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About the National Centre for Atmospheric Science

The National Centre for Atmospheric Science (NCAS) is one of the Natural Environment Research Council’s (NERC) established research centres. NCAS is the primary Research Council body that provides research capability on air pollution in the United Kingdom. The Centre increases knowledge of key environmental issues including: climate change, weather processes and atmospheric composition including air quality. By its very nature, atmospheric science research is multi-disciplinary and NCAS brings together around 120 scientists from a range of core disciplines such as physics, chemistry and mathematics. NCAS uses state-of-the-art technologies for observing and modelling the atmosphere and its research is used by policy makers and the wider UK science base. NCAS is not based in one location, rather it is made up three science directorates (climate; weather; atmospheric composition) and four services and facilities distributed across key UK universities.

Declaration of interests.

NCAS derives the majority of its funding for air pollution research from the Natural Environment Research Council (NERC) in addition to grants and contracts from the European Commission, UK Government departments and industrial sources.

NCAS currently delivers the Secretariat functions of the Defra Air Quality Expert Group (AQEG) and contributes advice on atmospheric processes, severe weather and air pollution to the Cabinet Office Natural Hazards Partnership. It also receives funding from BEIS associated with research into the atmospheric impacts of shale gas industries and MOD agencies for research into other airborne chemical hazards.

NCAS works with a number of private sector organisations providing scientific advice on atmospheric chemistry, instrumentation, air pollution process and global trends in pollution.
How effectively do Government policies take account of the health and environmental impacts of poor air quality?

1. Air pollution is clearly recognised within Government as being an issue with significant impacts on public well-being and an environmental degradation that generates real, if still imprecisely defined, cost to the UK economy. The public awareness of the negative impacts of air pollution in urban areas of the UK has undoubtedly increased over the past three years, and the media profile given to the Volkswagen nitrogen oxides (NO\textsubscript{x}) emissions issue has catalysed both public debate and an increased seriousness and focus from across Government.

2. As a research organisation working in the area of air pollution science we would comment that there has been a very notable increase in the prioritisation of air pollution as an issue in Government and some increase in resources directed to this, within Defra and DfT. We welcome the establishment of the Defra-DfT Joint Air Quality Unit in acknowledgement of the need for cross-departmental consideration of and action on air quality. This, and other cross-departmental activities, such as the Air Quality Strategic Evidence Leadership Group initiated by the Defra CSA's office, demonstrate that there is increasing awareness of the need for coordinated action on this complex issue. We would also comment that despite extreme budgetary constraints many Local Authorities have also substantially increased investment and resources focused on local air pollution improvement.

3. Some of the major constraints on how effectively policy takes account of the health and environmental impacts of air pollution are associated with the certainty of evidence that can direct action. While the impacts themselves have been demonstrated to be sufficiently large to drive action, the scientific evidence lacks the detailed information to direct where actions to reduce air pollutant concentrations would have the greatest effect. Prioritisation of the various policy options is necessary but the information to inform that prioritisation is often incomplete or uncertain.

4. In this complex area it will become increasingly important to decide how to deal with incomplete or uncertain evidence. This is particularly pertinent around the issue of policies to control PM\textsubscript{2.5} (particulate matter with a diameter less than 2.5 micrometers). There is clear evidence that PM\textsubscript{2.5} impacts health in various different ways but this is insufficient to determine what actions to reduce PM\textsubscript{2.5} are likely to provide the greatest improvement in human health. PM\textsubscript{2.5} can be made up of many different chemical compounds in different forms and there is currently no consensus about what properties of PM make it most toxic to human beings.

5. The Committee on the Medical Effects of Air Pollution have stated that evidence is not strong enough to say that any particular source or chemical composition of particulate matter is more or less toxic than another. Some scientists assert that certain sources are more likely to cause harm than others. Finding a way to draw reasonable conclusions from this uncertain evidence base is key to enable the development of robust policy for reducing the human health impact of PM\textsubscript{2.5}. This is one particular example but there are other areas where the evidence available to inform air quality policy is uncertain so thinking around communicating and dealing with uncertainty will have applications across multiple policy issues.

6. Although not currently captured by the regulatory framework for air pollution, air indoors is an increasingly important route for human exposure. This is a result of improving outdoor air quality and decreasing building ventilation rates. We would encourage a holistic view of air pollution including advice to the public that captures both indoor and outdoor environments. A degree of confusion continues to exist over ownership of this emerging issue.
7. The vast complexity of different polluting emission sources to the atmosphere means that air pollution is a contributing factor that influences, and is influenced by, a vast range of different policy choices. These range from very large national infrastructure decisions associated with issues such as new power generation and airport capacity, to local choices associated with urban transport, planning and development. The coupled effects of air pollution and climate change are both factors that influence policies associated with industrial and energy sector development in the UK. The breadth of areas where air pollution is a factor inevitably means that it is an issue that cuts across boundaries of Government departments, and this creates complexity.

8. The focus for new air quality-related policy is currently on interventions that will improve the national attainment of ambient air quality standards, and this is an area where there are some clear metrics against which progress can be measured. In general terms ambient air quality in the UK is very much better than it was 20 years ago and a number of air pollutants are essentially consigned to history in the UK. For example, carbon monoxide, benzene, 1,3 butadiene, sulfur dioxide, and polycyclic aromatic compounds very rarely exceed EU Directive air quality targets in the UK.

9. The significant attention currently (and correctly) being paid to continuing high urban nitrogen dioxide (NO$_2$) and PM$_{2.5}$ can result in the public and policy discourse sometimes overlooking some of the past successes of previous policies. We raise this since there may well be generic lessons that can be learned from those past policies that may help inform how the most pressing problem of high urban roadside NO$_2$, and the longer-term issues of managing PM$_{2.5}$, may be best tackled over the next few years.

10. It is worth noting that air pollution is often discussed as if it is a single entity. This can be unhelpful for facilitating understanding of this complex issue. Even when specific pollutants such as PM$_{2.5}$ or NO$_2$ are individually identified, discussions rarely acknowledge that actions to reduce one pollutant are not always effective at reducing other pollutants and may in fact do the opposite. An example would be particle filters for diesel engines which greatly reduce emission of particulate matter but increase NO$_2$ emissions, or so-called zero emission vehicles which have zero emissions from their exhausts but continue to be a source of particulate matter from brake and tyre wear, the road surface and resuspension of dust.

11. There is no doubt that air pollution impacts can cause tensions with other policy priorities made in economic and social domains. The high profile given to air pollution as a potential by-product of runway expansion in the South East of England is a good example. In this case there is undoubtedly a trade-off to be made between projected economic benefits from the new infrastructure, against economic costs to public health and quality of life. The lack of precision with which either can be calculated clearly compromises debate, but there is no doubt that air quality is an acknowledged factor by Government in its decision-making process on this particular issue. The potential future economic / air quality trade-offs from shale gas expansion in the UK is another example where policies in the economic and industrial domains can conflict with air quality policy.

12. The current national planning framework accounts for air pollution in a relatively comprehensive manner, both effects on human exposure and the management of ecosystem critical loads. In simple terms air pollution is however only a restraining factor on development where ambient air quality or critical load standards are currently exceeded, or would be at risk of being exceeded. The local planning framework does not take into account the impacts of local development on the wider attainment of national emission targets (via the National Emissions Ceiling Directive, NECD) or UK obligations to international trans-boundary agreements such as the Gothenburg protocol.
13. The range of different air pollution objectives that Government sets itself means that difficult choices may arise – for example whether Government should invest first in the attainment of health-related ambient air standards in cities potentially at the cost of not pursuing actions that would support total emissions reduction obligations.

14. When the capacity for new investment is limited, greater clarity over priorities of Government would be beneficial. Planned reductions in total national emissions of species such as NO\textsubscript{x}, PM, volatile organic compounds (VOC) have been relatively straightforward to achieve over the past two decades through targeting the clean-up or removal of the largest polluting point sources such as coal-fired power stations. These national investments supporting total emission reductions have meant the UK has met its obligations under NECD and there have been some benefits in reducing ecosystem damage from nitrogen deposition, but they have led to rather limited impacts on improving UK urban public health.

15. Future reductions in total emissions may be harder to enact and require tougher choices in a difficult financial climate. Where the easiest, most obvious options have already been exhausted it will become increasingly necessary to make numerous, smaller interventions across multiple sectors in order to meet emission reduction targets. This is set against a backdrop where some sectors feel they have already been required to invest in emission reduction technologies and are reluctant to be penalised further.

16. Demonstrating the clear benefit for air quality of each individual small policy change is likely to be more difficult and less persuasive for businesses, decision makers and the public. Thought needs to be given to how communication can be optimised (or incentives given) to demonstrate the need for, and benefits of, actions that do not individually effect a large improvement. This may be most challenging but essential where a collection of measures need to be taken simultaneously to bring about a reduction in specific air pollutant species.

17. It is inescapable that the UK will continue to be faced with choices on policy where government aspirations and obligations to provide better air quality may come into conflict with other national priorities, for example on economic and industrial growth. There is no simple equation that can balance these two issues; as a minimum there should always be a robust and open assessment of possible air quality impacts that might arise as potential consequence of any policy or action in another area.

Do these plans set out effective and proportionate measures to achieve necessary emissions reductions as quickly as possible?

18. The most recent and detailed planning from Government at present is for the management of excessive NO\textsubscript{2} at roadside locations in urban areas in the UK, although a wider air quality strategy is expected early next year. This plan is not focused on reducing emissions of all pollutants nor specifically on reducing total NO\textsubscript{2} emissions but on the subtly different target of reducing NO\textsubscript{2} concentrations. It is worth considering that in focusing purely on meeting NO\textsubscript{2} concentration limits in urban areas as fast as possible opportunities for action that will also decrease emissions of other pollutants, including greenhouse gases, may not be prioritised. There needs to be a strategic view of how best to achieve reductions in air pollution over a longer timescale across all pollutants and how current action on NO\textsubscript{2} fits into that. It is hoped that the air quality strategy will do this. We will comment here specifically on the NO\textsubscript{2} plans.

19. Since it is the urban roadside where NO\textsubscript{2} compliance issues arise then it is reasonable that this is where current policy and directed action by Government is focused. It
should not be forgotten however that the national aspiration is to achieve the best possible air quality for all citizens, and there is some risk that too great a focus on a rather narrow set of technical infringements may result in national policy losing sight of the much more important aim of improving air quality wherever possible for the whole population.

20. The problem of NO\textsubscript{2} should in many ways be more tractable to solve than for some other secondary pollutants (those produced by atmospheric processing of other pollutants) such as ozone (O\textsubscript{3}) or PM\textsubscript{2.5} whose concentrations are controlled by much more complex non-linear chemistry and which can be highest away from the source of the initial emissions. Direct reductions in total NO\textsubscript{x} (sum of NO+NO\textsubscript{2}) emissions broadly result in linear reductions in NO\textsubscript{2} ambient concentrations, although there are some complications at roadside associated with the relative proportions of emissions that are released from the tailpipe as NO vs NO\textsubscript{2}, that will be commented on later in this submission.

21. Since the locations of highest NO\textsubscript{2} are roadside clearly the transport sector is key to resolving the outstanding issue of non-compliance with limit values. Current government plans apply two main levers to reduce roadside NO\textsubscript{2} concentrations.

(i) devolution to a city level of the practical management of the existing transport fleet to minimise emissions, including supporting local actions like bus retro-fitting, vehicle congestion/pollution charging, banning older vehicle types, clean air zones and so on, and,

(ii) at a national scale introduction of a fleet of intrinsically lower emissions vehicles into the UK over time, via tightened emissions regulation for new vehicles and natural technological evolution. Potential acceleration of this has been mooted through actions such as scrappage schemes, and a firm long-term target set for 2040 for the banning of combustion engines in private vehicles.

22. We support the general policies that are in place for reducing NO\textsubscript{2} roadside, but highlight the considerable uncertainty over the timescale for change. A major cause of this uncertainty is the real-world performance of emissions controls from new vehicles, and how current vehicles emissions will change as those vehicles age. Policies that target reducing emissions through technological evolution will only work if those technologies function over many years in the real-world as the policy intended.

23. History will likely show that the intention to ratchet tighten the limits on NO\textsubscript{x} emitted from new diesel vehicles via the EURO standards, were in principle reasonable and proportionate, but simply did not play out effectively in practice. A lack of surveillance of real-world vehicle emissions allowed the problem to grow unchecked. The current Government plans do not propose any expansion of emissions surveillance beyond the testing of a small number of new vehicles using the new improved type-approval acceptance tests. We highlight this as a substantial shortcoming and would recommend that there is a much more comprehensive programme of emissions testing through the full vehicle life-cycle.

24. The current plans for improvement rely largely on cumulative effects of multiple small policies interventions and then assessing these using the metric of ambient NO\textsubscript{2} concentrations. Whilst of course ambient NO\textsubscript{2} is the final test for whether the basket of interventions has been successful, it will not provide any great insight into which of those policies have worked and which have not. The complexity of the atmospheric system, including meteorological and other uncontrollable and external confounding factors, means that ambient air pollution is a noisy signal, and one where many years of data can be needed to robustly determine a trend.
25. A narrow focus on investing only in ambient measurements will meet current regulatory requirements, but does not get to the heart of the problem very quickly. It is quite possible to measure urban emissions of NOx directly - that is terms of tonnes NOx per year per m², or kg NOx per km per vehicle. This remains however the preserve of the research community and is very infrequently applied in the UK. In our previous submissions to the committee in 2014 we highlighted a range of technical methods to measure emissions directly, as distinct from concentrations. These can be done at the city scale right down to individual vehicles.

26. If long-term remote sensing measurements of vehicle exhaust or long term urban flux measurement of city NOx emissions had been in place in the UK twenty years ago it would be highly unlikely that the diesel NO₂ issue would have been allowed to run on for such an extended period. Policy would have been more directly tested, effects seen and, one hopes, timely adjustments made.

27. We would also highlight the need to measure directly emitted NO₂ from vehicles as part of the conformity testing regime, and not solely total exhaust NOx. As has been shown by Carslaw et al., the fraction of NOₓ a vehicle emits as NO₂ can have a substantial impact on whether a roadside location is compliant with standards, but NO₂ emissions are not directly reported even in the new European vehicle testing regime. This is a simple measure that would greatly improve the accuracy of future forecasts of NO₂.

28. We consider therefore that the outstanding question for debate is not whether the Government’s current NO₂ plan will improve compliance in the UK, but rather when. This is not to trivialise the issue in any way. The integrated health costs of a slow, perhaps multi-decadal shift to lower NO₂ could run to many billions of pounds more than a faster change over perhaps 3-5 years.

29. A challenge in the short-term and using practical management of the existing transport fleet or ‘lever (i)’, is the complexity of that fleet, and its intrinsic role in the successful functioning of UK cities. Although private diesel passenger cars often sit at the centre of the public and policy debate about NO₂ and its controls, city centre roadside locations are also impacted by many other NOx sources, including taxis, lorries, vans, buses, and from other nearby sources of high temperature combustion, including trains, aviation, heating and construction. Not all of these NO₂ sources are amenable to direct and short term manipulation through policy.

30. As an example we show in the figure below the fractional contribution from private road transport individual sources to overall NOx emissions in London. Whilst passenger cars make up around 50% of NOx emissions in the London suburbs, in central London where the highest NO₂ occurs, private cars can form as little as 10% of total emissions. Current initiatives that target non-car emissions, such as bus retrofitting, plug-in taxis, and direct T-charging of larger vehicles are therefore essential.

31. Given the rather small fraction of emissions that come from private cars in central London, interventions such as the T-charge are, in isolation, unlikely to result in a major change to the trajectory of NO₂ over the next few years. Reducing or eliminating other NO₂ sources in the most polluted locations is technically feasible (all diesel lorries, vans, buses, trains, generators could be banned, domestic and business heating combustion limited) but this would come at a very large economic cost to the functioning of the city.
Figure 1. Fraction of London NOx emissions from private road transport (the sum of all diesel, gasoline and hybrid private vehicles).

The UK may meet NO\textsubscript{2} standards quicker than the Government plans.

32. We provide a brief comment here on potential revisions to estimates of when the UK may come into full compliance with NO\textsubscript{2} air quality requirements. One of the more nuanced aspects of the NO\textsubscript{2} problem is associated with the relative amounts of NO and NO\textsubscript{2} in exhaust gases. Overall NOx (the sum of NO+NO\textsubscript{2}) emissions in the UK have declined over the last decade and there is evidence that the total transport NOx has also declined. That this has not fed through into reduced NO\textsubscript{2} at the roadside is in part due to a shift in the fraction of NOx that is directly emitted from vehicles as NO\textsubscript{2}.

33. Historically the majority of NOx leaving the exhaust pipe was in the form of NO, with perhaps only 5-10% as NO\textsubscript{2}. A result was that at roadside locations total NOx concentrations could be high, but NO\textsubscript{2} (the regulated species) relatively low. Over time atmospheric chemistry reactions convert NO into NO\textsubscript{2} through reaction with O\textsubscript{3}, but this occurs away from the roadside, and when coupled to the dilution that occurs in the atmosphere this results in lower average concentrations of NO\textsubscript{2} that are spread out over wider areas. The exhaust gas control systems on modern vehicles promote the internal conversion of NO to NO\textsubscript{2} resulting in more NO\textsubscript{2} leaving the exhaust directly. This has particular impact at the roadside, where the same amount of NOx emitted now means more NO\textsubscript{2} close to source. This has been reported on in: Carslaw, David C., Murrells, Tim P., Andersson, Jon, and Keenan, Matthew. Have vehicle emissions of primary NO\textsubscript{2} peaked? Faraday Discussions 189 (2016), pp. 439–454. issn: 1359-6640. url: http://dx.doi.org/10.1039/C5FD00162E.

34. We alert the committee to some research in the journal Nature Geosciences, which will be available in the public domain at the time of the enquiry. “Lower vehicular primary emissions of NO\textsubscript{2} in Europe than assumed in policy projections” authors Stuart K. Grange, Alastair C. Lewis, Sarah. J Moller and David C. Carslaw.

35. This research has re-analysed public data records from across Europe and calculated the trends in directly emitted NO\textsubscript{2}. It shows that the fraction of NOx emitted directly as NO\textsubscript{2} from road transport increased substantially through the 2000s (to as much as >20%), but reached a peak around 2011 and is now declining. This measured trend is at odds with the forecasts being used by the UK Government for direct NO\textsubscript{2}, which assume a much higher fraction of direct NO\textsubscript{2} out to 2030. The implication of this is
that less NO₂ is now being directly emitted by vehicles than forecast and a result may well be an earlier attainment of the roadside NO₂ standards than the UK government is currently forecasting. In Figure 2 we show the NO₂:NOx emissions inferred from measurements from monitoring stations across Europe and compare this to two widely used projections on which policy development is based, including the UK’s own emission factors in the National Atmospheric Emissions Inventory (NAEI).

![Figure 2. Comparison of three methods which estimate roadside primary NO₂ as a NO₂/NOx ratio and forecasts from two other sources used for policy development. Shaded zones are the individual EU member state range in Kiesewetter et al. 2014 and the 95% confidence interval of the observation filtering method’s loess fit. The NO2:NO emissions from observations in purple are very much lower than the estimates being used currently in UK Government air quality planning.](image)

36. NO produced by road transport currently leads to a lowering of O₃ concentrations close to roads due to the reaction between these two species. It is worth being aware that a consequence of reducing NOx emissions in urban centres is likely to lead to an increase in urban O₃ concentrations. Although O₃ has impacts on human health and ecosystems this increase is a necessary consequence and should not be seen as a reason to avoid action on NOx. The relationship between NOx and O₃ is non-linear and further reductions in NOx will ultimately reduce the efficiency of O₃ production and therefore reduce potentially both urban and suburban O₃ concentrations.

37. While the current plan focuses on NO₂, the evidence for impacts of PM on human health is stronger than for NO₂. PM₂.₅ levels are below EU limit values across most of the UK however, they are above the World Health Organisation Guidelines at many locations. For this reason, and in order to meet NECD PM emissions limits, action will also be needed on PM. It is more complex than NO₂ as it is both a primary pollutant emitted from human activities and a secondary pollutant formed in the atmosphere by chemical and physical processing of other primary emissions. Some of the issues that will need to be considered for future PM₂.₅ control are:

(i) The changing sources of primary PM driven by decreasing contributions from exhaust emissions and resulting in increasing importance of non-exhaust, cooking and solid fuel burning emissions;
(ii) Related to (i) above, there are both relative and actual increases in wood burning emissions, a source that is highly variable and that is not currently well monitored or effectively controlled; and

(iii) Emissions of precursors to secondary PM, particularly ammonia, and the non-linear response of PM concentrations to reductions in these emissions. There is potentially a need here for simultaneous reductions in multiple precursors to bring about significant change.

38. As mentioned previously the reference in the plan and wider discussions of zero emission vehicles are perhaps misleading; while electric vehicles have zero emissions from the exhaust they are still a source of non-exhaust PM from brake, tyre and road wear, and from resuspension of previously deposited PM. Some studies suggest that as electric vehicle are heavier than their diesel or petrol counterparts that they will emit higher levels of non-exhaust PM. This does not mean that moving to electric vehicles would be a bad idea for air quality but rather it is not a complete solution and innovation around vehicle design and efforts to incentivise behavioural change to reduce the number of vehicles should still be encouraged.

Are other nations or cities taking more effective action that the UK can learn from?

39. There is an exceptional diversity of measures being considered worldwide for the management of air pollution since this is a global issue. It is important to remember however that actions should always be designed to reflect local conditions, meaning geographic, social, technological maturity and geophysical parameters such as temperature, wind-speed and solar insolation. In Europe there are many different flavours of road transport actions being proposed with NO$_2$ as the priority pollutant. In China, the emphasis for policy and action is currently placed on PM$_{2.5}$ and the control of major industrial point sources. In the US surface ozone is a current policy priority, since that country is particularly susceptible in some locations to high ozone formation efficiency.

40. It would not be sensible for the UK to ‘import’ actions from other countries without first thoroughly evaluating whether they would be beneficial here. In the most extreme cases sometimes a policy that improves air pollution in one location can worsen it in another. In some cases, simply differences in weather might render a solution ineffective if translated between countries.

41. Actions in other European cities widely reported in the news have in many cases had limited success. The ban on vehicles with alternately odd or even number plates across 4 days during an air pollution event in Paris was relatively ineffective at reducing traffic flow and therefore pollution sources. Rather than achieving the potential 40% decrease in vehicles if everyone had complied with the ban, only a 5% decrease was observed. Anecdotally people preferred to pay the fine than alter their behaviour. While there are a number of reasons for this, for example lack of alternative travel options, there are lessons that can be learned from this experience. That should be true for the failure or success of implemented measures across other European cities/countries.

42. It is helpful however to examine the extent to which certain trends in air pollution are influenced or controlled by local actions (city, state) vs wider macro-trends that may be set by technological factors outside of city or state.

43. In Figure 3 we show the recent trends in NO$_2$: NOx across 61 cities in Europe for the period 2005-2010 and then for the period 2010 to 2015. We use this to illustrate that
the increases seen in the direct emissions of \(\text{NO}_2\) from vehicles were a continent-wide phenomenon driven by the wide-spread adoption of a particular set of technologies. The second panel shows the more recent changes to this ratio across Europe. 93% of cities now show downward trends with less \(\text{NO}_2\) being emitted directly. This major change is seen across Europe, even though there are major differences in the range of policy interventions used to manage air pollution in those 61 cities. We conclude that much of the trend in direct \(\text{NO}_2\), used here as a case study, are driven by continent-wide changes in the underlying technologies and that differences arising from local pollution management practices are rather less clear to detect. It is perhaps worth noting that some cities in the UK are amongst those that do not follow this trend and further analysis is needed to understand why.

Figure 3. Changes in \(\text{NO}_2 : \text{NO}_x\) in 61 urban centres across Europe. Red shows an increasing trend, blue decreasing. The size of the dot shows the size of the trend.

44. The figure is not meant to imply that local management of air pollution is not worthwhile or effective, but rather to highlight that the major drivers in air pollution can often result from unexpected external global technological factors that may lie outside of direct local or national controls. Influencing those wider global technology trends in positive ways should be a high priority for policy makers.

45. Behavioural change could also be a key driver for reduction in air pollution. Whether that be achieved by policy measures, by changing public perceptions and acceptability, a mixture of the two, or something completely different is an issue for social scientists but in other areas this has been shown to be effective. While the smoking ban in public places was a policy decision it was potentially difficult to enforce, but it is now socially unacceptable to smoke in those locations and infringements are often dealt with by the public themselves. Driving this sort of behavioural change is something that would be done most effectively at the national level.

46. Evaluating the effectiveness of local and national policy actions is the subject of considerable academic debate. The Defra Air Quality Expert Group (AQEG) is considering this at the moment and is producing a report on the various methodologies that have been used to assess whether a particular intervention has been effective. For some pollutants that have only a limited number of known
sources, attributing outcomes to actions can be clear-cut. There are recent examples
where rule changes on fuel composition resulted in directly attributable changes in
concentrations of pollutants such as SO$_2$ and benzene. For pollutants with multiple
sources such as NO$_2$ or PM$_{2.5}$, or secondary pollutants such as ozone, it becomes
more challenging to identify whether any individual action has lead to a change since
no counterfactual is available.

47. Large-scale technological trends (for example in exhaust control technologies,
electrification, clean energy and so) have profound effects that can overwhelm the
changes induced by local action. The divergence of trends in cities across the UK in
Figure 3 suggest that local characteristics do play a role but we would urge the
enquiry to ask searching questions over whether improvements in air quality can
really be quantitatively attributed to local or national action or international trends.
Highly localised actions may augment or reduce the observed trend at a specific
location or monitor (for example re-routing traffic, bus electrification etc), but the
overall air pollution changes at the city scale and larger will likely be driven by
external factors.

We would re-emphasise the importance of engaging in policy-making at a level that
may positively influence the key macro-trends in emissions including from power
generation, agriculture, solvents, domestic combustion, in addition to transport
sectors that have been discussed extensively here. This ultimately will be the most
effective long-term strategy for improving air quality across the UK.

Is there enough cross-government collaboration to set in place the right fiscal and policy
incentives?

48. It is encouraging that as a research organisation our discussions and interactions with
Government on air pollution research have broadened considerably over the last five
years. Whilst Defra hold the central responsibilities for ensuring good air quality in
the UK the establishment of a joint unit with Department of Transport is very
positive. As an external research organisation, we also now see increased engagement
with BEIS on air pollution impacts that might arise from the development of certain
industrial sectors, and that air pollution co-benefits are an important factor in their
planning and policy development relating to greenhouse gas management for the UK.

49. As we identified earlier in this submission, practical local management of the traffic
fleet may well be a method to achieve localised reductions in roadside NO$_2$ and PM$_{2.5}$
in urban centre hotspots, but this comes with real costs and is often not universally
popular locally. In the long-term it would be more effective if policymaking was
focused on setting national and international standards for emissions at their source,
influencing trends for the adoption of cleaner technologies and driving a societal and
cultural shift away from highly polluting activities. Local management of existing
polluting sources might be an acceptable short-term remedial action but it is not a
long-term strategy for cleaner air.

50. With many incentives driving towards electrification of vehicle fleets it is imperative
that energy policy is focusing on cleaner technologies for electricity generation. If not
carefully coordinated this change in transport fleet shifts emissions from the transport
sector to electricity generation, mitigating urban hotspots but potentially increasing
national emissions. There is also the potential that to meet higher peak electricity
demand, use of diesel generators through the capacity market also increases, in turn
creating a different air pollution issue.
51. For individuals, fiscal incentives to reduce air pollution is notionally included in the indirect proxies of carbon pricing, climate policies and associated taxation measures. The road-tax system for vehicles for example is based on CO\textsubscript{2} emissions but this is, at best, only loosely associated with a vehicle’s reactive air pollution emissions of NO\textsubscript{2} and PM. Better knowledge of the real-world performance of new vehicles and ideally the ageing existing fleet, may offer up some opportunities to finesse this system to be a composite of both carbon and air pollution intensity. We appreciate that at a local level some low emissions zones and clean air zones do now (or will) consider a vehicle’s EURO classification for charging, a move in this direction already.

52. The current taxation system on fuel continues to prioritise carbon intensity over air pollution, if one broadly accepts that as a class diesel vehicles are more polluting for NO\textsubscript{2} and PM than gasoline, hybrid or fully electric. It would seem worthwhile revisiting whether this long-standing climate prioritisation and fiscal instrument still fully matches national priorities, and whether climate and air pollution can be combined into instruments that consider a composite carbon/air pollution metric.

How can those charged with delivering national plans at local level be best supported and challenged?

53. Managing air pollution at a local level is very challenging and while it may bring particular pollution hotspots back into compliance it will not be sole the solution to realising more widespread human health or environmental benefits at city scales or larger. As identified earlier, the potential for local action is somewhat limited because of the sheer diversity of polluting sources in cities that release NO\textsubscript{x} and PM. There is no magic bullet for local councils; realistically no single action or intervention within the power of a local authority will likely in isolation have a major impact on concentrations. Rather the emergence of global changes in technology and in social responses that will give rise to the largest effects and improvements.

54. What is currently inadequate is the evidence base to support local decision-makers actions in their management of hotspots, particularly what actions have been seen to be effective and what scale of change should be anticipated. As discussed previously it is very difficult even for detailed academic studies of air pollution to attribute changes in concentrations to individual interventions, and this is likely well beyond the capacity of local authorities to evaluate themselves.

55. Any claim that a past action has been effective for air pollution improvement needs to be very carefully scrutinised to ensure that it really was the action that was responsible and that it did not result from some other unplanned change. Air pollution as a topic has many passionate advocates for action and change; zeal for a change must be tempered with realism over the extent of impact an action will have. It is beyond this enquiry scope, but interventions such as green walls and tree planting all have very vocal supporters, but the evidence for their impact is slight, and they generally do not make meaningful changes to air quality in cities.

56. Local action should be underpinned with improved evidence that is collected and synthesised at the national level. It is the job of local authorities to apply knowledge about sources and their impacts in their local context, but not to undertake the basic evidence gathering needed to formulate policy. The evaluation of emissions from vehicles as they age should be a responsibility of central government, not local; that information should be shared to help local councils make better choices. For emerging issues such as domestic wood-burning, central government have a responsibility to establish the evidence base on the impacts, on the typical quantities
of PM emitted and on proven positive interventions. With this evidence in hand then local authorities may be able to apply that knowledge in a local context.

57. The research community has a role to play in supporting both local and national decision-making on air pollution. As we enter a period of increased diversity of local approaches to air pollution management, greater emphasis must be placed on the academic evaluation of those interventions. Research Councils and reviewers often view this as lower priority applied science, but the impacts on the UK are enormous and mechanisms are needed to ensure it is supported.

58. Finally, a more nuanced view on observations and measurement is needed to support local decisions on air pollution. At present the overwhelming national investments in detecting air pollution are in the context of the demonstration of the attainment of EC Directive ambient air quality standards. Little emphasis is placed on the collection of data that might give more direct insight into whether actions or interventions are working. A local and national focus solely on only those parameters where there is a statutory obligation, limits the diversity of evidence available to support wider goals. Some rebalancing of local and national resources away from compliance monitoring and towards the surveillance of more appropriate metrics such as emissions measurement at source, would greatly improve the evidence base to underpin future action and possibly head off emerging air pollution issues before they became national problems to then solve.

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