

# UKRI SPF Clean Air: Scoping Workshops

28 January 2020, The Met Hotel, Leeds

11 February 2020, Blu Radisson Hotel, Birmingham

## 1. Executive Summary

This report summarises the content and discussions of the UKRI SPF Clean Air workshops which were held to scope upcoming funding opportunities through the programme. A read-out of the material produced by participants is also shown in the annexes.

The information is shared to provide a read-out of the workshop events and the information is presented within this report in the format and language that it was captured at during the events.

Information discussed and electronic copies of the workshop documents are provided in good faith.

The Clean Air programme is jointly delivered by the Natural Environment Research Council (NERC) and the Met Office, with the Economic and Social Research Council (ESRC), Engineering and Physical Sciences Research Council (EPSRC), Innovate UK, Medical Research Council (MRC), National Physical Laboratory (NPL), Science and Technology Facilities Research Council (STFC), Department for Environment, Food and Rural Affairs (Defra), Department for Health and Social Care (DHSC), Department for Transport (DfT), Scottish Government and Welsh Government.



## 2. Contents

1. Executive Summary.....	1
2. Contents.....	2
3. Introduction/Background .....	3
3.1. Workshop Aims.....	3
3.2. Workshop Structure.....	3
4. Session 1: Scene Setting and Context .....	4
5. Session 2: Understanding the Problem.....	4
5.1. Part 1: Current state of the Art .....	4
5.2. Part 2: Unpacking the Problem.....	5
6. Session 3: How to achieve the required outcomes of the programme.....	7
7. Session 4: Priority Themes.....	8
7.1. Elaborate the content of the Themes.....	10
8. Annexes.....	11

### 3. Introduction/Background

The SPF Clean Air programme held a series of workshops in early 2020 to scope upcoming funding opportunities through the programme. These events were an opportunity for the research and stakeholder community to engage with the programme funders to learn more about the aims of the programme and the research and innovation already underway, and to shape our thinking on the scope of future funding opportunities.

Individuals were invited to submit expressions of interest to attend either of the two workshops, and the funders invited applicants to attend to give a range of expertise and institutional representation. There were over 90 participants involved across the two events.

#### 3.1. Workshop Aims

The aims of the workshops were to:

- communicate the remit and objectives of the Clean Air programme;
- bring together researchers and stakeholders from diverse disciplines with interests in managing public health impacts of air pollution exposure at the indoor/outdoor interface;
- seek input on the research and innovation challenges and opportunities relative to the aims of the programme; and
- inform the scope of future multi- and inter-disciplinary funding opportunities.

#### 3.2. Workshop Structure

The workshops comprised of 4 main sessions ranging from outlining the research challenges and knowledge gaps, to identifying potential consortia themes:

Session 1: Scene Setting and Context

Session 2: Understanding the Problem

Session 3: How to achieve the required outcomes of the programme

Session 4: Priority Themes

The sessions were followed by a wrap up which included a brief discussion on delivery mechanism where the need for interdisciplinarity of the Consortia was highlighted. Participants were thanked for attending and for all their participation. Participants were informed that the funders would use the information gathered at the workshop events to support the development of the SPF Clean Air Consortia call specification.



## 4. Session 1: Scene Setting and Context

Caroline Culshaw (NERC Head of Healthy Environment) at the Leeds event, and Matt Hort (Met Office Air Quality Lead) at the Birmingham event, gave a presentation introducing the SPF Clean Air Programme.

## 5. Session 2: Understanding the Problem

### 5.1. Part 1: Current state of the Art

Presentations were given to set out issues and current state of the art in research and innovation from various stakeholder perspectives. There were 3 presentations given at the Leeds event, and 4 presentations given at the Birmingham events.

Presentations given are shown below:

Leeds

Prof. Nicola Carslaw <i>Professor of Indoor Air Chemistry, University of York</i>	Research challenges and state of the art in indoor air pollution
Dr Ian Hall <i>Director of the Nottingham Biomedical Research Centre, University of Nottingham</i>	Research challenges and state of the art in air quality and health
Dr Chantelle Wood <i>Lecturer, Department of psychology, University of Sheffield</i>	Research challenges and state of the art in behaviour change, particularly interventions to translate behavioural intentions into actual actions.

Birmingham

Prof. Prashant Kumar <i>Professor and Chair in Air Quality and Health; Directors, Global Centre for Clean Air Research, University of Surrey</i>	Research challenges and state of the art in air quality and health
Prof. Jonathan Grigg <i>Professor of paediatric respiratory and environmental medicines, Queen Mary University of London</i>	Research challenges and state of the art in air quality and the health of vulnerable groups, with a focus on children and youth.
Dr Gráinne McGill <i>Researcher, Mackintosh Environmental Architecture Research Unit</i>	Research challenges and state of the art in indoor air quality, health and the built environment.
Dr Claire Holman <i>Brook Cottage Consultants</i>	What is being done, what could be done and what are the research needs from an industry perspective

Copies of the 'Scene Setting and Context' and 'Understanding the Problem' slides (Annexes A and B) will be available on the associated NERC web page.

## 5.2. Part 2: Unpacking the Problem

Clean Air programme aim is to bring together the UK's world-class research base and support high quality multi- and inter- disciplinary research and innovation to 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.

This includes:

- Managing human exposure to the very smallest airborne PM (PM<sub>1</sub> and ultra-fine PM), the complex cocktail of volatile organic compounds (VOCs), and other potential exposures (e.g. biological)
- Provide critical foresight on emerging air pollution challenges and associated health risks
- Enable us to better understand and quantify human behavioural change and practices and how to influence through communication and technology interventions in order to limit exposure routes and mitigate health risks at vulnerable stages of the life course
- Scientific, technical, behavioural and policy approaches used to assess and manage exposure to air pollution need radical change to reflect the indoor/outdoor continuum of exposure.

Participants were asked to discuss and comment on: pollutants; exposures and health impacts; mitigations to reduce emissions at the source; and interventions. The main points raised in discussion are shown in Table 1, and summarised as a word cloud in Figure 1:

Table 1: Points raised in discussion from session 1 part 2: Unpacking the problem.

Topic	Points raised in discussion
<b>Pollutants</b> <i>Known and potential sources; Types; Processes; Timescales; etc</i>	1. More knowledge is needed to understand: <ul style="list-style-type: none"> <li>• what pollutants are present and their sources;</li> <li>• Chemistry of pollutants including secondary pollutants;</li> <li>• Toxicity of pollutants;</li> </ul> 2. There needs to be a systems approach.
<b>Exposures and health impacts</b> <i>Which groups; Where; When; etc</i>	1. More knowledge is needed to understand: <ul style="list-style-type: none"> <li>• Understand who, how, when and where people are exposed.</li> <li>• Understanding personal exposures inc:               <ul style="list-style-type: none"> <li>○ peaks of high exposure;</li> <li>○ exposure in different microenvironments e.g. schools/home/travel.</li> </ul> </li> </ul>
<b>Mitigations to reduce emissions at the source</b> <i>How to bring manufacturers on board; Product labelling; Reformulation; etc.</i>	1. More knowledge is needed to understand: <ul style="list-style-type: none"> <li>• the link between activity and pollution to design targeted mitigations.</li> </ul> 2. Stakeholders need to be involved early in the process.
<b>Interventions</b> <i>Options for indoor air quality improvement; Applicability of existing and emerging technologies within this sector; etc.</i>	1. Need for evidence required to design intervention. 2. Techniques for monitoring and assessing the effectiveness of interventions. 3. Who is responsible for implementing and monitoring interventions? 4. Understanding of behaviour approaches.



Figure 1: Pollutants (green); exposure and health effects (blue); mitigations (brown); interventions (purple)

## 6. Session 3: How to achieve the required outcomes of the programme

This session focussed on the generation of ideas for research and innovation.

The participants were reminded of the impact and outcomes for the wave 2 of the Clean Air programme.

Impact: Protect the health of vulnerable groups from air pollution at the indoor/outdoor interface in the 2030s and beyond, whilst promoting clean growth.

Outcomes:

- Critical foresight on emerging air pollution challenges at the indoor/outdoor interface and associated health risks
- Better understanding how to quantify and influence human behaviour and practices to limit exposure and mitigate health risks
- Consistent, evidence-based advice for stakeholders through open data and tools
- Sustainable products and services to protect health at the indoor/outdoor interface and grow UK businesses

Participants were asked to think about as many knowledge gaps and research needed to achieve the required impact of the programme.

Participants were asked to think about the following questions and focus points.

Questions:

- What are the knowledge gaps/research questions we need to answer through research and innovation?
- What do we need to be able to do the research? (e.g. access to certain resources e.g. datasets)
- How do we translate that research into action?
- Who are the partners that need to be involved in the research (e.g. disciplines, mid- and end-users)

Focus points:

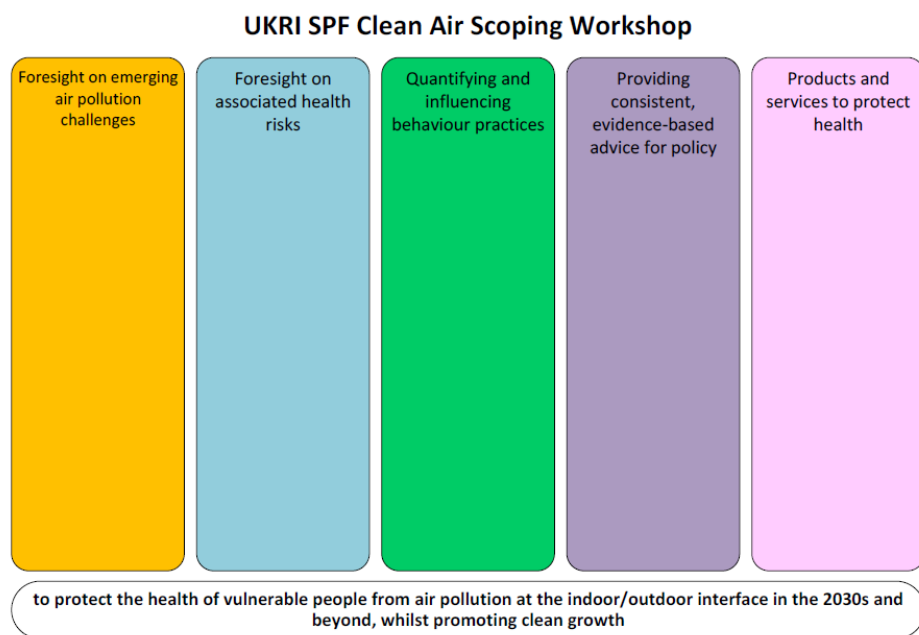
- How do the ideas address the programme aims;
- What new knowledge would be delivered;
- How could these link up together;
- How can previous and current work funded elsewhere feed into these ideas/align;
- Who are the stakeholders? When and how should they be engaged?

To support the activity, participants were split into 6/7 groups and provided facilitation sheets, shown in Figure 2. The facilitation sheets included columns to aid conversation, and participants were encouraged to write in as few or as many columns as they could. The columns were:

- Foresight on emerging air pollution challenges;
- Foresight on associated health risks;
- Quantifying and influencing behaviour practices;
- Providing consistent, evidence-based advice for policy;
- Products and services to protect health.







*Figure 2: Facilitation sheet to support the session ‘Generation of ideas for research and innovation.’*

The key points from discussion were:

- Knowledge gap in understanding pollutant pathways including sources, transformations and secondary pollutants, health outcomes etc.
- Knowledge gap in understanding toxicology of pollutants including mixtures, varying exposures
- Knowledge gap in understanding which vulnerable group(s) to focus on.
- Importance of education to encourage behaviour change.
- Knowledge gap in understanding of how to encourage behavioural change, and targeting mitigations and interventions.
- Stakeholder co-creation/co-design and buy-in of stakeholders

An electronic version of the workshop facilitation sheets are provided in Annexes C (Leeds) and B (Birmingham).

## 7. Session 4: Priority Themes

Participants were asked to think about how the ideas generated could be grouped into themes which a consortia could address. When considering prioritising ideas, the participants were asked to consider the following:

- Establishing the goals of the research and what the research outcomes will look like: e.g. longer term research of a transformative nature? Healthy people?
- What will the research outcomes be? What are the longer term transformative goals of the research?
- What would be the prioritisation criteria to ensure we achieve this?

A list of themes generated by the participants is shown below in Table 2.



Table 2: Grouping of ideas to give themes a consortia could address.

Leeds Event	Birmingham Event
<ul style="list-style-type: none"> <li>• AQ in the zero carbon home (zero carbon world)</li> <li>• Tool kit to help to derive evidence needed to make and assess interventions – including real time personal monitoring of AQ and health. Developing the capabilities, technologies and meta data analysis needed; How to assess and quantify the importance of different species, groups and activities of total exposure, and health of the whole population.</li> <li>• What are we exposed to, why and where?</li> <li>• What are the harmful effects and what causes them?</li> <li>• What and who’s behaviour do we want to change and how do we change it?</li> <li>• Technological ecosystem around air quality.</li> <li>• Cooking – what are the chemicals, what are the pollutants including toxicity, health impacts, exposures, potential interventions, industry practice, and economic analysis.</li> <li>• Transport – indoor/outdoor transition between different transport systems.</li> <li>• Underpinning theme – we need to consider the key resources are which will be necessary to address the questions we have heard so far, smart monitoring in smart cohorts, health data, nutrition data.</li> <li>• Significance of risk – what are the risks associated with different sources and activities, and prioritise them amongst different paradigms, understanding the relative role between indoor/outdoor and travel between the two.</li> <li>• Expected impacts –think through the likely impacts.</li> <li>• How do we begin to understand the feasibility of interventions?</li> <li>• Quantifying exposure – across the whole continuum (indoor/outdoor) workplace etc. Strong behaviour change component.</li> <li>• Future direction of travel exposure patterns – build on what we know now and what may happen in the future.</li> <li>• Clean air in the context of climate change.</li> <li>• Intervention studies for health – assessment, behaviour changes, methodology, monitoring effectiveness, impact on health.</li> <li>• Underpinning resources – existing resources.</li> </ul>	<ul style="list-style-type: none"> <li>• Breathable homes – including living walls. About understanding what makes a good healthy home.</li> <li>• Exposure and impacts of pollutants on pregnant women.</li> <li>• Indoor environment – characterisation of sources and physical chemistry and toxicology.</li> <li>• Urban design – interface between indoor and outdoor exposures.</li> <li>• What people do in the home – how does this effect health and influence manufacturers.</li> <li>• Human centric approach – reducing health effects from exposure to domestic products and changing behaviour to reduce those exposures.</li> <li>• Mitigate and characterise exposure in a changing climate – including changes in transport, layout of cities, lifestyles</li> <li>• Mitigating against emerging pollutants in a changing environment – mainly targeting emerging pollutants.</li> <li>• Reducing a person’s microenvironment exposure – long and short term integrated exposure as people move between microenvironments.</li> <li>• Nature based solutions for exposure mitigation – infrastructure e.g. living walls.</li> <li>• Air quality health risks index for the built environment – indoor and outdoor range of microenvironments and how they may relate to exposures through types of buildings, materials used, activity etc.</li> <li>• Quantifying childhood exposure and health impacts – broad early life exposure, homes/schools.</li> <li>• Changing nature of the exposure and policy.</li> <li>• Big data – dealing with data, models, observations and bringing together in a meaningful way.</li> <li>• Prescribing clean air, specifically people with asthma – behaviour to influence public health.</li> </ul>

## 7.1. Elaborate the content of the Themes

Each of the groups at the workshop were asked to identify their top priority from the themes identified (Table 1) and to elaborate on the content in more detail.

An electronic version of the elaborated content of the themes produced at the workshop are shown in Annexes E and F.

The top themes were:

Leeds

- Quantifying exposure, health impact behaviour change. Defining the consequences of environmental exposure.
- Underpinning resources and capabilities
- Sources and pathway of pollutants indoors
- Super emitters
- Behaviour change in emitters and exposed
- Providing healthy air in a zero-carbon building

Birmingham

- Breathable home
- Exposure and impacts of pollutants on pregnant women and children
- Urban design
- A human-centric approach to reducing the health effects from exposure to consumer products
- Reducing an individual's exposures
- Air Quality Health Risk Index for the Built Environment
- Prescribing Clean Air

## **8. Annexes**

Annex A - Session 1: Scene setting and context (available on associated NERC web page)

Annex B - Session 2: Understanding the Problem (available on associated NERC web page)

Annex C - Session 3: How to achieve the required outcomes of the programme (Leeds)

Annex D - Session 3: How to achieve the required outcomes of the programme (Birmingham)

Annex E - Session 4: Priority Themes. Elaborate the content of the themes (Leeds)

Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

## Annex C - Session 3: How to achieve the required outcomes of the programme (Leeds)

The outputs are listed below as collated per table.

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• Understanding dominant emissions across the continuum and understanding change</li> <li>• Generation – understanding pathway – health outcome</li> <li>• Exposures and key groups to target e.g. cleaner/painter (industrial ‘injury’)</li> <li>• Continuum exposure for the individual</li> <li>• Using databases? Integration of databases? Daphne-UKRI</li> <li>• Pollution inventory to understand exposure</li> <li>• Time spatial resolution – to understand triggers. Understand average but not spikes. No idea on indoor. (low cost + calibration + maths)</li> </ul>	<ul style="list-style-type: none"> <li>• Don’t know different toxicity of PMs (need to understand)</li> <li>• What is exposure in the workplace – data mining</li> <li>• Health outcomes to emissions (pathways to emitters)</li> <li>• Occupational exposure in cooks</li> <li>• Health data sets: what can be used; working to coordinate data (pollutants) with health data</li> <li>• Vulnerable people: generation markers may change over time</li> <li>• Understanding vulnerable group exposure and gathering health data</li> <li>• Using data on asthmatics? Widely research already?</li> <li>• Understanding super emitters in the home e.g. vaping</li> <li>• Understanding what to measure from the health perspective</li> </ul>	<ul style="list-style-type: none"> <li>• Education to help with solutions</li> <li>• Unintended consequences to affect behaviour change?</li> <li>• Behaviour change for areas e.g. wood burning stoves?</li> <li>• Behaviour change in use of products is faster than legislating</li> <li>• Information and education – how to change behaviour even if educating?</li> <li>• Dissemination of information: high pollution areas/behaviour nudge or commercial change?</li> <li>• Can behaviour change reduce exposure at PM2.5?</li> </ul>	<ul style="list-style-type: none"> <li>• Products: Information gap on safety of components evidence in 10 years?</li> <li>• Legislation: can we do this in the timeframe?</li> <li>• Consultation with bodies/stakeholders to influence change</li> <li>• Understanding the chemistry source information to target interventions</li> <li>• We don’t have data to give evidence to inform policy. Quality of measurements is not high, needs better accuracy.</li> <li>• Stakeholder engagement? E.g. sensor manufacturers, food stakeholders (cooking)</li> <li>• Screening of products to find effects</li> <li>• Is the toxicology information available to know what to target?</li> <li>• Health care stakeholder engagement – shaping studies. Diaries/longitude data?</li> </ul>	<ul style="list-style-type: none"> <li>• Information on health effects of products</li> <li>• Evaluating new products to reduce health impacts? E.g. rubber in road surfaces.</li> <li>• ‘Fit bit’ type wearable to monitor and advise of changes</li> </ul>

### Annex C - Session 3: How to achieve the required outcomes of the programme (Leeds)

	<ul style="list-style-type: none"> <li>• What is the clinical data we need to understand – clinical economics.</li> </ul>			
--	---	--	--	--

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• Building stock change with climate change</li> <li>• Change to EV</li> <li>• Relative contributions indoor vs outdoor: communities need to come together; and at level of individual</li> <li>• Co-exposure c.f. noise/plastic</li> <li>• Data science and data linkage/integration. Probabilistic modelling?</li> <li>• Temporal spatial dimensions – local, regional, national, international</li> </ul>	<ul style="list-style-type: none"> <li>• Early life impacts on later stage disease</li> <li>• Response curve. Cost/benefit</li> <li>• Possible unintended consequences of reduction in one source – cars moved air through street their ban led to worse air quality in town</li> <li>• Key at risk groups</li> </ul>	<ul style="list-style-type: none"> <li>• Need for feasibility framework to prioritise resource and package of intervention</li> <li>• People at the centre of the issue/research</li> <li>• Stakeholder – charity</li> <li>• Evidence to support behavioural change</li> <li>• Ethnographic evidence of what people do indoor and outdoor: monitoring, co-design, citizen science</li> <li>• Barriers to change</li> <li>• Changes in norms</li> <li>• Who carries out the mitigation, and what involvement have they had in the process e.g. LAs</li> </ul>	<ul style="list-style-type: none"> <li>• Evidence of cost benefit of a policy intervention</li> <li>• Consideration of spill over benefits: green space + mental health, cycling/walking</li> <li>• Recognising health inequalities</li> <li>• What can we ensure are not used in future polluted sources?</li> </ul>	<ul style="list-style-type: none"> <li>• Monitoring systems – feedback to user</li> <li>• Filters of inlet and where</li> <li>• Play off between systems change c.f. ban driving vs specific filter In the house</li> <li>• Quieter extractors</li> <li>•</li> </ul>

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• Knowledge gaps of transformation before understanding toxicology</li> <li>• Digital twin for ‘real-life’ house env for testing</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge gap in who should be targeted – how and which vulnerable group</li> <li>• Exposure-concentration e.g. spray vs liquid</li> </ul>	<ul style="list-style-type: none"> <li>• Encouraging behaviour change without legislating home ‘life’</li> <li>• Targeting and digestible/accessible info</li> </ul>	<ul style="list-style-type: none"> <li>• Evidence benefits of policy</li> <li>• Clear supporting knowledge for policy (and available)</li> <li>• Understanding policy needs – what do end users e.g.</li> </ul>	<ul style="list-style-type: none"> <li>• Gap between tech development and data. Users for mini sensors</li> <li>• Open science framework is being used by the US for</li> </ul>

### Annex C - Session 3: How to achieve the required outcomes of the programme (Leeds)

<ul style="list-style-type: none"> <li>• Economic effects. Cost-benefit (health, reformulation, retrofit)</li> <li>• Testing products/pollutant alone and not in multi-env context.</li> <li>• Knowledge gap for alternative products e.g. alternative to cleaning chemicals</li> <li>• Personalised exposures understanding of variance and diversity.</li> <li>• Sensors in the home – personalised</li> <li>• Data ethics – how to use, how to store</li> <li>• Leverage anonymised data e.g. from fit bit</li> <li>• Source apportionment – what’s coming from indoors and what’s coming from outdoors</li> <li>• Data collection, accessibility, interoperability</li> <li>• BIDC (British Indoor Data Centre) – would be useful?</li> <li>• Effect of building size, layout, surface etc. on exposure</li> <li>• Inventory of data sources and what data the UK community are collecting.</li> </ul>	<ul style="list-style-type: none"> <li>• Balance between hygiene/contamination risk etc, and reducing exposures</li> <li>• Knowledge gap and lack of engagement with health practitioners</li> <li>• Hygiene hypothesis</li> <li>• Knowledge gap: Health effects of combined chemicals – i.e. multi-exposures</li> </ul>	<ul style="list-style-type: none"> <li>• Who enacts these measures? Gov, local authority, healthcare practitioner?</li> <li>• Changing people’s expectations</li> <li>• Company reputation and legislation to drive change – reformulation etc.</li> <li>• Promoting awareness of alternatives e.g. shower gels without fragrances</li> <li>• Wearable data and real time info</li> <li>• Citizen science – schools</li> <li>• Understanding effects in different housing stocks</li> <li>• Mould/damp, sources beyond control, bioaerosols, interacting chemistry</li> <li>• Involved in discussions – buy in e.g. Local authorities.</li> </ul>	<p>local council) want – data, format, context?</p> <ul style="list-style-type: none"> <li>• Increased interest and understanding of indoor air</li> </ul>	<p>homechem project – sharing best practice</p> <ul style="list-style-type: none"> <li>• Changing consumer perception of chemicals e.g. not wanting chemicals in product</li> <li>• Tech development should be solutions driven</li> <li>• Utilise health professional who go into vulnerable people’s homes – to educate about indoor pollution i.e. district nurses.</li> </ul>
--	--	---	--	---

### Annex C - Session 3: How to achieve the required outcomes of the programme (Leeds)

Sharing and access and awareness.				
-----------------------------------	--	--	--	--

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>Quantifying 'toxicity'</li> <li>Quantifying sources across the I-O-N</li> <li>Changes in 'toxicity' with time</li> <li>Quantify exposure (identify super emitters vs slow burners)</li> <li>Behaviour-vulnerability</li> <li>Generating FAIR I-O-N data</li> <li>Drive to net zero (EV, H<sub>2</sub>, etc)</li> <li>Beyond PM<sub>x,y</sub>.</li> <li>Communication – over simplified (i.e. mass vs toxicity)</li> <li>Climate change</li> </ul>	<ul style="list-style-type: none"> <li>Better cross-dis links: Dispersion – Chem – Epi – Tox – Psych – Heath – Policy</li> <li>Short term vs long term</li> <li>Suitable health models (i.e. assays, artificial lung models)</li> <li>New pollutant models needed (microplastics)</li> </ul>	<ul style="list-style-type: none"> <li>COM-B</li> <li>Monitoring</li> <li>Quantifying 'interventions'</li> <li>Who are the 'people' – just young/old/sick? Occupations?</li> <li>Messaging</li> <li>Beyond cost benefit</li> </ul>	<ul style="list-style-type: none"> <li>Trouble with metrics</li> <li>Sharing data (FAIR)</li> <li>Interpretations of policy</li> <li>Linking policy (BEIS, Defra)</li> <li>Local vs regional interventions</li> <li>Citizens assembly</li> </ul>	<ul style="list-style-type: none"> <li>Exposure alerts</li> <li>Filtration, adsorption and absorption</li> <li>Ventilation</li> <li>Retrofits for existing buildings.</li> </ul>

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>Understanding the human trajectory through the exposure (segmentation analysis)</li> <li>Characterisation of the physical, chemical and toxicological properties of</li> </ul>	<ul style="list-style-type: none"> <li>Understand confounding influences on the effects of air pollution exposure e.g. lifestyle, co-morbidity, genetics, (Syndemics)</li> <li>Understand the toxicology to indicate associated risk of different pollutants.</li> </ul>	<ul style="list-style-type: none"> <li>Align behaviour change messages with appropriately timed life events</li> <li>Utilise big data from 'smart city' to better understand people's behaviour</li> </ul>	<ul style="list-style-type: none"> <li>Identify the most hazardous compounds or pollutants to legislate against</li> <li>Involve policy makers from outset of programme</li> </ul>	<ul style="list-style-type: none"> <li>Assess effectiveness of air purifiers.</li> </ul>



### Annex C - Session 3: How to achieve the required outcomes of the programme (Leeds)

<p>pollutants and their sources in the exposure.</p> <ul style="list-style-type: none"> <li>• Systematic review to identify vulnerable groups e.g. pre- and post-natal exposure, economic statuses</li> <li>• Settings where can have the most impacts</li> <li>• Activities which generate most harmful pollutants</li> <li>• Quantifying the relationship between activity and harmful pollutants e.g. driving, cooking (links to influencing behaviour)</li> </ul>		<ul style="list-style-type: none"> <li>• Delivery specific messages to particular segments identified through research</li> <li>• Undertake participatory data collection and co-creation of research to increase buy-in</li> <li>• Work with media and broadcasting to communicate desired behaviour change</li> </ul>		
---	--	---	--	--

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• Understanding consequence of zero carbon policy (interdisciplinary) and unintended consequences</li> <li>• Importance/significance of secondary aerosols in indoor community</li> <li>• Appropriate surrogate indicator for indoor pollution – VOC &amp; aerosol (PM<sub>2.5</sub>?) – to support large scale studies</li> <li>• Personal exposure monitoring technologies? What quality is needed?</li> </ul>	<ul style="list-style-type: none"> <li>• Long-term averages vs. short-term peak exposure</li> <li>• Changing aerosol composition (indoor and outdoor) dose-response, size, composition</li> <li>• Parameters and technologies for ‘real time’ health impact evaluation</li> <li>• Contribution for VOC emission to health impacts (secondary process?)</li> <li>• What parameters need to be monitored?</li> </ul>	<ul style="list-style-type: none"> <li>• Is cooking the biggest sources of indoor AQ? Different cooking practices</li> <li>• How to link generalised exposure with generalised health impacts?</li> <li>• How to target activity on most vulnerable groups? Different for behaviour change for individuals or organisations</li> <li>• Engagement with younger age group – c.f. climate</li> </ul>	<ul style="list-style-type: none"> <li>• Which metrics are appropriate for policy evidence? Broken down by risk group?</li> <li>• Tools to optimise planning to improve/reduce exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Advice for vulnerable groups</li> <li>• Personal, real-time monitoring technologies</li> <li>• Product testing for supply chain into indoor products(c.f. paints)</li> <li>• Costing mitigation options</li> <li>• Address both AQ and energy efficiency at same time</li> <li>• Local filtration and capture and conversion technologies – recirculated vs extracted</li> </ul>

### Annex C - Session 3: How to achieve the required outcomes of the programme (Leeds)

<ul style="list-style-type: none"><li>• Monitoring high risk group exposure e.g. in hospitals</li><li>• Balance of energy efficiency vs exposure</li></ul>	<ul style="list-style-type: none"><li>• Predicted toxicity of complex mixtures?</li></ul>	<ul style="list-style-type: none"><li>• Occupational vs personal exposure – different interventions</li><li>• Included behaviours linked to overall exposures – 2<sup>nd</sup> step is effectiveness of intervention – different scale of study</li><li>• How to evaluate/quantify mitigation practices?</li></ul>		<ul style="list-style-type: none"><li>• Products design vs product maintenance/use</li></ul>
--	---	--	--	--

## Annex D - Session 3: How to achieve the required outcomes of the programme (Birmingham)

The outputs are listed below as collated per table.

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• How much air pollution gets indoor (different types of building) and what are the indoor sources and contribution from outdoor</li> <li>• Formulation of secondary pollutants and removal</li> <li>• Holistic approach to air pollution challenges</li> <li>• Long term exposure vs short term exposure in different environments</li> <li>• Disease transmissions - bioaerosols, issues with air recirculation, what pathway? E.g. airborne etc.</li> <li>• Climate change exacerbating air quality issues – brings in a wider community</li> <li>• New data and tools needed for buildings. Understanding what buildings are – neighbourhood scale, urban design</li> </ul>	<ul style="list-style-type: none"> <li>• How much from pollutants is deposited in lungs and what are the impacts – infection</li> <li>• Trade-off between exercise/pollution/cycle/outdoor. Mental health benefits from being outside</li> <li>• Vulnerable groups – Children (know little about), pregnancy (what can be focused on). People in care who can't physically get outside.</li> </ul>	<ul style="list-style-type: none"> <li>• Indoor behaviour affecting health – e.g. exercising indoor</li> <li>• Understanding exposures and different activities</li> <li>• Engaging citizens in a positive way. Promoting green cities that are better places to live in. Ensuring a better city</li> <li>• Planning/design of streets. Integrated design.</li> <li>• Views from buildings for mental health</li> <li>• Stakeholder and users – medical practitioners, policy makers (national and local), practitioners, developers, individuals and communities, NGOs, media, Industry</li> <li>• Disciplines needed – control engineering, atmospheric chemistry, social scientists, health scientists, public health scientists, toxicologists, data scientists, exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Indoor air quality monitoring protocol – consistent monitoring</li> <li>• Public advice – long term impacts and methods of engagement when can go outside</li> <li>• Trust – in what they are being told? Building trustworthy data. Trust of individuals- what officials tell them? Do policy makers trust evidence? Can lead to disengagement</li> <li>• Medical practitioners</li> </ul>	<ul style="list-style-type: none"> <li>• Regulation and other green walls. Awareness of product standards</li> <li>• Smart buildings – ventilation practices control mechanisms, smart environments, e.g. in cars. Affordability, accessibility and inequalities</li> <li>• Apps –engage people in healthy activity –link to Met Office scientists as influencers on Instagram</li> <li>• App –exposure –where to walk – where are the good locations?</li> <li>• Well standard – benchmark. More sustainable evidence needed to enhance it. Can use framework</li> <li>• Retrofit of equipment in existing buildings. Filtering etc.</li> <li>• Early warning systems/repeated schedule. When industrial activity takes place.</li> </ul>

## Annex D - Session 3: How to achieve the required outcomes of the programme (Birmingham)

<ul style="list-style-type: none"> <li>• Exposure –where we spend our time – home vs work vs transport. Has been monitored but don't know if data has been applied/modelled yet</li> <li>• Impact of environment on pollution</li> <li>• Don't know what the health exposures are from different microenvironments</li> </ul>		<p>&amp; epidemiology scientists, integrated modelling, systems-thinking, policy, behavioural &amp; medical community.</p>		
---	--	--	--	--

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• What future pollutants are going to be of concern in the future?</li> <li>• Biologically active pollutants?</li> <li>• Biomarkers for specific pollutants</li> <li>• Synergistic effects of multiple pollutants? Especially when combined with biologically active pollutants</li> </ul>	<ul style="list-style-type: none"> <li>• Need more evidence linking the interdependent indoor pollutants with health effects</li> <li>• Require longer and medium term data regarding indoor pollutants impacts on health</li> <li>• Require more toxicological modelling and indoor AQ impacts on health. Could help with identifiable biomarkers</li> <li>• Where should we target clean air solutions e.g. enclosed railway stations, schools, underground. We need to know where to put</li> </ul>	<ul style="list-style-type: none"> <li>• Impact of dose thresholds</li> <li>• Access to useful data (visual) with appropriate spatial and temporal resolution will enable people to make informed decisions</li> <li>• Access to simple indoor air biomarker for people to check on the status of their own indoor environments</li> </ul>	<ul style="list-style-type: none"> <li>• Communication action to policy developers and local authorities/Gov</li> <li>• Support for evaluation of interventions and financial ring-fenced support</li> <li>• Awareness of synergies with bigger issues e.g. climate change, to provide an integrated approach/policy</li> <li>• Business opportunities</li> <li>• Will provide evidence to bolster occupational health risks mitigation</li> <li>• Regulation vs consumer driven</li> <li>• Scoping and sharing international best practice</li> </ul>	<ul style="list-style-type: none"> <li>• Use of existing technologies to improve air quality in different environments. Including an understanding of the practicalities</li> <li>• How to incorporate biological solutions</li> <li>• Benchmarking mechanical and biological solutions for improving indoor air quality i.e. independent testing &amp; collaborative academics with business – to show what works</li> <li>• More research into which plants and cultivators remove pollutants the best.</li> </ul>

## Annex D - Session 3: How to achieve the required outcomes of the programme (Birmingham)

	solutions to achieve the highest impacts e.g. green infrastructure.			
--	---	--	--	--

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>Indoor and pollutants: complex microenvironment, UK specific</li> <li>Lack of risk data</li> <li>New rules – insulation, fire retardants, vaping. Old rules – radon, mould, benzene, smoke</li> <li>Exposure vs concentration</li> <li>Measurements? What to measure.</li> <li>Model for a standard house?</li> <li>Chemicals in the home</li> <li>Detect – known rules, new potential rules</li> </ul>	<ul style="list-style-type: none"> <li>What is ‘good air’</li> <li>What risks for new pollutants</li> <li>Room scale/ventilation</li> <li>Furniture risk to health</li> <li>Model for lung exposure</li> <li>Genetic risk factors?</li> <li>Vulnerable groups</li> <li>Cocktail effects</li> <li>Toxicity – understand effects on health and risks</li> </ul>	<ul style="list-style-type: none"> <li>Home temp 20 vs 22</li> <li>Top pollutant</li> <li>Window opening – levels of insulation</li> <li>Contradictions – open/close window</li> <li>Open window? Better or worse?</li> <li>Worried – inappropriate stress – lack of data</li> <li>Identify where behaviour can reduce risk of these toxic compounds</li> <li>Personal responsibility vs state intervention (i.e. banning)</li> <li>Message to vulnerable groups</li> <li>Air quality stats</li> </ul>	<ul style="list-style-type: none"> <li>Workplace, schools, prisons?</li> <li>Nudge vs regulation</li> <li>Planning – reduced traffic areas</li> <li>Building regulations – air flow, ventilation</li> <li>Manufacturing regulations</li> <li>EU bans certain fire retardants</li> <li>Ventilation vs security</li> <li>Policy to support behaviour change or reduce risk</li> </ul>	<ul style="list-style-type: none"> <li>Building materials ‘natural’ – log cabin, supporting farmers</li> <li>Air con/heat removers – filters?</li> <li>Mould resistant materials</li> <li>More secure windows</li> <li>Auto windows</li> <li>Risk apps</li> <li>Research tools – measurer, detectors</li> </ul>

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>Dealing with non-exhaust emissions</li> <li>Microplastics?</li> <li>Nanoplastics</li> </ul>	<ul style="list-style-type: none"> <li>Personal monitoring</li> <li>School children, infants</li> <li>Emerging – neurodevelopment and mental health disorders</li> </ul>	<ul style="list-style-type: none"> <li>Personal interaction, behaviour, citizen science</li> <li>A measure of how behavioural change will impact you – including</li> </ul>	<ul style="list-style-type: none"> <li>Policy makers – need to make sure science is relevant and interventions are implemented</li> </ul>	<ul style="list-style-type: none"> <li>Targeted forecasting</li> <li>Product labelling – how a product will contribute to air pollution (come back to understanding risk)</li> </ul>

## Annex D - Session 3: How to achieve the required outcomes of the programme (Birmingham)

<ul style="list-style-type: none"> <li>• Link between air quality and climate change</li> <li>• Scale interaction – links outdoor – to microenvironment</li> <li>• Low-cost sensing – reliable data – accessible wider</li> </ul>	<ul style="list-style-type: none"> <li>• ENM nanoparticles</li> <li>• Unknown impacts e.g. choose from microplastics and engineered nano materials. Digestion of pollutants and microflora interactions.</li> </ul>	<p>timescales, what interventions can be measured?</p> <ul style="list-style-type: none"> <li>• Sensors – targeted advice to individuals</li> <li>• Influencing product manufacturers</li> <li>• Need for more info sharing (positive and negative)</li> </ul>	<ul style="list-style-type: none"> <li>• How do we change policy process?</li> <li>• Workable solution i.e. cities that don't require car travel. Need multidisciplinary to tackle this, including climate change thinking</li> <li>• Engagement of stakeholders (public, local councils)</li> </ul>	<ul style="list-style-type: none"> <li>• Cost-effective portable devices for monitoring and removal for indoor.</li> <li>• Product certification – evidence based to do what they say on the label.</li> </ul>
---	---	--	--	--

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• VOC emission from indoor sources, cooking, candles, scents, cleaning products</li> <li>• Existing policy outcomes and their impact on the socioeconomically disadvantaged</li> <li>• Climate change vs air quality</li> <li>• Emission/Flux</li> <li>• Speciation and combined pollutant and impacts on health</li> <li>• Technology – do we have the tools to answer the questions? Expensive!</li> <li>• Bioaerosol measurement – optimal (spatial, temporal, resolution), standardisation of sample</li> </ul>	<ul style="list-style-type: none"> <li>• Health effects of co-selection/synergistic effects of chemical and biological species</li> <li>• Health implication from mould in damp/older houses and bioaerosols may settle as dust in houses</li> </ul>	<ul style="list-style-type: none"> <li>• Shifting focus from monitoring in spaces only. Individuals</li> <li>• Public confidence in advice to changing behaviours. Translating research to policy</li> <li>• Education –starting early in school</li> <li>• Unintended consequences of awareness raising about air pollution and factors to mitigate</li> <li>• Factors beyond awareness that affect behaviour that target the sources of air pollution (e.g. active track for mental health/exercises)</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluating policies and interventions requires casual inference methods to algorithms</li> <li>• Improve knowledge mobilisation between Gov depts. / academic / enforcers / public</li> <li>• Reducing emission rather than mitigation after the fact. Regulation and product design.</li> <li>• A human-centric approach. Reducing the health effects from exposure to consumer products (domestic activities and behaviour)</li> <li>• Mitigating and characterising exposure in a changing climate (transport, green cities, lifestyles)</li> </ul>	<ul style="list-style-type: none"> <li>• Safe and green cycle routes. Thinking about societal inequalities.</li> </ul>

### Annex D - Session 3: How to achieve the required outcomes of the programme (Birmingham)

<ul style="list-style-type: none"> <li>• Changing compositions of bioerosols with climate change</li> </ul>			<ul style="list-style-type: none"> <li>• Human-centric approaches and analysis</li> </ul>	
---	--	--	---	--

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• Use of fire retardants, recycling/waste (productivity. Understanding types of indoor pollutants</li> <li>• Understanding variability of level and composition of indoor/outdoor</li> <li>• Range of indoor environments</li> <li>• Range of human activity</li> <li>• Interactions between pollutants – PM as a vector; mould interactions</li> <li>• Multi sensors &lt; interference</li> <li>• Balance: individual vs population</li> <li>• New pollutants: Microplastics from clothing; 3d printing in schools and homes; vaping</li> <li>• Bioaerosols and PM</li> <li>• Many more epidemiology studies needed on the different pollutants to see which have the largest health impact</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding the relative importance on health impact of different components</li> <li>• Risk: short and long? Trade off</li> <li>• Large number of unknowns – want benefit from what we do</li> <li>• Lack of epidemiological studies on many indoor pollutants</li> <li>• Which are the vulnerable groups? Are their exposures different to others?</li> <li>• Trade offs</li> </ul>	<ul style="list-style-type: none"> <li>• Ethical and GDPR issues relating to quantifying behaviour</li> <li>• Lack of range and volume of data. Data access.</li> <li>• Behaviour and changes must be enacted at the start of the project. People are much more likely to enact change if they have buy in from the start of the project &amp; a say on what problems are being looked at.</li> <li>• Models</li> <li>• Big data</li> </ul>	<ul style="list-style-type: none"> <li>• Multidisciplinary group/network addressing specific issue (not too broad)</li> <li>• Understanding: co-benefits; unforeseen side effects</li> <li>• Implementation of the data and unwillingness to lead to brave national changes</li> <li>• Smart homes/cities</li> <li>• IOT</li> <li>• Sharing of data</li> <li>• Technology intervention: smart ventilation; filtration; IoTs (automation)</li> <li>• Role of weather on AQ and behaviour</li> </ul>	<ul style="list-style-type: none"> <li>• Identify substances of interest, list and priority – Industry challenges</li> <li>• Broad range measurement devices?</li> <li>• Citizen science – how to engage deprived populations ; health inequality; AQ; Link to models and how they use data</li> <li>• Social inequality must be considered</li> <li>• Engage – need more; link to what people are interested in</li> <li>• Access to data – connecting existing data sets and proxies (IAQ measurement)</li> </ul>

## Annex D - Session 3: How to achieve the required outcomes of the programme (Birmingham)

Foresight on Emerging air pollution challenges	Foresight on associated health risks	Quantifying and influencing behaviour practices	Providing consistent, evidence-based advice for policy	Products and services to protect health
<ul style="list-style-type: none"> <li>• Bioaerosols in the home</li> <li>• Bacterial and viral transmissions</li> <li>• Microenvironment exposures: behaviour of people; building technology</li> <li>• Chronic vs acute exposure</li> </ul>	<ul style="list-style-type: none"> <li>• PM composition dependent risk factors</li> </ul>	<ul style="list-style-type: none"> <li>• Health professionals (GPs, nurses, etc) need to be able to 'prescribe' clean air</li> <li>• 'Prescribing' Clean air/air quality interventions</li> <li>• Provide helpful info to the mobile phone of citizens – nudge behaviour change</li> <li>• Start education early – school</li> <li>• Public services – prioritise comms</li> </ul>	<ul style="list-style-type: none"> <li>• Clean air tax on private vehicles to subsidise public transport</li> <li>• Study decisions to focus equally on implementation as well as effectiveness of air pollution interactions</li> <li>• Need to know how to measure interventions – data attribution – implementation – mixed methods</li> <li>• Big data companies – leverage</li> <li>• Policy?</li> <li>• Using media to influence</li> <li>• Agency – home/outdoor</li> <li>• Data management policy needed</li> </ul>	<ul style="list-style-type: none"> <li>• Key tech: Filters and integrated devices</li> <li>• Low cost monitors for homes: CO<sub>2</sub>, PM, activity in home, noise</li> <li>• Need for calibration of standardisation of behavioural understanding</li> <li>• Climate proofing buildings</li> <li>• Personal devices to monitor health impacts as well as exposure</li> </ul>



## Annex E - Session 4: Priority Themes. Elaborate the content of the themes (Leeds)

<b>Title:</b> Quantifying exposure, health impact, behaviour change. Defining the consequences of environmental exposure
<b>Aim and Required Outcomes:</b> <ul style="list-style-type: none"><li>• Defining risks. Understanding what we are exposed to.</li><li>• Quantifying risks of exposure as people move through their day and space (measure, observe health outcome and improve the risk).</li><li>• Working with vulnerable groups (e.g. pregnant mothers, neonatal)</li><li>• Overall chemical composition information</li><li>• Effecting change in vulnerable groups.</li></ul>
<b>Rationale:</b> <ul style="list-style-type: none"><li>• New range of pollutants i.e. expanded across indoor/outdoor occupational.</li><li>• Understanding health impacts, comorbidities</li><li>• Life course? What impact of exposure?</li></ul>
<b>Specific focus areas and opportunities to address:</b> <p>Assessing a person's exposure:</p> <ul style="list-style-type: none"><li>• Contributions from each part of the day</li><li>• What is trajectory?</li><li>• Systems approach: mixtures of pollutants or dominant components</li><li>• Understanding comorbidities and linked health problems</li><li>• Toxicity studies</li><li>• Quantifying chemicals (chemical/pm mix) and environments</li></ul>
<b>What is needed to be able to do the research?</b> <p>Health history? How spots for specific conditions? Data mining – with health data.</p> <ul style="list-style-type: none"><li>• Toxicology data – tox study in vitro data not always useful</li><li>• Inhalation studies? Does response</li><li>• Instrumentation to observe exposure, wearable monitors</li><li>• Measure metabolomics, biomarkers</li><li>• Modelling exposure</li><li>• Understanding behaviour to effect behaviour change (why people exposing themselves to these risks)</li><li>• Model of exposures to inform health outcomes</li></ul>
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Co-design – participant buy in</li><li>• Citizen science</li><li>• Practitioner buy in to the research</li><li>• Toolkits for doctors – to assist in health care</li><li>• Toolkit for organisation to advise on pollutants</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• GPs, patient groups</li><li>• Transport operators</li><li>• Local govt</li><li>• Employers</li><li>• Building groups</li></ul>

## Annex E - Session 4: Priority Themes. Elaborate the content of the themes (Leeds)

<b>Title:</b> Underpinning resources and capabilities
<b>Aim and Required Outcomes:</b> <ul style="list-style-type: none"><li>• Lot of smart cities – smart data collection → do something with it</li><li>• Research Questions – are people most likely to be exposed at home/school/work/travelling?</li><li>• Monitor record the required data to carry out research.</li><li>• Effect of pollution and how to mitigate.</li><li>• Provide data (gathering, storage, provision) - Framework/database to answer research questions. Including informing computer models as a resource.</li></ul>
<b>Rationale:</b> <ul style="list-style-type: none"><li>• Lack of understanding of the level and duration of exposure indoor/outdoor/travel during activities.</li><li>• Metrics used for decision making need to be revisited – outdoor.</li><li>• Without fundamental, empirical data, we can't verify models to correlate with health outcomes. With more measurements comes more information.</li><li>• Timelines: ASAP → 2030 onwards.</li></ul>
<b>Specific focus areas and opportunities to address:</b> <ul style="list-style-type: none"><li>• Study a cohort to measure activity (fit bit) with diary data simultaneously with static measurements indoors and outdoors, to develop proxy measures for pollutants – explore noise.</li><li>• The way we use sensors understanding the processes used by manufacturers to deliver the data.</li><li>• Lack of a resource to bring together data from 'low cost sensors' in such a way that its reproducible and understood.</li></ul>
<b>What is needed to be able to do the research?</b> <p>Bringing together static indoor/outdoor data with mobile data simultaneously in space and time.</p> <ul style="list-style-type: none"><li>• Quality data, synchronisation, analytics, align with research questions, measure pollution indoors/outdoors simultaneously, behavioural study, diary, cooking, cleaning fluids.</li><li>• Children 10-11yr olds.</li></ul> <p>Collaboration/discussion between:</p> <ul style="list-style-type: none"><li>• Sensor developers</li><li>• Research involved with instrument intercomparisons</li><li>• Researchers involved with model development</li><li>• Characterisation of sensors</li><li>• Homogenisation of implementation – design/develop single (few) sensors platforms. Prevent (reduce need for) people to roll their own low cost sensor platform.</li></ul>
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Feedback to participants to explore potential changes</li><li>• Traffic control engineers, public transport operators to make changes.</li><li>• Involve end users (county councils/HSE/Industry etc)</li><li>• Sensor developers</li><li>• Everyone in-between the above two.</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• Local authorities</li><li>• Health and safety executive</li><li>• industry</li><li>• School teachers</li><li>• Sensor developers.</li></ul>

## Annex E - Session 4: Priority Themes. Elaborate the content of the themes (Leeds)

<b>Title:</b> Sources and pathway of pollutants indoors
<b>Aim and Required Outcomes:</b> What exactly are these pollutants? How are pollutants getting indoors: <ul style="list-style-type: none"><li>• Outdoor coming indoors</li><li>• Pollutants directly emitted indoors already (i.e. personal care products)</li><li>• Outdoor/indoor flux</li></ul> Based around activities and behaviours e.g. cooking, cleaning, living on a busy road etc.
<b>Rationale:</b> Understanding the sources of these pollutants so can then move onto how to mitigate their effects Also investigate the transformations Strongly considered as research that should be undertaken at the very early stages of the research programme.
<b>Specific focus areas and opportunities to address:</b> <ul style="list-style-type: none"><li>• Understanding the transformations of these pollutants (chemical, physical transformations etc). Use existing tools and develop new technologies.</li><li>• Understanding the pathways/sources – based on building design for example.</li></ul>
<b>What is needed to be able to do the research?</b> <ul style="list-style-type: none"><li>• Realistic indoor environment that is controllable → we need to build this.</li><li>• Measuring kits – high end. Sage of the art equipment, much of which already exists.</li><li>• Experienced staff</li><li>• Someone to co-ordinate measurements. Other people could come in and do their own measurements</li><li>• Computing infrastructure – net servers etc.</li></ul> (note: similar to what has been done for 'outdoor' pollution)
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Chemical industries need to be involved from the start.</li><li>• Look at getting the media involved</li><li>• Policy makers involved from the start</li><li>• Develop 'traffic light' system for air quality</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• Product makers i.e. air purifiers</li><li>• Policy makers</li><li>• Chemical industries</li><li>• Vulnerable groups</li></ul>

## Annex E - Session 4: Priority Themes. Elaborate the content of the themes (Leeds)

<b>Title:</b> Super emitters
<b>Aim and Required Outcomes:</b> Overall outcome would be reduced exposure/improved health impacts <ul style="list-style-type: none"><li>• Identify the super emitters and their properties (exposure, dosage, toxicity)</li><li>• Identify the vulnerable groups</li><li>• Identify technological and behavioural adaptations.</li></ul>
<b>Rationale:</b> <ul style="list-style-type: none"><li>• Large scope to have 'bang for buck' by going after super emitters</li><li>• Leverages full/holistic multidisciplinary at the core of the project</li></ul>
<b>Specific focus areas and opportunities to address:</b> <ul style="list-style-type: none"><li>• Leverage industrial support</li><li>• Leverage existing data and support FAIR data policies for the field</li><li>• Make use of existing outdoor/indoor networks</li><li>• Share best practice/methodologies</li></ul>
<b>What is needed to be able to do the research?</b> <ul style="list-style-type: none"><li>• Data (size, mass, flux, speciation, composition, concentration time-activity, behaviour, health data, toxicity, lifetimes.</li><li>• Intervention experiment – what happens before and after intervention?</li></ul>
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Testable interventions: behavioural, technological</li><li>• COM-B (dif. S.E will require dif. Approaches because of their nature i.e. one S.E could be cooking, another cleaning)</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• Likely to be S.E dependent</li><li>• PHE, PHW, NICE, EA</li><li>• 'Building regs'?</li><li>• SMEs</li><li>• Industry (again dep. On super emitter)</li><li>• LHA, LEA, (good and the great)</li><li>• Arup, WSP, env. Consultants</li><li>• GPs</li></ul>

## Annex E - Session 4: Priority Themes. Elaborate the content of the themes (Leeds)

<b>Title:</b> Behaviour change in emitters and exposures
<b>Aim and Required Outcomes:</b> <ul style="list-style-type: none"><li>• To understand the behaviours we want to change, how this behaviour could be changed, and whether behaviour changes are effective (in reducing exposure/long term health impacts)</li><li>• What the COM-B model looks like for air pollution related behaviours.</li></ul>
<b>Rationale:</b> <ul style="list-style-type: none"><li>• Behaviour change community could focus on AQ research, as lots of behaviour change work in other fields</li><li>• Needs to come after the fundamental research on exposure and risk.</li></ul>
<b>Specific focus areas and opportunities to address:</b> <ul style="list-style-type: none"><li>• Trend for low-cost monitoring – might not be high quality data, but the high vs low is important – trends are important for influencing behaviour.</li><li>• How does feedback impact behaviour?</li><li>• Ethnographic approach to explore the cultural practices around air pollution emission and exposure</li><li>• Existing behavioural change initiatives in the air pollution arena and their efficacy.</li></ul>
<b>What is needed to be able to do the research?</b> <ul style="list-style-type: none"><li>• Review of the behaviour change literature or explore what works and why – partly from AQ literature, wider e.g. climate change</li><li>• Understanding of the dis-benefits/unintended consequences of behavioural change interventions</li><li>• Access to the grey/non-academic literature including via data-mining/textual analysis.</li></ul>
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Participatory approaches in the work are more likely to lead to change.</li><li>• Co-created science – involve people in setting the research questions, interventions to test, communication etc media + messages</li><li>• Involvement with policy makers from the beginning e.g. timing of policy interventions.</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• Policy makes – local, national, regional level</li><li>• Businesses</li><li>• Community leaders e.g. school teaches, GPs, social influencers</li><li>• BIT – nudge team</li><li>• NGOs already working in the area</li></ul>

## Annex E - Session 4: Priority Themes. Elaborate the content of the themes (Leeds)

<b>Title:</b> Providing healthy air in a zero carbon building
<b>Aim and Required Outcomes:</b> <ul style="list-style-type: none"><li>• Understanding of the impact of zero carbon policies on IAQ</li><li>• Reducing the potential impacts to IAQ during these changes</li><li>• Defining groups who would benefit the most</li><li>• Cost benefit analysis of different intervention – techno-economic analysis.</li></ul>
<b>Rationale:</b> <ul style="list-style-type: none"><li>• Need to understand the homes to change</li><li>• Sell AQ advantages on top of zero-carbon innovation</li><li>• Minimise the negative AQ input of zero carbon innovation.</li><li>• NICE now recommends indoor air</li><li>• Improvement to productivity and concentrations and well being</li></ul>
<b>Specific focus areas and opportunities to address:</b> <ul style="list-style-type: none"><li>• New builds and retrofit</li><li>• Homes vs workplaces vs public (schools, hospitals)</li><li>• Assess technology and behavioural changes in zero-carbon implementation that could impact AQ</li><li>• Modelling possible scenarios</li><li>• Occupational behaviour</li></ul>
<b>What is needed to be able to do the research?</b> <ul style="list-style-type: none"><li>• Need long-term (before and after) monitoring</li><li>• Limit to work already underway</li><li>• Toolkit on what should be measured</li><li>• Ambient AQ input (under climate change)</li><li>• Small scale detailed case studies and wide-scale national data resources.</li></ul>
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Incentivise change → tools → cost-benefit</li><li>• Validation of intervention tools/technologies</li><li>• Work with technology developers</li><li>• Best practice for building use</li><li>• Reputation guidance – NICE has report out for consultation on AW will be reviewed and enhanced in 3 years</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• Air quality – indoor and outdoor</li><li>• Medical personnel</li><li>• Behavioural scientists</li><li>• Construction</li><li>• Planning</li><li>• Regulators</li><li>• Technology monitors</li><li>• Health data research UK</li><li>• Large data resource</li><li>• Local landlords</li><li>• Exploring net zero implementation</li><li>• Google data</li><li>• Digits companies</li><li>• House building</li><li>• Facilities management (NHS, LAs etc)</li><li>• LAs and academies</li></ul>

## Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

<p><b>Title:</b> Breathable home</p>
<p><b>Aim and Required Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Affect in a house of: emission, dispersion and how people are affected → variables to change</li> <li>• Understand what makes a good healthy home → understand toxins, ventilation, indoor/outdoor pollutants → important change behaviour</li> </ul>
<p><b>Rationale:</b></p> <ul style="list-style-type: none"> <li>• Uptake in interest in indoor AQ – climbing up the agenda – health, public, policy</li> <li>• Recognition that its IAQ not just ambient air – public perception</li> <li>• Siloe approach to outdoor and indoor → bring together and health</li> <li>• Combination metric of IAW and OAQ</li> <li>• Childhood asthma and lack of data on houses (variable not considered)</li> <li>• Improve health outcomes and reduce health risks from ‘bad air’</li> <li>• 50+% time spent in home</li> <li>• UK/modern home is different – unknown risks</li> <li>• Feeds into national home building</li> <li>• Asthma/respiratory</li> </ul>
<p><b>Specific focus areas and opportunities to address:</b></p> <ul style="list-style-type: none"> <li>• Modelling and under control – 3 identical houses: natural house, standard developer house, super air tight house. Leverage existing houses.</li> <li>• Protocol for what should be tested e.g. pollutants</li> <li>• Test house</li> <li>• Socioeconomic effects – inequalities of focus on retrofit vs new homes, and vice versa.</li> <li>• New build and retrofit are different</li> <li>• Leverage LA interest and charities</li> <li>• Detect ‘energy home’ and range</li> <li>• Model dispersion and potential risks</li> <li>• Highest risk to health – dose response – modelling air flows</li> <li>• Identify highest risk in home</li> <li>• Identify mitigations</li> </ul>
<p><b>What is needed to be able to do the research?</b></p> <ul style="list-style-type: none"> <li>• 3 homes – leverage existing</li> <li>• Human cohort + human data → leverage existing?</li> <li>• Models and data → replicated at scale</li> <li>• Human cohort – swap between the houses – live a period in each house?</li> <li>• Surrounding environment of the house – model could have this built in</li> <li>• Capture public imagination</li> <li>• Experimental homes/rooms</li> <li>• Detectors</li> <li>• Volunteers</li> </ul>
<p><b>Approaches to translate research into action/change:</b></p> <ul style="list-style-type: none"> <li>• Variables – focus and targeted interventions e.g. effect of cooking or cleaning</li> <li>• Focus involvement with industry</li> </ul>
<p><b>Partners/Stakeholders that need to be involved:</b></p> <ul style="list-style-type: none"> <li>• Public</li> <li>• Industry</li> <li>• Built environment</li> <li>• Atmospheric sciences</li> <li>• Behavioural sciences</li> </ul>

## Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

<b>Title:</b> Exposure and impacts of pollutants on pregnant women and children
<b>Aim and Required Outcomes:</b> Improved understanding of the impacts of indoor pollutants on pregnant women and children. Methods to mitigate the risks in this group. Distinguish between the impacts of indoor pollutants as against outdoor pollutants.
<b>Rationale:</b> There is now clearer understanding of some of the impacts – especially to the unborn. Better measurement instrumentation will allow for better and more numerous studies. Also now able to distinguish between outdoor and indoor exposures. The possibility of enacting short term change to bring about major improvements in health is possible.
<b>Specific focus areas and opportunities to address:</b> Work would have to be done to establish which metric to measure – birth weight, preeclampsia etc. Study period should include pregnancy and 1 <sup>st</sup> year of life. Need to explore which biomarker is most appropriate. Would make use of outdoor pollution levels to compare with indoor levels. Possible to use info from biobanks? Possible to use cheap available low tech devices such as diffusion tubes and low cost monitors. Utilise information from other health areas such as GP surgeries.
<b>What is needed to be able to do the research?</b> Large cohort study – 75k people ideally. For monitoring though smaller group using birth weight metric. Description of house hold and other demographic info. Input from the normal health checks etc. Data from rural/urban locations as well as economic groups.
<b>Approaches to translate research into action/change:</b> The research can be used to identify key sources of key pollutants and helping to remove these sources. Could give pregnant women the information to allow informal behavioural changes. Research can also be used as evidence to encourage a change in materials and products found in the home.
<b>Partners/Stakeholders that need to be involved:</b> Antenatal groups, expertise in home structure/ventilation etc. Local authority house planning, manufacturers of home furnishings, cleaning products etc. Expertise in measurement of micro-climate environments. Policy people to inform changes in building regulations.



## Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

<p><b>Title:</b> Urban design</p>
<p><b>Aim and Required Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Identify planning and building design regulations to reduce exposures and improves health.</li> <li>• Evidence (for planners and architects) – qualitative and quantitative of ow design influences indoor air quality and exposure to air pollution and health. What effect does it have on people?</li> <li>• Reduce exposure to poor air quality</li> <li>• Places that are enjoyable to live in (healthy and wellbeing indicators)</li> </ul>
<p><b>Rationale:</b></p> <ul style="list-style-type: none"> <li>• Don't know much about indoor exposure/pollution</li> <li>• People spend most of their time indoors</li> <li>• Don't know how much influence urban design has on indoor exposure</li> <li>• Don't know enough about indoor air pollution</li> <li>• Lack of connection between planners, healthcare etc.</li> <li>• Policy to build new homes</li> <li>• Growing population</li> <li>• Spotlight on climate change</li> <li>• City has become more urbanised – more people in urban environments.</li> </ul>
<p><b>Specific focus areas and opportunities to address:</b></p> <ul style="list-style-type: none"> <li>• Retrofit, regeneration and new design in scope</li> <li>• Ventilation as part of the building design</li> <li>• Transport infrastructure → urban design</li> <li>• Green spaces</li> <li>• Speed control and effect on emissions</li> <li>• Trade-offs and co-benefits</li> <li>• Behaviour – to understand use of technologies, where people are, what they are breathing etc.</li> </ul>
<p><b>What is needed to be able to do the research?</b></p> <ul style="list-style-type: none"> <li>• Money</li> <li>• Properties – to do interaction for research and willing participants</li> <li>• Modelling and monitoring – not just pollution but behaviour</li> <li>• Mapping sources</li> <li>• Study of emissions from different products</li> <li>• Existing data – meteorological</li> <li>• Access to a building</li> <li>• Exposure – designers, emissions, building engineers, social scientists</li> </ul>
<p><b>Approaches to translate research into action/change:</b></p> <ul style="list-style-type: none"> <li>• Develop guidelines – behaviours</li> <li>• Communication and engagement and guidelines with different stakeholders</li> <li>• Involvement of users from the beginning</li> <li>• Understanding of how to engage – mix perception.</li> <li>• Developing actionable info – meeting with public to ensure useable</li> <li>• Lessons learnt from others environmental behaviours – e.g. plastics, climate change</li> </ul>
<p><b>Partners/Stakeholders that need to be involved:</b></p> <ul style="list-style-type: none"> <li>• NHS and medical practitioners</li> <li>• Public</li> <li>• Policy-makers (national and local) including local councillors</li> <li>• Professional bodies</li> <li>• Construction industry</li> <li>• Planners – transport, town, building</li> <li>• NGOs</li> <li>• Trade bodies</li> </ul>

## Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

- Developers
- Architects
- Urban designers

**Title:** A human-centric approach to reducing the health effects from exposure to consumer products

**Aim and Required Outcomes:**

- Better understand how humans are exposed to pollution in indoor environments
- Understand relationship between human activities and behaviours on exposure in a changing world.
- Mitigating health effects through targeted interventions.

**Rationale:**

- Why now → transport and work env are rapidly changing and exposure risks are shifting
- Public perception of air pollution is high and good opportunity to engage with public
- Petrochemical emissions less important, and consumer products/biological sources becoming increasingly important
- Industry developing new 'green' products → are these really greener

**Specific focus areas and opportunities to address:**

- Emission and secondary product formation indoor/outdoor exchange
- Links between pollutants and health effects
- How does socioeconomic characteristics impact exposure and related health effects
- How human behaviour effects exposure levels
- Communicate results of effect behaviour change to reduce emissions of exposure
- Working with industry and regulators

**What is needed to be able to do the research?**

- Open access data → manufacturers?
- Indoor AQ measurements and tools (monitoring)
- Health outcomes and links to exposure
- Socioeconomic data/behaviour scientist
- Cohort or test house

**Approaches to translate research into action/change:**

- Impact/translation/education
- Interaction with local council AQ teams → authorities
- Champion
- Expert network
- Links to industry
- Provide advice to those who go into homes → health visitors, cares, pharmacists
- Media → Big brother IAQ experiments?

**Partners/Stakeholders that need to be involved:**

- PHE
- DSTL
- EA
- NPL
- Charities
- BEIS
- Building design/managers
- Defra
- MHCLG
- RCP
- Turing institute
- Consumer groups – which?

## Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

- Industries
- Planners
- TCP

<p><b>Title:</b> Reducing an individual's exposure</p>
<p><b>Aim and Required Outcomes:</b> To reduce an individual's exposure through improved process understanding and effective interventions</p> <ul style="list-style-type: none"> <li>• Improved process parameterisation in models</li> <li>• Quantification of exposure related activity patterns and time use</li> <li>• Identification of high exposure hotspots including peak exposure and long-term</li> <li>• Characterisation of responses by susceptible groups (e.g. pregnant women, schools), to allow targeted interventions</li> <li>• Air quality health index for an individual</li> </ul>
<p><b>Rationale:</b></p> <ul style="list-style-type: none"> <li>• Direct health impact on future generation</li> <li>• Multiplier effects: social cohesion, performance in schools, reduced healthcare burden</li> <li>• Improved health and well being</li> <li>• Empowering end users</li> <li>• New technologies emerging</li> <li>• Outcome is population based</li> </ul>
<p><b>Specific focus areas and opportunities to address:</b></p> <ul style="list-style-type: none"> <li>• Targeting one key group. School children, schools (staff) parents – stakeholder engagement.</li> <li>• Fundamental science: How do aerosols ingress (outdoor – indoor); how do they change → would need to look at this process/transformation</li> <li>• Targeted observation: exposure measurements – use established technology and emerging</li> <li>• Evolution of tools.</li> </ul>
<p><b>What is needed to be able to do the research?</b></p> <ul style="list-style-type: none"> <li>• Needs a multidisciplinary team (social sciences, medicines, stakeholders, policy, families (children and parents)</li> <li>• Need for detailed data → data scientists and capability</li> <li>• Qualitative approach → focus groups</li> </ul>
<p><b>Approaches to translate research into action/change:</b></p> <ul style="list-style-type: none"> <li>• Identify key interventions – intervention dependent on the individual: Green infrastructure; education → schools, children, parents; Guidance, air quality health risks indoors</li> <li>• Behavioural change</li> <li>• Production of guidance to be used by the public.</li> </ul>
<p><b>Partners/Stakeholders that need to be involved:</b></p> <ul style="list-style-type: none"> <li>• Needs a multidisciplinary team (social sciences, medicines, stakeholders, policy, families (children and parents) and Defra.</li> </ul>

## Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

<b>Title:</b> Air Quality Health Risk Index for the Built Environment
<b>Aim and Required Outcomes:</b> To develop an integrated methodology for assessing health risks from exposure in air from the built environment.
<b>Rationale:</b> <ul style="list-style-type: none"><li>• We spend most of our time indoors</li><li>• Systematic evidence base to construct policy</li><li>• Integration to matrix form essential to allow translation to the public</li><li>• It is timely due to the awareness of the public in this area and our improved ability to measure and model these pollutants.</li></ul>
<b>Specific focus areas and opportunities to address:</b> <ul style="list-style-type: none"><li>• Characterise a range of built environments e.g. school, train stations, homes, care homes etc.</li><li>• Method development for data collection (monitored and modelled) e.g. how to measure the chemicals/use of proxies</li><li>• Health impacts – epidemiology – show impact on the health. Early markers on health.</li><li>• Social descriptors, what people do in the environments</li><li>• Fire retardants</li></ul>
<b>What is needed to be able to do the research?</b> <ul style="list-style-type: none"><li>• Buy in from the stakeholders, trust of the public, industry for policy take up or product development</li><li>• Use of existing databases from HSE, Fire department, BRE, for who lives where and other rises (building type and use)</li><li>• Social science must be front and centre</li><li>• Sensors and standardisation of methods, connectivity</li><li>• Health impacts –exposure vs impact – existing cohorts with available information</li><li>• Intervention study must happen</li></ul>
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Database of built environment types and their risks, open to the public.</li><li>• Use matrix as simple explanation to general public</li><li>• Health professional workshop/information</li><li>• Method for homeowners to perform their own interventions</li><li>• Guidance for builders and planners</li><li>• Co-benefits (health, living, better diet)</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• Designers</li><li>• General public</li><li>• Local authorities</li><li>• Regulators</li><li>• Industry partners</li><li>• Charities and NGOs</li><li>• Health professionals</li><li>• Researchers</li><li>• Social scientists</li><li>• Medical professionals</li><li>• Architects</li><li>• Engineers</li><li>• (everyone!)</li></ul>

## Annex F - Session 4: Priority Themes. Elaborate the content of the themes (Birmingham)

<b>Title:</b> Prescribing Clean Air
<b>Aim and Required Outcomes:</b> <ul style="list-style-type: none"><li>• Use behaviour technologies. PPE and policy to influence public health. Develop effective 'nudges' to change behaviour. Defining technological solutions for interventions.</li><li>• 2 streams: Behavioural and technological</li><li>• Linked to a specific medical endpoint</li><li>• Build upon existing literature</li><li>• Outcome – information transfer to passive housing developments</li></ul>
<b>Rationale:</b> <ul style="list-style-type: none"><li>• Technology is emerging now</li><li>• Preventative rather than cure</li><li>• Cheaper now to use technology</li><li>• Cost benefit analysis/economics work package (e.g. equipment vs. hospital stays)</li><li>• Pedagogy → proactive approaches needed to reduce exposure</li><li>• Working age people most affected</li><li>• Social vs pharmacology – benefits vs risks, and symptoms management</li></ul>
<b>Specific focus areas and opportunities to address:</b> <ul style="list-style-type: none"><li>• Reducing economic impact: NHS, workplace</li><li>• More informed decision making</li><li>• Positive messaging/empowerment</li><li>• Social focus vs pharmacology focus</li></ul>
<b>What is needed to be able to do the research?</b> <ul style="list-style-type: none"><li>• Scoping studies – identifying cohorts etc then tools</li><li>• Logic models</li><li>• Modelling of intervention</li><li>• Cohorts – people (medical endpoint?) and buildings</li><li>• New technology</li></ul> <p>What can we do vs what we want to do → keep separate</p>
<b>Approaches to translate research into action/change:</b> <ul style="list-style-type: none"><li>• Pilot for research to be used in conjunction with clinicians.</li><li>• Control groups receiving interventions.</li><li>• Co-operation with third sector of patient groups.</li></ul>
<b>Partners/Stakeholders that need to be involved:</b> <ul style="list-style-type: none"><li>• NHS/clinicians</li><li>• Third sector advocates</li><li>• Consultancies/private sector</li><li>• public</li></ul>