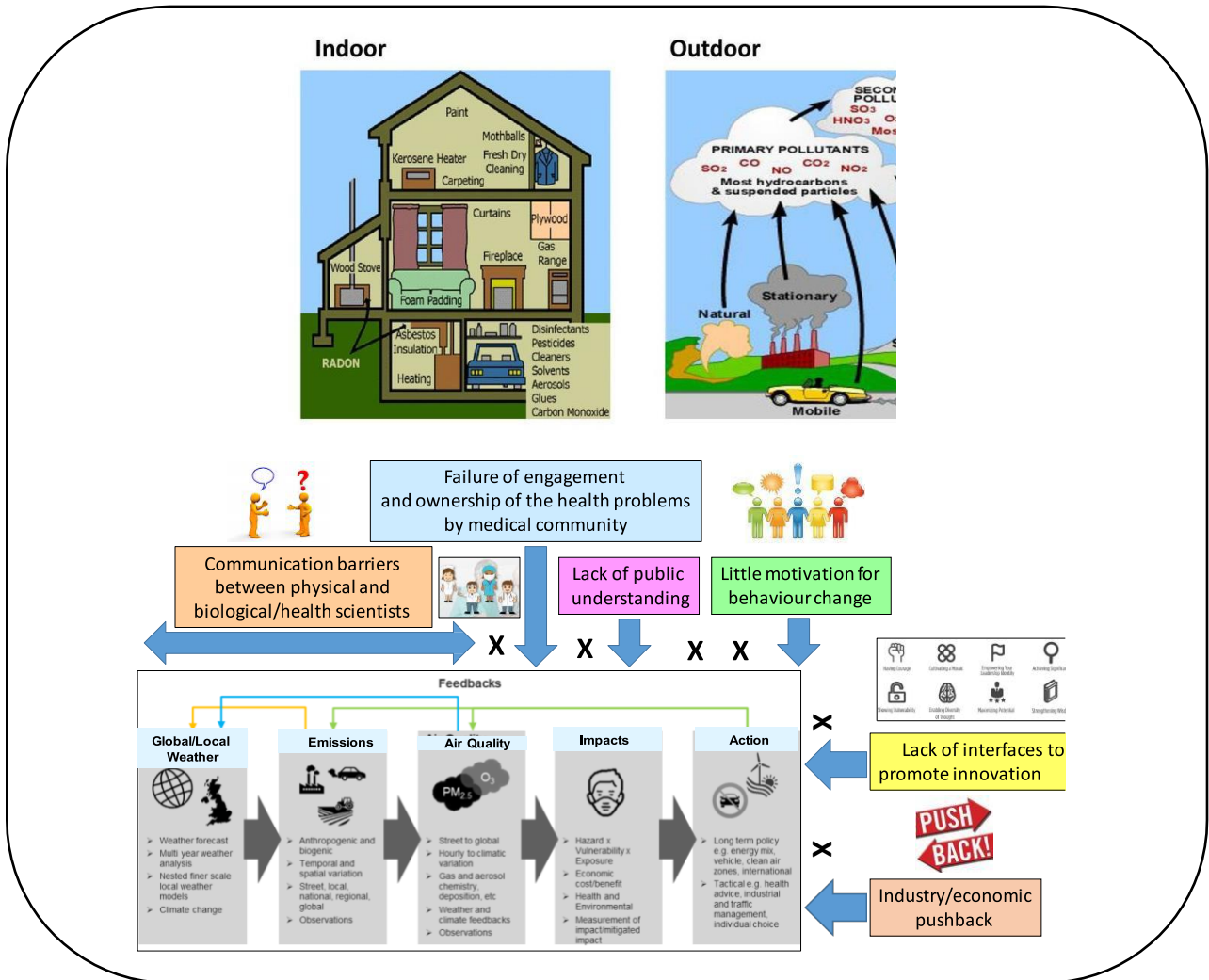


A Research Roadmap for Clean Air in the UK



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The overarching aim of this UKRI/Met Office Clean Air Strategic Priority programme is: **To equip the UK to proactively tackle new air quality challenges related to changing emissions and exposure patterns, in order to protect human health and support clean growth.**

The objectives of the UKRI/Met Office SPF on Clean Air to be delivered by March 2025, are to:

1. Build a new influential interdisciplinary community in the area of the indoor/outdoor air quality interface, comprising academic, PSRE, business and stakeholder members across the required disciplines.
2. Deliver new knowledge that provides critical foresight on emerging air pollution challenges and associated health risks, and new knowledge to better understand the human behavioural change and new technologies needed to limit exposure routes and mitigate health risks at vulnerable stages of the life course.
3. Provide consistent, evidence-based advice for stakeholders through open data and tools in order to stimulate policy and regulatory innovation.
4. Stimulate business-led innovation for sustainable products and services for indoor air to protect health and grow UK businesses.

Impacts

- Improved public health
- Cost savings to health services and businesses through avoided health impacts
- Clean growth

Summary

Since their appointment in June 2019, the Clean Air Champions have been exploring where some of the major issues impeding progress within the UK in cleaning up the air we all breathe, both outside and inside. As Clean Air Champions in post since June 2019, we have spoken to many stakeholders with an interest in the field as well as researchers and have attended a range of events targeting different aspects of the air pollution problem. While we received many different views, as would be expected, several over-arching themes emerged where gaps were identified and where new activity would likely be productive in meeting the objectives laid out for this SPF. While we recognise that the views we heard cannot be seen as a systematic overview of the field, several threads emerged from different sources that have served to reinforce particular concerns and possible solutions. Our thoughts have been greatly informed by our discussions with the Wave 1 project teams, as well as with all the stakeholders we have talked to. These have led us to a number of key emerging themes:

1. The primary target for the damaging effects of air pollution are humans. In the past there has been strong emphasis on pollutant measurement in outdoor settings but relatively limited gain from this to create real world solutions.

2. Much more work is required to connect the Health/Medical Sciences with Atmospheric Scientists. A helpful step would be to explore ways that the Atmospheric Science research community could interact with the medical charities, medical royal colleges, and others concerned with informing the public about what they can do to prevent or mitigate air pollution creation and its effects on health. The Atmospheric Science community need to seek ways to explain their research in a way that the public understands and identify collaborators who can utilise the science in practical ways.

3. The language used to portray health messaging and communication is often negative and sometimes expressed in punitive terms. The narrative needs changing to give more emphasis to solutions and added values for reducing pollution sought and explained. There needs to be greater emphasis on Social/Behavioural Science, Psychology and Economics to help in creating a new narrative designed to change the behaviour of targeted audiences and to drive effective policy.

4. Recognising that there are great opportunities for advancing the field through digital science, an effort should be made to bring together data scientists from health (HDR-UK, NHS Digital, Usher Institute, industry e.g. Dyson, Philips, Microsoft, Google etc.) with the Met Office and large data sets on atmospheric science. Some of these may be found in other large depositories such as the Ordnance Survey (e.g. <https://www.ordnancesurvey.co.uk/business-government/innovation/happens/articles-ehs/mapping-pollution-cleaner-air>) and Ministry of Defence (e.g. <https://data.gov.uk/search?q=air+defence&filters%5Bpublisher%5D=&filters%5Btopic%5D=&filters%5Bformat%5D=CSV&sort=recent>)

5. A more coherent and strategic effort is required to improve the quality, visibility and extent of messaging and communication transfer to health scientists, practitioners and the public at large.

6. Recognising the urgent need for greater granularity of air pollution as it affects people in the localities of their daily living it should be possible to make available more information on the performance of affordable (<£1000) pollutant sensors to those wishing to do hyperlocal monitoring. Easily accessible information on the performance and reliability of affordable sensors is lacking. It is often stated that such instruments are simply not fit for purpose. With sensor and materials technology at such an advanced stage of development in universities and the private sector, it should now be possible to take a “Which Best Buy”-type approach to sensors and make such information easily accessible to those wishing to use them. This needs a comprehensive assessment of the state of sensor performance bringing together the findings of the multiplicity of research groups active in this area.

7. Most of the policy making in air pollution regulation has been informed by epidemiology. While, initially, toxicology attributing mechanisms to pollutant health effects was considered an integral component of regulation (e.g. experimental medicine chamber studies, identification of biomarkers on causal pathways), in the UK this has declined raising concerns over the capacity of the current toxicology workforce to undertake new work. Crucial questions require answering for effective emissions controls especially in the field of different types of particles that are simply still regulated by size and total mass characteristics alone. While such research may not generate the level of excitement that discovery science achieves, it is essential if targeted policy on pollutant control is to be developed.

8. The indoor air environment is a virtually unresearched space for air pollution exposure whether from house materials, furnishings and fittings personal and cleaning products, and indoor activities. We heard strong support for recent legislation on coal and wood burning fires in homes, but much more needs to be understood about exposures occurring where most people spend their time. It is timely to ramp up connectivity of researchers and new research projects in the indoor air research space including personal monitoring and devices capable of doing this. Equally, understanding health effects of indoor pollutant sources will require larger and better designed and coordinated studies as well as real world and experimental settings where specific pollutants and their health effects can be monitored in depth. Cross-cutting influences such as socioeconomic deprivation, moisture/damp and heat inside buildings need factoring into such studies.

9. More effort needs to be made in connecting the climate change policy and research community with those interested in air pollution since there are both strong positive and negative interactions and large improvements to be made in public health if the antagonisms are recognised and managed.

10. A specific target for this Clean Air SPF is greater ease of access of information, publicity and education about the adverse health effects of air pollution. A more joined up approach by government is required to pull together the disjointed fragments of information available and being created. Maybe the next phase would be to allow a wider range of stakeholders to participate in the SPF activities and add to them e.g. the Third Sector, NGOs, Industry (beyond SMEs), the DH and NHS in their wider functions as well as those involved in medical undergraduate and postgraduate education and places of education (schools, universities and other Higher Education Institutes).

Overall conclusions

While we accept that our attempts to obtain intelligence on air pollution issues was not systematic, what was clear from many different stakeholders that there were some key overarching themes that required special attention if the “wicked problem” of air pollution in the UK is to be effectively tackled for improved health. Before identifying some of the principal common themes that have emerged from our national survey, it is worth making a few contextual points which emerged, but do not necessarily reflect views held by the CACs.

- 1) Wherever we went and whoever we spoke to, there was overwhelming enthusiasm for this SPF and what it wished to achieve. We did hear from several sources that there were counterviews such as from the Society of Motor Manufacturers and Traders (SMMT), Port Authorities and even some organised groups such as the Taxpayers Alliance (https://www.taxpayersalliance.com/there_s_something_in_the_air) and the Road Hauliers Association (<https://www.rha.uk.net/news/press-releases/2019-06-june/time-for-a-rethink-on-clean-air-zones>). For example, we learnt that a SMMT poll shows almost three quarters (72%) of motorists were against penalties for UK’s “cleanest” diesels, and yet even the most up-to-date diesel vehicles are emitting UFPs at very high levels without the public being aware of this (<https://airqualitynews.com/2020/02/26/dangerous-ultra-fine-particles-from-diesel-cars-ignored-by-the-law/>). It seems that, as with PM_{2.5} and NO₂ emissions, real world emission testing still has a long way to go before it can be said to be reducing emissions to levels claimed by the vehicle manufacturers and narrowing the gap between emission inventories and air pollution as measured on the ground (https://www.transportenvironment.org/sites/te/files/publications/Dont_Breathe_Here_report_FINAL.pdf).
- 2) The UK has built up a strong and well-connected research community in atmospheric sciences as applied to air pollutant measurement with strong links to Defra which is the Government Department responsible for delivering air quality targets for outdoor air. Since the 1950s, this research community has delivered some of the best atmospheric science on air pollutants and sources of emissions. What has not worked so well is the transfer of this knowledge to those concerned about health and those with influence over transport and planning. This has led to a somewhat partisan approach by different parts of government each doing their own thing in the absence of what others are doing (a lack of a coherent joined-up strategy). Similarly, there seemed to be a lack of communication/relationship between city and local authorities and central government thinking with local government being asked to meet demands of meeting air quality limits but little or no resource to do this.
- 3) Since human health is the reason for improving air quality, involvement of the DHSC in this field of public health has waned since the early years. While COMEAP has produced many “influential reports” on various aspects of air pollution in the UK which add to those produced by AQEG, it is not clear that

these have been translated into policy on the ground in which the focus is human health. Public Health England (PHE) when created in 2013, was largely given the responsibility of delivering health messaging relating to air pollution. While again many good reports have been produced, translation of these into public health actions on the ground has not been achieved with air pollution being a subject which is largely invisible to health professionals from primary care to specialists who are at the receiving end of the adverse health impacts. Public Health Physicians are so overwhelmed with other issues (the latest being COVID-19) that they have insufficient bandwidth to take on the challenges required to effect behaviour changes. The devolvement of the responsibility for public health now being devolved to local government means that lobbying and competing interests keeps air pollution side-lined to the “too difficult box”.

- 4) The health messaging to the public and professions regarding air pollution and its solutions has largely been picked up by the third sector. Medical charities such as the BHF and Asthma UK BLF Partnership, Guys’s and St Thomas’ Charity, the Medical Royal Colleges, NGOs such as the Global Action Plan. In addition, some local support networks such as the Clean Air Parents Network (<https://www.clientearth.org/clean-air-parents-network/>), Mums for Lungs (<https://www.mumsforlungs.org/>), Mothers Against Pollution (<https://makemothersmatter.org/mothers-in-action-against-air-pollution/>) and Mothers in Action Against Air Pollution (<https://makemothersmatter.org/mothers-in-action-against-air-pollution/>). We heard from Sustrans that one in three teachers are worried about air pollution, the survey for walking and cycling charity, found, with 43% saying idling car engines outside school gates concerned them and 63% said air pollution was a problem because their school was based on or near a busy main road. While the charity sector and NGOs have an important role to play, what is now needed is a coherent narrative that can be rolled out across the country where instruments used to communicate are designed fit for the target audiences.
- 5) Awareness and knowledge of the effects of air pollution as a driver of human disease is woefully lacking amongst the majority of health professionals who deal with the very diseases that are affected by air pollution. This is true across the medical profession and amongst other health professionals such as physiotherapists, pharmacists and nurses. The extent of hospitals and primary care settings as setting examples for cleaner air is extremely low yet for tobacco smoking the health professionals were leaders of policy change.
- 6) The way air pollutants are regulated is through one pollutant at a time, and yet the adverse health seen is likely to be the result of multiple pollutants acting together (mixtures) and with biological pollutants such as allergens and microorganism fragments attached to particulates or suspended separately. The generation of secondary pollutants is a key area for further research.
- 7) Using size alone to regulate particles as air pollutants is appreciating only part of the problem. Different sources of particles give rise to different toxicological properties, yet this is not taken into account the regulatory framework for emission controls. With a decline in air pollution toxicology in the UK, concerns over the capacity of the current toxicology workforce to undertake new work is very limited yet is required urgently if source control is to be effective and feasible. The toxicological properties of new pollutants (e.g. primary and secondary components of outdoor particles, indoor pollutants) requires attention if the public is to be informed appropriately and transparently, adequate labelling of products emitting pollutants provided and substitutions found.
- 8) UK citizens spending an average of around 95% of their time indoors, with 66% of their time spent in their homes and for vulnerable people, this may increase to 100% (<https://www.sciencedirect.com/science/article/pii/S0160412015300507#bbb0555>). It is surprising how little is understood of the air pollutants that are present in these spaces whether primary or secondary. Almost nothing is known about the health effects of indoor pollutants beyond those ingressing from outside sources and what role indoor exposures make to the total exposure of normal and vulnerable

subjects. With the exclusion of radon, asbestos and acute CO exposure, most health studies are small bordering on the anecdotal. Concerns over indoor air are enhanced when adding covariables such as moisture (damp) and heat as well as the impact of sealing homes to increase energy conservation without taking sufficient account of ventilation of occupied spaces (<https://www.gov.uk/government/publications/ventilation-and-indoor-air-quality-in-new-homes>). Even ventilation in existing housing stock is not up to standard, a by-product in some cases of making buildings more energy efficiency, or ventilation measures not being used/maintained as they should; and Evidence of poor practice when installing gas protection measurements with poor understanding or deliberate misunderstanding of the requirements for verification.

- 9) There are clearly concerns over emissions from soil (or ground gas emissions) and how climate change is accentuating problems. To make our ground gas management climate proof, we need to understand how will methane, carbon dioxide, VOCs and other hazardous ground gases behaviour changes as a result of changing climate and will this change the risk associated with ground gases, particularly on indoor quality, bioaccessibility and how this affects the health of the occupiers of the buildings?
- 10) Exposure to poor air quality is an under recognised contributor to health inequality. This link has been known for many years e.g. Air Quality and Social Deprivation in the UK: an environmental inequalities analysis https://uk-air.defra.gov.uk/assets/documents/reports/cat09/0701110944_AQinequalitiesFNL_AEAT_0506.pdf and if anything the gap has widened since 2006 when this report was released (Emissions vs exposure: Increasing injustice from road traffic-related air pollution in the United Kingdom <https://www.sciencedirect.com/science/article/pii/S1361920919300392#!>).
- 11) Air pollution seems to be a low priority in urban planning whether access to public transport, placement of roads or public services. While guidance provided by the Ministry of Housing, Communities & Local Government (MHCLG) is available such as Guidance on Air Quality which provides guidance on how planning can take account of the impact of new development on air quality (<https://www.gov.uk/guidance/air-quality--3>). In this it is stated that assessments need to be proportionate to the nature and scale of development proposed and the potential impacts (taking into account existing air quality conditions), and because of this are likely to be location specific. The difficulty lies in the interpretation of this, failure of air pollution reporting locally and the observation that overriding interests take priority (<https://www.desmog.co.uk/2017/05/19/local-authority-air-pollution-reporting-failures>).
- 12) Lack of a clear picture of air pollution in localities greatly hampers planning decisions, informing on health concerns and advising the public at large. While the UK has a network of around 300 Environment Agency managed monitoring sites in total across the UK, outside of London there may be only 1 or 2 monitoring stations covering a single town or city e.g. 2 in each of Southampton, Portsmouth and Bournemouth with widely differing local sources of pollution. This places strong dependency on modelling which while being informative for providing background concentrations, provides little information about local pollution and hotspots where emissions from specific sources may expose local populations to elevated health risks. For example, data from the most recent annual air quality status reports that have been submitted to government, with the results adjusted for distance and other factors revealed that in England, Wales and NI in 2019 almost 2,000 locations across England, Wales and Northern Ireland had levels of air pollution that exceed EC safety limits (<https://www.google.com/maps/d/viewer?mid=1nxsB438uIxBcXx0m8FpFT-3ULszPc6Ka&ll=53.98535326879092%2C-1.9447625000000244&z=5>). This has focussed attention on the need for improved local air pollution monitoring with more densely distributed affordable air pollutant sensors.
- 13) While it is clear from the UKRI/Met Office Announcement Opportunity (AO) for this SPF that industry was a key component of finding innovative solutions towards cleaning up the air, the reach of this was

restricted to SMEs and support for several new projects. We heard that many much larger industrial enterprises could add value to the SPF and had their own enterprise activities. They were keen to add value to the SPF going forwards.

- 14) Having a one stop go-to place for information on air pollution research and development was a frequently expressed view both across researchers and for other stakeholders including the public(s).
- 15) We heard that people had to find out their own information about air quality unless there was announcement with the weather forecast of an air pollution episode. Lack of visible information to inform the public about pollution in their own locality was seen as a particular problem. Moreover, much of the messaging when found is couched in negative terms. Much work needs to be done to improve this situation involving social scientists and psychologists to create more positive messaging portraying not only health but wellbeing and environmental gains to be achieved. Co-benefits with climate change objectives are known but not widely disseminated. Information and displays relating to air quality are rarely seen in GP surgeries or hospitals or available in other public spaces such as libraries, schools, transport hubs and town halls.

Gaps in the Clean air Strategy Deserving Attention: Delivering a Theory of Change



People will change their behaviour only if they see the new behaviour as easy, rewarding, empowering and normal



Annex

Benefits pathway

