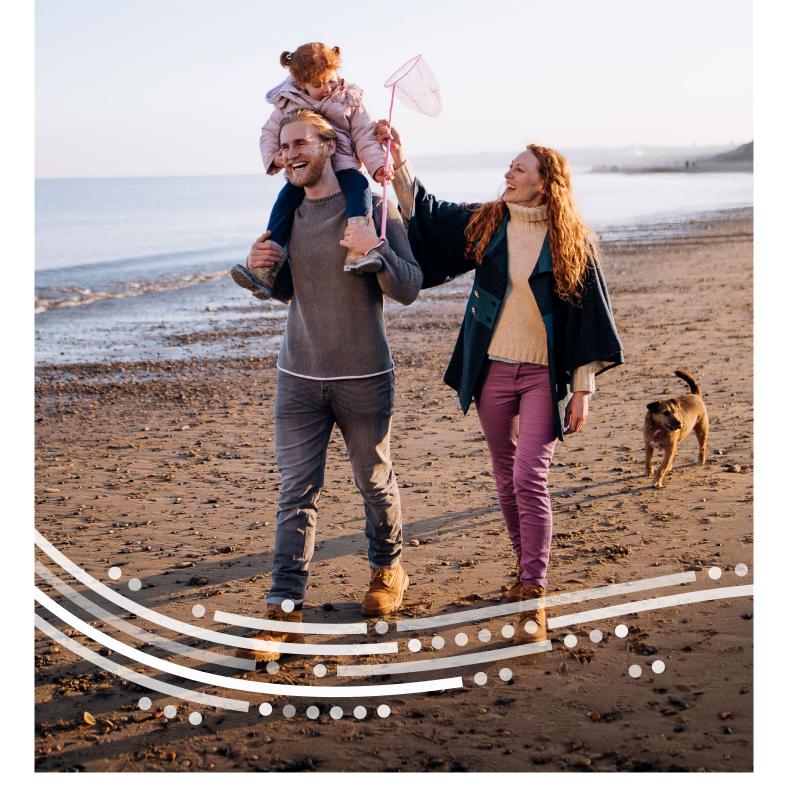






SPF Clean Air Programme Annual Review 2022



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The SPF Clean Air programme is a £42.5 million investment that brings together the UK's world class air quality research base and supports high quality multi- and inter-disciplinary research and innovation to develop practical solutions to today's air quality issues in the UK.

The aim of this programme is to support high-quality research and innovation that will help develop practical solutions for today's air quality issues and equip the UK to proactively tackle future air quality challenges in order to protect health and support clean growth.

The Clean Air Programme brings together leading researchers from across atmospheric, medical, and social science to better predict exposure to air pollution and its effects on vulnerable groups such as children and the elderly.

The programme is jointly led by UKRI (UK Research and Innovation) and the Met Office and delivered in two waves:

- Wave 1 Clean Air: Analysis & Solutions (£20.5 m) is focussed on near-term outdoor air pollution issues and the funded projects will leverage existing long term strategic investments in order to develop short-term policy relevant outputs, support commercialisation of near-market solutions for non-exhaust transport emissions and deliver a pilot systems framework for clean air analysis.
- Wave 2 Clean Air: Addressing the Challenge of the Indoor/Outdoor Continuum (£22 m) aims to equip the UK to proactively tackle new and emerging air quality challenges related to changing emissions and exposure patterns and health impacts on groups of people most at risk.

This review covers the period from April 2021 to March 2022 and is an opportunity to celebrate successes, reflect on learning to ensure continual improvement of the programme and to maximise benefits from achieving the objectives.

During this period, the programme has seen considerable development with many key milestones completed or progress made towards them. Some of the highlights are presented below:

April 2021	Start of the Clean Air mid-term review
April 2021	Phase 1 Innovation Pilots for competitions 'Removing air pollutants from homes to safeguard health' launch
May 2021	NERC (Natural Environment Research Council) Consortia Call panel
May 2021	Met Office Consortia Call closing date (wave 2)
June 2021	Start of the summer IOP (Intensive Observation Period)
June 2021	• The SPF Clean Air Programme Annual Conference 'Working in partnership for cleaner air' was delivered over two days
June 2021	New website www.ukcleanair.org launched
June 2021	The programme marks Clean Air Day

July 2021 Summer IOP concluded July 2021 • Annual review 2019-2020 approved by the Programme Board August 2021 • Three Phase 2 Innovation Pilots for competition 'Monitor and visualise domestic pollution to safeguard health' launch • NERC Consortia Call projects have started August 2021 · Phase 2 of Innovation Competition 'Removing air pollutants from homes to safeguard health' opens August 2021 • Met Office Consortia Call evaluation takes place September 2021 • Data Workshop takes place over two days September 2021 • Clean Air Networks projects and the SAQN (STFC Air Quality Network) roundtable Integrated assurance and approvals plans submitted September 2021 • Regional Clean Air Champions appointed September 2021 Clean Air mid-term review concluded • Clean Air Networks projects roundtable Official starting date for RESPIRE Consortia December 2021 • Met Office Consortia Call projects have started January 2022 • The winter Intensive Observation Period started January 2022 Three Phase 2 Innovation Pilots for competition 'Removing air pollutants from homes to safeguard health' launch January 2022 Wave 2 Champions AO published • The winter Intensive Observation Period concluded February 2022 March 2022 Procurement to engage consultant to conduct research unto UK's Clean Air Technology Sector launched March 2022 Announcement of additional Consortia (RESPIRE)





The top programme successes were identified as:

- Effective integration of the programme while funding multi and inter-disciplinary projects
- Community building by fostering cross-programme collaboration
- Research progress and outputs

The key lessons that should be taken into consideration for future learning were identified as:

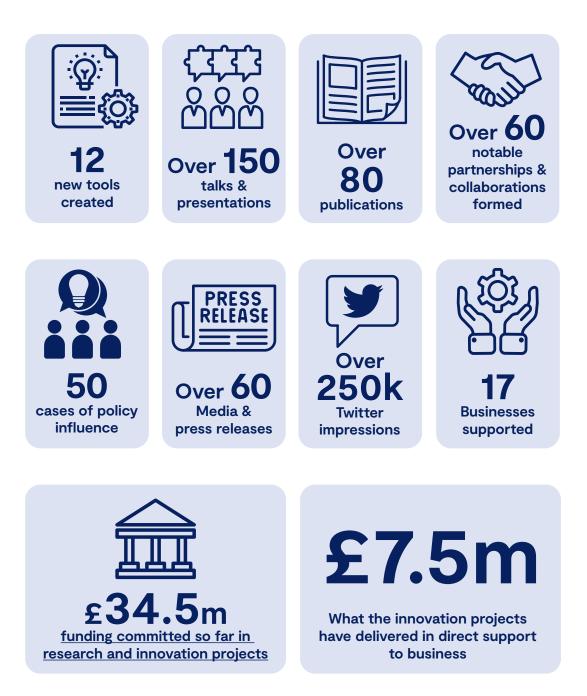
- Agree a joined-up vision of the programme legacy
- Increase engagement with the wider Clean Air community to understand needs
- Ensure engagement at different geographical scales

Summary

Overall, the programme management team and the Champions are pleased with how the programme has progressed over the last year. Particularly good progress has been made in building the clean air community through virtual communications, such as the conference, workshops, the improved website, the Champions activities, and project exposure at the COP26 conference in Glasgow in November 2021.



CLEAN AIR AT A GLANCE



Air pollution is the top environmental threat to people's health, in the short and long-term. Some groups are more vulnerable to its impacts: children, pregnant women, the elderly, people who are already ill, or live in poverty.



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INTRODUCTION

Background and purpose

This document provides a review of the SPF Clean Air Programme (Wave 1 & Wave 2), and captures the headlines on successes, lessons learnt, and progress towards the aims from April 2021 to March 2022.

The purpose of the Annual Review is to help inform the programme-level analysis of the Clean Air Programme, to promote accountability, and to provide enough time for lesson learning and course correction for the continuation of programme implementation.

Approach

The review is focused on two areas: programme management and the delivery of outcomes and benefits related to the programme's strategic objectives. The programme was reviewed against evaluation questions, adapted from the end of programme evaluation questions, as set out in the Monitoring and Evaluation Plan. We have used programme documents such as meeting minutes, the risk register and finance reports, and monitoring data from monthly dashboards, Researchfish, Innovate UK periodic project reviews, and the Met Office's input to support the review process where necessary.

Audience

This Annual Review is intended for all stakeholders to gain a better understanding of the programme and the progress that has been made over the period April 2021 to March 2022. The review will also enable the Programme Board (PB) and programme team to learn lessons about the design and management of the programme informing:

- discussions on potential improvements in the management and delivery of the Clean Air Programme; and
- the development of similar programme approaches and other interventions in the future.

A condensed version of this review will be shared with the Steering Committee (SC) to enable them to give advice and guidance on maximising benefits, and extracts may be shared more widely with stakeholders or through comms opportunities.



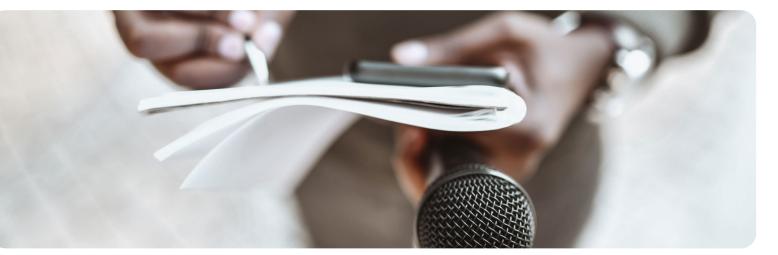
66 The purpose of the Annual Review is to help inform the programmelevel analysis of the Clean Air Programme, to promote accountability, and to provide enough time for lesson learning and course correction for the continuation of programme implementation.



Events and stakeholder engagement have been important for promoting the SPF Clean Air programme and progressing towards the aims. Met Office and UKRI owned communication channels have promoted the programme since the launch. The Met Office and UKRI websites have dedicated sections for the SPF Clean Air programme including latest news and funding opportunities, and the dedicated Clean Air programme website contains more content regarding the projects, events, news etc. The other main channels utilised are the Met Office Science, UKRI and Clean Air twitter pages that amplify the messages and news.

The most notable items of press coverage during the review period are listed below:

- Gary Fuller authored an article for the Guardian on tyre wear and the Auto-Align project (published on 23/04/2021). His air pollution pieces for the Guardian are published each two weeks and can be found under his profile.
- Stephen Holgate participated in a BBC Morning Live Indoor Air Pollution film (aired 01/06/2021)
- UKRI Press Release to announce the appointment of the Regional Clean Air Champion (RCACs)- (01/10/1021)
- The Conversation blog: Air pollution: most national limits are unsafe for human health (22/09/2021)
- UK Clean Air Programme blog has published the following pieces:
 - o 27th May 2021 Air Pollution A call to action by the Medical and Health Professions
 - o 30th June 2021 Focus on the Planning White Paper: A Chain Of Consequences For Clean Air
 - o 31st August 2021 All change please? Is it time for air pollution management to catch up with the health evidence?
 - o 7th October 2021 Clean Air bringing together, building together
 - o 11th November Air Pollution: A Global, National and Regional Challenge
 - o 27th January 2022 A community-based approach to investigate how indoor air pollution impacts our health



- Programme wide news is periodically published on the UK Clean Air website.
- The RCP (Royal College of Physicians) podcast on Air pollution and health inequalities by Professor Sir Stephen Holgate and Dr Jenny Baverstock was published on 20th January 2022.
- Neil Rowland Clean Air Regional Champion took part in an interview for radio programme about the air pollution dashboard that was officially launched on 10th November. Aired 11th December on BBC Radio Ulster's On Your Behalf
- The Regional Clean Air Champions, contributed to a blog post 'Air Pollution: A Global, National and Regional Challenge,' published 11/11/21
- Birmingham Clean Air Zone launch (1st June 2021) the supersite featured on ITV TV, Birmingham Mail, ITV Central. Daily Mail "Beating the silent killer" feature article.
- Wave 2 Consortia launch Exploring how air pollution in indoor spaces affects human health
- Additional funding from DHSC/NIHR allowed a 4th Consortia project to be funded New study explores how pollutants indoors impact child health
- Innovate UK has published a blog covering the ambitions of the Clean Air Programme and highlighting the Wave 1 Innovation Pilots in study videos: www.ukri.org/blog/ research-and-innovation-to-develop-solutions-to-air-pollution/





PROGRAMME SUCCESSES

The programme had many successes and highlights throughout the review period. Below are the key successes identified by the programme team and Champions (in no particular order).

Effective integration of the programme while funding multi- and interdisciplinary projects

- The research and innovation elements of the programme have become more integrated as the innovation pilots mature and detailed academic research informs product development.
- All three Wave 1 innovation pilots have delivered successfully, producing impressive results on budget. All of the pilots have moved on rapidly to commercialisation.
- The Wave 2 innovation pilots have progressed successfully to Phase 2.
- The Summer Intensive Observation Period (IOP) which was re-scheduled and happened in June/July was a remarkable success, especially given the circumstances and saw eight different universities all working together.
- Successful Wave 2 call resulted in three Consortia being funded: West London Healthy Home and Environment Study (WellHome); Hazard Identification Platform to Assess the Health Impacts from Indoor and Outdoor Air Pollutant Exposures, through Mechanistic Toxicology; Ingenious: Understanding the sources, transformations, and fates of Indoor air pollutants.
- Aligning priorities with other bodies has opened opportunities to leverage further funding and DHSC (Department for Health and Social Care) to offer £2.3m, which resulted in one extra consortia project (RESPIRE – Relating Environment-use Scenarios in Pregnancy/Infanthood and Resulting airborne).
- Completion of the Clean Air Science Plan.

Community building by fostering cross-programme collaboration

Cross-programme collaboration of projects has included collaboration between NPL (National Physical Laboratory), QUANT (Quantification of Utility of Atmospheric Network Technologies) and OSCA (Observation System for Clean Air) projects; collaboration between MOASA flights and IOP on ground observations and cross-programme collaboration between CERC, DUKEMS and DIMEX.

The Clean Air Networks and Consortia have generated multiple interdisciplinary
interactions that are being enhanced by the various topic-specific workshops, annual conferences and other local and national workshops and events being orchestrated by the Clean Air Champions and individual research groups.

Four RCACs (Regional Clean Air Champions) were appointed to act as the pivotal point

 for air quality research in their region, with a view to increase collaboration and impact across and beyond the programme.





- The programme's Mid-term Review) was conducted last year and has generated clear recommendations included in an implementation plan.
- The SPF Clean Air Annual Conference 2021 brought together researchers from across Wave 1 and Wave 2 investments and partners to highlight the wide range of highquality research being undertaken in projects. The Conference aimed to develop an understanding of the completeness of the Clean Air programme and provide an opportunity to network across all the projects involved in the programme and with Clean Air stakeholders.

Interdisciplinary collaboration was implemented by bringing together and working with stakeholders from various sectors or policy relevant communications – i.e. meetings with leaders of London local authorities – the London Environmental Director's Network (LEDNet), meetings with the Environment Agency who are running an initiative about air quality inequality issues, NPL was part of the Breath London pilot study which implemented a network of low-cost sensors in London. Several projects have held workshops e.g. NPL held a combined air quality and health workshop in August 2021, DIMEX is working in partnership with Manchester City Council and Transport for Greater Manchester.

Collaboration between Wave 1 ANTICIPATE and Wave 2 TRANSITION has produced a participatory system map for the Covid, carbon and air quality trilemma.

Research progress and outputs

- The innovation projects have integrated more effectively and fully with research elements as the pilot projects have matured. The trial of Clean Air Gas Engine (CAGE) technology with HS2 has been a fantastic opportunity to demonstrate the technology as a viable alternative to diesel and represents a major milestone in the drive to improve air quality in off-grid construction sites across the UK. The CAGE project worked closely with academic researchers at Imperial College to test and demonstrate the effectiveness of their technology. Newly released initial findings suggest the technology results in:
 - 95% CO reduction compared to Stage III-A and Stage V diesel emission standards and 94% CO reduction compared to spark ignition emission standards.
 - 96% NOX (nitrogen oxides) reduction compared to Stage III-A and Stage V diesel emission standards and 94% NOX reduction compared to spark ignition emission standards.
 - 98% PM (Particulate Matter) reduction compared to Stage III-A and 33% PM reduction compared to Stage V diesel emission standards; there are no spark ignition emission standards.
 - 95% PN reduction compared to Stage V diesel emission standards (there are no Stage III-A PN emission standards); there are no spark ignition emission standards.
- The supersite data recorded as part of IOPs (OSCA project) was put forward to DEFRA AQ-CV-19 call for evidence, to local authorities [BCC, TfWM and WMCA in the Birmingham case; TfGM, MCC, and GMCA in Manchester case and TfL in Imperial case], also presented at SAQN network meeting on 20th May.
- An additional 30 commercial sensors from 9 manufactures were installed at the Manchester supersite, the data from which will enhance the reach of the WP1 analysis (QUANT project).
- Ongoing collaboration between the ANTICIPATE project and TRANSITION Clean Air Network project (2nd wave SPF funded) has produced strong co-benefits for both projects. ANTICIPATE was able to link into the TCAN's contacts regarding the recent Participatory System Mapping (PSM) workshop, 'Mapping the Covid-19, Carbon and Air Quality Trilemma in Personal Transport'. The projects co-convened the workshops to build a system map with stakeholders from industry and academia. This has been developed with further 1-2-1 stakeholder engagement and was showcased at the recent DecarboN8 Conference (16th Sep) as a live PSM workshop with conference attendees. The audience was made up of industry, academia and public.
- The investigators of TRANSITION project published a letter to the Secretary of State for Transport Grant Shapps in response to publication of the Transport Decarbonisation Plan. The letter outlines the need to substantively address the social, behavioural, and planning changes to reduce total vehicle use in both urban and rural areas and capitalise upon opportunities to improve air quality and deliver wider societal public health benefits.

- The TRANSITION Clean Air Network had a major presence at COP26 including participation of lead investigator Dr Suzanne Bartington in the University of Birmingham Observer delegation as an invited speaker and delivery of a TRANSITION Clean Air Network Green Zone public exhibition led by PhD students Kayla Schulte, Rabee Jibrin and Post-Doctoral Researcher Dr Ajit Singh on the topic of hydrogen fuel cell technology.
- TAPAS (Tackling Air Pollution at School) project has awarded funding for three Early Career Researcher research visit grants and completed the second and third series of lunchtime seminars.
- A joint seminar between CleanAir4V/Air Pollution and Atmospheric Chemistry has been organised on 10th December regarding the behavioural aspects of air pollution vulnerability to motivate a bid development related to WP2.
- Breathing City (Future Urban Ventilation Network) has organised a series of seminars with circa 50 attendees per fortnight. The project also organised three workshops in September 2021 and awarded four seedcorn funding projects (total value £20k). A paper titled "Air Quality and Climate Impacts of Biomass Use as an Energy Source: A Review" was published in July 2021 in the journal Energy Fuels.
- HEICCAM has organised a Joint Webinar and Panel Discussion in collaboration with HPRU (Health Protection Research Unit) on 30 June 2021. The webinar explored the relationship between home energy retrofit, indoor air quality and health under the path to Net Zero.
- BioAirNet has prepared two reports as part of Theme 2 (BioPM sampling and characterisation) and Theme 3 (Human health, behaviour, and wellbeing). Infographics on gap analysis outcome on biological particulate matters at the indoor-outdoor continuum were published. Open access material (article and video) for young learners providing an overview of BioPM science, challenges and risks was also published.
- The three Wave 1 Innovation Pilot projects have advanced rapidly to commercialisation and have begun to build a customer base of investor interest and international partnership. The CAGE project in particular has an order book with hundreds of thousands of pounds of deals in place for Clean Air Gas Engine products.
- NPL presented at a summit as part of the City of Glasgow's programme of COP26 events at the University of Strathclyde in collaboration with the City of Glasgow, University of California, Berkeley, Stanford University, and the Met Office. The summit illustrated how a dense network of greenhouse gas and air quality sensors can help provide critical evidenced based information for cities to meet greenhouse gas and air pollution reduction targets. The summit was attended by city officials, scientists, technology developers and economic, legal, and public policy experts from 43 different countries.



LESSONS LEARNT

The lessons learnt throughout the review period are an important part of reflecting on progress so far and can be used to inform future decisions. Below are the key areas we can take learning from, identified by the programme team and Champions (in no particular order).

Agree a joined-up vision of the programme legacy early on

The programme started in earnest with little understanding and agreement on what the legacy should be and how this should be achieved. This was, in part, due to the speed at which the programme started, the programme being comprised of two funding streams and multiple delivery organisations involved.

The development of the programme's Science Plan took longer than anticipated, but its publication has helped to define the programme aims. In addition, now that the programme is concluding the commissioning phase, more resource is available to co-develop the legacy areas of the programme and work towards them.

Earlier understanding of the desired legacy would have helped in the development of some of the funding calls, aided project, and work package development, and created a more unified and directed approach. In addition, this would have helped to better manage stakeholder expectations who are often seeking information on what they can expect, and when. An outputs map is currently under development which should provide a more holistic understanding across the programme and provide a useful tool to engage with key stakeholders, helping to manage expectations.

Now that the commissioning phase is concluded, the programme is making a marked shift in focus towards benefits realisation and achieving a legacy. This will include knowledge dissemination and communication with stakeholders to ensure that outputs are taken up and used.

Increase engagement with the wider Clean Air community to understand needs

The programme has made good progress engaging the wider air quality community, but it is apparent that some communities are better engaged than others. This is due to several factors which will require different approaches to rectify. For example:

- Further integrating the research and innovation work would enhance both elements and the overall programme and will require internal programme coordination.
- Enhancing engagement from communities with other priorities (such as the heath sector, which has been focussing on e.g., COVID-19) will require outward facing engagement. Understanding their needs and resources available will require working with them to help them further understand the importance of enhanced engagement with the air quality community.
- Engaging wider communities such as the social sciences and economics will require outward engagement to understand their drivers, develop a common language, and agree priorities.



It is recognised that increased engagement will require additional resource, which is limited. As such, it will be necessary to prioritise engagement and the stakeholder map that is being developed should help with this. Increasing engagement on all these fronts is not easy and will require consolidated effort from across the programme with input from the Steering Committee to help ensure engagement is as targeted and effective as possible while also using their connections and influence to aid the programme with this objective.

Ensure engagement at different geographical scales

While the programme has been effective at engaging nationally, it is noticeable that further work is required to engage stakeholders at the local/regional and international scales. In recognition of the former, Regional Clean Air Champions (RCACs) have been recruited and tasked with accelerating engagement within their region.

International engagement has, understandably, taken a back seat to that within the UK. This has been in part due to a lack of clarity about expectations in this area, which has recently been agreed. Namely that international engagement should focus where there is a direct impact on the UK; for instance, through changes in World Health Organisation (WHO) guidelines.

Putting additional effort into ensuring engaging at all geographical scales will increase the reach, impact, and legacy from the programme.



PROGRAMME CASE STUDIES

This selection of case studies highlights successes of the programme and illustrates the breadth of good stories there are to tell.

Collaboration for better data in air quality research - Intensive Observation Periods (IOPs)

The IOPs were facilitated by the National Centre for Atmospheric Science and leveraged the three NERC urban air quality supersites in London, Manchester, and Birmingham. The already highly detailed long-term measurements were supplemented by other instruments from within the UK scientific community, along with an enhanced PM2.5 sampling campaign, generating a sample archive on multiple filter substrate types. This collaboration included institutes from within the OSCA consortium (Universities of Manchester, Birmingham and York, Imperial College London, and UKCEH (UK Centre for Ecology and Hydrology)) and external partners (Universities of Lancaster, Leeds, Brighton and Leicester, and the Met Office). Funds came from within the OSCA project budget and the NCAS (National Centre for Atmospheric Science) Atmospheric Measurement and Observing Facility (AMOF). More information on the Intensive Observation activities can be found in here.

Research and innovation to develop solutions to air pollution

Air pollution is a global health concern. Innovate UK is supporting UK businesses to develop new products to tackle key unmet pollution challenges. Innovate UK is leading a series of innovation pilots which will employ the pre-commercial procurement instrument Small Business Research Initiative (SBRI) to use business expertise to bring new products to market that address pressing air quality challenges. In the first of three competitions, Innovate UK looked to tackle three causes of pollution which have yet to be resolved:

- 1. Particulates from road vehicle brake and tyre wear or road surface wear.
- 2. Emissions from machinery used for construction.
- 3. Pollution from transport refrigeration units.

Six businesses were funded initially to conduct feasibility studies, and of these, three were further funded to produce, test, and optimise prototypes ready to commercialise. All three of these innovations are now entering the market with the aim of tackling air pollution and the health issues it causes. They will also be creating high quality sustainable jobs for the UK. The Clean Air programme will continue to produce research and innovative solutions until 2025. Detailed information about each of the projects can be found here.

Clean Air at COP26

The Clean Air SPF has had a good presence at COP26 with the TRANSITION Network showcasing several exhibitions, invited speakers and great social media coverage. The TRANSITION Clean Air Network's COP26 activities are an example of how air quality research from the Clean Air programme has been represented at an international event.

Details of the COP26 activities are presented in here and here. These activities reached a wide section of government, policy makers, industry, the publics, and third sector. Embedding air quality research and debate into such climate focussed activities is a required first step to ensure relevant polices consider the holistic evidence available so that adverse detrimental effects can be avoided, as far as possible.



The annual programme evaluation scores indicate how the programme team and Champions feel the programme has progressed towards the aims within the review period. Each evaluation question has been scored between 0 and 10 to give an indication of how the programme is progressing and flag any areas of the programme that may need course correction to get back on track or are working exceptionally well and could be learned from or celebrated more.

Question 1: To what extent, and how, has the programme progressed towards building better connection, cross discipline interaction and interdisciplinary capacity?

- To date, the focus has been on setting the foundations and in awareness raising of this work. This has predominantly focussed on the air quality community but there have been efforts to extend reach to others, particularly the health sector.
- The establishment of the Networks and Consortia has generated multiple multi- and inter-disciplinary research and innovation (MIDRI) interactions. These are being enhanced by the various topic-specific workshops, annual conferences, and other local and national workshops and events being orchestrated by the Clean Air Champions and individual research groups. There is now both, public and political appetite for receiving new knowledge that will improve air quality both outdoors and indoors. The willingness for change in society appears to have become tangible. What is now required is collaborative transformation across the clean air movement to aid coordinated implementation and the programme is well positioned to assist this.
- Over the last year, the programme has continued to maintain connections that have been built but does not appear to have significantly extended them further. However, with the RCACs now on board and the Networks ECR (Early Career Researchers) grants this will likely develop.
- The innovation activities of the programme have integrated more effectively and fully with research elements over the past year as the pilot projects have matured. However, there is still a disconnect with no direct feed through from the research to the innovation activities. The review of the clean air tech sector should help to highlight opportunities for engagement.
- The tools and resources that are being developed have not really impacted the communities yet, as they are still under development. As these are completed and disseminated, we should be able to assess how well the new tools and resources have impacted the wider communities.
- While the work to date has helped to build some useful MIDRI communities, there is still much to do to ensure these are built upon and self-sustaining once the programme ends.



- The Programme still has minimal outputs from the research side of the programme; consequently, minimal knowledge exchange has taken place to date. However, the foundations have been laid and planning for this has started. The next two/three years will be critical to ramp up this activity.
- The first wave of innovation pilots is now able to communicate their activities and impact to the broader public and stakeholders through video case studies and blogs.
- The Clean Air Website is particularly useful with ongoing reports of the SPF Activities.
- The programme is on course in facilitating knowledge exchange even though the outcomes of the research investments are yet to be realised.
- Many of the Wave 1 activities have focuses on the development of tools and resources, as well as raising awareness of the need for a multi-disciplined approach encompassing various communities at varying levels of engagement. Some substantial progress has been made within the UK to link up with the third sector groups as well as both local and national policy developers. It is fair to say that many of these relevant sectors have some involvement with us now. There is still much to do though regarding the planning of joint activities to take the initiative forward.
- So far, the Clean Air programme overall has not made strong attempts to reach out internationally, although this is now starting to happen (WHO, Professional Societies, and individual outreach by the individual research groups).

Question 3: To what extent, and how, has the programme been engaging with policy makers, the health sector, and industries?

- Over the past 12 months there has been greater interaction with these three sectors, although there is much more to do once the outputs of the research are realised, and outcomes known.
- The health sector has remained a key focus. There is now a new Department for Health and Social Care (DHSC) Minister with an Air Quality brief (Gillian Keegan MP), and the Chief Medical Officer's (CMO's) Health of the Nation Report will be on Air Pollution. NERC has also been in discussion with the CMO over future collaborative working and the Clean Air Champions are in active discussion with the National Institute for Health Research (NIHR). Indeed, the NIHR have contributed the major funding to one of four consortia, and financial and other inputs into supporting the Networks. Possible new opportunities may arise from discussions with the third sector e.g., Royal College of Physicians, the Clean Air Fund.
- The programme has useful links with Defra, the Environment Agency, and some Local Authorities. Regular discussions are maintained between the Met Office and Defra to ensure the work they are doing, as well as the wider Clean Air initiatives, remain relevant to Defra's plan of actions. As an example, the Met Office have recently been invited to join a UKRI/Defra initiative to examine how the messaging around poor air quality needs to change.

The programme engages with groups such as the London Environmental Director's Network and Merton Council, which keeps us informed about local authority requirements. For example, the Met Office have been asked to join a task force headed by Merton to examine ways in which the Local Authorities may be able to disseminate air quality information to the public. The idea would be to unify what is happening in London in this regard and to roll the same approach out to other local authorities outside London if and where appropriate.

- NPL's field assessment of diffusive NO2 measurement technologies will have immediate impact on the quality of results from Defra's new UK Urban Nitrogen Network and help in the selection of technologies and mounting requirements for future monitoring networks.
- NPL has participated in the European Committee for Standardization (CEN) activities through convenorship and membership of WG11 (Diffusive samplers), WG12 (Inorganic reference instruments and benzene) and WG42 (Air Quality sensors). WG42 has published a Technical Specification for evaluating the performance of low-cost sensors measuring gaseous pollutants (CEN/TS 17660-1:2021). This establishes an internationally agreed basis for the performance requirements, and related test protocols, for gaseous air quality sensors in order to meet defined classes of measurement application.
- There has been some engagement with policy makers in Department for Transport (DfT), however it would strengthen the commercial potential of the innovations to focus more on policy interventions to enable them.
- Working with the third sector is also rapidly evolving and it is hoped that engagement here can leverage their influence for the achievement of the Clean Air programme.
- It is recognised that this activity has been hampered by COVID-19, both in terms of limiting engagement opportunities and diverting resources. This is particularly the case with health sector and some policy makers.
- The appointment of the RCACs will help to strengthen overall work in this area and enable engagement at various levels helping to ensure that diverse needs are met.
- Additional engagement opportunities would be beneficial, and steer from the SC on this, using the new stakeholder map would be welcomed.
- The Clean Air Tech Sector research being commissioned should provide the programme, and broader Government Agencies, with clear direction on how best to engage with businesses in the sector to ensure the UK's position as a global leader in the development and sales of clean air technology.

Question 4: To what extent, and how, has the programme been driving new knowledge such as IP, TRL advancement, process, and conceptual innovation?

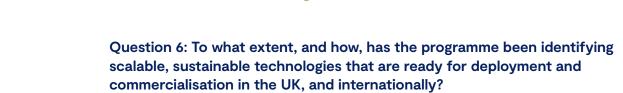
- The Wave 1 innovation pilots have been a significant success with all projects concluded successfully, commercialising products, and introducing them to the market.
- It is still too early to know the outcomes of the research investment that has been made, but expectations for IP, TRL, and conceptual innovation are high. A good example is the coming together of various technological and practical activities around portable sensors, their deployment in local communities and schools, and their networking to inform the public. A new focus on indoor air has brought expectations for entirely new opportunities for IP etc.



Question 5: To what extent, and how, has the programme been engaging the public in activities in order to raise the profile of, contribute towards the development of, and increase the uptake of possible solutions?

- Still in similar position to last year. However, plans of the CACs/RCACs will likely enhance this.
- There is more to do in this domain; however, engagements now in place with the third sector (e.g., GAP, Asthma/BLF, RCP, RCPCH, EPUK, National Medical Societies such as the BTS, BSACI) will help.
- The individual activities of some projects e.g., the Networks, and Clean Air Champions (CACs) events are attracting continued public interest and feature in the lay press and other media outlets. Examples include, the Annual Clean Air Day with GAP, the Westminster Commission on Road Air Quality, and the mayor's upcoming Summit in London. The appointment of RCACs in the four components of the UK is likely to further support this work.
- Virtual working has impeded progress to some of this outreach work, but now that restrictions are lifted it is hoped that some of this can accelerate.
- The wave 1 innovation pilots have developed solutions most effectively deployed by businesses and so worked with commercial end users to refine the solutions, not the publics. The wave 2 innovation pilots are focused more on the domestic market, and are now entering their development and testing phase, working with real end users.
- Generally, the engagement the programme has had with the public has been indirectly attained through connections with the third sector groups and of the Environment Agency who have been running an initiative to investigate air quality inequalities.





- The programme has largely focused efforts on developing new ideas, and providing the funding to build, evaluate, and test them ahead of subsequent commercialisation. The tools and resources being developed will allow others to commercialise products with many of these outputs being scalable and adaptable and can be used in different areas of the UK/world.
- The Wave 1 innovation pilots have progressed incredibly quickly into commercialisation; for example, CAGE already has hundreds of thousands of pounds worth of orders, and customers oversees.
- The Wave 2 innovation pilots are still in development but are focused on producing solutions for the B2C market which are expected to be available, attractive, and affordable to households in the UK and overseas markets.

Question 7: To what extent, and how, has the programme integrated the different work packages to create coherence?

- The programme was designed with complimentary work packages and avenues for these to integrate and create programme wide coherence. This has happened to varying extents between different work packages, with some being better integrated than others.
- The programme delivery team and Champions team lead on this programme wide integration through activities such as the Annual Conference.
- It is anticipated that as outputs are delivered integration between work packages and projects will increase.
- Both, within individual work packages and between different work packages, there is connectivity and interaction between projects which they have often led themselves through recognition of the benefits this would bring to their work. For example, a collaboration between ANTICIPATE and TRANSITION resulted in a publication titled "Adopting a whole system approach to transport decarbonisation, air quality and health: an online participatory system mapping case study in the UK."
- The first of the intensive operating periods (June/July 2021) involved measurements from the OSCA research organisations and collaborators (University of Lancaster, Leeds, Leicester, and Brighton and NCAS).
- A joint BioAirNet and TRANSITION stakeholder workshop titled "Future mobility beyond COVID-19: two steps forward, one step back for clean air and public health" was held in January 2022.
- Innovate UK is working to integrate the innovation pilots together as far as is possible. Commercial sensitivity and competition preclude deep integration of all pilots, however sharing sessions have been organised to identify synergies and shared opportunities.
- While tools and resources are still under development, some effort has been made to ensure that the new tools 'talk' to one another as well as being easily integrated with pre-existing tools and resources.





The programme management and the projects have worked together to produce a matrix to identify scientific interdependencies across the SPF Clean Air Programme. This review of interdependencies and gaps that will affect delivery of benefits, has contributed to better work packages integration, and agreed strategies to mitigate this risk, with regular review by the Programme Board.

Question 8: To what extent, and how, has the programme identified, improved, and expanded the evidence and knowledge base on new air pollution challenges and associated health risks?

- The programme is still in the initial stages of this activity, with outputs only starting to come through; some of which have been delayed due to COVID-19. However, the projects funded are expected to make a worthwhile contribution to expanding the evidence and knowledge base.
- Some of the tool development has revealed gaps or irregularities in the way work in this area is conducted and are seeking to rectify these issues, where possible, during the development of the new tools.
- Wave 2 work will further progress the understanding of challenges and health risks.
- The Wave 1 innovation pilots have focused on solving known but unaddressed causes of air pollution. The Wave 2 innovation pilots are likely to generate more insight into new health risks in the domestic environment in particular.

Overall

Although all scores remained static, the programme management team and the Champions are overall pleased with how the programme has progressed over the last year. Particularly good progress has been made in building the clean air community through virtual communications, such as the conference, workshops, the improved website, the Champions activities, and project exposure at the COP26 conference in Glasgow in November 2021.



FORWARD LOOK

- The second SPF Clean Air Programme Annual Conference "Seeking Solutions for Clean Air," scheduled for 5,6 & 7 April 2022
- Activities are planned to celebrate Clean Air Day 2022 on 16th June
- Innovate UK will represent the programme at the Engineering Net Zero Showcase in Glasgow on 21–23 June 2022
- The results of the research undertaken by Innovate UK to better understand the size, shape, and strengths of the Clean Air Tech sector are expected in the autumn 2022.
- The programme is now shifting focus towards benefits realisation and achieving a legacy. The Programme Board has approved the Legacy Framework and the implementation of Task & Finish groups which will be implemented in the next 12 months.
- An Output map for all the NERC, Innovate UK and Met Office project will be implemented as a live document and made available for consultation by the stakeholders.
- Work will continue to produce the Wave 2 Communication Plan.
- Launch of the DUKEMS system (June 2022)
- Development of the infrastructure of the Clean Air Framework, ready for testing by the research community.



ACRONYMS

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BEIS	Department for Business, Energy, and Industrial Strategy
BLF	British Lung Foundation
BTS	British Thoracic Society
BSACI	British Society for Allergy & Clinical Immunology
CACs	Clean Air Champions
CERC	Cambridge Environmental Research Consultants
CleanAir4V	Air Pollution Solutions for Vulnerable Groups
DEFRA	Department for Environment, Food and Rural Affairs
DUKEMS	Developing a UK Community Emission Modelling System
DIMEX	Data integration model for exposure modelling
EPSRC	Engineering and Physical Sciences Research Council
EPUK	Environmental Protection UK
ESRC	Economic and Social Research Council
GAP	Global Action Plan
HE	Higher Education
HEICCAM	The health and equity impact of climate change mitigation measures on indoor and outdoor air pollution exposure
IOP	Intensive Observation Period
IP	Intellectual property
KEQ	Key evaluation question
MEL	Monitoring, evaluation, and learning
MIDRI	Multi-disciplinary and inter-disciplinary research and innovation
NERC	Natural Environment Research Council
NPL	National Physical Laboratory
OSCA	Observation System for Clean Air
QUANT	Quantification of Utility of Atmospheric Network Technologies
RCACs	Regional Clean Air Champions
RCP	Royal College of Physicians
RCPCH	The Royal College of Paediatrics and Child Health
RESPIRE	Relating Environment-use Scenarios in Pregnancy/Infanthood and Resulting airborne material Exposures to child health outcomes
SPF	Strategic Priorities Fund
STFC	Science and Technology Facilities Council
SAQN	STFC Air Quality Network
TAPAS	Tackling Air Pollution at School
TRANSITION	Optimising air quality and health benefits associated with a low-emission transport and mobility revolution in the UK
UKRI	UK Research and Innovation
WellHome	West London Healthy Home and Environment Study

Clean Air SPF Programme

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Met Office



Department for Transport