Environmental Research Group
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ENVIRONMENT, FOOD AND RURAL AFFAIRS COMMITTEE INVESTIGATION INTO AIR QUALITY – WRITTEN EVIDENCE SUBMITTED BY THE ENVIRONMENTAL RESEARCH GROUP (ERG) KING'S COLLEGE LONDON

1. Introduction

This evidence is submitted on behalf of ERG at King's College, London. ERG undertakes research on atmospheric science, measurement and modelling of air quality, toxicology and epidemiology of air pollution and science relevant to policy issues.

2. Summary

- Continued monitoring of the real-world performance of Euro 6 vehicles is essential to monitor the effectiveness of Euro standard regulations and to track progress towards achieving legal air quality limits. Policies need to respond quickly to the findings.
- Nitrogen dioxide (NO_2) concentrations are now a public health issue, potentially as large as that from particulate matter ($PM_{2.5}$) and there is a very strong case for reducing concentrations below legal compliance limits.
- Defra have not made clear how it plans to ensure that the Clean Air Zones (CAZs) are actually established and are sufficiently stringent should local authorities fail to implement them adequately. The timetable for their effective working appears optimistic on the evidence provided.
- Euro 6 diesel cars are still likely to emit much more nitrogen oxides (NO_x) than petrol or petrol hybrid equivalents. Further fiscal and other measures to encourage vehicles and fuel other than diesel would help speed up the effectiveness of CAZs.
- Encouragement of active travel is another measure which would benefit public health from reduced emissions and exposure and increased physical activity.
- Reducing ammonia emissions in the UK and Europe represents the single most effective method of reducing $PM_{2.5}$ levels to minimise adverse effects on human health and on ecosystems. Agriculture is the dominant source of ammonia emissions. Emissions from the rest of the economy have contributed to reductions in NO_x and sulphur dioxide of 64% and 89% between 1990 and 2013 while ammonia emissions have only reduced by 21%.
- The Defra consultation on NO_2 is restricted solely to legal compliance for a single pollutant in relatively small areas and is too narrow to make as large an improvement in public health as is desirable. A wider comprehensive air quality strategy is urgently needed, focussing on minimising the impacts on public health as well as on legal compliance. A co-ordinated strategy across Government departments is needed to maximise public health benefits and achieve the Climate Change Act target for 2050. This offers the opportunity to achieve the largest improvements in air quality related health impacts since the Clean Air Act of 1956.

3. Trends in Vehicle Emissions

The disparity between the absence of a downward trend in measured NO_2 concentrations and earlier emission calculations suggested that emissions were actually much greater than

had previously been thought. One of the main reasons for this has turned out to be the failure of the 'Euro Standard' test driving cycle to reflect adequately real world emissions. The result has been no significant change in real-world emissions of NO_x from diesel vehicles, particularly from cars, for the past 20 years or so despite increasingly stringent legal emission limits. This was demonstrated in papers by King's College London and others up to 5 years ago, but with the more recent admission by Volkswagen that it had used 'defeat devices' to maintain low emissions during the legal test but not necessarily in real world driving.

Apart from the obvious impact on ambient concentrations and on public health, this has resulted in significant uncertainty in real-world emission factors for NO_x from diesel cars. This is much more than a purely scientific issue. Realistic emission factors are fundamental to making robust projections of future emissions and hence compliance with EU limits for NO_2.

It is essential that we learn from the lessons of the Euro standard test failure and continue to monitor the real-world performance of Euro 6 vehicles, including light vans, and the findings need to be fed back unto the policy process. This should be carried out using two methods PEMS (Portable Emission Measurement System) and remote sensing. PEMS has the advantage of being the method to be used by the Euro standard process for Euro 6c tests; however it has the disadvantage of being labour intensive to the extent that a relatively small number of cars can be tested in a practicable period, typically one or two vehicles per week in a given testing facility.

Remote sensing methods measure vehicles actually in use as they pass by the measurement system and large numbers of vehicles can be sampled; depending on the traffic flows in the particular location, thousands of vehicles can be measured in a day. One perceived disadvantage of this method is that a single location is used with the argument that this represents only one driving mode. However by using different locations, a wide range of vehicle operating conditions can be sampled. A combination of these two methods would be an optimal way forward but it is essential that monitoring is undertaken of the real-world performance of Euro 6 vehicles.

King's College London has recently analysed trends at roadside and urban background stations in London (Font and Fuller, 2015, to be published). Between 2010 and 2014 an improving picture was found with overall decreases in the roadside increment[1] for NO_x, NO_2 and $PM_{2.5}$. It appears that the changes in the roadside increment for $PM_{2.5}$ can be explained by changes in exhaust emissions of black carbon consistent with particle traps and other diesel emissions abatement. However, PM_{10} concentrations showed no significant overall change suggesting an increase in coarse particles, from brake and tyre wear and wind blown dust for example, was offsetting decreases in tailpipe emissions; this was especially the case in outer London where some sites had increasing trends in the PM_{10} roadside increment. This was demonstrated by King's some ten years ago; no policy currently exists to address the sources of the coarse fraction of PM_{10}.

[1] The roadside increment is the amount by which the roadside concentration of a pollutant exceeds the nearest urban background measurement.

This work suggests that diesel particle filters are having a beneficial effect, although there are still websites offering a service to remove these filters. Evidence that control technology to reduce NO_x emissions from diesel cars is still being gathered. The preliminary signs are that Euro 6 diesel cars will have lower NO_x emissions than Euro 5, but they are still likely to emit significantly more NO_x than a petrol car or a petrol hybrid.

Decreases in $PM_{2.5}$ and PM_{10} at all sites will require concerted action across the EU since a large amount of PM measured in the UK is formed from emissions in neighbouring countries. The foregoing comments suggest controls on diesel particle emission could be making an improvement but action on ammonia is now vital if PM concentrations are to be reduced further. This is discussed further below.

4. Health Impacts of Air Pollution

The evidence for the adverse effects of PM, both $PM_{2.5}$ and PM_{10}, has been the strongest and this evidence is now even stronger according to the latest review by the World Health Organisation[2] (WHO). Moreover a wider range of health impacts have now been identified. Other witnesses can elaborate on this latter point.

Until the WHO review, the health effect evidence for the adverse impacts on health of NO_2 was less convincing that that for PM, not least because of the close correlation between PM and NO_2 making it difficult to identify an independent effect of NO_2. The WHO review however concluded that there was now evidence to suggest an effect of NO_2 independent to a large degree of that of PM. Moreover a subsequent stage of the WHO review[3] recommended numerical relationships ('concentration-response functions' or CRFs) between annual average NO_2 concentrations greater than 20 $\mu g/m^3$ and all-cause mortality in people over the age of 30. Note that the EU Limit Value is an annual average of 40 $\mu g/m^3$, so that there is now a strong case for reducing concentrations of NO_2 even further below the legal EU Limit Value. The latter is based on the WHO air quality guideline for NO_2 and in the light of the recent evidence for effects below the existing guideline and legal limit, the WHO REVIHAAP review recommended revisiting the guideline.

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2 Review of evidence on health aspects of air pollution – REVIHAAP Project , WHO, 2013 available at http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report

3 Health risks of air pollution in Europe – HRAPIE project: Recommendations for concentration–response functions for cost–benefit analysis of particulate matter, ozone and nitrogen dioxide, WHO 2013, available at http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/health-risks-of-air-pollution-in-europe-hrapie-project.-new-emerging-risks-to-health-from-air-pollution-results-from-the-survey-of-experts

More recently the Committee on the Medical Effects of Air Pollution (COMEAP)[4] statement on the health effects of NO_2 concluded that evidence associating NO_2 with health effects has strengthened substantially in recent years. In ongoing work COMEAP are carrying out a systematic review and meta-analysis of epidemiological studies of long-term average concentrations of NO_2 and all-cause mortality to derive a new single-pollutant model summary estimate for all-cause mortality. An interim update on this work is scheduled to be published on December 15th 2015 and this will be followed by a full report by the end of March 2016.

This recent work now means that we are not just dealing with a legal non-compliance problem with the EU Directive, we are facing an important public health issue.

5. Policy issues

5.1 Defra Plans for Compliance with NO_2 Limit Values

There are several issues of detail related to the Consultation but this note will address only what we consider to be the more important issues for the Select Committee.
While we welcome the introduction of a national framework for Clean Air Zones (CAZs), it is not clear how Defra will enforce the overall Plan. The implementation of CAZs is left to the local authorities (LAs) with no obvious sanction if an LA declines to impose a CAZ, or imposes one weaker than is necessary to achieve compliance.

There must also be some doubt over whether or not the CAZs can be implemented in time, and importantly, whether they will be sufficient to turn the vehicle fleet over in time to achieve compliance by the dates which Defra suggest. Compliance by 2020 in areas other than London is challenging, requiring the full implementation of CAZs *plus* a turn-over of the vehicle fleet, all in four years. For London the time frame of projected compliance by 2025 – only 9 years away – also looks challenging. These doubts arise not least from the fact that modelling behaviour change and purchasing decisions, on which the projected compliance is predicated, is difficult and appears to be based on 'expert judgement' (Table 6.7 of the Draft Evidence Annex of the Defra Consultation). Monitoring of progress is essential both in terms of policy implementation and concentrations of NO_2.

The results of a sensitivity study to address the possibility of Euro 6 not working for diesel cars to the levels assumed are welcome. However, this study results in a large increase in non-compliant areas, but there is no subsequent discussion of what additional policy measures would be needed if Euro 6 emissions turned out to be higher than assumed in the 'base case'. Defra appear to have used the same emission factor for all Euro 6 diesel cars including those already on the road so their base case assumption could be optimistic for NO_x emissions.

Other pressures on diesel cars would accelerate this process of turning over the fleet faster and give more confidence in the achievement of the limits in the timeframe suggested. It is largely ignored by the media but a Euro 6 petrol car is likely to be significantly cleaner in

[4] COMEAP is the expert group advising the Department of Health.

terms of NO_x than is a diesel car, even a Euro 6 diesel. Further fiscal pressures to redress the balance in favour of petrol, hybrid and electric cars would accelerate the change in purchasing decisions and make achievement of compliance by the stated dates more likely (2020 outside London and 2025 in London).

5.2 Wider policy issues

The Consultation on NO_2, for understandable reasons, concentrates on a relatively narrow aspect of air quality policy, namely achieving legal compliance for one pollutant in a narrow range of predominantly roadside locations.

Although achieving the Limit Values for NO_2 will result in public health benefits, the current consultation is too narrow to provide the *optimum* benefits to health. Larger benefits are possible. This requires a more comprehensive strategy for air quality in the whole of the UK, with the aim of providing the maximum feasible benefits to human health. Legal limits do not represent 'safe' levels below which no adverse effects occur and strategies should be considered which go beyond these limits. The strategy should also take a holistic view of transport and its impact on air quality and health going beyond the establishment of CAZs, but looking more widely at the policy portfolio to encourage the use of the cleaner options for vehicle purchasing and use, and to encourage active travel, replacing car journeys by walking and cycling, or by public transport.

This broader longer term view should combine strategies to mitigate climate change and achieve the UK Climate Change Act target of 80% reduction on carbon dioxide equivalents by 2050. Achieving this target in concert with optimal air quality policies offers the opportunity to make the biggest improvement in public health impacts from air pollution since the 1956 Clean Air Act, as long as the Climate Change Act target is met with minimal use of harmfully polluting fuels such as biomass in small scale boilers and stoves. This strategy should involve close co-ordination between all Government Departments.

A very significant improvement in public health from air pollution reductions in the short to medium term could come from reductions in $PM_{2.5}$ and PM_{10}. Apart from reducing particle emissions from combustion systems including diesel and other forms of stationary source combustion, measures for which are already in place, the single most effective way of reducing PM concentrations in the UK and in Europe is to reduce ammonia emissions from agriculture[5].

There are few measures in place to address these emissions currently in the UK. The agriculture sector stands out as being the one important area of the economy which has not delivered significant emission reductions over the past decades, unlike the other sectors of the UK economy. Nitrogen oxides emissions have reduced by 64% in the period from 1990 to 2013, those of sulphur dioxide have reduced by 89%, but ammonia emissions, of which agriculture is the overwhelmingly dominant source, have reduced by only 21% in the same

[5] Report by the Air Quality Expert Group advising Defra: Mitigation of United Kingdom PM2.5 Concentrations, 2015 available at http://uk-air.defra.gov.uk/assets/documents/reports/cat11/1508060903_DEF-PB14161_Mitigation_of_UK_PM25.pdf

period. There are techniques readily available which can achieve significant reductions, and other countries such as Denmark and The Netherlands have achieved this without affecting the viability of their agriculture sectors.

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