "TfL is also in the process of putting in place a Low Carbon Taxi Trial where taxis utilising low carbon technologies will be tested and assessed in 'real world' working conditions." Boris Johnson; *Mayor Answers to London: Electric Taxis*; 17th June 2009; http://mqt.london.gov.uk/mqt/public/question.do?id=26625

81 Natural gas fuelled buses may be a cheaper alternative to diesel-electric hybrids that also enable particulate and NO_2 emissions reductions compared to conventional diesel engines, though Transport for London has shown relatively little enthusiasm for them.

82 Based on estimates of £10,000 per SCR retrofit, and £200,000 per New Bus for London. See Transport for London; http://www.tfl.gov.uk/static/corporate/media/newscentre/archive/22022.html

author the effectiveness of the SCRT refit technology (having found around 70% reductions in NOx emissions from buses to which it was fitted), but the financial constraint still remains to a wider refit programme.[83] The New Bus programme has other motivations beyond air quality, and as TfL modernises its bus fleet, the New Bus will continue to be an option for bus replacement and fleet expansion. But SCRT refits offer a chance to improve air quality quickly and cheaply,

Recommendation: For immediate impact, money would be better spent on reducing the NOx emissions from buses with full rollout of SCRT retrofitting, rather than relying on the slow and expensive process of replacing the fleet with New Buses, even just on targeted routes, to improve air quality. *New Buses would remain available for TfL and their bus operations contractors as they expand their fleets or replace existing vehicles.*

Setting standards for vehicles is one method to restrict pollution from transport – controlling (or pricing) where they can be driven is another. London has instituted two major policies which aim, in whole or in part, at tackling pollution in this way – Low Emission Zones and the Congestion Charge.

Low Emission Zones

In the UK, three cities have, or are on their way to having, instituted Low Emission Zones (LEZs). Norwich has a limited LEZ that restricts access to the city for the most polluting buses; Oxford will bring in a similar rule in 2013. The London system is more comprehensive (see Box 5.1).

Box 5.1: Basic information about the London Low Emission Zone

Transport for London operates a Low Emission Zone covering almost all of Greater London. Owners of heavy diesel vehicles which do not meet emissions performance standards and who wish to enter the LEZ must pay a daily charge of £100 or £200 depending on the size of the vehicle. Buses, lorries, and other types of the heaviest vehicles must currently conform to EURO IV standards for PM to be exempt from the charge; smaller vans, pickups, minibuses, 4x4s and their ilk must reach EURO III standards for PM. Most family cars are not covered by the LEZ. Owners of older, more polluting vehicles therefore have the options of replacing their vehicle, refurbishing it with emissions filtering equipment, converting it to run on a cleaner fuel (such as natural gas), or paying the charge.

One option for improving the strength of the LEZ is further tightening the performance standards required for exemption from the daily charge. Moving lighter goods vehicles (LGVs), minibuses and 4x4s from EURO III to EURO IV, or even jumping straight to the imminent benchmark EURO VI standard would enable further reductions from road transport, but obviously bears compliance costs to vehicle owners – the extent of those costs are not yet clear. Mayor Johnson previously delayed the most recent tightening of standards for light goods vehicles, pushing them back from 2010 to 2012. He cited the recession as reason to avoid imposing additional costs of compliance on businesses and households. Any future tightening would presumably be subject to similar considerations, although the Mayor's office has already published suggestions for future

83 Author conversation with Transport for London.

improvements. The Mayor's office is considering introducing an NO_2 criterion for the LEZ from 2015, and also claims to have "secured big discounts off new vans and minibuses for drivers that will be affected by changes to the zone".[84] The politics of the decision are challenging when the costs are clear and visible, while the benefits of tighter pollution controls are less immediately apparent. Attempts by the Mayor's office to mitigate the costs to drivers of replacing vehicles to enable compliance with a more stringent LEZ are welcome.

The tightening of standards aims to speed up the replacement rate for larger vehicles beyond its 'natural' level, incentivising earlier substitution. Because of this, the burden of the policy falls most heavily on those otherwise less inclined or able to afford to replace their vehicles. While the burden of air pollution, as we have seen earlier, also falls disproportionately on the least well-off vehicle owners (often, given that it is largely commercial vehicles that are affected by the LEZ, small businesses and sole traders).The distributional effects of tightening LEZ limits creates a challenge to policymakers – one that could possibly be offset by grants to cover part of the cost of replacement, as was the case with the scrappage scheme (see Box 5.2) although obviously this in turn has budgetary implications. Furthermore, savings to the health system are uncertain, and occur in part in the future, while costs of implementation are immediate.

Box 5.2: Scrappage grants

The car scrappage scheme, which ran in 2009–2010 took a different approach to incentivising replacement of old vehicles. Government provided a £1,000 incentive, with matched funding from vehicle manufacturers, for consumers to replace a ten year old or older car with a brand new one. Though it was promoted largely as an economic stimulus programme with benefits for climate change, it also helped improve the air pollution performance of the vehicle fleet. Around 390,000 cars were replaced through the scheme. For each of those vehicles, NO_x emissions were reduced by 50–89% (depending on the fuel for the old and new cars), and PM emissions were cut by around two thirds.[85]

A number of other cities (listed in Table 5.1) have begun exploring the feasibility of setting up Low Emission Zones, with Defra providing funds for feasibility studies. The cities listed in Table 3.1 as having failed to receive time extensions to reach NO_2 limits are also likely to have to investigate LEZs, although at time of writing no firm decisions had been taken.

Table 5.1: Local authorities conducting Low Emission Zone feasibility studies in 2011/12

Aylesbury Vale	Newcastle Upon Tyne
Bath and North East Somerset	Reading
Birmingham	Sheffield
Bradford	Southampton
Horsham	Warrington
Leeds	Warwick
Lewes	Waverley
Maidstone	York

84 Greater London Authority; 'Low Emission Zone: delivering cleaner air in London'; http://www.london.gov.uk/priorities/transport/green-transport/low-emission-zone

85 Using data from the Society of Motor Manufacturers and Traders.

Both local authority interest and Defra support for feasibility studies of potential new LEZs are welcome. The next hurdle to clear will be when the results of these studies are in. Questions that need to be answered include: what support will be available for implementation, should authorities decide to go ahead? And what alternative options could they pursue, if they decide the case for an LEZ is not sufficiently persuasive? If local authorities show interest, there may be a further important role for the Department for Transport in helping ensure that businesses and drivers with activities in many cities avoid having to deal with different rules in each city.

Recommendation: Department for Transport, Defra and local authorities should continue to develop a wider network of Low Emissions Zones to cut emissions in locations where limit values for NO_2 are being breached.

Box 5.3: Parking incentives

Local authorities have introduced discounts for parking permits and parking charges based on the vehicle's carbon emissions. The ambition to reduce carbon emissions can have unfortunate consequences: incentivising carbon efficiency for vehicles can end up promoting diesel over petrol vehicles. As we have seen, this exacerbates problems with air quality.

As a result, some inner London boroughs have moved to redress the balance by introducing diesel surcharges on their parking permit prices. In April 2012, Camden introduced a £10 additional charge for diesel vehicles, on top of a permit price ranging from £85–250/year depending on engine size and carbon emissions. Kensington and Chelsea charges £16 per year for EURO IV and older diesel vehicles, on top of a £70–171 permit price. Both schemes are too recent to see whether they have led to any change in the choices residents make about their vehicle buying choices. It is unclear whether the Camden and Kensington and Chelsea initiatives have been implemented in a way that their impact on pollution levels can be tested. In future, local authorities should be encouraged to conduct follow-up assessment to test whether such schemes make a difference.

- **Recommendation: Test differentiated parking permit charges based on emission of vehicles. Local authorities in Camden and Kensington and Chelsea have both introduced parking charges for residents partly based on the emissions level of the vehicle. It is imperative that these small-scale programmes are designed in such a way that their success can be rigorously assessed.**

Box 5.4: The Berlin Low Emission Zone model

In Germany all vehicles are issued with stickers, red, yellow, or green, corresponding to the vehicle's EURO emissions class. Berlin (and other cities) have established zones where drivers may only bring in their vehicles if they are displaying the appropriate sticker. Without the appropriate sticker, drivers risk incurring a €40 fine and having a penalty point added to their driving record. In the UK, a Berlin-style system has been suggested as a way to tackle vehicle emissions in the most polluted parts of cities, including London. One of the appealing aspects of the Berlin model is the relatively

low-cost enforcement procedure. It does not require a network of cameras and number-plate recognition (as used for the extant London LEZ). It uses relatively 'soft' enforcement methods, appealing to social norms – a strong sense of environmental responsibility – as well as spot fines by police and traffic wardens for drivers of vehicles without the required sticker.

TFL declined to consider an analogous system for London in a 2011 review of possibilities for enhancing the LEZ, with the absence of a national categorisation system for vehicles based on their emissions being the main reason.[86] While installation of the surveillance equipment needed to add an inner LEZ modelled on the extant one (i.e. with number plate recognition) would be costly, the relative costs and benefits of a Berlin-style system have yet to be quantified; nor, to the best of the author's knowledge, has the cost of establishing a Germany-style nationwide stickering scheme (one imagines it could be merged with the tax disc process). With information already kept for vehicles' registration purposes about models' production years, identifying their EURO standard does not appear challenging.

Elements of the Berlin scheme could be incorporated into other systems. For example, the idea of colour-coding permits could be applied to council parking permit systems, with vehicles which are receiving discounts for being cleaner (or surcharges for being more polluting) being identifiable by the colour of their permit. Piloting 'nudges' like this on a small scale would allow better estimates to be made of the behavioural impact of the policy before being considered for a larger-scale project.

With the government looking for low-cost measures, the Berlin model is worth looking at properly.

- **Recommendation: Defra should encourage a local authority to consider piloting a Berlin-type system in their city, where cars have to display colour-coded visible road tax permits based on the emissions levels (where, for example, a low polluting car would display a green sticker and high polluting one a red). Again, any pilot should be designed so that the behavioural impact of such a 'nudge' can be rigorously assessed.**

Box 5.5: Heathrow

Heathrow Airport is a hotspot for pollution in London outside the city centre. Just over half the NOx emissions on the Heathrow site come from aircraft on the ground, with ground transport making up the rest.[87] A continued (or expanded) role for Heathrow will require improvements in transport accessing the airport, as well as potentially a marked improved in aircraft emissions, if the area is to have a chance of meeting limit values for NO_2. Transport for London may need to consider introducing a tighter localised Low Emission Zone (either implemented with camera enforcement, like the current London-wide LEZ, or following the Berlin model described in Box 5.4) around the airport with more stringent standards for vehicles accessing the airport if it is to keep Heathrow within pollution limits.

- **Recommendation: Air quality impacts must be given due weighting in decisions about the UK's future aviation strategy. Transport for London should consider introducing a tighter localised Low Emission Zone around the airport.**

86 Transport for London; *Stricter emissions standards for central or inner London: a provisional assessment of potential feasibility and effectiveness;* http://boroughs.tfl.gov.uk/documents/general/feasibility-study-into-or-central-inner-london-lez.pdf; p. 11

87 *Heathrow Air Quality Strategy;* http://www.heathrowairwatch.org.uk/reports/HAL_Air_Quality_Strategy.pdf

London congestion charge

All vehicles (barring a few exempt categories such as taxis and low carbon dioxide emissions vehicles which meet EURO V standards) entering central London between 7am and 6pm on weekdays are charged £10/day. The primary objective is congestion reduction, but pollution reduction has been an important additional benefit of the congestion charge. Assessment of the impact on air pollution has found evidence of improvements in particulate (PM_{10}) and carbon monoxide pollution, though did not identify any improvement in oxides of nitrogen as a result of the congestion charge.[88]

The congestion charge zone covers many, but not all, of the worst pollution hotspots in London. Between 2007 and 2011 the congestion charge zone covered a wider area including the parts of Westminster not covered by the original area, plus the borough of Kensington and Chelsea. When the Western Extension Zone was repealed, Mayor Johnson asserted that removal of the WEZ would only "result in small increases in emissions of PM_{10} and NO_X". Although the Impact Assessment his office commissioned projected a 3–4% rise in PM_{10} and a 2–3% rise in NO_X as a result of its removal, he stated that "should monitoring show that the removal of the WEZ is having a detrimental impact on local air quality, TfL will look to implement targeted local mitigating measures".[89] Recorded emissions data for the period after the removal of the WEZ are not yet available, but should emerge soon which will show whether or not those reassurances were justified.

Exemptions for the congestion charge are based on emissions of carbon dioxide (CO_2). This is a significant greenhouse gas, but does not have local environmental consequences. It would arguably be more appropriate to base exemption policy on those pollutants which cause the greatest localised problems – particulate pollution and oxides of nitrogen. In practice this would have a significant implication. The current system favours the use of diesel, which is moderately better for the climate but far more harmful to public health. Vehicle access to central London is too small a jurisdiction to operate effective climate policy – however, it is exactly the scale needed to address the localised air pollution that causes illness and deaths. The Mayor's office should look at reducing or removing exemptions from those vehicles (mostly small diesel-engined cars) which come under the CO_2 emissions threshold, but which cause considerable localised air pollution. The Mayor and Transport for London have already stated their intention to tighten the Greener Vehicles exemption from the charge from 100g CO_2/km to 80g CO_2/km. This should be done in parallel with minimum EURO standards for PM and NO_X.

Elsewhere in the country, other cities have explored the possibility of initiating their own congestion charge schemes. However, the example of Manchester, where a bid to launch a congestion charge was comprehensively rejected in a 2008 referendum (79% of voters voted against the proposal), has deterred anywhere else from establishing one.

Recommendation: The Mayor's office must stick to its pledge to mitigate pollution if the removal of the Western Extension Zone turns out to have led to increased pollutant concentrations.

Recommendation: The Mayor's office should look at reducing or removing exemptions from the congestion charge from those vehicles (mostly small diesel-engined cars) which come under the CO_2 emissions threshold, but which cause considerable localised air pollution. This may be accomplished by tightening the criteria for the Greener Vehicles congestion charge exemption, as part of the environmental legacy the Mayor has said he wants the Olympic Games to leave behind.

88 Kelly, Frank et al; The Impact of the Congestion Charging Scheme on Air Quality in London; http://pubs.healtheffects.org/getfile.php?u=638; p. 5

89 Scott Wilson; Variation Order 1 Impact Assessment; http://www.tfl.gov.uk/assets/downloads/WEZ-VO1-IIA-Report.pdf

Vehicle tax

Vehicle Excise Duty (VED, commonly known as 'car tax' or 'road tax') must be paid for vehicles which use public roads. The lowest CO_2 emission vehicles are exempt from VED. The highest band is £475/year. An average family hatchback will be charged around £120/year. To the extent that it bears an incentive structure today, it is now largely targeted at climate change. Cars are banded according to their carbon dioxide emissions, with the lowest-emitting vehicles being exempt altogether. As a national policy, it is arguably more appropriately targeted at climate than the London-only policies assessed above. However, the trade-off between impact on climate and impact on public health, as reflected in the decision to incentivise buying diesel versus petrol vehicles, is also seen here.

> "Vehicle access to central London is too small a jurisdiction to operate effective climate policy – however, it is exactly the scale needed to address the localised air pollution that causes illness and deaths"

Company cars are taxed according to a different schedule, but CO_2 emissions are the main factor. However, for company cars, a diesel vehicle will be charged 3% more than a petrol vehicle with the same CO_2 emissions. Bringing a similar diesel surcharge to the VED schedule would help ameliorate the current, arguably perverse, encouragement of diesel vehicles (though we do not have sufficient evidence to judge what size of surcharge would be needed to affect these decisions) and bring consistency to the treatment of private and company cars.

Because the EURO standards already regulate new vehicle emissions (even if they don't achieve in the real world what they can achieve in the laboratory), the main role for making VED incorporate some kind of diesel surcharge would be to affect decisions about used car purchases. Emissions performance is only one of a number of factors that go into buying a new car (and, for most people, not a highly prioritised one). The ongoing ratchet of the EURO standards applied to new vehicles is likely to be a more effective tool for reducing emissions than tweaks in the tax bands. But inclusion of a diesel or 'air pollution' measure in the tax band makes the pollution performance of the vehicle more prominent at time of purchase, especially for second hand purchases where customers may be choosing between vehicles of different ages and EURO levels. It would also be an incentive for people to trade in for a newer model. Although again as it is the least well-off vehicle owners who are likely to be driving the oldest, most-polluting cars, this is also true of the current CO_2 performance-based system.

A future move towards road pricing could merge the best aspects of the VED and congestion charging approaches. A system for charging road users could be established in a way that takes account of road demand (i.e. congestion) – if very ambitious, assessing it in real time – and the degree to which the vehicle in question emits harmful pollutants. Of course, ideas for road pricing have been circulating round Westminster for decades, and have never got far in the face of public disdain and technical challenges. However, the Coalition government is again talking about the idea (presently only for newly built roads).[90] Comprehensive road pricing is still a distant prospect, but it has become a technologically achievable one. It could be implemented in a way that constrains road transport emissions. If in future the government does move towards road pricing, pollution should be one of the bases for determining price.

90 BBC News; 'Private cash needed to boost roads network, says David Cameron'; 19th March 2012; http://www.bbc.co.uk/news/uk-politics-17423693

Recommendation: Diesel vehicles should be subject to the same small surcharge under Vehicle Excise Duty as they are under the Company Car Tax regime *(though we do not have sufficient evidence to judge what size of surcharge would be needed to affect these decisions). This would help ameliorate the current, arguably perverse, encouragement of diesel vehicles and bring consistency to the treatment of private and company cars.*

Transport choices

Decisions about transport have a powerful effect on air pollution. While vehicles are getting cleaner, the number of miles driven is steadily increasing, cancelling out some of those gains. Reducing the number of road vehicle journeys, by increasing the use of public transport, cycling and walking has benefits for air pollution, while reducing congestion for remaining road users (which in turn has benefits for air pollution as less time is spent with the engine idling in traffic jams) and improving physical fitness. Government, both local and national, is active in promoting alternative transport modes. Maximising use of public transport, as well as walking and cycling, to reduce road journeys is a vital component of any air pollution strategy, and one that government at all levels must continue working towards. At the local level, this can involve building cycle lanes, identifying safe routes to walk to work, and providing places to store bicycles safely at destinations including schools, stations and town centres. Retaining or improving reliability and regularity of public transport services is also important.

Pollution abatement techniques

Reducing emissions of pollutants is one way to keep concentrations down. Removing pollutants from the air could provide an alternative method. Transport for London is experimenting with different techniques, aimed at extracting pollutants from the atmosphere or temporarily attaching them to roads and buildings rather than curtailing their emission at source.

One of the most controversial actions taken by Mayor Johnson to attempt to address air pollution concerns has been the introduction of 'pollution suppressant' or 'dust suppressant' spraying at key locations in Central London.[91] Adapted gritting trucks spray a biodegradable compound onto the surface of roads, which causes particulate matter to stick to the road surface. Early testing of the suppressant pilot programme found it produced up to 14% reductions in detected particulates, an effect which lasted about 24 hours.[92] Researchers are working on creating even more effective materials which can absorb pollutants from their surroundings.[93]

There are concerns that using suppressants is more about protecting against the legal problems of pollution than the more fundamental public health issue. For example, Barry Gardiner MP has described the use of pollution suppressants near air quality monitors as being "a fraud on the public health" akin to "putting an oxygen mask on the canary in the mines".[94] By deploying the suppressors on London's most polluted streets (including in the vicinity of two key monitoring stations at Marylebone Road and at Upper Thames Street, see Map 5.1), the suppressants help keep *reported* emissions down. However, because the effects of spraying are very localised, the impact on pollution for those members of the public who don't spend most of their time beside the sprayed routes is negligible.

91 Transport for London; 'Reducing dust'; http://www.tfl.gov.uk/corporate/projectsandschemes/17246.aspx.

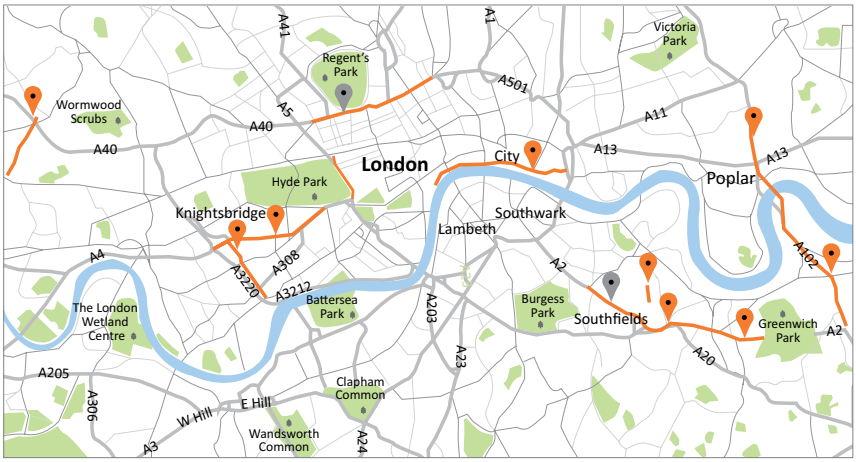
92 Deakin, David and Ren, Chuansen; *Targeted Application of Calcium Magnesium Acetate (CMA) Pilot Study*; URS Corporation; http://www.tfl.gov.uk/assets/downloads/corporate/dust-suppressant-results.pdf

93 For one of many competing examples, see Science Daily; "Pollution Deadening Construction: Nanoparticle Coating Interacts With Sunlight to Eliminate Contaminants"; http://www.sciencedaily.com/releases/2012/05/120530100416.htm

94 Harvey, Fiona; 'Boris Johnson accused of hiding London air pollution' in *The Guardian*; http://www.guardian.co.uk/environment/2012/apr/24/boris-johnson-london-air-pollution

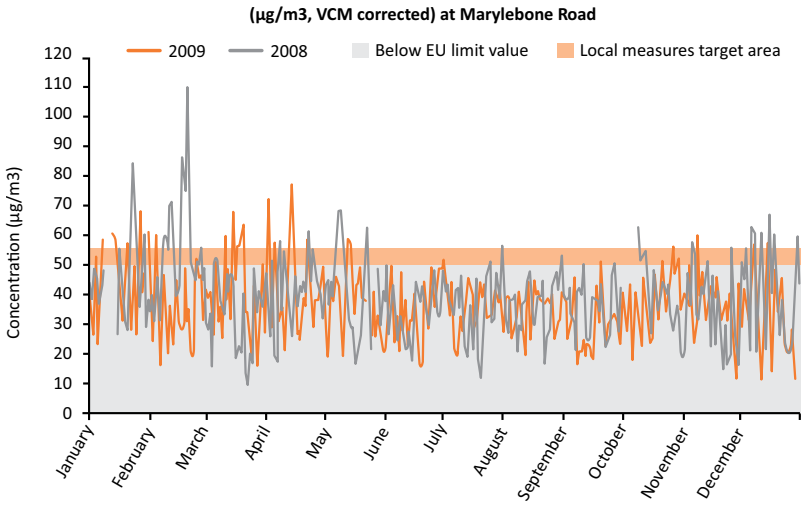
Figure 5.1, reproduced from the *Mayor's Air Quality Strategy* shows the extent to which pollution suppression can cut reported breaches of local pollution limits. Peaks which stop in the orange band indicate days where the use of suppression may have prevented a breach from being reported. About a dozen days a year could have been kept from having a reported breach in this way. If breaches are not reported because the immediate vicinity of the monitoring station has been cleaned, but the wider atmosphere is unchanged, people are less informed about the issue but barely any better protected against it.

Map 5.1: Pollution suppressor routes and locations of monitoring stations on routes[95]



Note: Orange markers indicate monitoring stations that are part of the London Air Quality Network (LAQN); grey markers are monitoring stations that are part of the UK wide Automatic Urban and Rural Network (AURN).

Figure 5.1: Time series distribution of 24-hour mean PM_{10} concentrations at Marylebone Road, Westminster[96]



Note: Spikes peaking in the orange band show days where "a location only just exceeds the EU limit value" and "a reduction in local emissions or concentrations... will help achieve compliance".

95 Routes from Transport for London. http://www.london.gov.uk/moderngov/mgConvert2PDF.aspx?ID=7373

96 Mayor of London; *Clearing the Air;* http://www.london.gov.uk/sites/default/files/Air%20Quality%20Strategy%20v3.pdf; p. 76

Adhesive substances that 'stick' pollution to surfaces have also been used on construction sites to prevent dust and particulate pollution caused by building work from spreading.

'Green walls' are another innovation aimed at drawing pollution out of the atmosphere. The Mayor's office spent £120,000 on installing a 200-metre green wall (i.e. a wall covered in plants) outside Edgware Road Underground station. Imperial College scientists are collecting data from the site, with the intention of releasing preliminary findings on the wall's effectiveness in the second half of 2012.

Recommendation: Until more is known about the potential of pollution suppression methods, strategy for reducing pollution concentrations should not rely on them. If, after testing has been carried out, the technologies prove effective, they should be deployed in sensitive areas for public health, such as near schools and hospitals, whenever pollution levels are elevated. If they prove ineffective, they should be stopped, and resources used for other things. *The Mayor's office has publicly agreed with this approach, saying such initiatives form only a small part of their overall pollution reduction plan. However, they have also stated that use of these local measures will help achieve compliance at the most sensitive pollution monitoring hotspots. The Mayor's office needs to clarify its position on the extent of their reliance on local spot-treatments to comply with limit values. As well as demonstrating whether suppression can reduce pollution at kerbsides, Transport for London should also demonstrate whether a beneficial effect can be detected as one moves further from the roadside.*

Biomass

In recent years the government has pushed the use of biomass as an energy source. It can be used in large industrial applications, such as power stations, or small domestic contexts (biomass boilers). Biomass is a beneficiary of subsidy programmes. For electricity generation the Renewables Obligation pays generators who burn biomass, either in isolation or 'co-fired' with coal. In 2013 the Renewable Heat Incentive is due to be introduced, which will subsidise renewable heat sources, including biomass, in domestic and small business settings.[97]

The overall direction of energy policy in recent years has been beneficial for air quality. Unfortunately, current proposals for biomass are a backward step in what has otherwise been a steady improvement in air quality impacts of the energy system. Back in 2009 it was estimated that the biomass strategy of the day would lead to £557 million in additional costs as a result of pollution.[98] However, the Impact Assessment for the Renewable Heat Incentive in December 2011 found the biomass brought forward by the RHI alone (i.e. not including biomass projects supported by other instruments) will cause £1.8 billion in air quality (health) costs.[99]

Biomass has been supported for two main reasons.

1. Greenhouse gas reduction: In theory, biomass is supposed to be carbon neutral. (The long-term carbon savings from biomass are heavily debated. This paper is not the place to rehearse those arguments. However, the government now considers biomass to need to reduce carbon emissions by 60% – rather than 100% – in order to qualify under sustainability criteria.)[100]

97 Multiple aspects of the RHI (including those directly relating to air quality regulations) are due to be consulted on and laid in Parliament in autumn 2012. Until the RHI is concluded, the Renewable Heat Premium Payment scheme offers support for renewable heat systems (£950 for a biomass boiler) to homes off the gas grid. http://www.decc.gov.uk/en/content/cms/meeting_energy/Renewable_ener/incentive/incentive.aspx

98 Irranca-Davies, Huw; Written Answer, Energy and Climate Change; *Hansard*; 26 March 2009

99 Department for Energy and Climate Change; *Renewable Heat Incentive – Impact Assessment;* 2011

100 "The government are introducing sustainability criteria for the use of solid and gaseous biomass, other than waste or wholly derived from waste, to generate electricity under the renewables obligation (RO) from April this year. These sustainability criteria include a minimum greenhouse gas emissions saving of 60% compared to fossil fuel…" Barker, Gregory; Ministerial Written Response to a question by Graham Stringer MP; *Hansard* Columns 935–6W

2. It qualifies as a renewable source: Contributions from biomass count towards reaching the 2020 renewable energy target. However carbon emissions for centralised electricity generation are in any case dealt with by the EU Emissions Trading Scheme under the current policy framework. The situation for heating is different – falling outside the 'traded sector' covered by the ETS, carbon reductions made in heating are 'additional' to the level set by the ETS and so adoption of biomass (or other renewable heat sources) here could lead to genuine carbon reductions.

The Impact Assessment for the RHI seems to consider the contribution to the renewable energy target (i.e. the second of these) to be the main objective of the policy ("As well as providing a direct contribution to the 2020 Renewable Energy Target, the policy is in line with longer-term energy and climate change goals.")[101]

The air quality costs of the RHI are heavily driven by how much biomass is used in urban areas – urban biomass use has far more severe consequences than rural biomass does. Climate and renewables policy often entails tradeoffs with other policy objectives, and in this case, decision-makers must weigh the benefits of biomass deployment against the burden imposed on public health. As we have seen, a reappraisal of the health impacts of biomass 21 months after the first estimate found costs were quadruple what had been initially thought. When the government's statutory climate change advisers, the Committee on Climate Change, produced its *Bioenergy Review*, it gave no consideration to the health problems it might create.[102] Even though air quality is not directly covered by the Committee's remit, as a major externality of biomass use the air quality impacts should be considered in any analysis of its desirability. Tradeoffs may be inevitable, but they should not be ignored.

Box 5.6: Renewable heat incentive key facts

- Costs due to health impacts of air pollution: £1.8 billion
- Resource costs: £11.6 billion
- Value of carbon emissions reductions due to RHI: £9.9 billion (of which £8.9 billion outside the ETS)
- Net benefits of the RHI: -£4.3 billion (i.e net cost to the nation of £4.3 billion)
- Subsidy costs (transfer from consumers to producers, not overall loss to economy): £20.8 billion
- Biomass as proportion of total energy delivered through RHI: 48%

Ideally, the RHI would support non-biomass technologies in cities and biomass in the countryside. In practice, it is not quite so subtle. In combination with local authority decisions, however, it can be steered toward that more preferable structure.

Local authorities have several tools available to them that could be used to restrict the deployment of biomass installations in areas where there are concerns about air quality. Smoke control and air quality management rules empower local authorities to tackle air quality. These rules should not be weakened as government attempts to "promote biomass through easing planning restrictions",

101 Department for Energy and Climate Change; *Renewable Heat Incentive – Impact Assessment*; 2011

102 Department for Energy and Climate Change; *Renewable Heat Incentive – Impact Assessment;* 2011 Committee on Climate Change; *Bioenergy Review;* 2011; http://www.theccc.org.uk/reports/bioenergy-review

and if necessary should be strengthened to ensure that local authorities have discretion to determine whether biomass installations are right for their area.[103]

In 2007 the government required that all UK planning authorities adopt the 'Merton Rule' on renewable energy.[104] The 'Merton Rule' is a prescriptive planning policy that requires new developments to generate at least 10% of their energy needs from on-site renewable energy equipment. In a lot of cases the only viable way for a project to fulfil the Merton Rule will be with biomass. If that biomass capacity is used, it risks detrimental effects on public health (and in some cases, the installation has not even operated). There may be parts of the country where pollutant concentrations are sufficiently low that the additional emissions from biomass projects brought forward by the Rule might have no real impact on health outcomes. But in urban areas – especially in London – not every project that meets the rule is going to be desirable.[105] Exemptions should be granted where the only feasible way to comply with the Merton Rule is with the installation of biomass if the area is exceeding, or is close to exceeding limit values for air quality.

Recommendation: So far as is practical, the Renewable Heat Incentive and other small-scale renewable energy support programmes should support non-biomass technologies in cities.

Recommendation: Smoke control and air quality management rules should not be weakened as government attempts to promote renewable energy in homes and businesses, and if necessary should be strengthened to ensure that local authorities have discretion to determine whether biomass installations are right for their area.

Recommendation: Exemptions should be granted where the only feasible way to comply with the Merton Rule is with the installation of biomass if the area is exceeding, or is close to exceeding limit values for air quality, and the biomass equipment does not contain stringent PM controls.

103 Defra; *Air Pollution: Action in a Changing Climate*; 2010; http://www.defra.gov.uk/publications/files/pb13378-air-pollution.pdf

104 Department for Communities and Local Government; *Planning Policy Statement: Planning and Climate Change;* 2007; http://www.communities.gov.uk/documents/planningandbuilding/pdf/ppsclimatechange.pdf

105 Harford, Tim; *Adapt*; 2011; pp. 169–174

6
Conclusion and Summary of Recommendations

Air pollution is undeniably a difficult problem. Tightening budgets combine with growing awareness of the scale of the problem to create a growing disparity between desirable and actual action. Because of this, there is a lot of scope for well-designed policy experimentation that can identify effective – and cost-effective – solutions. We have proposed some actions that government and local authorities should consider to help alleviate the enormous burden on public health created by air pollution in the UK.

Stop providing incentives for polluting technologies

- **The London Mayor's office should look at reducing or removing exemptions from the congestion charge from those vehicles (mostly small diesel-engined cars) which come under the CO_2 emissions threshold, but which cause considerable localised air pollution. This may be accomplished by tightening the criteria for the Greener Vehicles congestion charge exemption, as part of the environmental legacy the Mayor has said he wants the Olympic Games to leave behind.**
- **Diesel vehicles should be subject to the same small surcharge under Vehicle Excise Duty as they are under the Company Car Tax regime** (though we do not have sufficient evidence to judge what size of surcharge would be needed to affect these decisions). This would help ameliorate the current, arguably perverse, encouragement of diesel vehicles and bring consistency to the treatment of private and company cars.
- **So far as is practicable, the Renewable Heat Incentive and other small-scale renewable energy support programmes should support non-biomass technologies in cities.**

Local authorities should be cautious about renewable energy pledges that, in practice, demand biomass installations in built-up areas. Exemptions should be granted where the only feasible way to comply is with the installation of biomass if the area is exceeding, or is close to exceeding limit values for air quality, and the biomass equipment does not contain stringent PM controls.

- **Smoke control and air quality management rules should not be weakened as government attempts to promote renewable energy in homes and businesses, and if necessary should be strengthened to ensure that local authorities have discretion to determine whether biomass installations are right for their area.**

Need for technology and policy innovation

- **Department for Transport, Defra and local authorities should continue to develop a wider network of Low Emissions Zones to cut emissions in locations where limit values for NO_2 are being breached.**
- **Test differentiated parking permit charges based on emission of vehicles. Local authorities in Camden and Kensington and Chelsea have both introduced parking charges for residents partly based on the emissions level of the vehicle. It is imperative that these small-scale programmes are designed in such a way that their success can be rigorously assessed.**
- **Defra should encourage a local authority to consider piloting a Berlin-type system in their city, where cars have to display colour-coded visible road tax permits based on the emissions levels (where, for example, a low polluting car would display a green sticker and high polluting one a red). Again, any pilot should be designed so that the behavioural impact of such a 'nudge' can be rigorously assessed.**
- **A strategy for reducing pollution concentrations should not rely on pollution suppression methods until more is known about their potential. If, after testing has been carried out, the technologies prove effective, they should be deployed in sensitive areas for public health, such as near schools and hospitals, whenever pollution levels are elevated. If they prove ineffective, they should be stopped, and resources used for alternatives.** The Mayor's office has publicly agreed with this approach, saying such initiatives form only a small part of their overall pollution reduction plan. However, they have also stated that use of these local measures will help achieve compliance at the most sensitive pollution monitoring hotspots. The Mayor's office needs to clarify its position on the extent of their reliance on local spot-treatments to comply with limit values. As well as demonstrating whether suppression can reduce pollution at kerbsides, Transport for London must also demonstrate that a beneficial effect can be detected as one moves further from the roadside.
- **In London, public money would be better spent on reducing the NO_2 emissions from buses by retrofitting buses with SCRT pollution filtering systems, rather than relying on the slow and expensive process of replacing the fleet with New Buses (commonly referred to as 'Boris Buses' or 'New Routemasters') to improve air quality.** New Buses would remain available for TfL and their bus operations contractors as they expand their fleets or replace existing vehicles as there are other motivations (aside from air quality) behind their development.
- **Transport for London should consider introducing a tighter localised Low Emission Zone around Heathrow airport.**

Improved public awareness

- **The government, or the private sector, could establish a competition to build a website that improves on existing resources by clearly and accurately portraying air pollution, including criteria for health, cost, and geography.** It would be a low-cost method of improving the communication of the problem. Both the contest process, and the resulting website, would provide a boost to public awareness of the problem.

- **Local authorities and institutions such as schools should begin or continue awareness programmes around relevant behaviours such as leaving engines running when vehicles are stopped ('idling'), or encouraging cycling and walking.** If possible these should be done in a way in which the impact of the programme can be assessed. For instance, if a school is near to an air quality monitoring station, pollution data from before and after the campaign can be compared to determine if it is an effective way of lowering pollution concentrations.

Air pollution is Britain's forgotten environmental and public health crisis. Each year, around 29,000 deaths are attributable to man-made fine particulate air pollution in the UK, at a cost to the economy of £15 billion a year. Other pollutants cause further damage to our health and our economy. This report aims to highlight the seriousness of the problem of air pollution in the UK. It notes deficiencies in public awareness of air pollution and its costs, and considers policies that can reduce pollution levels.

The report finds that it is often the most vulnerable and deprived communities who suffer the worst effects of air pollution. Air pollution "hits the poorest hardest" yet is rarely considered to be a 'fairness' issue.

Air pollution undeniably presents a difficult policy problem. Tightening government budgets and the difficulty of identifying politically-acceptable policy measures combine to prevent action, even as evidence on the scale of the problem strengthens and targets risk being missed. Because of this, there is scope for well-designed policy experimentation that can identify effective solutions. Moreover, it is crucial that perverse incentives that encourage polluting vehicles and technologies are removed. Finally, policymakers should clearly focus on the most cost-effective policies that deliver the greatest environmental benefit for a limited set of resources.

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