# Cleaner Air for Scotland – Air Quality Public Attitudes & Behaviour Review – Final Report

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# Executive Summary

The scope of this project was to provide a review and assessment of the existing evidence on public attitudes and behaviour related to air pollution to inform the draft of the new Cleaner Air for Scotland (CAFS) strategy. The objectives of the literature review were to:

- Identify, review and synthesise up-to-date evidence on Scottish public attitudes, perceptions and behaviours towards air quality, to understand the key findings, robustness of evidence base and any outstanding gaps in the evidence,
- Identify and review recent approaches to engaging the public on air quality, to understand effectiveness, limitations and applicability in different contexts, and
- Make recommendations for a public engagement strategy for air quality as part of the planned public consultation on the new CAFS strategy.

Based on the wide range of studies identified in this review, there appears to be a strong awareness of, and engagement with, air quality and climate change issues, at least in certain sectors of society in Scotland. There are however, significant barriers to engagement and importantly behaviour change, amongst particularly deprived communities. This is well-documented and requires a detailed level of understanding of the complex factors at play in order to ensure that future engagement is meaningful and effective.

A range of public engagement approaches have been identified in this review, from communication tools, traditional questionnaires and focus groups, to more participatory ‘citizen panels’, ‘citizen science’, ‘living labs’ and co-creation, and novel techniques using social media and gamification. Whilst traditional communications approaches, such as questionnaires and marketing campaigns, can help to raise awareness across a wider number of people, they can be relatively shallow in their impact. More participatory approaches can create deeper, more meaningful engagement, generating greater public support, which can help to address issues of perceived behavioural control and shift subjective norms, making policies easier to implement and therefore more effective.

Good public engagement should therefore draw upon an assortment of different approaches, using materials from other successful strategies to build a coordinated suite of multi-media initiatives, with support from communications experts and commitment from a range of actors, e.g. national and local government, public health agencies, public transport providers, businesses and schools. Planned longitudinal monitoring and evaluation should be designed into the campaign to identify the effectiveness of strategies, and to allow organisers to learn from the successes and follow up on areas of weakness. Coupling evaluation with evidence on how public engagement has contributed can create a feedback exchange, and also enable

citizens to reflect on their experiences in a more informed way. Furthermore, the engagement strategy, materials and evaluation reports should be transparent and publicly available to allow others to benefit.

The following highlights key recommendations for a public engagement strategy for air quality in Scotland to inform the new CAFS strategy and future public engagement approaches.

1. Consider a holistic approach that reflects citizens' lived experiences rather than focusing exclusively on air quality.
2. Use a range of pre-piloted engagement approaches, informed by communications and subject experts.
3. Ensure engagement approaches are inclusive of all sectors of society and appropriately communicated.
4. Target specific groups separately, e.g. vulnerable groups, user groups.
5. Gain support from and include a range of actors, e.g. national and local government, public health agencies, public transport providers, businesses and schools.
6. Research the affected communities and actively engage with them to understand the socio-cultural contexts and complexities of their needs.
7. Co-create solutions that work for the affected communities, through citizens' panels, and 'living labs', ensuring participants are demographically representative.
8. Support citizen-led engagement events and activities, e.g. citizen science.
9. Ensure promoted behavioural changes are easier, more convenient and preferably cheaper than the status quo.
10. Raise awareness responsibly, ensuring that risk perceptions and data interpretation are managed and achievable behavioural responses are provided.
11. Focus communication on health impacts, rather than concentrations or emissions.
12. Use change agents, influencers and middle actors to help raise awareness and promote behaviour change to affect normative behaviours.
13. Use social media to spread awareness through wider social connections and families.
14. Plan longitudinal monitoring and evaluation, coupled with citizen feedback, into the public engagement design.
15. Ensure materials and evaluation are made available to benefit other public engagement strategies.

# Contents

# 1 Introduction

- **Introducing the premise for the report, i.e. context in relation to its contribution to CAFS Strategy.**
- **Summary of the key findings of the CAFS Review**
- **Background to the issues.**
- **Specific assignment objectives**

## 1.1 Cleaner Air for Scotland – Air Quality Public Attitudes & Behaviour Review

The scope of this project is to provide a review and assessment of the existing evidence that will inform the draft of the new Cleaner Air for Scotland (CAFS) strategy. An independent review of the current CAFS strategy in 2019[1] identified the need for more research on public knowledge, attitudes and concerns as well as on willingness to change behaviours to reduce air pollution in Scotland. Moreover, there is a need to identify the real and perceived barriers to change behaviours that generate air pollution. The scope also requires a critical review of methodologies implemented in public engagement on air quality and underpinning behaviour change methodologies. This research, therefore, highlights key recommendations for a public engagement strategy for air quality in Scotland to inform the new CAFS strategy and future public engagement approaches.

## 1.2 Relevance

### 1.2.1 The importance and rationale of this assignment

Around 1,700 premature deaths annually are associated with exposure to air pollution in Scotland[2], and 14 of Scotland's 32 local authorities currently have longstanding Air Quality Management Areas, declared for exceedances of the national air quality objectives, mainly for nitrogen dioxide ($NO_2$) and particulate matter ($PM_{10}$)[3].

Scotland is a proactive and ambitious country in developing and implementing environmental policies, such as pursuing World Health Organization standards for $PM_{2.5}$, implementing a framework of national Low Emission Zones, and setting zero-carbon targets for 2030 in Glasgow. However, it also faces significant challenges in achieving these goals, including climatic, economic and transboundary issues. Glasgow's hosting of the UN climate summit, COP26 (now postponed until November 2021), provides an opportunity to help raise the profile of climate change

[1] https://www.gov.scot/publications/cleaner-air-scotland-strategy-independent-review/
[2] https://www.hps.scot.nhs.uk/web-resources-container/air-pollution-and-health-briefing-note-mortality-associated-with-exposure-to-fine-particulate-matter-pm25-attributable-mortality-in-scotland/
[3] http://www.scottishairquality.scot/laqm/aqma

and related issues and could act as a catalyst for driving forward necessary policies and measures.

Achievement of these air quality and carbon reduction ambitions could have significant benefits for Scotland, but requires support and action at all levels from national government to citizens. Public engagement is therefore key to improving air quality and reducing carbon emissions through supporting policies and changing behaviours. The Scottish Government's phase out of new petrol and diesel cars by 2032[4] will necessarily enforce change on citizens, requiring adaptation and modification of behaviours. As the CAFS strategy review recommends, given the strict $PM_{10}$ and $PM_{2.5}$ objectives in Scotland, there is also a need to understand the contribution of domestic solid fuel burning to local air quality, and to also move away from gas sources, linking air quality policies with climate change and household energy efficiency. The importance of behaviour change in achieving carbon reduction goals is recognised by the UK Committee on Climate Change, which estimates that 60% of recommended interventions require some element of societal change[5]. Understanding how people currently contribute to emissions of air and climate pollutants is vital to influencing that behaviour[6]. Previous studies, including ClairCity (www.claircity.eu), have indicated that the public are concerned about air pollution, but feel ill-informed[7], despite education and awareness campaigns, e.g. http://www.scottishairquality.scot/education/. As a result, reducing air pollution is not currently a major driving force for behaviour change and does not factor significantly in day-to-day decision-making[8].

Before undertaking public engagement, as advised in the 2019 CAFS strategy review, the Scottish Government therefore needs to understand the Scottish public's current attitudes, perceptions, and behaviours towards air quality, and to identify successful approaches undertaken in other consultation and engagement activities that may be adopted and adapted for use in informing the new CAFS strategy.

## 1.3 Specific assignment objectives

In order to address the need for further evidence, the Scottish Government requested a literature review to fulfil the following objectives as outlined in the tender specifications:

1. Identify, review and synthesise up-to-date evidence on Scottish public attitudes, perceptions and behaviours towards air quality, to understand the key findings, robustness of evidence base and any outstanding gaps in the evidence:

[4] https://www.gov.scot/publications/fm-programme-government/
[5] https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/
[6] https://info.uwe.ac.uk/news/UWENews/news.aspx?id=4000
[7] https://airqualitynews.com/2019/03/26/majority-of-adults-anxious-about-air-pollution-and-worried-they-are-not-being-properly-informed/
[8] http://randd.defra.gov.uk/Document.aspx?Document=14242_DefraBMGResearch-PublicAttitudestoAirQuality-SummaryReport-May2018FINAL.pdf

- Provide an updated summary and review of latest available information, drawn from both scientific and grey literature sources, covering past qualitative and quantitative studies of Scottish public attitudes and behaviours towards air quality.

2. Identify and review recent approaches to engaging the public on air quality, to understand effectiveness, limitations and applicability in different contexts and make recommendations for public engagement as part of the planned public consultation on the new CAFS strategy:

    - Provide an expanded discussion and categorisation on recent public engagement approaches on air quality in Scotland, UK and internationally on the basis of existing information. This should highlight the various factors that help determine the effectiveness of public engagement approaches, as well as what is required to tackle real or perceived barriers.

3. Making recommendations for a public engagement strategy for air quality:

    - On the basis of the evidence gathered, we will assess the applicability of public engagement approaches to the Scottish context and make key recommendations to inform future public engagement strategies, as well as highlighting key knowledge gaps and future research needs.

### 1.3.1 Geographic scope

Overall, this report aims to capture a broad range of evidence from Scotland to document Scottish public attitudes to air quality policies but draws upon a broader range of UK and international case studies to identify effective public engagement approaches and assess their applicability to the Scottish contexts.

# 2 Methodology

**This chapter presents our methodological framework, including the peer-reviewed and supplementary sources used, the selection of search terms, the search limits and parameters, evaluation of search results and thematic analysis of the findings.**

## 2.1 Overall approach

The objectives outlined in Chapter 1 were addressed by conducting a review of available scientific and grey literature, including policy documents, research project reports. Figure 2-1 depicts the methodological approach.

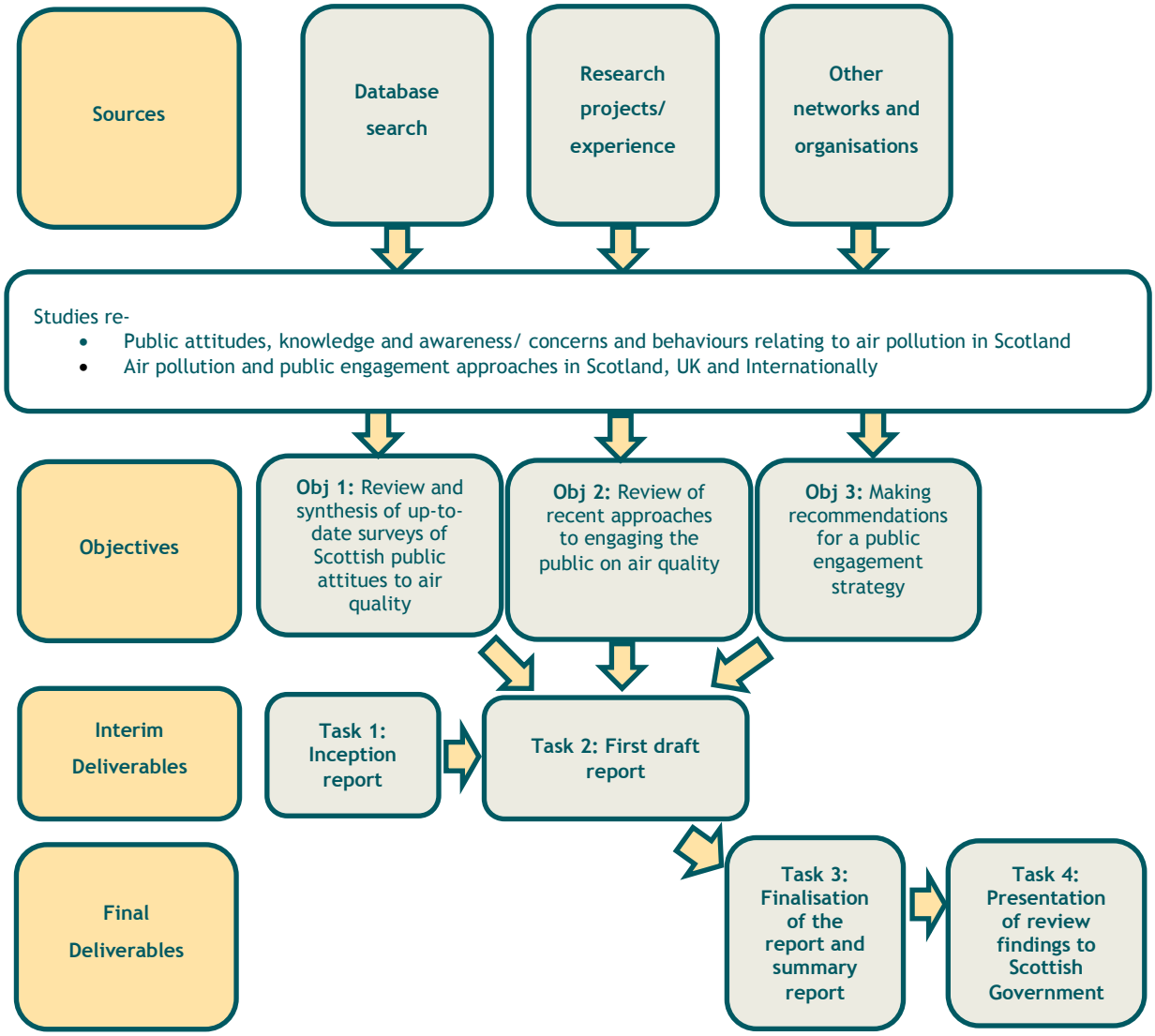


Figure 2-1: Methodology flow chart

### 2.1.1 Peer-reviewed sources

UWE Bristol has access to more than 40,000 journals, many of which are online, and a wide range of databases containing peer-reviewed journals and other relevant sources and resources across a broad array of subjects. Previous experience suggests a targeted approach focused on one or two key databases can yield cost-effective yet comprehensive results. To that end, we focused on the Scopus database and the ENDS Report.

### 2.1.2 Supplementary sources

While peer-reviewed literature provides the most scientifically robust and rigorous source, it was recognised that studies on public attitudes and behaviour change related to clean air policies in Scotland may not necessarily have been published in academic journals. In addition to the database searches therefore, a review of grey literature and other sources was also undertaken. Research projects identified from the CORDIS database and other relevant documents selected from organisations' and institutional websites including EU institutions' websites, Eurocities, C40, SEPA, Scottish Government, DEFRA, The Behavioural Insights Units OECD, Global Action Plan, and the UK Committee on Climate Change, were included in the search.

### 2.1.3 Search terms

Search terms were standardised and recorded to facilitate transparency and reproducibility, and were relevant to the objectives as set out in the tender specifications.

The key subject areas of relevance to this review are:

- Public attitudes, knowledge and awareness/ concerns and behaviours relating to air pollution in Scotland
- Air pollution and public engagement approaches in Scotland, UK and internationally

Search terms were therefore included that reflect these key themes. The use of appropriate search terms is vital to conducting a successful and useful review and therefore expertise was sought from across the project team in consultation with the Scottish Government to agree an appropriate search strategy.

Search terms were themed according to the core criteria:

- Search 1 (Public Attitudes to air pollution in Scotland): Air pollution (focused terms and related issues) + Scotland + Public + (Attitudes OR Knowledge OR Awareness OR Concerns OR Behaviour) (TITLE-ABS-KEY search)
- Search 2 (Air pollution and public engagement approaches): Air pollution (focused terms) + Public + (Attitudes OR Knowledge OR Awareness OR Concerns OR Behaviours) + Approaches (TITLE-ABS-KEY search)

Search 1 presents a relatively narrow search of literature relevant to Scotland and hence the intention was to broaden the scope of air pollution theme terms to

incorporate wider issues, including climate change, sustainability and place-making. By contrast, Search 2 focused more narrowly on air pollution specific terms as it was expected that this search would generate a much larger number of relevant results and hence requiring a need to limit these in line with the project scope, resource and timeframe. Both searches shared search terms relating to public and attitudes, knowledge, awareness, concerns and behaviours, given that this was relevant to both, however, Search 2 also included terms representing methodological approaches used in public engagement. Detailed search terms used for the Scopus search are provided in Appendix A. Further refinement of the search terms was required for the ENDS Report (Appendix B) and CORDIS database (Appendix C) searches due to inherent limitations of their search functionalities.

### 2.1.4 Search limits/parameters

Searches of the Scopus and ENDS databases were carried out on the 6th and 7th April 2020 respectively. Searches were limited to scientific literature published since 2015, to ensure only the most up-to-date evidence was included, but earlier literature was also included where relevant. Search terms for Scopus, run as Title and Abstract searches. Results from the Scopus search were stored and classified according to the Search 1 and 2 categories using Mendeley reference management software.

Searches of the CORDIS database were also carried out on the 6th April 2020. Searches were limited to EU projects funded since 2015. Search terms for the CORDIS search primarily focused on Search 2. The search was extended beyond CORDIS using the same search terms, but also expanded to include additional sources relevant to Search 1 where identified. Results from the supplementary source searches were recorded in an Excel spreadsheet.

Both searches were limited to English language documents.

### 2.1.5 Evaluation of search results

The level of significance attributed to the search results were subject to a risk assessment derived from the 'Six categories Quality Assurance Model' in which higher scoring literature carry more weight. The categorisations are based on the Quality Assurance statement reported (Table 2-1).

Table 2-1: 'Six categories Quality Assurance Model'

| Literature type | Quality Assurance Statement | Weighting |
|---|---|---|
| Grey literature/ published reports | Public awareness or behaviour change relevant, but not air quality specific and without quality statement | 1 |
| | Elements of public awareness and behaviour change and air quality or with an explicit quality statement | 2 |
| | Primary focus on public awareness and behaviour change and air quality or with an explicit quality statement | 3 |
| Peer-reviewed journal articles | Low-Citation Paper (FWCI <1), Low-Impact Journal (SJR <1) | 4 |
| | Low-Citation Paper (FWCI <1), High-Impact Journal (SJR >1) | 5 |
| | High-Citation Paper (FWCI >1), Low-Impact Journal (SJR <1) | 5 |
| | High-Citation Paper (FWCI >1), High-Impact Journal (SJR >1) | 6 |

For Scopus, Search 1 returned 6732 papers whilst search 2 returned 1066. These were screened by title and abstract for relevance to search 1 and 2 criteria. Search 1 subsequently returned a shortlist of 219 relevant documents whilst search 2 returned 75 relevant documents.

Shortlisted Scopus results were extracted to an Excel spreadsheet and assigned scores based on their Field-weighted citation impact (FWCI )[9] and SCImago Journal Rank (SJR )[10] (Scopus research metrics[11]), before a further, more in-depth screen of each paper content was undertaken for relevance. Finally, a detailed review of each remaining paper was undertaken.

For the Scotland-specific Search 1 shortlist, key findings, themes, robustness of evidence base and outstanding gaps in evidence were extracted where possible. For Search 2, behaviour change theory/methodology, the results/effectiveness and

[9] Field-Weighted Citation Impact in SciVal indicates how the number of citations received by an entity's publications compares with the average number of citations received by all other similar publications in the data universe, i.e. how do the citations received by this entity's publications compare with the world average; A FWCI of 1.00 indicates that the entity's publications have been cited exactly as would be expected based on the global average for similar publications. FWCI is size-normalized, field-normalized, publication-type normalized, resistant to database coverage and difficult to manipulate. FWCI also accounts for the relative number of citations relating to the age of the entity.
[10] SCImago Journal Rank is a prestige metric, whose methodology is similar to that of Google PageRank. It weights the value of a citation depending on the field, quality and reputation of the journal that the citation comes from, so that "all citations are not equal". SJR also takes differences in the behaviour of academics in different disciplines into account, and can be used to compare journals in different fields. The average SJR value for all journals in Scopus is 1.000
[11] https://www.elsevier.com/research-intelligence/resource-library/research-metrics-guidebook

limitations, and applicability in different contexts and recommendations for public engagement were extracted where possible. If information relevant to Search 2 was identified in Search 1, it was also recorded.

The ENDS database search returned 26 articles were for Search 1, of which, following a more detailed screen of the Title (no abstract available), 6 were shortlisted. Search 2 returned 17 articles, of which 12 had some relevance. Following a more detailed review of the content of Search 1 articles, no articles of relevance were recorded. Search 2 recorded 3 articles of relevance for the grey literature search and were subsequently screened for grey literature relevance.

The supplementary source search returned initially 227 results. The content of the projects' deliverables and the retrieved documents were screened for relevance to Search 1 and 2 criteria. A detailed screening of titles, abstracts, and content of deliverables or report returned 42 relevant documents. These were filtered to 41 results and expanded to 45 following inclusion of subsequently identified sources. Relevant results included research projects (22), reports (11), toolkits, news items, a poll, campaign, conference paper, consultation responses and an advice paper, from various sources, including academic institutions, consultancies, government departments and agencies, local mayors, charities and NGOs. Shortlisted documents were assigned scores based on a scale from 1 to 3 (based on Table 2-1). Details of the specific behaviour change theory/methodology, and their documented results/effectiveness and limitations were extracted from the sources and entered into the search results spreadsheet. Further information on their applicability in different contexts and recommendations for public engagement were also extracted where possible.

Once all relevant records from all sources were effectively extracted, the results were thematically analysed by topic (e.g. air, transport, domestic energy), behaviour change theory/methodology (e.g. Theory of Planned Behaviour) and/or public engagement approach (e.g. citizen science), by reviewing the extracted material in the Excel spreadsheet and creating a separate column by which the records were then filtered. This was further refined as the synthesis of the literature was undertaken.

# 3 Results

**This chapter presents the results of the literature review under the following headings: 1) Behaviour change theory, 2) Public engagement, 3) Scottish public engagement approaches, 4) Scottish public perceptions.**

## 3.1 Overview of the findings

The purpose of this review was to better understand the public knowledge, attitudes and concerns on air pollution in Scotland, as well as willingness and real and perceived barriers to change behaviours to reduce air pollution. The review also sought to identify methodologies implemented in public engagement on air quality in order to provide a critical review of approaches that could inform key recommendations for a public engagement strategy for air quality in Scotland, to inform the CAFS strategy and future public engagement approaches. In addition, the Scottish Government explicitly requested the review consider behaviour change methodologies.

In practice, the literature identified limited studies on public perceptions in Scotland specifically on air quality. In anticipation of this, a wider range of search terms were used and returned papers, reports and consultation responses that covered emissions-generating activities (e.g. transport/travel, domestic energy) and related issues (low carbon, climate change, energy production).

With regards public engagement approaches, the grey literature search identified just two Scottish sources on air quality and active travel and a small number of similar studies, not specifically relating to public engagement but providing useful narrative on Scotland and air quality and transport/travel. The majority of the public engagement studies in both grey and peer-reviewed literature searches were not related to Scotland. The grey literature sources mostly comprised research projects, providing useful evaluation of different engagement approach methodologies and were largely air quality-related. From the peer-reviewed literature, however, the Scottish studies identified were not specifically focused on public engagement techniques or air quality, but provide insight into various applications of public engagement in related areas (e.g. transport, active travel, planning and place-making, low carbon, climate change, energy and public health). In addition, there were a large number of non-Scottish papers covering behaviour change theory in the contexts of air quality, travel, climate change and low carbon.

On the basis of the findings described above, the Results section is structured as follows:

- Behaviour change theory (covering air quality but not necessarily Scotland),
- Public engagement approaches (covering air quality but not necessarily Scotland),

- Scottish public engagement approaches (findings rather than evaluation of techniques and not necessarily covering air quality),
- Scottish public perceptions (but not necessarily covering air quality).

In this way, the findings from the wider literature on behaviour change theory and public engagement can be related to the Scottish context of public engagement with an understanding of Scottish public perceptions on related issues. This synthesis will provide the basis for recommendations to the Scottish Government on future public engagement approaches relating to the revised CAFS strategy.

## 3.2 Behaviour change theory

Understanding behaviour and how it may be changed, requires an understanding of the factors that influence behaviours. The field of psychology has given us many theoretical models on which to frame that understanding, based on factors such as:

- Intentions – an individual's plans to carry out the recommended response,
- Attitudes – an individual's evaluation or beliefs about a recommended response,
- Benefits – positive consequences of performing recommended response,
- Barriers – something that would prevent an individual from carrying out a recommended response,
- Subjective norms – what an individual thinks other people think they should do,
- Self-Efficacy – an individual's confidence in their ability to perform a recommended responses
- Perceived Behavioural Control – similar to self-efficacy, but related more to an individual's perceptions of their ability to do the behaviour, rather than confidence, and
- Response Efficacy – perception that a recommended response will prevent the threat from happening.

The theory of planned behaviour (TPB) is a common theory used to understand and predict behaviours in many fields, and has been widely used in many of the peer-reviewed studies in this review. The theory posits that behaviours are immediately determined by behavioural intentions and, under certain circumstances, directly by perceived behavioural control. Behavioural intentions are determined by a combination of three factors: attitudes toward the behaviour, subjective norms, and perceived behavioural control (Figure 3-1) (Azjen, 1991; Kan and Fabrigar, 2017).

The TPB is normally modified (extended) to test additional factors (explanatory variables), e.g. the introduction of 'environmental concern' (e.g. Kai and Haokai, 2016; Fu et al., 2019; Zahedi, Batista-Foguet and van Wunnik, 2019); 'smog knowledge' and 'risk perception' (e.g. Zhu et al., 2019; Xu et al., 2020); 'past behaviour' (e.g. Hung, Chang, and Shaw, 2019); and 'habit', 'awareness of consequences', 'attitude towards public transport' and 'public acceptance of policy' (e.g. Liu et al. 2016).

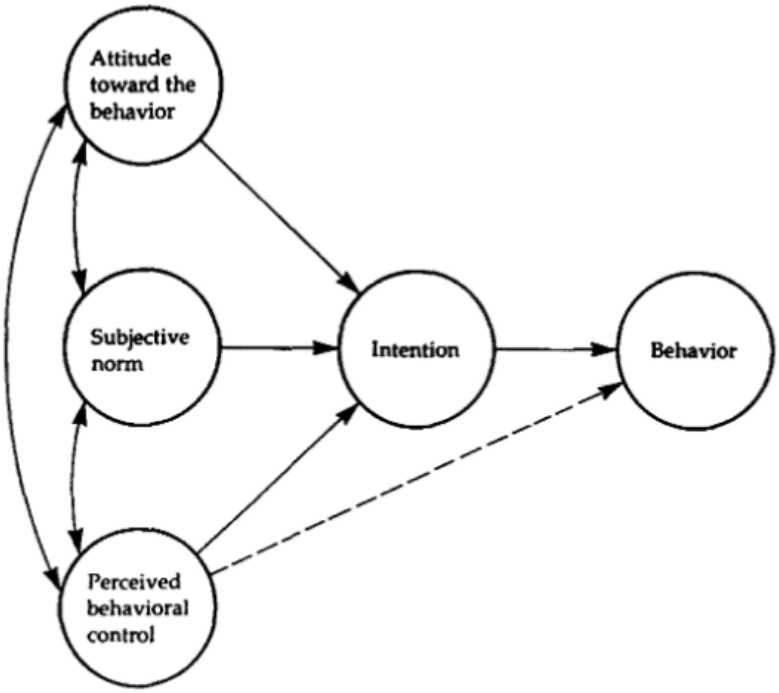


Figure 3-1: Theory of Planned Behaviour (from Ajzen, 1991)

In TPB studies, responses to survey questions designed to elicit understanding of each of the factors being tested are compared in a model, e.g. a structural equation model, to determine the contingent relationships between them and the dominant factors most likely to influence the behavioural intention. Various behavioural intentions have been studied, such as intentions to undertake behaviours to reduce air pollution (e.g. upgrade their vehicle) or to protect themselves or others from the effects of air pollution (e.g. wear masks). Sometimes studies (e.g. Fu et al., 2019) use respondents' 'willingness to pay' (WTP) for reductions in air pollution as the behavioural intention to ascertain a theoretical indication of strength of feeling.

The relevance of TPB, and other theories, in the context of behaviours concerning air quality are illustrated further in the following section. Given the limited scope of the literature review, this is not intended to provide a comprehensive history of behaviour change theory, but rather to highlight the findings of relevant studies published over the last five years to illustrate current thinking. The studies reviewed here focus on health protection, and mitigation of air pollution and carbon emissions, largely focused on reducing private car use.

Many of the Scopus Search 2 results (21) and a few of the grey literature results (7) provided studies examining behaviour change theories and models of behaviour in a predominantly Asian context (Chinese, Taiwanese, Malaysian, South Korean), although two European papers were identified (related to Catalonia, Spain and Yorkshire, England). Some of the studies undertaken in other countries and cultural contexts may have limited applicability for policy-making in Scotland, however the review has tried to discern relevance where appropriate.

The psychology of behaviour is complex and no single factor in the TPB or other behaviour change methodologies or models can be considered to explain completely

whether or why a change in behaviour is likely to be achieved. That said, according to the studies reviewed, some factors may be more dominant than others in certain contexts. The following sections highlight these studies by dominant factor in an attempt to explore these factors more fully.

### 3.2.1 Attitude

As the following examples demonstrate, individuals' attitudes to air pollution, or to the intended behaviour, can be fundamental, with increased environmental awareness or concern and associated risk perception acting as strong motivational factors. Increasing awareness of air pollution could therefore help to initiate or facilitate behavioural change.

In Zhu et al. (2019), public risk perception and willingness to mitigate climate change was explored, using city smog in China as an example. The study concluded that TPB is an effective model for predicting responses to city smog, and that risk perception is significantly positive in predicting attitude and behavioural intention, with knowledge about city smog a positive precursor to all three. As smog knowledge increases, people's risk perception increases accordingly. Individuals' high perception of threats from smog affects attitude, thereby stimulating higher intentions to adopt behaviours to reduce smog pollution. Knowledge about smog can therefore significantly influence people's attitude toward behaviours taken in response to smog, and to perceived behavioural control. According to the authors, individuals with considerable knowledge about smog are more likely to embrace positive attitudes, and feel more confident when participating in smog-reduction behaviour.

As part of the iSCAPE Improving the Smart Control of Air Pollution in Europe project, Adnan et al. (2019) used TPB to explore the determinants of pro-environmental activity-travel behaviour. The project investigated what could be possibly changed in the activity-travel routine to minimise the negative impacts of four dimensions: 1) Exposure analysis, 2) GHG emissions, 3) Involvement in physical activity and 4) Hot and cold car engine starts. The focus was on changing only those aspects of travel behaviour that are relatively easy e.g. short trips through active travel modes, use of public transport when it is easily available and reasonable in terms of travel time, chaining of flexible and non-mandatory activities in a single journey to reduce number of trips and cold starts. The results of the study verified that individual mobility decisions were highly influenced by attitude, but for people that are more environmentally aware and prefer to travel by using public and active transport, pro-environmental mobility was perceived to be easier, which translated into actual behaviour.

Zahedi, Batista-Foguet and van Wunnik (2019) also added environmental concern into their TPB model in exploring the public's 'willingness to pay' (WTP) to reduce air pollution and greenhouse gas (GHG) emissions from private road transport in Catalonia. The results indicated that environmental concern is positively related to the three main factors of TPB (attitude, subjective norms and perceived behavioural control), although subjective norms were less important, i.e. individuals with positive attitudes and perceived behavioural control indicated higher intention to pay and

WTP for the reduction of $CO_2$ emissions and air pollution. An increase in intention to pay thus relies on the combined effects of environmental concern, positive attitude and perceived behavioural control.

However, unlike Adnan et al. (2019) which was able to predict actual behaviour, Zahedi, Batista-Foguet and van Wunnik (2019) acknowledge one of the key limitations of their study, common to many TPB studies, is that adoption intention is not necessarily a reliable predictor of actual behaviour. Therefore, it may be necessary to examine the influence of motivational factors on real payment rather than WTP. Nevertheless, according to Zahedi, Batista-Foguet and van Wunnik (2019), citizens, particularly middle-aged adults and older adults (age 30+) in the mid-income level range, with low levels of environmental concern should be targeted with information about the importance of reducing GHG emissions and air pollution. Raising awareness in poorly informed groups that have the means to pay could positively affect their economic valuation of policies to reduce air pollution and GHGs, e.g. economic tools such as taxes. Furthermore, it is suggested that individuals may increase their intention to pay if they are informed that the tax revenue will be used to tackle the specific environmental problems mentioned.

Fu et al. (2019) also set WTP for air quality improvement as the behavioural intention and found that introduction of environmental concern and sense of duty can greatly improve the predictive utility of the original TPB model. However, they also found that subjective norms played a more important role than Zahedi, Batista-Foguet and van Wunnik (2019) suggest which, together with attitude and environmental awareness formed the major influencing factors in predicting intention.

In Fu et al. (2019), the level of air pollution was also a significant factor in affecting WTP due to the higher level of these motivational factors in highly polluted cities. Residents in the major cities of Beijing, Guangzhou, Hangzhou, Nanjing, Chongqing, expressed stronger concerns, environmental knowledge, attitudes, subjective norms, perceived control and sense of duty for paying for air quality improvement than those in Kunming city, reflecting the relatively lower levels of pollution in Kunming.

Interestingly, like Zahedi, Batista-Foguet and van Wunnik (2019), Fu et al. (2019) identify core social groups that showed a greater likelihood of higher WTP (i.e. males, middle-aged men, highly educated people, high-income earners, and people who spent longer amounts of time outdoors) suggesting that these individuals may be a good target for awareness-raising to facilitate behavioural change.

Li and Hu (2018) also found that in the Jinchuan mining area, residents' WTP for improving local air quality was significantly influenced by the perceived health risk of hazardous pollutants, environmental knowledge, socioeconomic status, current health condition, gender, work environment, and proximity to the pollution source. In this study, it is interesting to note that residents were only motivated by the perception of negative health outcomes caused by air pollution rather than to the exposure level.

Zheng et al. (2019) investigated green travel in the context of group behaviour in China. Their model showed that the individual intention for green travel is dependent

on behavioural attitude, but even if the knowledge level of green travel is high, if perceived behavioural control is low the proportion of individuals using green travel would still be low. Negative subjective norms and perception of behavioural result can also perpetuate low levels of green travel. However, in a connected network of individuals, where accumulation of environmental awareness is shared over time, a critical point may be reached whereby an explosive growth in the number of individuals choosing green travel is achieved through social interaction and learning, effectively shifting the social norms.

Absence of clear air quality information was found to be a barrier by Xu et al. (2020) in their investigation of residents' participation intention and behaviour in air pollution control in Beijing, China. A substantial difference between participation behaviour and intention was observed, and whilst the majority of respondents (65.1%) believed that participation behaviour can have a large positive effect on reducing the health risks posed by $PM_{2.5}$, most people also perceived great difficulty in performing the behaviour, citing insufficient reporting channels and low levels of information disclosure as contributory factors. The study also showed that people who have a stronger positive attitude and perceive greater social pressure to perform the participation behaviour have a stronger participation intention. Risk perception also showed significant positive effects on participation intention, attitude, subjective norm, and perceived behavioural control, and people with a higher income or illness experience perceived higher health risk.

Even in studies that did not use the TPB, strength of attitude, environmental awareness and risk perception as motivational factors is still apparent.

Factors influencing adoption of the Air Quality Health Index (AQHI) by 'at risk' populations' and their health care service providers' in Ontario, Canada, were investigated by Radisic and Bruce Newbold (2016). The AQHI is a national health protection tool in Canada, which provides air quality and health information to allow the public to implement health protective behaviours, such as reducing exposure. The AQHI is calculated based on the relative risks of a combination of common air pollutants that is known to harm human health: ozone, particulate matter ($PM_{10}/_{2.5}$) and nitrogen dioxide, and is measured on a scale ranging from 1-10+ grouped into health risk categories (i.e. 1-3 'low health risk' up to 10+ 'very high health risk').

The study found that knowledge of the AQHI centred on numerical reliance and health protective intent, with a higher level of AQHI knowledge among higher socioeconomic status (SES) individuals. The AQHI was not adopted by the majority of participants, in part due to lack of knowledge and time constraints, but also difficulties in perceiving the health benefits in relation to air pollution exposure. By increasing AQHI knowledge, emphasizing AQHI relevance, and reporting AQHI information at a neighbourhood scale via local media sources and wearable devices, the authors suggest that increases in AQHI uptake can be achieved while accounting for SES differences.

A study by D'Antoni et al. (2019) also compared the behavioural impact of the UK Air Quality Index (DAQI) with an alternative message format. The UK DAQI is very

similar to the Canadian AQHI, numbered 1-10 and divided into four bands, low (1) to very high (10), to provide health advice relating to different air pollution levels. In this study a 2 x 2 factorial design was used to compare the general population vs. at risk individuals, and presentation of usual DAQI health behaviour messages vs. behaviourally enhanced messages (i.e. targeting messages specificity and psychosocial predictors of behaviour change). An example of a behaviourally enhanced message during an air pollution episode could be: "*Adults and children with lung problems, adults with heart problems, and older people, should reduce levels and length of physical activity outdoors. Where possible, change travel route or exercise location (e.g. use our app to find less polluted roads or parks) or time (e.g. mornings or less polluted times)*". The researchers found that the enhanced messages increased intentions to make permanent behavioural changes (to respondents daily travel route, exercise location or exercise time) to reduce exposure. Like Radisic and Bruce Newbold (2016), this effect was mediated by a perception of not having enough time to follow the health advice received. However, they also found that higher levels of anxiety about air pollution, perceived severity, perceived efficacy of the recommended behaviour and self-efficacy were predictive of self-reported behaviour change at four weeks.

Jasemzadeh et al. (2018) looked at the effectiveness of a theory-based mobile phone text message intervention for improving protective behaviours against air pollution of 130 pregnant women in Ahvaz, southwest Iran, and found that there were statistically significant differences between perceived severity, response efficacy, self-efficacy, and protective behaviours between the control and experimental groups post-intervention. Mobile phone text messaging interventions could therefore promote protective behaviours against air pollution among pregnant women, but also more widely.

Awareness of air pollution can have negative behavioural consequences however when risk perceptions are inadequately managed.

Ego depletion theory and cognitive appraisal theory were combined in a study by Fehr et al. (2017) in which multilevel data was collected across two weeks from 155 employees located in urban China. According to ego depletion theory, acts of self-control draw from a common, finite global energy resource and, in the absence of sufficient recovery opportunities, individuals become drained of their capacity for self-control (Baumeister et al., 1998). Cognitive appraisal is essentially how an individual appraises a potential threat and their stress reaction to it (Lazarus, 1968). Results indicated that self-appraisals of air pollution severity depleted employees' self-control resources, which in turn mediated the effects of air pollution appraisals on employee behaviour, resulting in decreased organizational citizenship behaviour and increased counterproductive work behaviour. In other words, employees' perceptions of poor air quality led to selfish and disruptive work practices. Whilst the study accounted for employees' trait self-control, their daily negative affectivity and objective levels of air pollution, it didn't account for other confounding factors or desensitisation.

Heydon and Chakraborty (2020) used coping theory (i.e. the coping mechanisms individuals employ in response to stress (Lazarus and Folkman, 1984)) to explore the specific ways in which portable air quality sensors influence user behaviour in 15 primary schools across Sheffield, England. Whilst they found that participatory citizen science approaches can help to raise awareness of air pollution, when attempts at behavioural change fail to reduce risk, resulting psychological stress and negative feelings can ultimately lead to inaction.

The Protection Motivation Theory model assumes that decisions on whether an individual will engage in health-related behaviours are governed by two distinct cognitive processes: threat appraisal (i.e. the fear arising from perceived vulnerability and perceived severity of the threat) and coping appraisal (i.e. response efficacy, self-efficacy and perceived response-cost (or conversely relative benefits) – these terms are defined in section 3.2) (Rogers, 1983). Lam (2015) extended the Protection Motivation Theory model to include 'responsibility' and the 'subjective effectiveness of alternative solutions' in the context of climate change adaptation and mitigation in Taiwan. Their conclusion, that governments should focus on improving coping appraisal among the public rather than simply emphasising the probability and consequences of climate change, recommended focusing on policies that are simple to follow, and that people may be persuaded are both effective and beneficial.

Orset (2019) found that air quality information campaign messages in France failed to decrease respondents' preferences for their personal vehicles and were even counter-productive in some cases, although the reason for this perversity is not clearly explained. However, environmental awareness did increase individuals' WTP for their personal vehicle, leading the authors to conclude that creating awareness of the air pollution index and giving more confidence to travellers in air pollution recommendations would increase the travellers' WTP for low-emission means of transport. The study also found, however, that individuals who attach great importance to comfort are less likely to choose low-emission vehicles than those who value price above other factors, thus verifying the theory of the tragedy of the commons, whereby individual interest prevails over collective interest. The author suggests therefore that improving the comfort of public transport could be a way to encourage travellers to use low-emission means of transport, although this appears to disregard their earlier finding.

Kim and Kim (2019) suggest that risk communicators should take distinct social and cultural environments into account when developing strategies for effective risk communication. In their study on particulate air pollution in South Korea, they integrated cultural theory of risk with the Risk Information Seeking and Processing (RISP) model. The RISP model explains the cognitive, psychosocial, and communicative factors that determine when individuals are likely to seek out risk information and how they are likely to process it (Griffin, Dunwoody, & Neuwirth, 1991). Those that are more concerned about environmental issues (egalitarian worldview), were more likely to engage in information seeking to act on their perceived gap between what they know about particulate matter and what they need to know. In contrast, those that tend to discount environmental risks (hierarchists),

may be more sensitive to information insufficiency to engage in heuristic processing. Cultural worldview was therefore a significant driver in the relationship between information insufficiency and risk information seeking and processing.

Framing of perceptions on air quality was also the subject of Shapiro and Bolsen (2019) in their survey of residents in Seoul, South Korea. Koreans' views toward increased coal use depended on their exposure to a coal-costs or coal-benefits frames; however when both were presented, economic benefits outweighed concerns about the negative health effects. The results emphasise how, in this case, frames can shift perceptions about the need for policy action and the risks associated with a specific source, but also how economic arguments can have stronger relevance for the public than health effects.

In a review into the effectiveness of 55 behaviour change approaches in cleaner cooking interventions in resource-poor settings, Goodwin et al. (2015) found limited variation in the types of behaviour change techniques employed. Shaping knowledge, reward/threat, social support, and comparison appear most often and usually in combination, suggesting that a typical cleaner cooking intervention is one that promotes an economic incentive for the new technology combined with some form of social support. Successful interventions were shown to take into account various relationships and dynamics, including those at the individual, interpersonal, community and national levels, and use of change agents and demonstrations were also found to be effective. Data on the outcomes and impacts of activities, however, was often underreported and there was also a lack of evaluation of communication strategies.

Attitude Summary: In this section, we have observed that environmental awareness can positively impact attitudes on air pollution and behaviour change and that raising awareness of air pollution can help to engender those behaviours. There is also evidence to suggest that information focused on communicating health impacts, rather than concentrations or emissions may be more impactful. However, to be effective messages should be targeted at those that have the means to be able to make the necessary changes. Furthermore messaging need to consider different sociocultural environments, be appropriately communicated, and constructive and empowering in order to combat paralysis of inaction resulting from negative psychological impacts and lack of perceived behavioural control.

### 3.2.2 Perceived behavioural control

As well as ensuring a positive attitude, behaviour change should also account for perceived behavioural control, to ensure that individuals and society feel the behaviour is within their ability to implement. As we have seen in some of the studies already reported, even when there is a strong positive attitude, individuals can feel unable to respond.

Kai and Haokai (2016) included environmental concern in their investigation of factors affecting green commuting behaviours in Beijing and Shanghai. However, in their analysis, although enhancing commuters' environmental concern would

indirectly contribute to improving intentions, perceived behaviour control, i.e. the difficulty individuals have in implementing the behaviour, was found to have a more direct impact on green commuting. Therefore, the authors conclude that increasing the development of transport infrastructure can help to reduce obstacles for commuters, and that creating a sense that public transport is easy and convenient would promote green commuting and help to create a new travel lifestyle.

Liu, Hong and Liu (2016) investigated whether driving restriction policies could effectively motivate commuters to use public transportation in Tianjin, China. The results support the findings of Kai and Haokai (2016), suggesting that a driving restriction policy alone cannot effectively motivate commuters to use public transport, but that policymakers must also improve public transport, enhance commuters' awareness of consequences, increase commuters' perceived behaviour control, and encourage car owners to change driving behaviour. Perhaps unsurprisingly, car owners tended to view driving restriction policy and public transport more negatively than non-car owners, which the authors suggest could be a barrier for the promotion of public transport among car owners. Also, attitude toward public transport was found to have positive correlation with commuting time indicating that improvements to frequency and punctuality of public transport could also facilitate behaviour change.

As Guerra and Millard-Ball (2017) report, however, driving restriction policies can be ineffective if deliberately circumvented. Challenging other studies, which suggest the ‘Hoy No Circula’ driving restriction in Mexico City resulted in households purchasing second, more polluting vehicles, to get around the odd-even registration plate ban, the authors suggest that residents had many other behavioural responses available to them, such as shifting trips to other days, upgrading their existing vehicle, or simply relying on the paucity of enforcement.

In a different context, Meinherz and Videira (2018) used participatory modelling to elicit behavioural drivers in the case of domestic wood burning in Talca, Chile and found a similar ‘tragedy of the commons’ issue as Orset (2019). The purpose of the model was to analyse which behavioural rationales interrelate in a household’s decision-making process regarding heating, as well as their inter-relations with the different governmental management options. Distinct differences were observed between middle-income and low-income households, with decisions determined by cost, whether householders suffer from air pollution, and the age of their current heating equipment. The paper highlights a series of dilemmas, notably the self-aware paralysis caused by a desire for societal change resulting in improved air quality coupled with the desire to maintain individual behaviours to continue low-cost wood burning. Timing of policy implementation was also highlighted as subsidising insulation was perversely found to reduce the desire to shift to more effective pellet-burners. Low-income households saw fuel substitution (to dry wood) as the solution rather than upgrading of appliances.

Nudge theory is discussed further with respect to subjective norms in the following section, however with regards to perceived behavioural control, it is useful to

consider as a facilitating approach. EAST - Four simple ways to apply behavioural insights, a report from The Behavioural Insights Team, presents an alternative to the traditional 'nudge' approach as defined by the acronym MINDSPACE. EAST (Easy, Simple, Attractive and Timely) aims to provide a complementary approach by focusing more on how to apply behavioural insights in practice. Although not specifically produced with emissions reduction strategies in mind, ensuring interventions follow the EAST acronym should improve individuals' perceived behavioural control. The report also highlights the need to define the outcome and understand the context before designing behavioural insight interventions, and that it is important to subsequently test the intervention to learn and adapt future practices.

The Stockholm Environment Institute (SEI) present 7 Reasons why behavioural science is crucial to sustainability, which briefly illustrates the importance of implementing people-centric, systemic, effective public policy, that more accurately reflects reality, and engages consumers so that sustainable behaviours are natural and allows approaches to be tested to see what works. This principle again embodies the idea that to enable citizens to adopt behaviours that are sustainable, they must be easily implementable.

Perceived Behaviour Control Summary: In order to address issues relating to a lack of perceived behavioural control, policies to encourage behaviour change must be enabling rather than simply restrictive. For example, introduction of driving restrictions, such as LEZs, should be accompanied with improved cycle and walking infrastructure and public transport. If behaviours are to be changed then the alternative must be easier, more convenient and preferably cheaper. The latter is particularly important when considering lower socioeconomic status groups. Different users and sectors of society will have different perceptions of behavioural control and different barriers to overcome. Where restrictive policies are imposed, consideration should also be given to the potential for people's perceived behavioural control to avoid those restrictions.

### 3.2.3 Subjective norms

Subjective norms affect how we see the world through the eyes of others and can perpetuate behaviours perceived to be socially acceptable or 'normal'. Changing behaviours can therefore be seen as 'bucking the trend' or even unpopular. By contrast, if our subjective norms tell us that the new behavioural intention is socially 'good' or popular, then this too can act as a driver for change.

Hung, Chang, and Shaw (2019) investigated individuals' intentions to mitigate air pollution from vehicles, household appliances, and religious practices (incense burning) in Taiwan, and found that subjective norms represent the primary driver of individual intentions to reduce air pollution, followed by perceived behavioural control, past behaviour, and attitude, in that order. The study suggests prioritising public information and educational campaigns targeting air pollution reduction to create a "social atmosphere" and "consensus", should be a top priority in policy communication. It also highlighted that measures that were simple to implement and had direct impacts would have the greatest effect on individuals' behavioural

intentions, but that relatively expensive measures, such as energy saving or electric vehicles, would have less influence behaviourally, despite having the potential to substantially reduce air pollution and $CO_2$ emissions. Interestingly, this study also found that air pollution, rather than carbon reduction, policy was more likely to be the greatest motivator in influencing an individual's attitude to transport modal choice. Although not explored within this study, it is inferred that this may be because individuals are directly affected by and are more likely to be concerned about air quality.

In investigating how exposure to social media health information during air pollution episodes influences health protective behaviour in China, Yang and Wu (2019) found that attitude and descriptive norm (i.e. whether other people perform the behaviour) positively mediated the relationships when using Weibo (a Chinese microblogging app similar to a combination of Twitter and Facebook) for health information and behavioural intention. Conversely, descriptive norm negatively mediated the relationship between using WeChat (Chinese micro-messaging platform) for health information and behavioural intention. The authors suggest that the differences in findings between the two social media platforms may be due to their differing utility, with Weibo used more as an information source, whilst WeChat is used more for informal communication between friends. Whether this finding is transferable to Western social media engagement is difficult to say, but it identifies that some apps may be more effective than others for communicating about air pollution and behaviour change.

Yang and Wu (2019 also found that attitude, descriptive norm, and injunctive norm (i.e. what individuals perceive significant others to approve of or think they ought to do) significantly predicted behavioural intention and mask-wearing, but perceived behaviour control did not. The lack of association with perceived behaviour control was attributed to the accessibility and affordability of masks in China. Following COVID-19, mask-wearing in the UK has become more ‘normal’, however, it is unclear whether this behaviour is desirable from an air pollution perspective given their limited effectiveness in protecting from gaseous pollutants.

A study of young Chinese college students in urban China (Hansstein and Echegaray, 2018) also found that social norms were the main motivations behind pollution-mask use, influenced by their friends’ and room-mates’ opinions. According to the authors, use of peer pressure, celebrities, key opinion leaders, or authoritative spokespersons to reinforce social adequacy and “coolness” may be an effective strategy to influence this behaviour. The study also found that past behaviour was important in strengthening the relationship between intention and behaviour by acting as an intention stabiliser.

In terms of reducing air pollution, Ru, Qin and Wang (2019) revealed that subjective norms indirectly affected perceived behavioural control and personal moral norms, which significantly affect young people’s attitude towards $PM_{2.5}$ reduction intentions. Therefore, subjective norms are a significant determinant of pro-environmental

behaviour, and social norms, perceived behaviour control, and personal moral norms play vital roles in promoting $PM_{2.5}$ reduction behaviour.

For parents of young children from urban and rural Beijing, subjective norms were most influential for predicting behavioural intentions to protect against $PM_{2.5}$ (Liu et al., 2018). Differences between urban and rural were observed, however. For urban parents, perceived behavioural control had a direct impact on behaviour intentions, and their attitude also had an indirect influence through subjective norms. On the other hand, rural parents' attitudes had both direct and indirect effects, and perceived behavioural control had an indirect effect on behavioural intentions through subjective norms.

In Komatsu et al. (2020), the perception of air pollution risk resulting from industrialisation in Japan was found to be mitigated when the benefits of industrialisation were supplemented with messages (particularly as a combination of textual and visual information) indicating altruistic intergenerational support. Whilst the findings of this study were used to show how risk perceptions could be reduced through communication of the intergenerational benefits of industrialisation, the authors suggest that this familial 'nudge effect' could be used to encourage pro-environmental behaviours.

Oxera's Agenda economics business briefing, Hard shoulder: using behavioural nudges to reduce congestion (2017) makes a case for nudge theory in behavioural economics. As the report states, behavioural economics has found that nudges work best when they harness or reinforce existing social norms—i.e. the values, behaviours or expectations that implicitly guide the behaviour of a community. For example, informing an individual that their peers are making socially conscious choices can reinforce his/her underlying motivations. Evidence suggests that comparing a consumer with their neighbours in this way is effective in encouraging them to make socially optimal decisions such as filing their tax returns on time or reducing energy consumption. For example, the 'Most of us wear seatbelts' campaign in Montana, USA publicised the fact that 85% of car users wore seatbelts, thereby enforcing an existing social norm and driving a significant increase in seatbelt use.

In the context of congestion reduction, transport authorities could inform individuals of the proportion of their neighbours who use car pools or cycle to work. Similarly, social norms against pollution could be leveraged to reduce car use by comparing the amount of carbon that an individual emits with a local benchmark or 'carbon budget'. Even when norms are weak, nudges can be applied to embed socially positive attitudes or behaviours. For example, individuals who commute at off-peak times or use public transport could be given a platform to communicate their socially conscious travel choices to their peers, generating a 'badge effect'. Behavioural economics provides a number of insights that can assist policymakers in efficiently reducing congestion. Evidence suggests that interventions based on nudging users can provide credible and cheaper alternatives to traditional price- or supply-side interventions. In particular, carefully framing how information and incentives are

presented to individuals, as well as considering when such interventions should occur, can have a significant impact on the travel choices they make. There is scope for policymakers, transport planners and private organisations to give greater thought to how and when such nudges can be used effectively in the transport sector.

Subjective Norms Summary: As these studies have shown, subjective norms are frequently identified as dominant or strongly influential in driving behavioural intentions, particularly relating to health protection. In the studies reviewed, young people and families appear to demonstrate this most clearly. Building on the social, familial and intergenerational drivers that affect subjective norms can therefore help to target behaviour change in these groups. As identified, nudge theory recognises the potential to shape individual behaviours through communication that appear to indicate the wider societal acceptability of the behaviour. There is therefore also significant scope to affect normative behaviours by influencing the influencers. Targeting those that are able to shift the social consciousness on air pollution, such as social media influencers and celebrities can help to signal the acceptability of desired behaviours, whilst using social networks, friends and families to help share these messages can help to reinforce their normality.

### 3.2.4 Summary of behaviour change theories

Whilst we have categorised studies here according to the dominant factors affecting behaviour change identified, as defined by the TPB model, it is clear that these internal factors act in combination and vary across studies and societies. Although TPB studies recommend policies focus on attending to the dominant factors identified in relation to their particular study, it is probably of greater value to try to draw out the key messages from all of the studies reviewed as a whole, rather than focus on the applicability of any one study in Scotland.

As a caveat, many of the behaviour change studies we have reviewed here focus on self-reported intentions, however, it is widely recognised that intention and self-assessments are not necessarily good predictors of actual behaviour.

The studies reviewed here mainly identified attitude as the dominant factor, which could be significantly strengthened with the inclusion of environmental awareness or concern. Hence, many of the studies recommended increasing public awareness of air pollution to ensure policies seeking to achieve behaviour change were more positively received. However, provision of information and awareness raising can be flawed if used in isolation. Furthermore, a number of studies reported that knowledge of air pollution can actually cause negative affective responses leading to stress and paralysis of action if risk perception and behavioural responses are not properly managed.

Subjective norms were also widely identified as dominant factors reflecting the normative drivers of our behaviours and acknowledging how shifting those norms can be a powerful mechanism to achieve desired behaviour change. Not only is this significant for individual behaviour change, but, by changing what is considered socially-acceptable, whole societies can be influenced with the potential for creating

significant impacts in improving air quality. Furthermore, by making use of social networks to disseminate messaging about the health effects of air pollution and the behaviours that can reduce them, this itself can start to engender the subjective norms.

Perceived behavioural control appears to be less significant as a dominant factor than attitude or subjective norms across the studies reviewed. This is not to say that it is not important, as it can still be a significant moderating factor where positive attitudes or subjective norms are high, reducing individuals' ability to enact the behaviours that they would like to, or that they feel society would like them to. As some studies have identified, it has also been considered dominant in its own right, particularly in commuting and home heating, where alternatives may be unavailable, or at least unobtainable given limited resources. The lessons from consideration of perceived behavioural control are therefore the need to consider all socioeconomic strata and to ensure that policies intended to change behaviours are simpler, more convenient and less expensive than the current behaviours. However, where this means making the existing behaviour comparatively less appealing, this must not penalise those that may have little ability to change.

## 3.3 Public engagement approaches

A range of public engagement approaches have been identified in this review, from communication tools, traditional questionnaires and focus groups, to more participatory 'citizen panels', 'citizen science', 'living labs' and co-creation, and novel techniques using social media and gamification. We have not included polls or public engagement that merely sought public opinions without any element of awareness-raising or behaviour change. The approaches identified here are not Scotland-specific (these are covered in the next section), but are focused on air quality, climate change or traffic emissions with the intention that this may provide a useful set of experiences from which lessons may be learnt. Around nine peer-reviewed papers and 21 research projects, reports, toolkits and campaigns were identified.

### 3.3.1 Communication tools

The Horizon 2020-funded ClairCity (Citizen Led Air pollution Reduction in Cities) project (2016-2020), which was conducted across six European cities and regions, including Bristol, England, used a range of public engagement approaches in order to better understand how to formulate policies to reduce air pollution and carbon emissions with citizens at the heart of the process. Some of these activities included schools engagement, community films, public events, an app, a game (see Gamification section 3.3.6), surveys (see Questionnaires, workshops and focus groups section 3.3.2) and social media. The Community Activator Pack is a fantastic guide that builds on the experiences of the ClairCity project, aimed at community groups and activists that are concerned about air pollution and carbon emissions, but also provides a valuable resource for policy-makers that are looking to engage members of the public. Additionally an Educator Pack was developed and promoted by the British Science Association for schools which has been downloaded >100,000

times. Further guidance was also produced specifically aimed at policy-makers and a series of webinars are available to view online.

Communicating on air quality and health - inspiring practices, challenges and tips is a report from the EU Urban agenda air quality partnership intended to provide hands-on examples of how communication on air quality, the health links and (policy and behavioural) changes takes place, as an inspiration particularly for urban authorities wanting to communicate on clean air. The report is based on the responses to a survey of 66 local authorities from 13 EU countries and presents a number of 'inspiring practices' as well as a section on challenges and stumbling blocks, some 'hands-on' communication tips and lessons learnt.

uCARe You can also reduce emissions is a Horizon 2020 project (2019-2022) that aims to improve understanding of motorists' behaviour and the impact of user-related reduction measures to improve pollutant emission legislation and policies. The project will create easy to use instruments based on measures targeting the reduction of emissions and develop information campaigns through stakeholders. A series of DIY videos have been created to help drivers to reduce their emissions.

Although not specifically focused on public engagement, the London Mayor's Toolkit of measures to improve air quality at schools may be a useful resource to use when communicating with schools on air quality measures. The toolkit provides a very detailed summary of measures, including behavioural measures, and case studies from which useful lessons may be learnt.

Naik et al. (2017) report on a collaborative health impact assessment and policy development to improve air quality in West Yorkshire, England. A broad engagement initiative was carried out as an integral part of the strategy development, including a full public consultation. Infographics were placed as street installations to raise public awareness of air quality, e.g. an infographic was displayed on air quality stations. Local authority officers worked with local doctors to develop an air quality campaign and petition to raise awareness in the local medical profession. Born in Bradford (a large birth cohort study) conducted their own engagement initiatives to disseminate the results of their air quality research. The National Centre for Atmospheric Climate also conducted roadshows in the region to raise awareness of air pollution and seek input from interested people. However, these engagement mechanisms were not evaluated.

Communication Tools Summary: There is a wealth of tools and examples of good practice communication on air pollution that are available for authorities and others to utilise, adapt and develop. Creative approaches to engage specific sectors of society, such as vulnerable groups (schoolchildren, the elderly and those with pre-existing conditions) and different socioeconomic groups, as well as user groups (e.g. drivers) should be considered as well as broad-brush campaigns to raise awareness more generally. Using communications experts, as in the ClairCity project, is highly recommended, and subject experts, such as doctors and scientists, as in the example from West Yorkshire. Planned evaluation of campaigns should be designed in and materials should ideally be made more widely available for others to learn from and use. Communication tools can however be perceived as one-directional,

top-down approaches, from which it is difficult to gauge engagement. Whilst potentially useful for awareness-raising, therefore, they may be limited as behaviour-change mechanisms.

### 3.3.2 Questionnaires, workshops and focus groups

As well as the engagement methods described above, the ClairCity (Citizen Led Air pollution Reduction in Cities) project also used some more traditional techniques. The Citizen Delphi involved a series of questionnaires and workshops, each building on the findings of the previous one. This was an innovative take on the traditional Delphi methodology, which normally uses experts to derive solutions to intractable problems. In ClairCity the citizens were seen as experts in their own lives and key to understanding the desires and challenges faced in undertaking the day-to-day activities (travel for commuting, school, shopping and leisure, and home heating) that ultimately generate most of the local emissions.

The first questionnaire was conducted largely face-to-face and included mainly open questions so as not to introduce researcher bias. The second round of the questionnaire was conducted online with mainly closed questions to try to focus responses into common themes. The next round was held as a number of small workshops with the purpose of deriving deeper understanding of how the desired behaviours and issues raised in the questionnaires could be better facilitated by policymakers.

As a Delphi methodology, the public surveys did not seek to be statistically representative, however efforts were made to purposively sample from under-represented demographic groups in less affluent areas and from BAME communities to ensure these groups were not omitted from the research. The Citizen Delphi comprised just one part of the ClairCity research process, which ultimately brought together outputs from the wider public engagement activities (discussed later in this section), with those from stakeholders and policy makers workshops to create a Policy Package of measures and recommendations.

One of the key findings of reversing the traditional top-down policy approach on air quality and carbon emissions in this project was the level of awareness and ambition that citizens had for their future cities, which had perhaps been underestimated by politicians in the past. Another strength of the Delphi approach is to ensure that the conversation is not dominated by the most vocal respondents as every respondent is heard equally and consensus is derived from collective responses. As a public engagement approach, the Citizen Delphi took a fairly traditional questionnaire and workshop approach but applied it in an innovative way to generate interesting and relevant findings.

The SEFIRA Socio-economic implications for individual responses to Air Pollution Policies in EU +27 (FP7, 2013-2016) pilot study involved 11 focus group interviews with citizens affected by (or affecting) local air quality measures. In particular, the research focused on traffic-related air pollution. This is not only because traffic is one of the main sources of pollutants in urban environments, but also because many city dwellers are being confronted with policies related to traffic on a daily basis. This

more narrow focus allowed the project to move beyond the mere exchange of 'opinions' in the direction of a more in-depth understanding of reactions to air quality policies, which also include 'experiences'.

Focus groups allowed the project to scan the diversity of possible opinions and reactions to the existing air quality situation and the measures intended to address air pollution, and also to try to arrive at in-depth insight into perceptions and behaviour with regard to air quality, as well as the reasons and motivations behind acquiescence, resistance or pro-activeness in relation to air quality policy measures and behaviour change. Furthermore, focus groups helped in gaining insight into the kind of group dynamics that generate social norms or expectations with respect to environmental issues. The overall goal was not only to acquire a better understanding of the perceptions and behaviours of individual persons in relation to air quality and related policies, but also to study social interactions and dynamics that arise when air quality becomes the topic of common action and debate.

Questionnaires, Workshops, Focus Groups Summary: Two examples of EU-funded projects have been presented here using questionnaires, workshops and focus groups to gain better understanding of citizens' views and opinions, but also their lived experiences. As we have seen in the behaviour change theory section 3.2, it is necessary to understand individuals' behavioural drivers (their attitudes, perceived behavioural controls and subjective norms) to target polices to address air pollution. Questionnaires can be useful in obtaining information from a large number of respondents, but they can also be limited in the depth of understanding that they are able to achieve, with a trade-off between the number of questions and the response rate a key consideration. Whilst iterative (such as in ClairCity's Citizen Delphi) or longitudinal 'diary' approaches can help to address this the information provided can still be difficult to interrogate. Focus groups enable a more in-depth conversation with individuals and the opportunity, as with the SEFRIRA project, to observe social norms at play. However, they generally are limited in the number of participants that they are able to engage, and there is a tendency for self-selecting participants to poorly represent the wider community, unless purposively targeted.

### 3.3.3 Citizens' panels

Three citizens' panels, or citizens' assemblies, on air quality were identified: Lille, France; Lublin, Poland; and Kingston-upon-Thames, England. The first two were in response to the EUROCITIES initiative based on the principles of deliberative democracy. The panels/assemblies were convened by local municipalities but recruited, run and facilitated by independent organisations. The panels were made up of ~40-60 demographically representative members of the public selected at random, from registered individuals. The purpose of the meetings, which were held from one to several days was to raise awareness about air pollution and seek solutions. The Kingston citizens' assembly was held over two weekends in November and December 2019, at Kingston University. The panels' deliberated over recommendations presented by invited experts or proposed their own. At the end of the meetings the chosen recommendations were taken to the council meeting or Mayors' Summit.

Citizens' panels provide a deeper level of engagement with citizens and presents a shift from the top-down engagement mechanisms reviewed so far to a more inclusive approach to policy development. They are less intent on raising awareness or understanding citizens' views (although that is a part of their function), but more specifically for citizens to consider and respond to evidence presented on an issue in order to make recommendations to policy makers. In contrast to typical focus groups, the citizen panels are selected to be demographically representative to better reflect society, although from the examples reviewed it is difficult to discern whether the panels are also socioeconomically diverse or successfully achieve engagement with typically hard to reach groups. Whilst the citizens' panels provide a more inclusive and deliberative approach to traditional top-down consultation techniques, the public are still presented with information and their recommendations ultimately are still for policy makers to decide upon. In the following examples, we examine approaches that seek to bring citizens even more fully into the development of policy.

### 3.3.4 Citizen science

The Doing It Together science (DITOs) project (Horizon 2020, 2016-2019), aimed to elevate public engagement with science across Europe from passive engagement with the process of developing science to an active one. The consortium delivered nearly 830 public events and engaged about 515,000 people face-to-face as well as 3,296,000 online interactions. Some of these activities included doing citizen science, as 'engaging by doing' is central to the effort of the project. Other activities, both online and offline, are focused on communicating different facets of citizen science, from in-depth engagement with small and organised groups to large-scale engagement via social media. Citizen science can play a prominent role in analysing and reducing inequalities in cities. Citizen science can help policy makers to think in new institutional models that are more permeable to society to facilitate new collaborations, experiments and knowledge production. This might lead to models where dissemination becomes coproduction.

Building on the Global Action Plan's UK Clean Air Day, members of the DITOs project and the European Citizen Science Association (ECSA) Working Group developed the annual EU Clean Air Day, which started on 20th June 2019 (DITOs Consortium, 2018). The primary goal of the event is to engage citizens across Europe in doing science on air pollution. Live events were held across 8 cities in 7 EU countries including do-it-yourself sensor-building meetups, 'hackathons' on visualizing air quality, symposia, creating posters in schools and creating a stand in a museum. While some activities focused on social-political aspects such as citizen engagement and empowerment, other live events presented and discussed technical aspects of sensors, data platforms and measurement methods.

The CAPTOR Collective Awareness Platform for Tropospheric Ozone Pollution project (Horizon 2020, 2016-2018), showed that the citizen science approach can help to raise awareness of environmental problems. In three testbeds, in Italy, Austria, and Spain, 46 low-cost ozone measurement devices, called CAPTORs, were installed outside citizens' private houses (hosts) to collect data on ozone

pollution in the summer months of 2017 and 2018. The project aimed to advance existing knowledge on the usage of low-cost sensors for ozone measurement and learn about the impact of the involvement of citizens as sensor hosts. The presence of devices outside private homes and in public spaces raised interest in the topic, leading hosts to search for information in addition to that provided from CAPTOR. In Austria, they rediscovered a "forgotten" pollutant, in Italy, they learned that this pollutant exists in the first place and in all three testbed areas, hosts improved their understanding of local impacts. This increased knowledge enabled hosts to discuss the issue with others, thereby becoming promoters for the topic in their private networks. Some hosts even brought the topic to their local environmental organisation or municipalities. In terms of behaviours change, some hosts tried to reduce their exposure to ozone (e.g. no jogging in the afternoon, opening the windows in the morning, warning family members to not do sport during ozone peaks), but none of the hosts said that they took their car less due to the CAPTOR experience. Firstly, this was because most of them had already been following an environmentally friendly lifestyle before CAPTOR; and secondly, because hosts felt that their personal behaviour had little to no influence on ozone being a secondary pollutant.

Various EU wide citizen science initiatives have evolved and use a combination and adaptation of two well established models for citizen science and citizen sensing: "The Bristol Approach" and the "Making Sense Framework". These methodologies have been successfully used in various participatory projects, such as Horizon 2020 D-Noses, which explores odour sensing and sustainability; Horizon 2020 CitieS-Health which is putting people's concerns at the heart of research related to environmental epidemiology; Horizon 2020 Sharing Cities, which is looking for common solutions related to smart cities; and Horizon 2020 WeCount which has citizens counting traffic in their streets using low cost sensors and empowering people to engage in the debate around urban mobility, safety and environmental challenges such as air pollution. Typically, the methodological process involves five steps: (1) Scoping and Community Building, (2) Co-design of research questions, (3) Data Collection, (4) Data Analysis and Awareness, and (5) Reflection and Legacy.

Citizen Science Summary: The focus of citizen science is typically to raise awareness by participation, rather than passive observation. From using nitrogen dioxide diffusion tubes to creating Raspbery Pi air quality sensors to air quality data programming hackathons to explore novel way to reduce or communicate air pollution there are a number of technically creative ways of engaging citizens, particularly, but not exclusively, children and young people, in creating or using air quality data. They are also a good way to build networks between researchers, citizens and policy makers and create engaged communities, which can themselves become disseminators and raise awareness of air pollution amongst their peers and families, as in the CAPTOR project. As we have seen from Heydon and Chakraborty (2020), however, although using low-cost sensors can raise awareness, changing behaviour requires individuals to feel empowered to make that change. Caution should also be applied to low-cost citizen science data to ensure that users are not

misinformed about the degree of accuracy that these devices can provide, that might either falsely alarm them or conversely give them a false sense of security.

### 3.3.5 Living labs/co-creation

An extension of citizen panel concept is to co-create and co-design solutions using the city environments as effectively 'living labs'. The IRIS Integrated and Replicable Solutions for Co-Creation in Sustainable Cities project (Horizon 2020, 2017-2022) is a good example of integrated interdisciplinary citizen engagement and co-creation. The expected impacts of IRIS are an open innovation ecosystem motivating citizens to act as prosumers; more effective urban planning and governance of integrated solutions; exploitation of validated innovative business models based on multi-stakeholder collaboration; and more stable, secure and affordable energy and mobility services for citizens, with improved air quality. In a webinar hosted by the project in May 2020, the researchers discussed and shared valuable insights from the citizen engagement activities that they have undertaken, including on the 4 stages of citizen engagement (citizen information, citizen dialogue, citizen co-creation and citizen orchestration), design systems thinking in cities, touchpoints and influencers. Focusing on energy use, the project has set out a range of approaches: identification of community change agents; creation of innovation hubs for co-creation activities; game design interaction scenarios, including connected app-based interfacing with smart streetlight sensors to collect data. They are also proposing participatory city modelling using a Minecraft 'Greenhack' to engage young people in the creation of forthcoming electrified bus stops; and a Personal Energy Threshold PET application tool to help improve energy efficiency.

The hackAIR Collective awareness platform for outdoor air pollution project (Horizon 2020, 2016-2018), aimed to develop and pilot test an open platform to enable communities of citizens to easily set up air quality monitoring networks, and engage their members in measuring and publishing outdoor air pollution levels, leveraging the power of online social networks, mobile and open hardware technologies, and engagement strategies. hackAIR helps to fill current gaps in areas where the distance between official air quality monitoring stations may be significant; improve access to data from different sources and provide up-to-date air quality information. The overall objective of hackAIR was to provide an open technology platform that citizens and interested parties can use to access, collect and improve air quality information in Europe, with the ultimate goal to raise collective awareness about air pollution and promote a change towards environmentally friendly behaviours.

hackAIR combines official open air quality data with a number of community-driven sources. Pilot projects in Germany and Norway contributed with a series of workshops and citizen engagement activities to raise local awareness on air quality issues and mobilise health-conscious communities. hackAIR also participated in a number of hackathons and summer schools, while the hackAIR platform continues to provide a customisable web application for local air quality information and a mobile app that citizens can use to access air quality information and contribute with measurements. Air quality data can be also accessed using an open API, and the full datasets of measurements are available as open data. Source code and hardware

designs are available for download under an open license and incorporate dozens of community suggestions and improvements.

Launched in early 2018, the hackAIR platform has engaged thousands of Europeans to map their neighbourhoods' air quality by taking pictures of the sky, providing their own measurements through open hardware sensors to see how air quality changes over time. More than 800 citizens across Europe started measuring particulate matter in their neighbourhoods using one of the hackAIR open hardware designs, while about 1,500 people helped in air pollution estimation by uploading sky photos to the hackAIR mobile app. Individual citizens have used the information to avoid polluting behaviour, reduce their exposure to air pollution and participate in the public discourse on improving air quality based on the collected data. Scientists and policy makers have used the resulting air quality data to gain insights on air quality patterns and inform public policy.

UNALAB Urban Nature Labs project (Horizon 2020, 2017-2022) aims to develop smarter, more inclusive, resilient and sustainable urban communities through the implementation of nature-based solutions (NBS) co-created with and for local stakeholders and citizens. One of the 'Living Labbers' they showcase in their webinar series is a webinar on the experiences of the Krakow Technology Park in implementing a living lab on air quality. Their approach engaged citizens in a series of workshops to better understand the roots of the smog problem and to co-create solutions to inform the development of the Air Protection Programme for the Malopolska Region. A really useful resource developed by the UNALAB project is the Co-creation Toolkit which provides a number of ideas for co-creation activities for different purposes, formats, time frames and group sizes. For each activity, the toolkit provides simple steps, recommended materials, tips and benefits. The project has also developed the Urban Living Lab Playground game, as a resource to help communicate the role of urban living labs through a storytelling approach.

iSCAPE Improving the Smart Control of Air Pollution in Europe (Horizon 2020, 2016-2019), tackled the problem of reducing air pollution impacts, focusing on the use of "Passive Control Systems" in urban spaces, on policy intervention and behavioural changes of citizens' lifestyles. Through the approach of Living Labs the team deployed a network of air quality and meteorological sensors (both stationary and mobile) and evaluated the benefits expected from the interventions on a neighbourhood and city-wide scale, ranging from quantification of pollutant concentration to exposure. iSCAPE encapsulated the concept of "smart cities" by promoting the use of low-cost sensors and engaging citizens in the use of alternative solution processes to environmental problems. The project supported sustainable urban development by sharing the results with policy-makers and planners using local test-cases, and providing scientific evidence ready-to-use solutions potentially leading to real-time operational interventions. The iSCAPE Living Labs Platform hosts a really useful How to Guide for engagement activities, including hackathons, video booths, and pledge cards, and tips for recruitment and facilitation. The project has also produced a Living Lab Guidebook for Cities fighting against Air Pollution, which presents the outcomes, experiences and lessons learnt of the six iSCAPE Living Labs.

ICARUS Integrated Climate forcing and Air pollution Reduction in Urban Systems (Horizon 2020, 2016-2020) aimed to develop an integrated approach to address simultaneously the need to improve air quality and to reduce the carbon footprint of European cities coupling technical and non-technical measures and contributing to urban resilience while actively engaging citizens. A personal exposure campaign was undertaken with around 1,000 individuals recruited in the nine cities. An agent-based modelling platform informed from wearable technology sensors was developed to capture individual spatio-temporal behaviours in order to model individual exposure taking into account societal dynamics. Citizens were also involved in a biology-based methodology to estimate intake and internal dose and assess health impacts, rather than using only well-established concentration-response functions. An ICARUS Decision Support System was developed and the functional and non-functional requirements of the ICARUS user centric tools were defined based on feedback received via interviews with citizens.

The Plume Air Cloud – Air Quality Data Crowdsourcing Platform for Environmentally-friendly Cities (Horizon 2020, 2017-2019) project developed an Internet of Things and data platform for live air pollution exposure forecast to help consumers track and reduce the impact of air quality on their health and well-being, and to support policymakers in promoting smarter mobility choices to build cleaner cities. The Plume Air Cloud leverages the latest advances in open data and predictive technologies, atmospheric sciences research, Internet of Things air pollution sensors, and collective awareness platforms to sense, track, map and predict air pollutants across urban areas. It builds upon Plume Labs's environmental health sensors for consumers and its successful API (supported by the H2020 Open Data Incubator in Europe programme) to build an open environmental data platform for smart cities. Plume Labs also use connected devices (such as the Flow mobile air quality sensor) to help consumers track their personal exposure to pollution; its data platform maps live air quality levels and forecasts around the world.

Schmitt (2019) proposes a series of steps for involving the public in creating a symbolic user-driven air quality index using citizen science monitoring and social media sharing. In the first instance he suggests that environmental protection agencies (EPA), should fund and set up community-based continuous monitoring system pilots with hand-held monitors, reference monitors and training to facilitate calibration. Community groups, including those vulnerable to air pollution effects, who then apply for funding from the EPA for this purpose, should be identified by social scientists. Social media technicians should be appointed to collate the communities' social media posts and design programmatic messages to recruit more community members. The social media posts are then analysed to create a symbolic air quality index. Schmitt recognises the need for ethical considerations, particularly with shared geographical information, but recommends that the community should be the orchestrators with officials and social scientists facilitating the process.

Living Labs Summary: This approach takes the principles of citizen science and uses it to help citizens build and shape policy development, in some cases using smart cities/Internet of Things interconnectivity, as in iSCAPE and the Plume Air Cloud or more "lo-fi" techniques such as in UNALAB. In all of the projects and studies

reviewed here, it is the co-creation of policy with citizens and the direct integration of their input into the planning and development of their cities that separates “living labs” from other citizen engagement approaches. These approaches not only raise awareness, but also directly tackle perceived behavioural control and subjective norms by creating communities of well-informed, empowered individuals.

### 3.3.6 Gamification

In addition to the Citizen Delphi previously mentioned, the Citizen Led Air pollution Reduction in Cities project, ClairCity, created a web-based game downloadable for use on iOS and Android devices. The Skylines Game puts citizens in the shoes of the city mayor with the challenge to balance environment, economy, health, and satisfaction by implementing policies that were derived from the Citizen Delphi process. The purpose of the game is to help to raise awareness of air quality but also illustrate the trade-offs that policy-makers face in protecting public health. The crowd-sourced results from the policy selections made by players were collated and, together with the Citizen Delphi and other stakeholder input, were used to inform the development of the citizen inclusive Policy Packages for each city. Additionally, the data from the Game can be used to understand the factors that influence people’s decision making and preference for particular interventions such as environment/health, personal satisfaction, economic cost (Hayes et al., 2018).

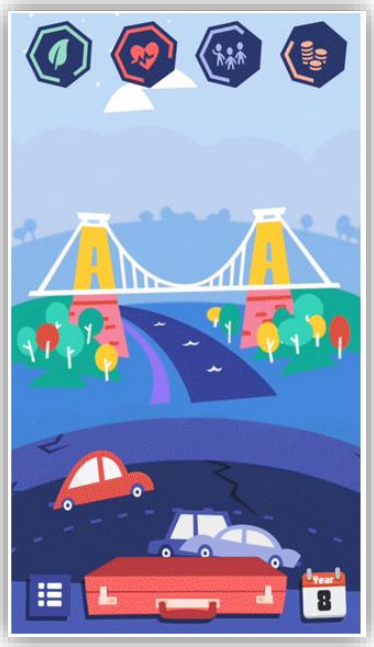

Figure 3-2: ClairCity’s Skylines interface

The objectives of the FEEdBACk Fostering Energy Efficiency and BehAvioural Change through ICT project (Horizon 2020, 2017-2020) were to develop, integrate and trial a wide range of energy focused ICT and behaviour modification applications, to be used to engage energy users and permit them to understand and change their energy consumption related behaviour in three different built environments (Office/Research Labs, Schools, Domestic smart homes). To encourage a more efficient energy utilization and a more responsible consumer behaviour, the gamification platform was used to motivate behavioural change by fostering awareness and consumer engagement through a pervasive application that analyses context, sends personalized messages and manages gamified peer competition and feedback. A mobile application called ECOplay was produced that provides players with tips on how to save energy, both at work and at home. Through sensors that measure temperature, luminosity, humidity and $CO_2$ concentration, ECOplay monitors users' comfort, notifying them whenever the parameters are far from what is considered as recommended to detect the best opportunities for reducing the consumption, taking into account past behaviours and the context, like the indoor and outdoor temperature. Games, quizzes and even a soap opera, built into the ECOplay app encourage players to learn, through receiving

points, coins and badges. These points can also be accrued as a team. The app is currently available to download for iOS and Android.

Wernbacher et al. (2015) present a theoretical framework for a mobility app, which aims to promote multi-modal mobility using elements from gamification, serious games and pervasive games. During the game players will be motivated to choose from a variety of inter- and multimodal mobility options. The gamification framework uses a pervasive gaming approach with location-based elements for changing behavioural patterns surrounding individual mobility choices. The main goal is to achieve a change in long established behavioural patterns, demonstrate feasible alternatives and establish an authentic gaming experience, creating an incentive to use inter- and multimodal mobility forms (persuasive design). Through the integration of modern ICT technologies, target groups will be addressed in real life conditions. The bi-directional transfer between the virtual and real game world will be additionally enhanced by offline-campaigns in urban space (pervasive design).

Gamification Summary: Gamification, or the development of mobile apps to engage people in non-game contexts, provides a way of raising awareness, providing and capturing information and helping to modify behaviour. Known as 'serious games' these tools can help to engage typical non-engagers as they do not require direct contact with the engager or group participation and can be engaged with whenever it is convenient. Some serious games can also incorporate social/online communities, such as ECOplay creating opportunities for sharing of information about the air pollution with wider social groups and enabling normalisation of the pro-environmental behaviours that the game is promoting. Used within a suite of engagement tools, as Skylines was in ClairCity, gamification can therefore be a useful mechanism.

### 3.3.7 Social media

Chen, Tu and Zheng (2017) used Twitter data on a $PM_{2.5}$ discussion network to integrate networked public sphere theory with the risk society theory to identify the actors who define risk and the role of media. They found that Twitter was effective in reaching diverse audience as about 30% participants were laypersons, 25% were professional and political elites, and about 17% participants were media. The networked public sphere allowed laypersons to share and endorse professional and political elite's risk definition via replying to/mentioning. There were 12 laypersons among the top 50, indicating that ordinary users, via unintended collective efforts, could filter and amplify certain message on social media platforms. The paper also highlighted that the US embassy in Beijing, using Twitter, played a pivotal role in defining the risk of air pollution and raising awareness of it in China, showing the democratising capability of this platform.

Lu et al. (2018) also examined data relating to the Twitter discussion of a high-profile 2015 TEDx documentary about air pollution in China 'Under the Dome'. The study used social network and content analyses to examine the mechanisms of media events in the networked digital space. Diverse actors were found to have engaged in the distribution and interpretation of this media event, most of whom were individual

actors. Two subnetworks were revealed on Twitter: the disengaged one mainly distributed links to the documentary, and the engaged one actively discussed the documentary. While Twitter discussion of Under the Dome lacked broad and sophisticated discourse, the authors still found promising signs of public discussion on the smog issue and public policy in the long run. Theoretically, this study underscores the potential of integrating media event and framing theories to tackle the refashioned nature of media events. Empirically, the findings inform a better understanding of how a wide range of individual and institutional actors co-stage and co-interpret media events by leveraging the technological and communicative affordances of Twitter.

Social Media Summary: Whilst the studies reviewed here have illustrated the value of Twitter in air pollution communication, other social media and social networking platforms, such as Facebook, Instagram and TikTok, also have the potential for widespread sharing of air pollution messages, capturing of public experiences through multimedia and exploration of public perceptions through hashtag searches and content analysis. Social media and real-time tracker apps are also valuable tools for facilitating public transport use. As the studies above demonstrated the key value of social media, however, is the ability to engage widely, not only with those that are primarily interested but also with their wider social networks. The opportunity this presents for affecting subjective norms makes this a particularly useful tool.

### 3.3.8 Summary of public engagement

Based on the studies and projects reviewed, we have examined a wide range of examples of public engagement approaches from communication tools to more participatory and novel methods. Each approach has its strengths and weaknesses, as described above, and therefore a complementary suite of approaches presents the best means of ensuring widespread engagement.

As we have seen from the review of behaviour change theory, communication can help raise awareness and lead to positive attitudes, as well as influencing subjective norms. However, to tackle negative risk perceptions and a lack of perceived behavioural control, it is important to engage in more participatory approaches. By actively engaging citizens in the development of policies, it is possible to co-create solutions that have public support and will be easier to implement and therefore more effective. Ensuring all sectors of society have an equal voice in this public discourse is therefore vital to avoid disaffecting communities and creating or exacerbating social inequalities.

## 3.4 Public engagement in Scotland

In this section a range of public engagement approaches undertaken in Scotland are described. The focus is broader than air quality reflecting the lack of specific examples available in this field, however examination of engagement activities in related fields will enable lessons to be learnt that may be applicable for the CAFS.

### 3.4.1 Clean Air Day 2019

Clean Air Day is an annual event, organised in the UK by Global Action Plan, which aims to increase awareness among the general public of the impacts of poor air quality and encourage people to take individual actions to reduce air pollution and improve public health. Clean Air Day 2019 in Scotland was delivered by Environmental Protection Scotland (EPS, 2019) as part of a communications action for the CAFS strategy commissioned by the Scottish Government. Working with Global Action Plan, EPS provided Clean Air Day merchandise (t-shirts, keyrings and aluminium water bottles), pop-up banners and flags to event organisers, ensured the Clean Air Day toolkits reflected Scottish policy, ran a social media campaign, organised national and regional press and media activities, liaised with external organisers on media opportunities, gave interviews to TV and press and spoke at conferences to promote the campaign. EPS also participated in public events in Glasgow and Aberdeen and organised a pledge card stall at the Open Streets event in Edinburgh in early June. Clean Air Day events were logged and uploaded by EPS onto an interactive map, which people could access via the Clean Air Day website.

Involvement of two cabinet secretaries (Roseanna Cunningham MSP, the Cabinet Secretary for the Environment, Climate Change and Land Reform, and Michael Matheson MSP, the Cabinet Secretary for Transport), the majority of local authorities in Scotland, NHS Scotland and health protection agencies, a number of schools, and private sector organisations was seen as major contributors to the success in raising the profile of Clean Air Day 2019 in Scotland, which was also able to capitalise on the growing public awareness around Scottish school climate change strikes and the Extinction Rebellion mass protests, as well as the declarations of a climate emergency by the Scottish Government and a number of Scottish local authorities in 2019.

### 3.4.2 Social marketing for sustainable and active travel (Dundee City Council)

McDowall (2012) discusses a social marketing campaign undertaken for Dundee City Council (DCC) in 2011 by JMP Consultants, to raise awareness of sustainable and active travel modes. Funded by the Scottish Government's Local Air Quality Management grant, the campaign's objective was to change private motorists' travel behaviour towards less polluting modes to help improve air quality on a congested corridor (Lochee Road). The paper showcases the wide range of individualised and mass media approaches that were used during the campaign, and demonstrates how such approaches can form part of a wider strategy to tackle air pollution in urban areas.

Social marketing established itself as a discipline in the 1970s when it became apparent that the same marketing principles that were being used to sell products to consumers could be used to 'sell' ideas, attitudes and desired behaviours. Effective social marketing focuses on the individual within their own personal and social context; understanding the decisions that are within that individual's control and those things that are not but may still have a powerful influence on them, and from this, working towards a change in behaviour that is both acceptable and achievable

to that individual. Furthermore, social marketing seeks to achieve a sustained change in behaviour, not just awareness or understanding.

The Lochee Road serves as an important radial route through the north-west suburbs of Dundee. This made it apparent that mechanisms for encouraging behaviour change could not focus solely on those people living in the immediate vicinity of Lochee Road; that wider broadcasting of messages would be necessary to reach the corridor's users, and that messages to target local people would need to be different from those travelling from further afield. Acknowledging the limitations of using air quality improvements as a motivation for change, the campaign used cost savings as a communication message.

Billboard advertising was found to be a visually direct and cost-effective mass-marketing method. A comprehensive local radio campaign was also delivered, involving a combination of traditional sponsorship with interactive presenter involvement and on-air interviews with project staff. To launch the campaign and promote the fuel-efficient driving message, two related events were held in the city centre. An eco-driving simulator challenge was held in one of the city's main shopping centres in which members of the public could attempt to drive a simulated urban route in the most fuel-efficient manner. Running parallel to the simulator challenge, the campaign received further support from Michelin who hosted a tyre check roadshow in the city centre, enabling motorists to bring their car along for a free tyre check and receive advice on how correct tyre maintenance can help save on fuel costs. In addition, a campaign leaflet and update to the existing Dundee Travel Active website ensured that individuals were provided with all the relevant information required on the benefits of making desired changes, how they could achieve these changes, and where to find further information. Stagecoach East Scotland also provided support to the campaign through their own direct mail activities, which sought to incentivise local people to use the bus, resulting in 67 households redeeming their seven-day ticket and travelling on Stagecoach services in Dundee between September and December 2011.

The individualised aspect of the campaign involved the provision of personalised travel planning advice to householders living in the area around Lochee Road, and work with local primary school pupils, building on the previous success of the Dundee Travel Active programme. An intensive programme of activity was delivered at each of the three schools for a four-week period with two overarching aims: firstly to educate pupils (and their family groups) about air quality issues, and secondly, encouraging behavioural change to more healthy and sustainable choices, as a way of resolving these problems. Each of the four weeks of the schools programme was designed to reflect the themes of the mass marketing elements of the campaign. From the response gathered from school staff and pupils alike, it is overwhelmingly clear that the schools campaign was well received and offered an effective means of communicating air quality issues and the benefits of active and sustainable travel to pupils. The walk to school week element of the campaign also appears to have provided increased opportunity to influence wider family groups.

The paper highlights how social marketing to encourage changes to more sustainable travel choices can complement a wider strategy of air pollution reduction. The social marketing employed in the Dundee campaign was seen to be publically and politically acceptable, relatively inexpensive and with rapid implementation and widespread benefits. However, the longevity of any behaviour change achieved through the campaign was not able to be documented in this paper.

### 3.4.3 Future City Glasgow programme

In 2013, Glasgow City Council received significant funding to develop innovative smart city applications, including the delivery of new electronic public services and the co-production of governance, known as the 'Future City Glasgow programme'. The Future City Glasgow programme ran from 2013–2015, and included the Open Glasgow project, and 'Demonstrator Projects' of Energy Efficiency; Intelligent Street Lighting; Active Travel; and, Integrated Social Transport. Leleux and Webster (2018) reported on the Energy Efficiency and Active Travel Demonstrators.

Core themes which emerged from the analysis of the Energy Efficiency Demonstrator, included the active participation of citizens in energy-saving practices, and the existence of a technical competence gap which impeded the achievement of real behavioural change amongst citizens. From interviews with Glasgow City Council officers, it was evident that the behavioural change tool proved to be too complex for citizens to use effectively. This meant that the intended roll-out of the tool across Glasgow was not viable. Glasgow City Council also interacted with citizens via community hubs, corresponding directly to citizens and using iPads for undertaking surveys, etc. GCC analysis found that the 'digital divide' in some areas did not relate to technical competence. Instead, some citizens whilst being technically competent did not have an iPad, laptop, or fixed Internet connection in their home and were therefore unable to participate in the technologically mediated governance mechanisms.

The Future City Glasgow programme Active Travel Demonstrator encouraged citizens and cycling/walking groups to engage with Glasgow City Council about infrastructure initiatives, through the creation of new cycling and walking apps developed alongside an education website tool. The 'Glasgow Cycling App' was launched in November 2014, and cycling organisations promoted the app through their networks and actively engaged with Glasgow City Council by supplying recommendations about the upgrading of routes and proposals for establishing new ones. Marketing took place through peer-to-peer networks and through social media. As of January 2016, there had been 1,200 downloads on iOS and Android and 1,393 routes had been captured with a total distance of 9,138 km.

Core themes which emerged from the analysis of the Active Travel Demonstrator included active citizen participation and the co-design of new cycling and walking routes, improved infrastructure which could lead to healthier lifestyles for cyclists and walkers, the creation of new apps which has led to improved conditions for knowledge transfer capabilities, and successful community/business networking.

Examples from the Demonstrator projects highlight there are more opportunities afforded to citizens for accessing information online and the use of apps and social media to engage, participate, co-produce and co-create with Glasgow City Council, alongside traditional participatory mechanisms. This has allowed citizens to contribute to local decision-making and influence local policy and services in a number of areas. Whilst it is evident that the capacity for smart governance in Glasgow has been enhanced it is not clear how effective these mechanisms have been or the extent to which citizens have been empowered. Despite efforts to attract the interest and participation of disadvantaged communities, engagement with these groups remained a challenge.

### 3.4.4 Co-designing carbon emissions reduction

A Community Engagement for Carbon Emission Reduction (CECER) Strategy for Fife Council was designed and conducted by White and van Koten (2016) to facilitate knowledge mobilization between three diverse stakeholder groups: community groups, local authorities (LAs) and academics from diverse disciplines. The goal was to co-design a strategy for Fife Council to enhance community carbon emission reduction and to enhance regional ability to respond to sustainability challenges. Co-creation refers to any act of collective creativity, but co-design implies a more fundamental, collaborative process in which stakeholders are involved in the initial conceptualization as well as prototyping and design adaptation. The methodological approach in this study included ethnographic and participatory methods; seminars; strategy prototyping; and shared governance processes. The academics included expertise in sustainability, design, anthropology, and ecological economics. The LA partner comprised a Sustainability Team Leader, a Community Development Officer and an Environmental Group Officer. Community participants were recruited through a snowball effect starting with known contacts' networks.

The seminars captured people from LAs, community, other relevant organizations and to a lesser extent academia (30–50 people per seminar). Each seminar addressed an issue (Energy, Food, Transport, Community), provided an opportunity for networking and knowledge exchange and actively contributed to production of the CECER strategy. Two capacity-building workshops were held, with the aim of enhancing understanding of contested concepts and strategic goals and establishing an arena of shared values.

The effectiveness of the co-designed strategy in terms of reducing carbon emissions could not be discerned in the paper. However other outputs were observed, including: a mentoring system between established community initiatives in more affluent areas and emerging initiatives in deprived areas; an explicit recognition of environmental considerations and need for community engagement within the LA; and a foundational CECER strategy with strategic goals and action points for the LA; as well as insights and shared understandings across all of the participating groups.

### 3.4.5 Focus groups and citizens' juries on decarbonisation

The following study is presented as an example of a detailed account of a public engagement approach utilising focus groups and citizens' juries in Scotland.

Ostfeld and Reiner (2020) conducted focus groups in Aberdeen, Edinburgh and Peterhead and citizens' juries with residents in Aberdeen and Edinburgh to explore public views on climate policy, renewable energy, and low-carbon technologies. The focus groups were held in January 2017 with 36 citizens in total. Two focus groups were conducted in Peterhead, one in Aberdeen, and one in Edinburgh. Recruitment of participants was undertaken by Ipsos MORI, and the focus groups were comprised of individuals from different age groups, social grades, educational background, employment status, and opinions on climate change to provide a representative sample of the Scottish public. Participants for both the focus groups and citizens' juries were recruited in accordance with Market Research Society guidelines and were balanced in terms of age, gender, education level and attitudes towards climate change in particular to be roughly proportionate to the Scottish population as a whole. The value of the focus groups is to provide the opportunity for group discussion to yield a range of ideas and opinions in a more natural setting than one-on-one interviews, however they risk being dominated by vocal group members.

Citizens' juries aim to provide policymakers with recommendations from individuals that are representative of the general public. Two citizens' juries were conducted in January and February 2017 following the initial focus groups. The juries took place over two consecutive Saturdays in Edinburgh and in Aberdeen, with 19 participants attending each. Ipsos MORI recruited the panelists, moderated the sessions, and transcribed the focus groups and citizens' juries. The researchers sought to ensure diversity in gender, age, social grade, educational background, employment status, and opinion on climate change to provide a representative sample of the Scottish public.

Focus groups were 90 min in duration – after some introductory discussion, an expert speaker provided a 10-min presentation on low-carbon technologies, with a particular focus on CCS, followed by the opportunity to ask the speaker questions. The focus group concluded with discussion on the current energy situation in Scotland, the future of oil and gas production, renewable energy, and CCS. Short written questionnaires were administered upon arrival and after concluding the session.

Citizens' juries took place over a period of two days and explored the focus group themes in greater depth. Each day of the jury lasted approximately 6 hours. Five questionnaires were administered – upon arrival, between activities, and at the end. During the initial icebreaker activity, participants were asked which words or phrases came to mind when thinking about energy in Scotland, and challenges they perceived Scotland faced in regard to energy. Next, the jury broke into two groups to discuss those challenges in greater depth and presented findings back to the full jury. A presentation on the current Scottish energy supply was delivered by an expert speaker, followed by a question and answer (Q&A) session. The jury discussed factors to consider when developing an energy policy in Scotland. A second expert speaker gave a presentation on low-carbon energy technologies including renewables, nuclear, and CCS. After Q&A with the second expert speaker, the day concluded with a summary, and final thoughts on day one.

Day two of the citizens' jury began with an introduction and recap of day one, followed by the third and final expert presentation on the future of Scottish energy systems followed by Q&A. The jurors broke into pairs to discuss their current opinions. The full jury then participated in forming an opinion grid along two axes "many risks" versus "few risks" and "many opportunities" versus "few opportunities." Jurors began by standing in the centre of the room, and for each option (onshore wind, offshore wind, nuclear, and CCS), moved to the part of the room that reflected their opinion of that technology. The jury then broke into small groups to discuss the most important factors to consider when developing an energy policy for Scotland. The moderators divided the factors into several themes. The jurors discussed why each factor was important and voted for the top five factors within each theme. Next, the jury then broke into small groups to discuss the recommendations they would give to the Scottish Government and presented their recommendations for the rest of the jury to react and comment. Each full jury voted on the recommendations they would give the Scottish Government.

The methodologies for the focus groups and citizens' juries are presented here verbatim as they provide excellent descriptions of the processes involved. The paper does not evaluate the approach but does acknowledge the limitations of the small size of the citizens' juries in terms of representativeness. The findings from this study are discussed in section 3.5.5.

### 3.4.6 Citizens' juries on wind farm development

Using the ClimateXChange 'citizens' juries on wind farm development in Scotland' project as a case study, Roberts et al. (2020) critically evaluated the use of testimonies by expert witnesses. In the case study, three citizens' juries were held at different locations in Scotland: Coldstream, Helensburgh and Aberfeldy. Coldstream did not have a wind farm nearby, nor one proposed; Helensburgh had a proposed wind farm development nearby, and Aberfeldy had an existing wind farm. The case study was a research project to trial the citizens' jury method and its applicability to a complex policy issue and to provide insight into what people feel about onshore wind farm development in Scotland.

The juries were held in autumn–winter 2013/14 over two Saturdays, 2–3 weeks apart. The first jury day was largely dedicated to evidence giving. Five experts provided testimony at each citizens' jury: one 'neutral' witness, providing contextual and background information to jurors: two representing pro-wind farm positions and two presenting anti-wind farm perspectives. The second jury day was focussed on deliberations and outcomes. There were no witnesses present in day two; however, two of the organisers acted as 'information officers' whereby they could refer back to information in witnesses' presentations if the jurors requested, or if misunderstanding or misinformation was affecting the course of the deliberation.

The expert witnesses were identified and selected by the Stewarding Board (A.K.A. oversight panel or steering group) and approached by the project organisers. Theoretically, to avoid bias, it is preferable for the jurors to select the experts, however, this may not always be practicable. In the case study, although the same

five witnesses were intended to be used for all three juries, due to substitutions, seven experts participated in the three juries. The time commitment made recruitment of experts difficult – two-thirds of those approached declined. The resulting panel of witnesses lacked gender diversity, as no female experts approached were able to participate.

The role of the witnesses was to assist jurors in getting to grips with key aspects of the topic, and equip and empower them to deliberate and respond to the task, however, many experts thought that they should be educating the jurors and did not identify them as equal participants in the process, able to evaluate the information presented. The witnesses identified by the wind farm project Stewarding Board were from industry, academia and advocacy communities, however the veracity of their evidence was called into question depending on their standpoint, with pro-renewables experts seen to be the 'industry mouthpiece', whereas academics, although more trusted by the public, seen to be less accountable by other witnesses. Even the 'neutral' witness lacked credibility by lack of accountability. The lack of experiential witnesses to better reflect non-expert views was criticised by jurors, but other witnesses considered their lack of expertise disqualified them from acting as witnesses.

The adversarial framing of the witness testimonies as pro and con was seen by witnesses to oversimplify the often more nuanced debate around wind farm development and even added to the mistrust of each other's' arguments. Furthermore, the one-way presentation was seen to be problematic with some witnesses preferring a more interactive approach. The paper's authors recognised that there was scope to enhance and broaden the traditional knowledge transfer approach if this enhanced the ability of jurors to engage and provide feedback.

Varying levels of communication skills and styles and preparation of materials between witnesses may skew the intended balance of evidence provision to the jurors. Many witnesses also found it difficult to pitch their testimonies and respond to questions as, having been exposed to the arguments, jurors were neither novices nor experts. There was also variability in the quality of the arguments made and evidence presented by the different witnesses in some cases.

Interestingly, in complete contrast to the jurors, most witnesses stated that they would not wish to participate in future citizens' juries, even if they had enjoyed the experience, with some questioning the role of the evidence they present in informing the jurors' deliberative process and the validity of the process in policy development.

A number of recommendations to facilitate the process and, in particular, the role of witnesses were proposed by the authors. Ensuring a diverse range of witnesses that reflect different viewpoints is vital, however greater transparency over recruitment, being explicit about the selection criteria, and involving jurors in the decision, particularly the inclusion of neutral witnesses or non-technical experts, can provide reassurance in the panel and avoid the confrontational experiences on both sides. Witnesses and jurors must be fully briefed about their respective roles, and guidance provided to both to enable them to meet these expectations. Inclusion of witnesses in later stages (albeit indirectly to avoid influencing the deliberative process) may

also engender better awareness of the value of their contributions and encourage future engagement.

### 3.4.7 Participatory arts engagement with climate change

Burke, Ockwell and Whitmarsh, L. (2018) present an innovative engagement approach using participatory arts to raise awareness about climate change in the Inner Hebrides. 'Bird Yarns' was a community knitting project, run by artist Deirdre Nelson and supported and funded by Cape Farewell on the Isle of Mull in summer 2012. As well as the audience who came to see the artwork, there was a group of local people who contributed to the physical making of the artwork by knitting arctic terns in a weekly knitting group. In total, 72 terns were knitted and displayed on wires along Tobermory's fishermen's pier for two weeks in June 2012. Next to the birds, was an audio description of the migration of the arctic tern, and the effects of climate change written by nature writer, Kenny Taylor, and read by local wildlife photographer and documentary presenter, Gordon Buchanan. In Nelson's own words, the artwork was a response to "…the way arctic terns' migration patterns have been altered as a result of rising sea surface temperatures; the number of sand eels which the terns eat are declining, and this can lead the birds to change their migration routes looking for food, with the result of some colonies becoming 'lost'".

Q methodology, an approach which seeks to reveal and describe divergent subjective views in a group as well as consensus, was used to unobtrusively elicit observers' responses to the artwork in their own words and ask them to reflect on whether and how the exhibition affected their attitudes, in particular to climate change. In total, 25 participants aged 20-65, three-fifths women, were recruited.

The informal nature and local setting for the artwork made the exhibition and message more accessible to a wider public, and the playful medium elicited emotional engagement with the subject matter. Although the work was not able to change strongly held preconceptions, both for and against climate change, for those that were undecided there was a positive response. Although this study was not intended to be representative or reflect wider opinions, it highlights the value that participatory arts can play in raising awareness and engaging with the public in a novel and unexpected way, and raises questions about how the impacts of these approaches can be determined, for example longitudinal studies to track any subsequent behavioural changes.

### 3.4.8 Summary of public engagement in Scotland

Lessons from the 2019 Clean Air Day in Scotland events, Dundee City Council's social marketing campaign and Glasgow City Council's Future City Glasgow project Active Travel Demonstrator indicate that a suite of coordinated initiatives supported by national and local government, public health agencies, public transport providers, businesses and schools are likely to be most impactful. Messaging was key, with Dundee City Council focusing on fuel cost saving as a motivational tool. A range of different media was also used to maximise transmission of the message, using billboards, local press, TV and radio, websites, mobile applications, social media and peer-to-peer networks. The ability of Environmental Protection Scotland to

coordinate its Clean Air Day organisation with the support of the national campaign organisers, Global Action Plan, enabled a stronger branding of the materials and the chance to build on the momentum and wider campaign, as well as the growing public awareness at the time over the climate change crisis.

Targeting of messaging was also key with different approaches used by Dundee City Council for local residents and those travelling from outside, including public transport promotion, eco-driving and vehicle maintenance advice for drivers, and an air quality awareness-raising campaign aimed at parents through engagement with schoolchildren. Appropriate use of media for specific user groups, however, was highlighted by the Future City Glasgow project where technical competences and financial limitations led to barriers in engaging certain sectors of society on energy efficiency behaviours.

As well as communication strategies and awareness raising, the examples presented in Scotland also demonstrate the use of co-creation and co-design through the Future City Glasgow project and the Community Engagement for Carbon Emission Reduction (CECER) Strategy for Fife Council. This inclusionary approach allows citizens to actively contribute to local decision-making and influence local policy and services, and can create a much stronger public buy-in than more top-down consultation approaches, resulting in more successful policies.

Citizens' juries are another inclusionary approach as presented in the examples from Aberdeen and Edinburgh on climate policy, renewable energy, and low-carbon technologies (Ostfeld and Reiner, 2020) and from Coldstream, Helensburgh and Aberfeldy regarding on-shore wind farm developments (Roberts et al., 2020), which similarly empower citizens to engage in and inform the decision-making process. As the examples demonstrate, this is an increasingly popular mechanism but which requires careful planning and coordination to ensure successful implementation and valuable outputs that do not disenfranchise either the jurors or the expert witnesses.

The final example presented an alternative, participatory arts method drawing on a climate change example on the Isle of Mull. Although limited in its reach, this novel approach demonstrates that unconventional methods can be useful ways in which to engage with the public 'unawares', thereby capturing the views of normally disengaged or harder to reach sectors of society.

As with all of these public engagement approaches, the longer-term effectiveness of the initiatives in terms of engendering changes in perceptions and ultimately behaviour, is difficult to directly determine. Longitudinal monitoring and evaluation plans need to be designed into public engagement strategies to record their successes and to establish transferable practices that can be adapted to locally-specific circumstances.

## 3.5 Public perceptions in Scotland

This section presents perceptions and behaviours of the Scottish public in relation to air quality, low emission zones, travel and domestic energy, energy production and carbon capture and storage identified in the literature, resulting from surveys,

consultations and research. The purpose of this this section is to illustrate the public's awareness and perceptions of these issues to provide a baseline understanding on the level of receptiveness that may be expected in undertaking public engagement activities on the CAFS. Whilst the scope of this section goes beyond air quality, the intention is to reflect sentiments related to emissions generating activities and climate change to capture the broader perspective. It must be recognised, however, that not all of the views and opinions presented here may be representative of the wider Scottish public given the narrow and often self-selecting range of respondents/participants within the studies reported.

### 3.5.1 Air quality

Global Action Plan operates a UK Public Insight tracker survey about attitudes to air quality, which includes a sample of 205 Scottish residents. Feedback to the survey between 28 June and 1 July 2019, as reported in Environmental Protection Scotland's Clean Air Day 2019 Post-Evaluation Report (EPS, 2019), suggested that 34% of Scottish-based respondents had heard of Clean Air Day compared to an overall UK figure of 40%. The research suggested that those who had heard of the campaign were more likely to take action to reduce pollution. The feedback also found that 93% of Scottish respondents thought that reducing air pollution should be a priority for the UK (cf. 84% in March 2019), slightly higher (97%) for male respondents than for female respondents (89%).

The survey asked respondents how often in the previous month they had taken actions to reduce air pollution. The results were as follows:

- 65% had taken 'quieter roads over busy roads' (rising to 74% of those who had heard of Clean Air Day);
- 58% had 'walked to work or when making other journeys' (rising to 69% among those who had heard of Clean Air Day);
- 23% cycled to work or when making other journeys (26% among those who have heard of Clean Air Day);
- 51% worked from home (68% among those who had heard of Clean Air Day).

Clearly an awareness of Clean Air Day equated to a higher likelihood of behaviours that would reduce generation of, or exposure to, air pollution. However, it is unclear whether the behaviour is due to awareness raised by Clean Air Day, or simply that respondents that were already aware of air pollution and ways to mitigate it were naturally predisposed to an awareness of Clean Air Day.

Furthermore,

- 63% of respondents said that cycling or walking instead of driving was the most effective way to reduce the level of outdoor air pollution;
- 56% said not idling a vehicle engine while stationary would improve air quality and
- 54% said that ensuring vehicles were well maintained would improve air quality.

Fewer than half (49%) said using public transport instead of driving would be the best way to reduce air pollution. Of these activities, 40% said they would cycle or walk instead of driving; 39% said they would ensure their vehicle was well maintained; 33% would switch off the engine while their vehicle was stopped and 30% would use public transport rather than driving. However, only 5% of respondents said that they were more likely to buy or use an electric vehicle or other low polluting vehicle. Despite the high level of awareness and support for government action on air quality, there is clearly room for improvements in personal behaviours warranting an investigation into the real or perceived barriers that prevent these being enacted.

### 3.5.2 Low Emission Zones

It is interesting to contrast the responses to the 2019 Global Action Plan survey with the results of the Scottish Government's 2017 Building Scotland's Low Emission Zones Consultation. The LEZ consultation, which took place between 6th September and 28th November 2017, generated a total of 967 responses including 225 substantive responses from 101 organisations and 124 individuals, and 742 Friends of the Earth Scotland campaign responses (CH2M, 2018). Recognising that these respondents are self-selecting, and therefore already concerned individuals, as opposed to representatives of the general public, there was a high level of consensus with 95.5% respondents supporting the principle of LEZs to help improve air quality in Scotland. In addition, the majority of respondents agreed that the primary objective of LEZs should be to support the achievement of Scottish air quality objectives (95.9%) or to go even further. Some 62.3% of respondents agreed with the proposed minimum mandatory Euro emission criteria for Scottish LEZs.

Respondents were asked whether they supported the principle of adopting a road access restriction scheme (as opposed to a charging scheme) for LEZs across different classes of vehicle. Views were very mixed with 42% in favour due to the positive impact it may have; 18.7% disagreed, 2.7% thought it unworkable and a further 7.1% would prefer an alternative option. Of those in favour of the road access restriction scheme a number of people commented that this was because they considered a charging scheme allowed people who could afford it to buy an exemption. Respondents also noted that a road access restriction scheme would encourage behavioural change more than a charging scheme. Others were against charging schemes because they allowed polluting vehicles to enter the LEZ.

The most popular suggestion was for LEZs to operate 24 hours, 7 days a week, albeit with conditions, such as the need to take local circumstances into account, the need to reduce restrictions at times when there are less vehicles on the road and to offer exemptions for vehicles that need to undertake 'emergency repairs'. The majority of respondents, 86.3% agreed that LEZ exemptions should be consistent across all Scottish local authorities. Respondents provided a range of views on lead in times and sunset periods, from 4 years as discussed in the consultation paper to shorter periods in order that air quality improvements could be made more quickly.

Respondents were asked how the Scottish Government could best target any funding to support LEZ implementation. Suggestions included the need to support public transport, support to enforce the LEZ and funding to help with retrofitting. Popular suggestions of criteria that the Scottish Government should use to measure and assess LEZ effectiveness included air quality and pollution levels, emissions per vehicle/passenger kilometre and the addition of air quality sites. A third (31.8%) of all responses suggested the Scottish Government should provide vehicle owners with information on implementation and compliance, exemptions, fines, appeals and penalties.

Respondents suggested a variety of actions local or central government should consider in tandem with LEZs to address air pollution including alternative transport solutions, bus priority and public transport measures, encouraging active and sustainable travel particularly through improved walking and cycling routes. Respondents indicated that investment in public transport was needed which would provide the public with access to more facilities and locations. Respondents also highlighted the need to reduce incentives for driving and to invest in public transport infrastructure in order to reduce emissions.

Respondents were asked for their views regarding how LEZs can help to tackle climate change, by reducing $CO_2$ emissions in tandem with air pollution. Some respondents indicated that LEZs are just one part of a much bigger issue and that other contributors to climate change are far bigger e.g. travel, power stations, shipping. Others indicated that implementing LEZs in Scotland alone would provide a minimal contribution to a global phenomenon and as such would be unlikely to tackle climate change. However, a number of respondents specifically indicated their support and approval for LEZs, agreeing that it will help to tackle climate change. When asked what measures would make a difference in addressing both road congestion and air pollution emissions, respondents cited a range of measures including the need for improved traffic management, improved public transport and the need for improvements in infrastructure.

Concerns were raised about the impacts of LEZs on the elderly, those on low incomes, and disabled individuals, although the negative impact of air pollution on these groups was also noted. Respondents considered that LEZs would impact on the elderly as they make up a large percentage of those who travel by public transport and so the cost of public transport would need to be considered, concerns about mobility and access for elderly individuals who may need their vehicles in order to access certain locations. There were also concerns about low income individuals due to issues of affordability and people on lower incomes not being able to afford to upgrade their vehicles or pay for the costs of LEZs. Respondents suggested disabled individuals do not have a choice in how they travel and there are issues of mobility to be considered.

Respondents considered that increased public transport costs, healthcare costs, increased business costs and increased costs on the private motorist would mean LEZs would affect all sectors and there is a need to consider both the short and long-term impacts, although others perceived there to be minimal impacts as polluters

currently fail to pay for their pollution anyway and that savings in some sectors may balance out with the costs from other sectors. Privacy was not seen to be a major concern with 53% of those responding considering that there was unlikely to be any impacts on privacy as a result of the introduction of LEZs. However, 32% were concerned about the use of ANPR and the monitoring of people routines and movements.

The majority of respondents felt that the proposals contained in the consultation would be beneficial for the wider environment at all scales. Some respondents were concerned about the potential displacement of vehicle emissions and congestion due to traffic re-routing, potentially leading to new problems in other locations.

Transport Scotland have recently undertaken another public consultation on LEZs (closed 24th February 2020), however the consultation responses have not yet been published.

It is interesting to contrast the high level of support for nationally-led LEZs with the public opposition to the local authority-driven Congestion Charge Zone proposed in Edinburgh in 2005 (Rye, Gaunt and Ison, 2008; Gaunt, Rye and Allen, 2007). As the paper identifies, the original public acceptability of a congestion charging zone was undermined by political and media opposition in the run up to the referendum, leading to a dramatic reversal and a 74% rejection of the scheme (with a 62% turnout). It is cautionary to note that public engagement is only a part of the picture in securing support for such measures. The paper, which also draws on the more successful experience of the London congestion charging zone, also highlights that simple schemes are more likely to be understood and gain support, and that supporting measures should be coordinated and cohesive to the scheme to provide confidence. Although the number of people negatively affected by congestion in Edinburgh was widespread the benefits of reducing it were too abstract, and the number benefitting from public transport improvements was seen to be limited. The proposal was further perceived as adding financial burden to motorists and penalising those least able to afford it. According to the paper, the press opposition was not adequately countered with positive messages about the benefits of the scheme, which helped to fuel the negative public views.

### 3.5.3 Travel

A number of other views and perception of transport and travel in Scotland were captured in the peer-reviewed literature that have relevance for reducing emissions from private car use.

Curl, Clark and Kearns (2018) undertook a cross-sectional and longitudinal survey of communities in Glasgow before, during and after the 2008 financial recession, and found that there is a growing phenomenon of ‘forced’ car ownership within deprived parts of the city where people, especially those with children, face particular challenges of multi-tasking and multiple responsibility. Trends of increased car ownership despite these households experiencing financial problems are complicated with some considering a car is necessary to improve their circumstances. The paper suggests that the sustainable transport agenda is not

reaching disadvantaged communities and there are concerns that regeneration strategies are failing to promote mobility and accessibility for poor communities via transport policies. As we have seen elsewhere in this review, emissions reduction strategies need to reduce inequalities and ensure that solutions are devised that facilitate the needs of all communities, taking account of their inherent complexities.

Another repeated cross-sectional study (Olsen, Macdonald and Ellaway, 2017), which surveyed adults from West Central Scotland in the 'Transport, Health and Well-being Study' conducted in 1997 and 2010, found that health inequalities can also be a factor in mobility decisions, with greater empowerment resulting from access to a car leading to greater transport satisfaction. Transport satisfaction was lower for those in poorer health suggesting that improvements to transport were required for these individuals. However, the study also found that the proportion of those who travelled using public transport, active modes or by multiple mode increased journey satisfaction over time at a greater rate than those who travelled by car, highlighting that continued efforts should be made to promote these more active transport modes which have potential to impact on health.

Community transport provides a crucial link for remote or isolated households without access to private transport. Community transport therefore has a role as a means of reducing reliance on private cars in areas where regular public transport options are not commercially viable, and ensuring equitable transport options, particularly for the elderly, immobile or those on low incomes. They are normally operated on a not-for-profit basis by the voluntary sector or the community themselves. Perceptions of community transport pricing were captured by Nelson et al. (2017) in a survey of community transport service users from across Scotland found that the majority of users in both urban and rural areas feel that the fare they pay is appropriate, whilst a significant minority would be willing to pay more. Moreover, the services provide a wide range of economic, social and health benefits.

A survey of university students' travel behaviours across Scotland, England, Northern Ireland and the Republic of Ireland found differences between each of these countries (Davison, Ahern and Hine, 2015). Public transport is a more popular choice in Scotland where the urban and interurban rail network allows for a comparatively high proportion of students to travel by train from a term-time or permanent address. Bus or coach is also a popular choice for students in Scotland when travelling from a permanent address, and in term-time too, exceeding the mean of all other modes, albeit for shorter distances than travelled by car. Walking is also most popular in Scotland. For travel to and from a permanent address, in Scotland opting to travel by air is proportionately much higher for students. In terms of $CO_2$ emissions, annual emissions are highest for regular travel to and from university when a student has a permanent address rather than a separate term time and permanent address. This is to be expected as those students who can choose where to live during term-time opt for residential locations that are closer to university campuses, and facilitate travel by public transport, walking or cycling. Across the administrations, Scotland has the lowest $CO_2$ emissions for student travel across all journey types (based on survey respondents ($n$ = 1049)), which is likely related to their propensity to use public transport and active travel, but despite the higher rate

of air travel. There was found to be a greater variability in trip distances in Scotland, reflecting the different transport geographies.

Use of real-time passenger information at bus stops and available via mobile apps in Edinburgh was examined by Islam et al. (2020). Web-based services were most commonly used for medium-length trips and by city residents, primarily younger travellers. Mobile apps were used most by residents to find bus arrival times while journey planners and Google Maps were preferred by visitors.

Nimegeer et al. (2017) explored community severance and connectivity following the construction of an 8 km extension to the M74 urban motorway in Glasgow in 2011. Interviews with residents from two neighbourhoods, Govanhill and Rutherglen (including Farme Cross) sought to understand how participants perceived, experienced and used their neighbourhood, whether these had changed, and what role (if any) the new motorway had played in these changes. Active travel was much more likely to be described as influenced by social factors than by those related to the motorway or traffic in general, particularly avoidance of specific roads for fear of crime. Factors such as poor upkeep of streets, perception of 'welcomingness', and quality of shops appeared to be more significant factors in local peoples' willingness to walk locally than any changes to traffic or local infrastructure related to the motorway. For some respondents, the 'mitigation features' associated with road building, such as pedestrian overpasses, tunnels and lighting, helped to overcome existing severance barriers during active travel where these measures improved feelings of personal safety from crime. For others, however, the new road was perceived as degrading the local experience of active travel and negatively affecting local spaces of connection.

Similar barriers to physical activity were also identified by residents in two deprived areas in Glasgow (Sawyer et al., 2018), categorised as 'diversity of destinations in the neighbourhood', 'provision of services to support healthy environments', 'ownership of public space and facilities', 'collective control of public space to prevent disorder' and 'perceived value of the neighbourhood'.

Curl et al. (2018) used household survey data from deprived neighbourhoods in Glasgow undergoing housing-led and area regeneration at two time points, 2011 and 2015, to examine changes in walkability and walking behaviour. A pre-existing Scottish-based walkability score was used based on a measure of intersection density (connectivity) and dwelling density, which have both previously been associated with increased levels of utilitarian walking behaviour (Saelens et al., 2016). The premise for the positive association is that areas with high dwelling density are less conducive to car travel and more convenient for walking, and where intersection densities are high, walking routes can be more direct and quicker. In this study, the net effect on walking behaviour was neutral, i.e. those whose walking behaviour increased were almost cancelled out by those that decreased, despite the walkability of regenerated areas improving over the four-year period. Those that had moved house were more likely to increase walking behaviours suggesting that life-changes are key motivators for habit-discontinuity. The researchers unfortunately did not survey residents' changing perceptions of the walkability of their neighbourhoods

in order to understand better the reasons for this limited behaviour change. The paper does suggest, however, that social regeneration, involving the stimulation of community empowerment and development activities, alongside physical regeneration may be a further means of facilitating walking. As with Nimegeer et al. (2017), clearly, it is important to understand the different local barriers to active travel first in order to facilitate uptake, particularly in lower income areas where, as Curl, Clark and Kearns (2018) also identified in Glasgow, there may be a range of completing and complex needs that dictate travel behaviours.

A study of schoolchildren aged 10-11 from across Scotland examined the effect of neighbourhood walkability and distance on propensity of active travel to school (Macdonald et al. (2019). Travel modes were self-reported, but the study found that walkability was positively associated with active travel to school within all distance categories. The data suggests that a more walkable environment may be less important to those who walk or cycle for every trip to school, presumably due to a lack of alternatives, however improving walkability appears to be more beneficial to those who actively travel most of the time. Investment is needed to improve less walkable neighbourhoods to provide infrastructure to support opportunities for active travel to school. In an earlier unrelated study of 10-11 year-olds, based on responses to the 2006 Scottish Household Survey, 'reasonable' distance (~0.5 miles) was found to be the strongest determinant of walking to school (Waygood and Susilo, 2015). As the paper suggests, walking school 'buses' with large groups of children may decrease parental anxieties about walking greater distances. Alternatively, improving cycling conditions or walkability of neighbourhoods could encourage active travel to schools.

In a survey of staff at a Scottish university, Brett and Pires-Yfantouda (2017) identified that improving personal fitness was the main motivation for wanting to increase walking. Barriers to initiating or continuing walking which respondents highlighted included lack of time (due to family, work, or in general), the weather, and a lack of motivation.

Hong (2016) also found that seasonality is another key factor in Scotland, with people more likely to walk more in summer and autumn. Using the Scottish Household Survey (SHS) to examine household characteristics and travel behaviour, the research found that, perhaps unsurprisingly, households with more cars are likely to walk less. Significantly, people living in towns or urban areas were found to walk more frequently than residents in rural areas, except during the summer. It is unclear from the study whether this geographical split is influenced by relative walkability or levels of car ownership, but the paper posits that the extreme weather in winter in rural areas is the determining factor. The Scottish Index of Multiple Deprivation (SIMD) was also positively correlated with walking frequency, indicating that people living in wealthy areas are likely to walk more frequently than residents in deprived areas. This supports the previous arguments made by Nimegeer et al. (2017) about fear of crime restricting active travel in poorer neighbourhoods.

Sun and Mobasheri (2017) analysed 'Strava Metro Nodes' data from Glasgow to explore spatial patterns of non-commuting cycling activities and associations

between cycling purpose (commuting and non-commuting) and air pollution exposure. Non-commuting cycling activities were more likely to be located in the outskirts of the city and commuters were more likely to be exposed to higher concentrations of air pollution. The authors also recommend that policymakers consider cycling infrastructure and road safety in the outskirts of cities as well as in the city centres. Analysis of Strava app data in Glasgow city centre by Hong, McArthur and Stewart (2020) also showed that providing safe cycle paths can encourage active travel but, like their earlier study (Hong et al., 2016), that there is a distinct seasonality effect, with use of cycle paths (preferred by less experienced/leisure cyclists) most affected. The implication that on-road commuter cycling is less seasonally-affected suggests that there is more that policymakers could do to facilitate all-weather cycling for less experienced cyclists using cycle path networks, e.g. providing shelters.

### 3.5.4 Domestic energy

Beyond travel, domestic energy is one of the key areas of emissions generation dependent to a large degree on public behaviour. Cleaner domestic heating appliances and fuels, as well as energy saving measures are important considerations whether focusing on reducing particulate matter or decarbonisation. These issues can directly challenge the public's perceived freedoms and rational decision-making over energy demand and home comfort.

Ellsworth-Krebs, Reid, and Hunter (2019) recruited 45 householders from 21 "zero-carbon" homes in Scotland to explore these tensions. The "zero-carbon" homes were not necessarily emissions-free, but homeowners had made efforts to save energy by improving the efficiency of their house (e.g. improving the building fabric, buying new boilers and A-rated appliances) and installing microgeneration technologies (e.g. solar thermal panels, photovoltaic panels, biomass boiler, heat pumps, wood stoves and wind turbines). It should be noted, "zero-carbon" does not necessarily mean measures are also targeted at improving air quality. Indeed, installation of wood stoves can significantly increase local concentrations of particulate matter, even though they are often perceived to be "green" from a carbon reduction perspective.

Significant life-changes, such as moving home, were highlighted as times when householders made key energy saving interventions, e.g. installing insulation and new windows. Building extensions was also seen as an opportunity for upgrading boilers and heating systems to accommodate the extra demand, however the upshot is still an increased energy demand. Extra space in a home was often seen as necessary by householders to accommodate (and separate) large or growing families and visitors, providing 'personal space', with energy demand per person a lower order consideration. Some new-build householders were swayed by architects to build bigger homes, even though they had initially set out to design low-energy eco-builds. This suggests that targeting middle actors, such as architects, estate agents and building professionals, can be a useful way to influence householders' decisions more positively with regards energy management. Challenging social norms over larger houses, accommodating 'peak household' and personal space, alongside building energy efficiency standards was highlighted by the authors as a

necessary to reducing overall energy demand. Another important opportunity to target this message is when children have moved out of the family home and downsizing could enable parents to reduce unnecessary energy demand. Reducing energy demand is a much more effective strategy than energy saving interventions in terms of emissions reduction, but requires significant social and personal shifts in expectations, desires and acceptability of living space and property ownership.

Arguably, a sociological approach is required that recognises that technocratic solutions are not necessarily effective for energy management, particularly for those at the lower end of the economic spectrum for whom fuel poverty is more present. In this context, Webb et al. (2016) investigated the experiences of low-income households, on a 1960s Glasgow housing estate in one of the most deprived areas of the UK, living through a major renovation programme to insulate homes and install community heating. Social housing improvements through better insulated buildings and cleaner heating systems with new technical controls and meters are expected to make homes easier and more affordable to heat, thus improving both welfare and climate protection. However, as the paper states, there is little research on low-income households' experiences of, and responses to, energy saving initiatives or new heating controls. In addition, the complex psychosocial processes governing the meanings of energy use, home and poverty suggest that achieving the desired benefits is likely to depend not just on the technical upgrades to buildings and heating systems, but also on the social relations of tenants, landlords, owner-occupiers and energy suppliers.

The works included external cladding insulation, replacement of electric storage heaters and hot water tanks with new central heating radiators, heat interface units, meters and programmers, and installation of a gas-fired combined heat and power (CHP) generator, plus three large gas boilers and a thermal store in a new energy centre on the estate. Overall, tenants and owners reported greatly increased satisfaction with the new heating system with a transformation in perceived warmth. Prior to the improvements, tenants and owners would cut back on food, delay paying other bills and/or borrow money to meet heating costs. Subsequently, although generally energy bills were not much reduced due to higher levels of consumption, for many their quality of life was improved through warmer homes and readily available hot water. For others, in more precarious circumstances, a lack of understanding or perceived control over the heating had resulted in significant increases in cost, in some cases compounded with confusion over the billing and a high standard charge. Some residents described being told that their energy spending was 'out of control', but could not understand why their bills were high. Users were not necessarily given access to usage data and a very high proportion (85% of tenants and 70% of owners) were not using the programmer one year after the heating was installed, and around half did not use the thermostatic radiator valves.

Although the primary motivation for the renovations was to improve social welfare, a lack of consideration of users' needs and limitations, together with an econometric approach, appears to have resulted in a greater economic burden for many, and a lack of (perceived) control over their energy usage. Secondary aims to reduce

emissions was reportedly met with cynicism from some residents, although the scheme has resulted in 62% reduction in GHGs, notwithstanding any increase in usage (overall emissions impact was not reported).

Original plans for a community energy scheme, run as a locally owned and controlled consumer cooperative, may have ensured local relationships and democratic control, and transparency over the costs and affordability of heat, as well as supporting the local economy by retaining a higher percentage of energy revenues in the locality, and sharing infrastructure costs across the larger co-op population. A lack of support from neighbouring organisations, however, meant this option was not viable.

### 3.5.5 Energy production

Interestingly, decentralised, community-led energy systems appeared to be favoured by workshop participants in Aberdeen (Thomas, Demski and Pidgeon, 2020), due to mistrust over traditional energy providers, and a desire to be able to increase personal control and self-sufficiency. There was recognition that low-income households may have difficulties contributing to capital expenditure, however, and participants acknowledged support needed for elderly and disabled citizens in operating smart meters and domestic technologies, as identified previously by Webb et al. (2016).

Scotland has over 650 community- and locally owned energy projects completed or in development with an installed community renewable energy capacity of >730 MW and ambition to reach 1 GW this year (Local Energy Scotland, 2020). Community energy project (CEP) interviewees from the Horshader Trust, Siabost, Western Isles and the Tiree Trust, the Isle of Tiree, Argyll acknowledged the support of the Scottish Government, particularly through the ‘Community and Renewables Energy Scheme’ (CARES) grants (Haf et al., 2019). According to Haf et al. (2019), the strong civil society in Scotland is also one of the reasons behind this success.

Ostfeld and Reiner (2020) similarly found a high level of public support for continued diversification of Scotland’s energy portfolio to include more renewable energy sources, particularly at the local level. Public views on climate policy, renewable energy, and low-carbon technologies were explored using focus groups conducted in Aberdeen, Peterhead, and Edinburgh and citizens’ juries in Aberdeen and Edinburgh. Even in communities historically reliant on jobs provided by the fossil fuel industry, like Aberdeen, pro-renewables sentiments and scepticism of industry pervaded as also found by Thomas, Demski and Pidgeon (2020).

### 3.5.6 Carbon capture and storage

Despite a low level of awareness of the subject, Ostfeld and Reiner (2020) also found that research and development on carbon capture and storage (CCS) was supported, building on the existing oil and gas infrastructure and providing local job opportunities. However citizens did not think it was appropriate for Scottish taxpayers to bear the costs of CCS projects while they perceived the industry to be profiting

from damaging the environment, preferring a 'polluter pays principle'. Perceived CCS safety issues were also a concern.

Five years earlier, Mabon and Shackley (2015) also reported on focus group data from Aberdeen and Edinburgh, which indicated public and stakeholder support for CCS as part of a managed transition to low-carbon economy. Nearly all participants – stakeholders and public – agreed human-induced climate change was occurring, and that changes to energy production and consumption were required to reduce climate risks. Within this, there was also good general agreement that CCS and associated carbon dioxide enhanced oil recovery could in principle be considered part of the suite of low-carbon energy sources that may be drawn on to mitigate climate change. Resistance was observed, however, as reported by Mabon and Littlecott (2016), and this tended to be from those that viewed CCS as slowing the transition to renewables or people that feared the potential psychological impacts of 'hiding' $CO_2$ underground. However, as observed by Ostfeld and Reiner (2020), the potential for employment opportunities also lent support (Brunsting et al., 2015).

### 3.5.7 Summary of public perceptions in Scotland

Based on the, albeit relatively small number of, responses to the Global Action Plan survey there is an increasingly high level of awareness of air pollution and understanding of the measures that could be taken to reduce it. However, there appeared to be a stronger support for national (UK Government) action than for individual travel behaviour change. It is unclear whether this is a lack of ambition on respondents' behalf, a detachment from ownership of the problem and responsibility for the solutions or a result of real or perceived barriers to enable them to act in more sustainable ways, an area that clearly warrants further investigation.

The strong support for the LEZs to reduce air pollution and protect public health, amongst respondents to the Scottish Government's consultation also indicates there is appetite for imposition of relatively stringent 24/7 vehicle restriction measures, in preference to charging zones. Furthermore, these should be supported with measures to facilitate alternative modes, e.g. improvements to public transport and walking and cycle routes. Respondents appeared to accept that such a scheme would affect all sectors of society, but that motorists should be paying for traffic pollution, notwithstanding the need to consider mobility and social justice issues for those that may be adversely impacted. It is worth reflecting, however, that these were self-selecting respondents and hence not necessarily reflective of the wider Scottish public. As learnt from the experience of the proposed Edinburgh Congestion Charge Zone, it is necessary to ensure much wider engagement with all communities affected by the scheme and, crucially, that the positive impacts of the scheme are well-publicised to counter any negative media bias.

Exploring Scottish behaviours and perceptions of travel more widely, much of the literature dwelt on aspects of deprivation, largely focused in Glasgow. A culture of 'forced' car ownership was noted in one study, particularly amongst families with children. The paper also highlighted that sustainable travel options were not reaching deprived communities, and furthermore, that regeneration strategies are failing to

promote mobility and accessibility. This is also discussed in other papers that suggest that despite regeneration apparently improving walkability, this did not necessarily equate to increases in active travel. In some areas this was due to inherent fear of crime and lack of safety creating 'no go' areas, although for others, improvements to cycle and walking infrastructure did help. Another study, which analysed walking behaviour by deprivation index, also found that households in deprived areas were less likely to walk than those in wealthier areas.

Propensity to walk was also determined by urbanicity with rural communities less likely to walk. This may be due to travel distances and higher levels of car ownership, but the authors also linked this to seasonal differences with weather being a driving factor. Health inequalities was also found to be a factor in mobility decisions leading to perceived car dependence. However use of public transport, active or multiple modes were found to increase journey satisfaction more than just cars, indicating that more support to shift behaviours in these communities could have multiple health and wellbeing benefits. For rural communities and those with mobility issues, there appears to be a good network of community transport provision in Scotland, which is highly valued by users.

Analysis of children's travel to school behaviours found that walkable neighbourhoods were conducive to walking to school over all distances, but ~0.5 miles was widely considered to be popular. Active travel and public transport was also popular amongst Scottish university students, whereas for staff at one Scottish university, ambitions to walk more were thwarted by work and family commitments as well as the weather and personal motivation. Increasing cycle infrastructure around cities was recommended to encourage more leisure cycling, but in order to increase year-round commuter cycling for new or less proficient cyclists, providing weather shelters on existing cycle networks was recommended.

In exploring domestic energy use, two key studies were reviewed reflecting opposite ends of the economic spectrum. In the first study on 'zero emission' homes, it was found that although householders were keen to install insulation, new windows and efficient heating systems, the demand for space and desire for bigger houses created an increase in energy demand. The second study examined the renovation of the heating system in a social housing situation and found that a lack of consideration of users' needs and limitations, together with an econometric approach, appears to have resulted in a greater economic burden for many, and a lack of (perceived) control over their energy usage. It is clear that at both ends of the economic spectrum, there is a need to consider the lived experiences of individuals when seeking to influence their energy usage to reduce emissions. Whilst neither of these studies particularly looked at solid fuel burning – indeed no Scottish papers or studies were identified in this review that did – there is an additional need to consider the negative effects of installation of wood-burners on local air quality despite their popularity as a 'low-carbon' heat source.

Decentralised, community-led energy systems appear to be very popular in Scotland, in part due to the availability of grants to facilitate their implementation, but also scepticism over national energy providers. In addition, there is also support for

renewable energy including local schemes, even in areas historically linked to oil and gas, such as Aberdeen. These areas are also supportive of CCS, due to employment opportunities, but only as part of a managed transition to low-carbon economy.

Based on the wide range of studies identified in this review, there does appear to be a strong awareness of and engagement with air quality and climate change issues, at least in certain sectors of society in Scotland. There are however, significant barriers to engagement and importantly behaviour change, amongst particularly deprived communities. This is well-documented and requires a detailed level of understanding of the complex factors at play in order to ensure that engagement is meaningful and effective.

# 4 Summary and recommendations

**This chapter presents a synthesis and summary of the literature review findings covering Scottish public attitudes to air quality and recent approaches to public engagement, and makes recommendations for a public engagement strategy.**

The objectives of this literature review were to:

- Identify, review and synthesise up-to-date evidence on Scottish public attitudes, perceptions and behaviours towards air quality, to understand the key findings, robustness of evidence base and any outstanding gaps in the evidence
- Identify and review recent approaches to engaging the public on air quality, to understand effectiveness, limitations and applicability in different contexts, and
- Make recommendations for a public engagement strategy for air quality as part of the planned public consultation on the new CAFS strategy.

## 4.1 Scottish public attitudes, perceptions and behaviours towards air quality

The literature identified limited studies on public perceptions in Scotland specifically on air quality. In anticipation of this a wider range of search terms were used and returned papers, reports and consultation responses that covered emissions-generating activities (e.g. transport/travel, domestic energy) and related issues (low carbon, climate change, energy production). It must be recognised, however, that not all of the views and opinions presented may be representative of the wider Scottish public given the narrow and often self-selecting range of respondents/participants within the studies reported.

Despite strong support for governmental action on air quality, and for the implementation of relatively stringent LEZ vehicle restriction measures to help reduce road traffic emissions, there is a modest level of ambition from individuals to change their travel behaviours, with only 5% Global Action Plan survey respondents likely to switch to a low emission vehicle. It is unclear what the barriers are here (the literature has reported issues such as cost, range anxiety, lack of charging point infrastructure, lack of awareness/knowledge as key barriers), hence, there is a need to explore this issue further. The survey also revealed a relatively low level of interest in switching from driving to active travel (40%) or to public transport (30%). Given actual behaviour is normally less than expressed intention, there is a need to investigate the reasons behind these responses. The LEZ consultation respondents preferred vehicle restrictions to charging zones, which were seen to penalise the poorest in society more, and recognised that, although motorists should be paying

for traffic pollution, there was a need to protect those with mobility and social justice issues, and to provide alternatives to private car use.

For university students walking, active travel and public transport levels are relatively high and for schoolchildren walking and cycling to school for distances less than 0.5 miles is popular, but that there is scope to increase this through measures that provide reassurance to parents. For university staff, ambitions to walk more for health reasons were thwarted by work and family commitments, as well as weather and personal motivation. Weather and seasonality was also highlighted as a restriction to active travel in other studies, and provision of weather shelters for cyclists and walkers was suggested as a possible solution.

For those living in rural areas and in lower socioeconomic households, reducing private vehicle ownership/use is a challenge as there is a (perceived) reliance on the car to manage complex needs (e.g. work, family, caring, health concerns). In the most deprived areas, this is compounded by a fear of crime, as well as a lack of infrastructure, which restricts perceived abilities to use active travel modes. Even where urban regeneration has improved infrastructure, active travel remains low, signalling a need to better understand the complex needs of these societies and the barriers that prevent them from shifting to more pro-environmental behaviours. Particularly for those with health issues, shifting from private car use can have multiple health and wellbeing benefits. One solution may be the good network of community transport in Scotland, of which the economic, social and health benefits are highly valued by users in urban and rural areas.

On the domestic energy side, solid fuel burning wasn't covered in the literature reviewed, however two key studies revealed very different issues on energy management from either end of the economic spectrum. In both, solutions were focused on energy saving measures rather than the much more effective reduction of energy demand. For the most affluent, although householders were keen to install insulation, new windows and efficient heating systems, the demand for space and desire for bigger houses created an increase in per person energy demand. For those in social housing, a lack of consideration of users' needs and limitations in renovating the heating system led to a greater economic burden for many, and a lack of (perceived) control over their energy usage. Both cases illustrate the need to consider the lived experiences of individuals when seeking to influence their energy usage to reduce emissions.

For energy generation, community-led energy systems are popular in Scotland, due to the availability of grants, but also scepticism over national energy providers. There is support for renewable energy, but also CCS as part of a managed transition to low-carbon economy.

Based on the wide range of studies identified in this review, there does appear to be a strong awareness of, and engagement with, air quality and climate change issues, at least in certain sectors of society in Scotland. There are however, significant barriers to engagement and importantly behaviour change, amongst particularly deprived communities. This is well-documented and requires a detailed level of

understanding of the complex factors at play in order to ensure that engagement is meaningful and effective.

## 4.2 Approaches to engaging the public on air quality

The majority of the public engagement studies in both grey and peer-reviewed literature searches were not related to Scotland. The grey literature search identified just two Scottish sources on air quality and active travel. From the peer-reviewed literature, the Scottish studies identified were not specifically focused on public engagement techniques or air quality, but provide insight into various applications of public engagement in related areas (e.g. transport, active travel, planning and place-making, low carbon, climate change, energy and public health). A number of results also examined behaviour change methodologies in the context of health protection, and mitigation of air pollution and carbon emissions, largely focused on reducing private car use. These were reviewed to understand the psychological drivers behind behaviour to inform recommendations on public engagement approaches. Although many of the studies identified were from an Asian context (predominantly Chinese, Taiwanese, Malaysian and South Korean), where higher levels of pollution and different politico-cultural norms from the Scottish context exist, the general findings are supported by the wider literature and therefore are considered to have broader applicability.

### 4.2.1 Behaviour change theory

Many of the studies on behaviour change theory reviewed used the Theory of Planned Behaviour and hence the framing has centred around the underpinning factors of: attitude (an individual's evaluation or beliefs about a recommended response); subjective norms (what an individual thinks other people think they should do) and; perceived behavioural control (an individual's perceptions of their ability to do the behaviour).

Environmental awareness can positively impact attitudes on air pollution and behaviour change, and therefore raising awareness of air pollution can help to engender those behaviours. However, provision of information and awareness raising, if used in isolation, can cause negative affective responses leading to stress and paralysis of action if risk perception and behavioural responses are not properly managed. If people feel that alternatives are unavailable, or unobtainable given limited resources, a lack of perceived control can also limit their ability to change behaviours. Subjective norms can reinforce existing behaviours, but can also help to shift societal attitudes. In seeking to change behaviours, it is therefore necessary to consider all of these factors:

- providing targeted messaging that considers all demographics of society, communicated appropriately for the target audience, that is both constructive and empowering;
- providing enabling polices that are easier, more convenient and preferably cheaper, and that consider the complexities of the lived experiences of different sectors of society; and

- influencing the influencers to shift the social consciousness on air pollution, building on social, familial and intergenerational drivers and communication networks to affect normative behaviours.

### 4.2.2 Public engagement approaches

A range of public engagement approaches have been identified in this review, from communication tools, traditional questionnaires and focus groups, to more participatory 'citizen panels', 'citizen science', 'living labs' and co-creation, and novel techniques using social media and gamification.

A wealth of tools and examples of good practice communication to help raise awareness of air pollution and emissions reduction behaviours exist from a number of EU projects, as well as examples from Scotland (e.g. 2019 Clean Air Day in Scotland and Dundee City Council's social marketing campaign). As well as campaigns to raise awareness in the general public, targeted communication to engage vulnerable groups (e.g. schoolchildren, the elderly and those with pre-existing conditions) and different socioeconomic groups, as well as user groups (e.g. drivers) should be considered. Communications experts and subject experts can help to inform and target messages appropriately and effectively. Planned evaluation of campaigns should be designed in and materials should ideally be made more widely available for others to learn from and use. Communication tools can be seen as one-directional, top-down approaches, from which it is difficult to gauge engagement. Whilst potentially useful for awareness-raising, therefore, they may be limited as behaviour-change mechanisms. Considering the three dimensions of public engagement, it is important that strategies move beyond traditional "Transmit" and "Receive" models of public engagement (e.g. websites, newsletters, workshops, consultations) but aim for the more ambitious and rewarding "Collaborate" models (e.g. citizen assembly) so that groups can work together to co-create consensus resulting in shared accountability, shared ownership and shared decisions.

Questionnaires can be useful in obtaining information from a large number of respondents, but they can also be limited in the depth of understanding that they are able to achieve, although iterative or longitudinal 'diary' approaches can help to address this. Focus groups enable a more in-depth conversation with individuals and the opportunity to observe social norms at play. However, they generally are limited in the number of participants that they are able to engage, and there is a tendency for self-selecting participants to poorly represent the wider community, unless purposively targeted.

Citizens' panels provide a deeper level of engagement with citizens and presents a shift from top-down engagement to a more inclusive approach to policy development. As described in two Scottish examples on renewable energies and low-carbon technologies, a panel of demographically representative citizens consider evidence presented on an issue in order to make recommendations to policy makers. Whilst the citizens' panels provide a more inclusive and deliberative approach to traditional top-down consultation techniques, the public are still presented with information and their recommendations ultimately are still for policy

makers to decide upon. Using independent chairs and/or organisers (i.e. non-governmental) can facilitate engagement and relieve potential political antagonism or distrust and resistance to engagement. Citizens' panels require careful planning and coordination to ensure successful implementation and valuable outputs that do not disenfranchise either the jurors or the expert witnesses

Citizen science raises awareness by participation using a range of technically-creative approaches, e.g. using nitrogen dioxide diffusion tubes, creating Raspbery Pi air quality sensors, and air quality data hackathons. They are a good way to build networks between researchers, policy makers and citizens, including children and young people, and create engaged communities, who can become disseminators and raise awareness of air pollution. Caution should be applied to ensure users are aware of low cost sensor data limitations, and care taken to manage risk perceptions.

Smart cities/"living labs" takes citizen science and uses it to help build and shape policy development. This co-creation of policy with citizens and the direct integration of their input into the planning and development of their cities separates "living labs" from other citizen engagement approaches. These approaches not only raise awareness, but also directly tackle perceived behavioural control and subjective norms by creating communities of well-informed, empowered individuals. The Future City Glasgow project and the Community Engagement for Carbon Emission Reduction (CECER) Strategy for Fife Council provide examples of co-creation and co-design approaches in Scotland.

Gamification provides a way of raising awareness, providing and capturing information and helping to modify behaviour. These 'serious games' can help to engage typical non-engagers as they do not require direct contact and can be engaged with whenever convenient. They can also incorporate social/online communities, creating opportunities for raising awareness with wider social groups and enabling normalisation of pro-environmental behaviours. Used within a suite of engagement tools, gamification can therefore be a useful mechanism.

Social media and social networking platforms, such as Twitter, Facebook, Instagram and TikTok, can be used for widespread sharing of air pollution messages, capturing of public experiences through multimedia and exploration of public perceptions through hashtag searches and content analysis. The ability to engage widely, not only with those that are primarily interested but also with their wider social networks also presents opportunities for affecting subjective norms.

Participatory arts, as in the "Bird Yarns" example from the Isle of Mull, present a novel approach to public engagement that can help capture the views of normally disengaged or harder to reach sectors of society in an accessible way. However, as with many other public engagement approaches, the longer-term effectiveness in terms of engendering changes in perceptions and ultimately behaviour, can be difficult to determine.

As we have seen from the review of behaviour change theory, communication can help raise awareness and lead to positive attitudes, as well as influencing subjective

norms. However, to tackle negative risk perceptions and a lack of perceived behavioural control, it is important to engage in more participatory approaches. By actively engaging citizens in the development of policies, it is possible to co-create solutions that have public support and will be easier to implement and therefore more effective. Self-run events using existing communities and groups can also lead to stronger engagement and citizen buy-in. Co-creation activities should be guided sensitively by experts to ensure that solutions are realistic and implementable whilst not closing down the innovative and creative ideas of citizens. Ensuring all sectors of society have an equal voice in this public discourse is vital to avoid disaffecting communities and creating or exacerbating social inequalities.

## 4.3 Recommendations for a public engagement strategy for air quality

Effective public engagement should draw upon an assortment of different approaches, using materials from other successful strategies to build a coordinated suite of multi-media initiatives, with support from communications experts and commitment from a range of actors, e.g. national and local government, public health agencies, public transport providers, businesses and schools. Planned longitudinal monitoring and evaluation should be designed into the campaign to identify the effectiveness of strategies, and to allow organisers to learn from the successes and follow up on areas of weakness. It can be challenging to engage people in post-activity evaluation without incentive; therefore coupling evaluation with feedback on how their engagement has contributed can create a feedback exchange, and also enable citizens to reflect on their experiences in a more informed way. Furthermore, the engagement strategy, materials and evaluation reports should be transparent and publicly available to allow others to benefit.

The following highlights key recommendations for a public engagement strategy for air quality in Scotland to inform the new CAFS strategy and future public engagement approaches.

1. Consider a holistic approach that reflects citizens' lived experiences rather than focusing exclusively on air quality.
2. Use a range of pre-piloted engagement approaches, informed by communications and subject experts.
3. Ensure engagement approaches are inclusive of all sectors of society and appropriately communicated.
4. Target specific groups separately, e.g. vulnerable groups, user groups.
5. Gain support from and include a range of actors, e.g. national and local government, public health agencies, public transport providers, businesses and schools.
6. Research the affected communities and actively engage with them to understand the socio-cultural contexts and complexities of their needs.
7. Co-create solutions that work for the affected communities, through citizens' panels, and 'living labs', ensuring participants are demographically representative.
8. Support citizen-led engagement events and activities, e.g. citizen science.

9. Ensure promoted behavioural changes are easier, more convenient and preferably cheaper than the status quo.
10. Raise awareness responsibly, ensuring that risk perceptions and data interpretation are managed and achievable behavioural responses are provided.
11. Focus communication on health impacts, rather than concentrations or emissions.
12. Use change agents, influencers and middle actors to help raise awareness and promote behaviour change to affect normative behaviours.
13. Use social media to spread awareness through wider social connections and families.
14. Plan longitudinal monitoring and evaluation, coupled with citizen feedback, into the public engagement design.
15. Ensure materials and evaluation are made available to benefit other public engagement strategies.

## 4.4 Recommendations for further research

The following gaps in the evidence base have been identified, requiring further research.

In raising awareness of air quality, the literature suggests that this should focus on health effects. To inform this, a baseline study is recommended to identify:

- Current awareness amongst the Scottish public of the health effects of air pollution and contributory sources

In terms of implementing behaviour change measures to improve air quality and carbon emissions, there is a need to develop a better understanding of the Scottish-specific real/perceived barriers and behavioural drivers around travel and domestic energy demand. Specifically, these should explore:

- Barriers to uptake of low emission vehicles in Scotland
- Barriers to modal change from private vehicles in Scotland
- Behavioural drivers around travel and modal choice in Scotland
- Behavioural drivers around energy demand in Scotland

The CAFS review also recommended improving understanding of solid fuel use in Scotland. Given none of the recent literature reviewed identified any evidence on this, there is a need for research that seeks to identify:

- Solid fuel use in Scotland, including behavioural drivers and barriers to alternatives

All of the recommended studies above would need to be demographically representative of the Scottish public, and consider the specific issues inherent in areas of different socioeconomic status and in urban/rural contexts.

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# 6 Appendix A – Scopus search terms

- Search 1 (Public Attitudes to air pollution in Scotland): Air pollution (focused terms and related issues) + Scotland + Public + (Attitudes OR Knowledge OR Awareness OR Concerns OR Behaviour) (TITLE-ABS-KEY search)
- Search 2 (Air pollution and public engagement approaches): Air pollution (focused terms) + Public + (Attitudes OR Knowledge OR Awareness OR Concerns OR Behaviours) + Approaches (TITLE-ABS-KEY search)

| |
|---|
| Air pollution (focused terms)<br>("Air pollut*" OR “Air quality” OR "Air toxics" OR “Clean air” OR "Black carbon" OR "Car emission*" OR "Carbon dioxide" OR "Carbon monoxide" OR "CO2" OR "Diesel emission*" OR "Diesel fuel" OR "Diesel fume*" OR "Elemental carbon" OR "Fine particle*" OR "Nitrogen dioxide*" OR "Nitrogen oxide*" OR "NO2" OR NOx OR Ozone OR Particulate* OR "Petrol emission*" OR "Petrol fuel" OR "Petrol fume*" OR "PM emission*" OR "PM2*" OR "PM10" OR Smog OR "SO2" OR "Sulphur dioxide" OR "Ultrafine particle*" OR "Vehicle emission*" OR "Vehicle exhaust*" OR "Vehicle fume*" OR "Air partic*" OR "Industrial emission*" OR “Domestic emission*" OR "Agricultural emission*" OR “Low emission” OR LEZ* OR CAZ*) |
| Air pollution (related issues)<br>(Traffic OR Transport OR Cars OR Vehicle* OR Placemaking OR “Place making” OR “Place based” OR Carbon OR Climate OR “Global warming” OR “Fossil fuels” OR “Wood burn*” OR Woodburn* OR “Coal burn*” OR Coalburn* OR “Solid fuel*” OR Environment OR Pollution OR "Public health” OR Health OR Wellbeing PR “Well being” OR CAFS OR “Green infrastructure” OR Congestion OR Commut*) |
| Scotland<br>(Scotland OR Scottish OR Alba OR Edinburgh OR Glasgow OR Aberdeen OR Dundee OR Stirling OR Inverness OR Perth OR Fife OR Falkirk OR Grangemouth OR Tayside OR Lothian OR Highlands OR Grampian OR Clyde) |
| Public<br>(Public OR Scot* OR Citizen* OR People OR Person OR Society OR Human* OR Individual* OR Household* OR Stakeholder* OR Family OR Families OR Respond*) |
| Attitudes<br>(Attitudes OR Support OR Opposition OR Judgement OR Judge OR Opinion* OR Conduct OR Practice* OR View*) |
| Knowledge<br>(Knowledge* OR Know OR Understand* OR Understood OR Learn* OR Inform* OR Experience*) |
| Awareness<br>(Aware* OR Visib* OR Perception OR Important OR Unimportant) |
| Concerns<br>(Concern* OR Engag* OR Involv* OR Particip* OR Consult* OR Campaign* OR Care OR Barrier*) |
| Behaviour<br>(Behav* OR Issues* OR Impact* OR Effect* OR Affect* OR Control* OR Barrier* OR Habit* OR Convenience OR Inconvenience OR Energy-saving OR Environmentally-friendly OR Sustainab* OR Green OR Eco-driving OR Idling OR Fuel-use OR “Fuel efficien*” OR “FuelGood” OR “Electric vehicle*” OR “Home deliver*” OR Switching OR Journey* OR Homeworking OR “Car club*” OR “Car pool*” OR “Park and ride” OR “Know and respond” OR “Travel plan*” OR Bus* OR “Public transport” OR “Active travel” OR Bicycle* OR Cycl* OR Bike* OR Walk*) |
| Approaches<br>(Method* OR Outreach OR Approach OR “Focus group*” OR Survey* OR Questionnaire* OR Workshop* OR Interview* OR “Self report*” OR Discussion OR Feedback OR Consultation* OR Census OR Research OR Communicat* OR Messag*) |

# 7 Appendix B – ENDS search terms

- Search 1 (Public Attitudes to air pollution in Scotland): Air Pollution AND Scotland AND Public AND Behaviour
- Search 2 (Air pollution and public engagement approaches): Air Pollution AND Public AND Behaviour (additional limit to 'Air' category of reporting)

# 8 Appendix C – CORDIS database search terms

- Search 2 (Air pollution and public engagement approaches): Air Quality OR Clean Air AND Public Engagement






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