The Implications of Behavioural Science for Effective Climate Policy

Output 1: Literature Review and Background Report

A report by the Centre for Climate Change and Social Transformations (CAST), commissioned by the Climate Change Committee (CCC)

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Centre for **Climate Change** and **Social Transformations**

Executive Summary

The UK has set targets to reduce greenhouse gas (GHG) emissions by 78% by 2035, and to reach Net Zero by 2050. These are ambitious plans and will require significant reductions to come from behaviour change by consumers, with further behaviour change needed within businesses. Adapting to climate change will also require substantial behaviour change.

The Climate Change Committee (CCC) commissioned the UK Centre for Climate Change and Social Transformations (CAST) to conduct an evidence review on the implications of behavioural science for effective climate policy. The present report represents Output 1 from the project. It comprises a literature review and background report that informs a separate policy recommendations report (Output 2).

Our analysis is divided into eight main sectors: (1) Diet change, (2) Reducing end-user consumption, (3) Aviation, (4) Adaptation, (5) Net Zero skills and careers, (6) Business leaders and the transition to sustainability, (7) Land use and farming, and (8) Policy acceptability. These areas were prioritised by the CCC, based on each area's relative contribution to emissions reductions in the Sixth Carbon Budget pathways. Some areas were omitted from the review where evidence is being collated as part of separate projects (e.g. surface transport, energy and buildings).

We used Scopus searches to identify relevant academic literature and issued a call for evidence to experts and stakeholders working in the environmental domain. We also used Google searches to identify grey literature reports. In total, we identified 398 sources. Our findings primarily derive from key review papers, supplemented by relevant empirical papers and reports where reviews were not available or suitably recent.

In general, low-carbon or climate-resilient behaviour is driven by factors including (a) individual knowledge, values, and emotions; (b) social factors (e.g. norms, group identity); and (c) practical factors, such as functionality, ease and price. Of these various drivers, individual factors such as knowledge tend to be less influential in changing behaviour than wider social or practical factors.

Consequently, 'downstream' interventions, which target an individual's decision-making or motivation (e.g. by providing information), tend to be less effective than 'midstream' interventions, which make a particular behaviour easier, more attractive or simply the default choice (e.g. by changing prices, convenience or salience). Similarly, downstream interventions tend to be less effective than 'upstream' interventions, which seek to shift norms through institutional leadership towards sustainability (e.g. via regulations, incentives and infrastructure changes).

Our review found that most evidence on climate mitigation and adaptation behaviour change relates to downstream approaches, whereas to achieve large-scale behavioural shifts, interventions should also apply midstream and upstream approaches that remove barriers to behaviour change.

The key findings and implications for each sector are summarised below.

Diet change

- As with other behavioural areas, tailoring dietary interventions to people's values, attitudes and emotions is important. For example, the desire to consume meat can be reduced by targeting positive or negative emotions (e.g. pleasure, guilt, sadness), or by emphasising the co-benefits of diet change (e.g. improved health, animal welfare).
- Highlighting the convenience and potential for saving time when preparing vegetarian or vegan dishes can encourage people to switch to a more plant-based diet.
- Lowering the price of vegetarian options and food labelling (e.g. carbon labels) stimulates behaviour change.
- Moments of change or life transition events such as relocation or retirement could be targeted to facilitate behaviour change.
- More systems-based approaches are necessary, focusing not only on individual diet change but also on transforming the present food system.
- Efficacy testing and real-world trials, especially those using a combination of intervention techniques and targeting different groups, are needed.

Reducing end-user consumption (e.g. reusing and repairing goods, recycling, cutting food waste)

- Demographic factors such as age and income are relevant for reducing end-user consumption as older people and those with higher income have higher levels of consumption.
- Values and social norms play a role in achieving consumption-related behaviour change, since consumer choices can express identity and reflect cultural aspirations.
- Barriers to repairing material goods include a lack of environmental knowledge, skills, free time, and equipment needed for repairs.

- Ease of implementation and the availability of infrastructure (e.g. recycling and food waste bins) should be considered when designing interventions.
- Financial incentives are important for recycling, while food labels and information provision are key for reducing food waste.
- Real-world trials, more longitudinal research, and using more precise trackers for behaviour change (e.g. mobile applications, diaries, etc.) are needed.

Aviation demand

- Aviation demand is very unevenly distributed amongst the population. Many people are reluctant to fly less because flying is associated with valued experiences, freedom, success, social capital, and progress. Alternatives to flying can seem expensive or impractical.
- A person's concern about climate change does not necessarily result in them flying less.
- A Frequent Flyer Levy or Frequent Air Miles Tax could be successful and acceptable behavioural interventions according to economic analysis and public polling.
- Social norms around flying have the potential to change as moral considerations come to the fore.
- Behaviour change can be aided through limitations on the advertising and incentivising of flying by the aviation industry, government, and celebrity culture.
- Research is lacking on the effectiveness of behavioural interventions that would substantially reduce emissions from aviation.
- If behaviour change is to make a significant contribution to emissions reductions from aviation, it is likely to require the alignment of action from multiple parties: consumers, governments, policymakers, cultural leaders, and the aviation industry. This will involve downstream, midstream, and upstream interventions.

Adaptation

- Adaptation behaviours (e.g. household/self-protection; civic engagement; lifestyle changes) are not widespread, and awareness of adaptation is lower amongst the public than about mitigation.
- Land managers are more likely than households to make permanent modifications to property (e.g. installing flood-proofing, shading) in anticipation of climate risks.
- Factors known to shape behavioural adaptation include individual-level factors such as knowledge of strategies, previous experiences with extreme weather events, levels of perceived responsibility, place attachment, educational level, and financial situation.
- Adaptation behaviours are also shaped by cultural and structural factors such as cultural norms (e.g. for water use), economic policies (e.g. farming subsidies), and the built environment.
- Most interventions focus on information provision (which can exacerbate inequalities because they do not remove cost barriers); although some financial interventions, such as access to credit or governmental grants, have been tested, particularly amongst farmers.
- Tailored information and advice on effective adaptation measures to both individuals and organisations/managers are needed, along with upstream interventions (e.g. regulations, incentives) to remove behavioural barriers.
- There are evidence gaps relating to types of risks, with flood risks being more researched within the UK context than other climate risks (e.g. storms, extreme cold/heat, drought). There are few evaluations of behaviour change interventions.

Net Zero skills and careers

- Net Zero skills can include the practical application of knowledge and professional abilities to help reduce emissions, however, a clearer definition may be needed. Green careers involve jobs that contribute substantially to preserving or restoring environmental quality.
- Lifelong learning should be embraced by employers and employees given the fast-changing technological advances and policy changes associated with the Net Zero transition.
- Training opportunities embedded in job descriptions could help people upskill, as around 50% of employees would need additional training to contribute to a Net Zero economy.
- Education at school on green skills and green careers could increase young people's interest, as young people believe they lack green skills or are unfamiliar with Net Zero career options.
- Environmental awareness, knowledge, and positive attitudes influence workers' decisions to undertake and use environmental training. Therefore, mandating environmental training across organisations ensures less motivated groups attend, and may result in greater reduction of organisational emissions.
- Research on green skills seems to be limited to the agriculture and energy sectors.
- Research on young people's green career choices is very limited.

Business leaders and the transition to sustainability

- Governmental regulations and economic policies (e.g. environmental taxes, labelling laws, emissions trading) are important for making businesses more sustainable.
- Sustainability awareness of managers, more specifically CEOs and board members, is a driving factor for organisational change.
- Social norms and between-firm competition could increase the switch to more sustainable enterprises.
- Extreme weather events and their effect on businesses can play a role in companies becoming more sustainable, as suggested by World Bank data and firm surveys.
- NGOs could help with the transition to sustainable business models by putting pressure on firms to comply with environmental standards and acting as a convener between businesses and government.
- There is a lack of behavioural interventions in this area, with research mainly focused on small and medium-sized enterprises in manufacturing and agriculture.

Land use and farming

- Social factors (e.g. social and descriptive norms) appear to be particularly important for behaviour change amongst farmers, so demonstrations by innovative farmers can be effective (e.g. for afforestation).
- Solutions should take into account differences in farm ownership (tenant-farmers, family-owned, corporation-owned), farmers' age, and plans for a farm's succession.
- In general, financial incentives such as grants seem to be less crucial due to concerns by farmers about losing land ownership.
- Educational training especially related to learning new skills and profitability are beneficial.
- Risk-aversion, values, beliefs, and time constraints also influence behaviour change amongst land managers, so should be considered in intervention design.
- Extreme weather events can motivate farmers in their decision to transition to sustainable practices as farmers seek to avoid future weather events damaging their business.
- There is a lack of research to test message framing, social norm approaches, and upstream measures.

Policy acceptability

- Perceived fairness across societal groups and effectiveness of climate policies are amongst the most important determinants of high acceptability.
- The public favour policies that distribute policy costs based on needs and responsibility, protect the disadvantaged, and fairly redistribute revenue to environmental initiatives.
- Policies are favoured if they are not perceived as coercive or infringing on personal freedoms and have some societal benefit.
- Policies may be better accepted when implemented by trusted leaders and organisations.
- Acceptability of adaptation policies varies according to climate change beliefs and level of concern, along with previous experiences of extreme weather and other climate impacts (e.g. living in a city with a history of water restrictions or a wildfire evacuation zone).
- Communicating the efficacy, urgency, and risk of adaptation responses may increase adaptation policy acceptability.
- Communicating the health and environmental co-benefits of policies and involving the public in policy design is likely to increase support.
- Across mitigation and adaptation policies, further work is required to quantify the most effective way to remove barriers to policy support across diverse societal groups and communicate policies to increase acceptability.

Overall, our review found that the quality of evidence on the effectiveness of behavioural interventions was methodologically weak with little quantification of impact. This means few conclusions can be drawn about the relative efficacy or scalability of different interventions. Most interventions to date have focused on low-impact 'downstream' interventions, such as tailored information provision or message framing, with far less evidence of the efficacy of midstream or upstream interventions. This is consistent with the wider policy evidence base, since downstream interventions are easier to test experimentally (e.g. in a randomised control trial) and quantify their efficacy compared to upstream or system-wide interventions. Moreover, existing work has not determined if some societal groups respond differently to behavioural interventions. Our review reveals substantial evidence gaps where future research would be beneficial. These are detailed in each subsequent section.

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1 Introduction

The UK has committed to reducing its greenhouse gas (GHG) emissions by 78% by 2035 and reaching Net Zero emissions by 2050. This will require emissions reductions from all sectors of the economy including transport, energy, agriculture, and industry. Analysis by the Climate Change Committee (CCC) for the Sixth Carbon Budget (CCC, 2020) shows that substantial emissions reductions to 2035 will require consumer behaviour change, with further behaviour change needed by businesses. Such changes include adopting new technologies (e.g. heat pumps, electric vehicles) and wider lifestyle changes to reduce consumption (e.g. dietary change, reducing waste). Behaviour change is also required to adapt to climate risks, such as flooding, drought and heat stress (Power et al., 2020). However, policies to deliver these required behaviour changes are currently lacking (House of Lords, 2022).

In view of this, the CCC has commissioned the Centre for Climate Change and Social Transformations (CAST) to conduct an evidence review of the implications of behavioural science for effective climate policy. The evidence review aims to identify how academic literature, along with government, third sector and business reports and polls, can inform *mitigation* behaviour changes aimed at reducing emissions, and *adaptation* behaviour changes aimed at preparing and adapting society to climate change impacts. The review also discusses limitations and key factors driving the success and failure of behavioural interventions. More specifically, it focuses on evidence about the role policies can play in stimulating behaviour change, particularly behaviours with large effects, or which could lead to changes at scale.

The review focuses on several different areas of study in the behaviour change literature. These were agreed with the CCC, taking into account each area's importance for reducing emissions, the existing evidence base, and their significance to the CCC's (2020) Sixth Carbon Budget. Accordingly, we have divided our review into eight sections.

The first section is 'diet change' and meat consumption in particular, which accounts for around 15% of global anthropogenic GHGs (Bailey et al., 2014) and is associated with a number of health risks, e.g. cardiovascular disease (Yang et al., 2016). Secondly, we investigate behaviours related to reducing end-user consumption, such as repairing and reusing manufactured goods, recycling, and reducing food waste. Currently around 2.1 billion tons of waste are generated yearly, with this figure expected to grow to 3.4 billion by 2050 (Kaza et al., 2018). Furthermore, in Europe over 40% of food is lost during the retail and consumer stage (Zeinstra et al., 2020), while in the UK, food worth more than £19 billion is wasted each year (WRAP, 2021). This represents a considerable contribution to emissions that could be tackled in part through household behaviour change. Our third area of focus is aviation demand, with flying contributing 2.4% of global CO_2 emissions and 7% of the UK's annual emissions (Lee et al., 2021).

Beyond mitigation, we explore 'adaptation' behaviour changes that can reduce people's vulnerability to climate impacts and increase their resilience. We also examine the evidence on behaviour change within businesses, and by business leaders. Our review explores research into organisations by identifying key factors that drive eco-innovation and Net Zero actions by employees, as well as people's decisions to upskill in the domain of sustainability or to start a green career.

We examine the behavioural literature on 'Land use and farming' towards sustainable farming. Agriculture represents a key element of the UK economy, as 70% of the UK's land is used for agricultural production, with estimates that by 2050 around 21% of this land will be needed for tree planting (Westaway et al., 2023). In view of this, we explore what motivates or hinders farmers and landowners when they engage with sustainable agricultural management practices and afforestation.

Given that the behaviour changes needed to address climate change will require extensive policy interventions, the final section of our review focuses on 'policy acceptability'. It explores factors that shape public acceptance of climate policies, and how these may vary between social (including minority) groups. This includes a focus on framing and communication techniques that are likely to promote higher acceptance of policies.

There are important areas of climate-related behaviour change that we have given less attention to in the present report; specifically surface transport, and energy and buildings. This is due to there already being several comprehensive literature reviews focusing on these areas (e.g. BIT, 2014; IPCC, 2022; BIT; 2022; European Environmental Agency, 2022). Consequently, after discussions with the CCC, we have focused the present review on areas that are less well documented, and that have been prioritised by the CCC as having significant behaviour change potential in modelled emissions reduction pathways for the UK, thus making them relevant areas for informing policy advice. Table 1 lists the main behaviours we explore, along with their relevance to the UK's Sixth Carbon Budget (assuming the 'Widespread Engagement Scenario', in which there is considerable willingness amongst the public and businesses to change behaviour). In the name of completeness, in Section 5 we signpost examples of existing reports on surface transport, and energy and buildings, highlighting key findings but without going into detail.

Table 1. Behavioural topics addressed in this review

Behavioural topic	Relevance to Sixth Carbon Budget – Widespread Engagement Scenario (CCC, 2020)
Consumer & Lifestyle Behaviours	
Diet change	50% shift away from meat and dairy products to plant-based products by 2050; Behaviour change leads to **10Mt** emissions reduction in 2035
Reducing end-user consumption	**3Mt** emissions reduction from reduction in end-user consumption in 2035; Food waste is halved by 2030 and continues to fall to 70% by 2050
Aviation demand	**16Mt** emissions reductions from demand management in 2035
Adaptation	Not quantified
Behaviours in the Context of Work	
Net Zero skills	Not quantified
Business leaders	Not quantified – but **2/3** of UK emissions currently are estimated to be scope 1 and 2 business emissions
Land use and farming	Annual afforestation rates reach 50,000 hectares by 2030 and 70,000 from 2035 to 2050; Forestry and peatland restoration lead to **5 and 6Mt** emissions reductions in 2035
General Outlook & Support	
Public acceptability	Not quantified

2 Theories and models of behaviour

Achieving behaviour change in any of the above-mentioned domains is a complex process that involves personal and social factors as well as insights from across and beyond the social sciences. Scientists have developed many theories and models of behaviour. These include psychological models that focus on drivers of individual decision-making, while others take broader social, structural, or systems perspectives. In order to avoid repeating these different approaches in each of the main sections of our report, we include below a brief overview of commonly used theories and models from behavioural science. Other approaches are noted within the report where appropriate.

A common social psychological model is the Theory of Planned Behaviour (TPB), which posits that behavioural intentions are influenced by attitudes, social norms, and both perceived and actual control over actions (Ajzen, 1991). In other words, what people do is a function of what they think and feel, what other people are doing, and the available options. The TPB has been used to predict various climate mitigation behaviours, such as reducing car use and recycling (Steg & Nordlund, 2018). However, the TPB assumes behaviour is intentional; whereas much of our behaviour is habitual, routine actions cued by a familiar context rather than conscious decision-making (Kurz et al., 2015).

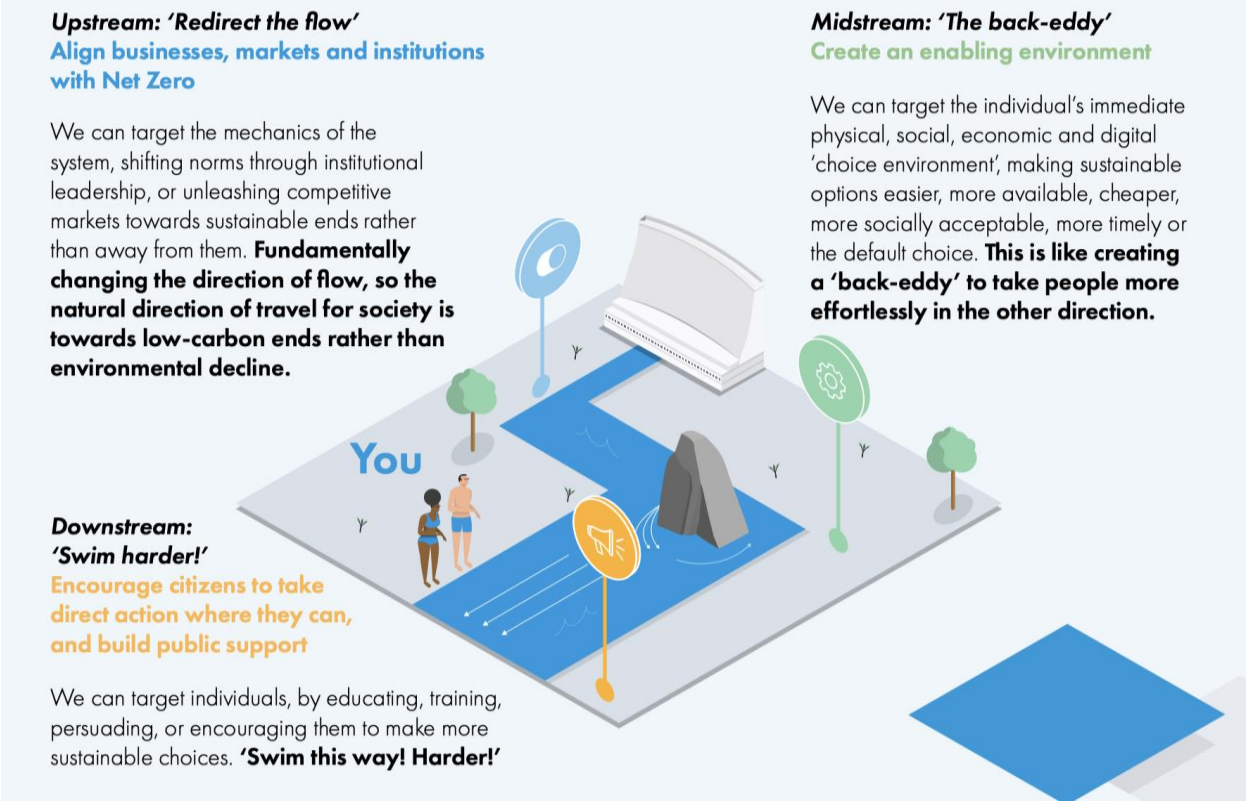
In the adaptation context, a more commonly used psychological model than the TPB is Protection Motivation Theory (Rogers, 1983), which posits that risk protection measures result from appraisals of a threat and an adaptive coping response to deal with the threat (Grothmann & Patt, 2005). These appraisals are in turn influenced by knowledge of available adaptation strategies, descriptive norms (i.e. what is seen as 'normal'), negative emotions, perceived self-efficacy and outcome efficacy (belief that the adaptive actions will have intended benefit) of adaptive actions (Moser, 2014; van Valkengoed & Steg, 2019).

Another widely-used behavioural model that accounts for the role of habit is the Capability-Opportunity-Motivation: Behaviour (COM-B) model (Michie et al., 2011), developed from a synthesis of other models and used widely across government (House of Lords, 2022). COM-B sees behaviour as arising from people's motivation (attitudes, habits, etc.), capabilities (psychological and physical abilities) and the opportunities (physical and social factors) to act. This model sheds light on the "value-action gap" or "attitude-behaviour gap" because wider social or physical factors may prevent people acting on their values or attitudes (Blake, 1999). For example, despite their environmental values many people drive short distances or fly on holiday if this is the cheapest, quickest, and socially normal option (Behavioural Insights Team, 2023).

Other models place less emphasis on individual decision-making and more on structural and cultural factors that constrain choice, shape aspirations, and lock in demand. Social Practice Theory (SPT), for example, sees routines as emergent properties of the interplay of physical and social factors, and emphasises whole-system interventions that focus on the purposes of consumption and how they can be provided in different ways (Shove et al., 2012). There is also a greater emphasis on the physical elements of practice, such as building houses with 'drying rooms' rather than space and plumbing for a tumble dryer (Maller & Strengers, 2013), whereas psychological approaches tend to focus more on influencing individuals' decision-making processes to change behaviour.

Consistent with behavioural theories, low-carbon or climate-resilient behaviour is driven by various factors, including (a) individual knowledge, values, and emotions; (b) social factors (e.g. norms, group identity); and (c) practical factors, such as functionality, ease and price (Stern, 2000; see also ISM model (Scottish Government, 2013)). Of these various drivers, individual factors such as knowledge tend to be less influential in changing behaviour than wider social or physical factors. Consequently, interventions targeting individual decision-making or motivation (e.g. information provision) tend to be less effective than interventions targeting the context of action that make behaviour easy, attractive and normal (or even the default), such as increasing the price, convenience or saliency of an action (Nisa et al., 2021), or policies that seek to shift norms through institutional leadership towards sustainability, e.g. via regulations, incentives and infrastructure changes (Behavioural Insights Team, 2023). These interventions are respectively termed 'downstream', 'midstream', and 'upstream'.

Figure 1: Upstream-downstream model of behaviour (Behavioural Insights Team, 2023; Verplanken & Wood, 2006)



Despite indications of its limited efficacy, recent reviews suggest a preference amongst policymakers for downstream approaches (Kelly & Barker, 2016; House of Lords, 2022). This may partly be due to political reluctance to intervene in lifestyles but is also likely due to the far greater evidence base that exists on downstream interventions compared to upstream. The wider policy literature shows that individual-level interventions are easier to experimentally test (e.g. in a randomised control trial) and their cost-effectiveness to calculate, compared to population/system-wide interventions for which experimental designs cannot readily be applied (Swinburn et al., 2011).

Evidence reveals that interventions are more effective when they are (a) targeted to the specific needs and abilities of different groups; and to points in time when people are most open to change (Galvin, 2013; Verplanken et al., 2021) and (b) combined, i.e. they include downstream and upstream approaches, and address the multiple behavioural drivers and barriers (Poortinga & Whitaker, 2018; Whitmarsh et al., 2021). Engagement is also important for effective behaviour change interventions to both foster acceptance and address contextual factors or constraints to efficacy (Howarth et al., 2021).

3 Project objectives

The present work has the following objectives:

1. To produce a comprehensive literature review on the *scale* of the potential impact of behavioural interventions for climate policy.
2. To identify key factors that lead to *success* or *failure* in behavioural interventions.
3. To identify evidence gaps and make recommendations for further empirical work.

4. To produce a summary of the high-level implications of behavioural science for climate policy informed by engagement with policy experts and the literature review.

We aim to achieve these objectives by delivering three outputs. Output 1 is a background report that summarises findings from the literature review, assesses their robustness and relevance, and highlights evidence gaps. Output 2 summarises the high-level implications of behavioural science for climate policy. It is informed by engagement with policy experts and the background report. Finally, Output 3 comprises an excel workbook, where we list the reviewed evidence such as academic papers and grey literature reports that we used to inform our work.

The current report represents Output 1 from the project.

4 Methodology

A literature review was conducted by the research team using Scopus to identify academic papers. We first conducted a series of searches with terms such as "behaviour change", "behavioural intervention", "policy acceptance", "climate adaptation" and various terms related to pro-environmental behaviours such as "transport", "diet", "energy", "consumption", etc. As these searches generated a very large corpus, we narrowed our search and used more specific behavioural terms, for example, "domestic waste"; "meat consumption"; "air travel", etc. See Appendix 1 for a complete list of our search terms. In addition, in line with the table below, guided by the CCC and their pathways, we focussed searches on high-impact behaviours (i.e. those that contribute significantly to reaching Net Zero or adapting to climate impacts) and for which recent syntheses had not been conducted (i.e. excluding energy use and surface transport). In our review, we have prioritised review papers and recent empirical studies. We have also included case studies for some topics to illustrate in more detail how behavioural science has been applied to real-world settings.

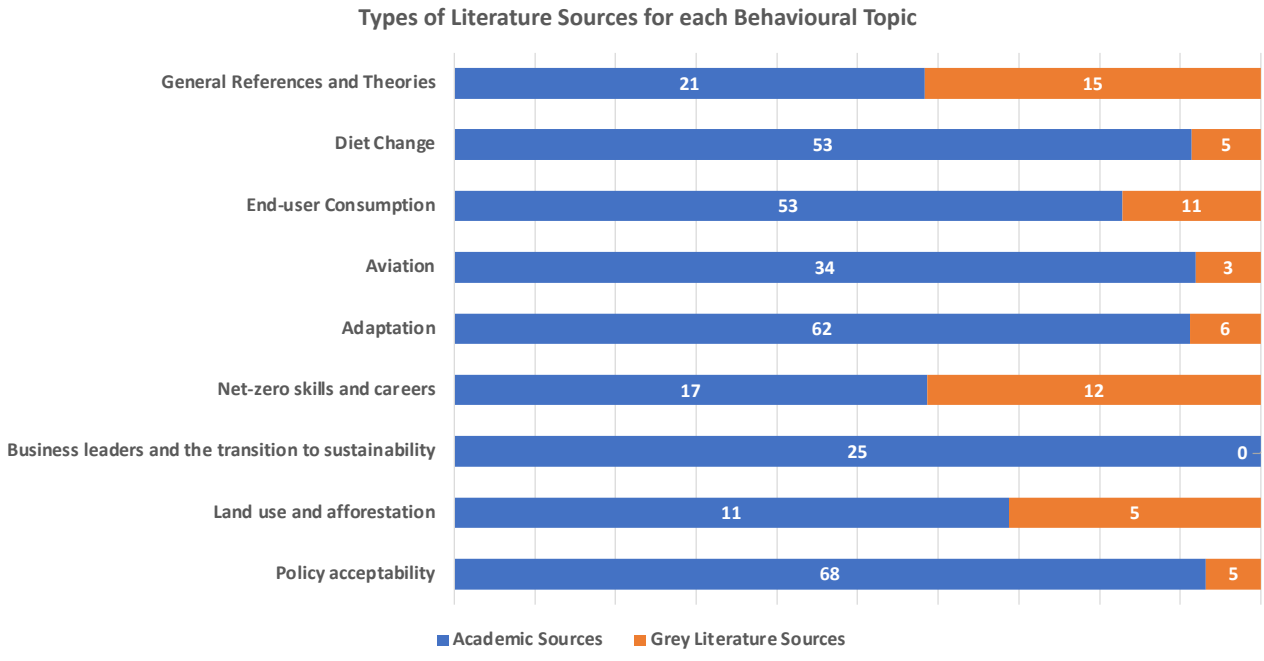
In addition to the Scopus searches, we issued a 'call for evidence' to identify additional sources from peers working in the domain of environmental science. Using this method, together with Google searches, we identified various grey literature reports. We reviewed the sources and identified the most suitable ones for the purposes of the review (i.e. those that addressed our research objectives).

In our review process we sought to focus primarily on evidence from the UK, but where this was lacking we drew on international evidence, noting where the transferability of insights from non-UK studies to the UK may be unclear or limited.

In total, we identified 398 sources, with 336 academic papers, and 62 grey literature reports (see Figure 2 for a breakdown). Note that the total number of sources according to the graph is higher than 398 as some sources were used in multiple sections of the review. These sources can be found in Output 3.

Next we present evidence from the literature review on each of the eight categories described in the introduction of this report.

Figure 2. Number of academic and grey literature sources used in this literature review



5 Surface transport, energy & buildings

For surface transport, substantial recent evidence reviews already exist. These consist of: a comprehensive report by the Behavioural Insights Team (BIT) (2022) exploring the reduction in commuting emissions; Chapter 10 from the IPCC (2022) report dedicated to transport; and the European Environment Agency (2022) report on decarbonising road transport across the EU and the UK. In addition, the UK Department for Transport published a report in 2021 on decarbonising transport. Some key findings relating to behaviour change include the need for further investments in infrastructure to help make public transport more desirable than driving, and investment in electric vehicles to reduce initial outlay and increase charging infrastructure. From a behavioural intervention perspective, 'nudges' (i.e. modifications to behavioural contexts to make desirable behaviours easier or more attractive) related to social norms together with informational campaigns or tailored communications to facilitate adoption and use of new technologies were proposed.

Reports in the energy and buildings sectors also exist. For instance the UK Government and BIT published a report titled "Behaviour change and energy use" in 2011 and another in 2014 titled "Evidence Review of the Impact of Central and Public Disclosure Methods for Reporting Energy Use and Energy Efficiency". In addition, the OECD (2017) published a report on behavioural insights to help policymakers including in the domain of energy. Finally, chapter six from the IPCC's (2022) AR6 report is also dedicated to energy use. Work on building efficiency includes UNEP reports in 2019, 2021 and 2022 'Global Status Report for Buildings and Construction' and their report on 'Buildings and Climate Change'. Some key findings emerging from past work are connected again with the use of social norms and informational feedback together with Net Zero building regulations and financial measures (subsidies, grants, etc.) as strong behavioural intervention techniques for energy efficiency. Further, findings also point to the use of new and smart technologies at home to achieve behaviour change.

6 Diet change

What we eat and the way we produce our food has a great impact on our land, climate, biodiversity, health, and communities (Willet et al., 2019). The Climate Change Committee (CCC) sets out a number of ways to reduce carbon emissions in their 2020 report 'Land use: Policies for a Net Zero UK'. Key recommendations include the reduction of high-carbon foods such as red meat (e.g. lamb, beef) and dairy by at least 20% per person up to a 50% shift away from meat and dairy products to plant-based products by 2050. Similarly, CCC Sixth Carbon Budget modelling estimates suggest that following the official Government's Eatwell Guide for a balanced diet would require around an 89% reduction in beef consumption, a 66% reduction in pork, a 63% in lamb, and a 20% reduction in dairy products (CCC, 2020).

To achieve the desired level of carbon emissions reductions, the government will need to consider ways in which people can be encouraged to change their diet and especially reduce the consumption of high-carbon foods such as meat and dairy. This chapter identifies relevant factors influencing people's dietary behaviours, public attitudes, and assesses the potential impact and scale of interventions on behaviour.

Key findings & implications

Factors that influence consumption

- There has been an increase in adoption of plant-based foods, and the public largely support a reduction of meat and dairy consumption in diets.
- The food ***environment*** strongly influences dietary choices including meat and dairy consumption, so measures that target this environment tend to be effective (Taufik et al., 2019; Marteau et al., 2022). These include for example, taxing high-carbon foods, labelling, subsidising meat-free options, and increasing the relative availability of plant-based food.
- Access to healthy and sustainable foods are strongly influenced by geographical inequalities, whereby limited retail and transport opportunities and low socioeconomic status can result in so-called "food deserts" (see Newing et al., 2022).
- Using communication and goal-setting approaches to target ***psychological factors*** that influence food choice can be relatively effective for some groups, but may also increase inequalities (Taufik et al., 2019). These psychological factors include, for example, individual identity, goals, emotions, and attitudes, which can be used to effectively frame messaging and target different populations.
- Making plant-based foods more appealing and connecting them to indulgent language and positive emotions supports diet change towards higher plant-based food consumption

(Behavioural Insights Team, 2020). Changing the names of vegetarian options can lead to an increase in choosing these meals by meat eaters (Vennard et al., 2019).

- Using co-benefits and combining message framing (e.g. health, animal welfare, environment) and supporting skill development can be important components of successful interventions.
- The removal of cigarette adverts resulted in reduced smoking rates (e.g. Saffer & Chaloupka, 2000), suggesting similar techniques might also be useful for changing meat and dairy consumption. For example, restrictions on the advertising of high fat, salt, and sugar products across the Transport for London network resulted in positive changes of household food purchases (Yau et al., 2021).
- Informational approaches play an important role in consumer choices, but work best in combination with other intervention approaches (e.g. pricing, increased availability). Information provision alone is not effective.
- Targeting ***interpersonal factors,*** for example through social norm messaging about others' dietary choices***,*** can be somewhat effective in changing behaviour (Taufik et al., 2019).
- Convenience factors (e.g. saving time on food preparation) and taste are additional factors to consider when designing interventions.
- Interventions are more likely to succeed when making use of ***windows of opportunity*** to break habits.

Considerations for scaling up interventions

- Achieving a 'balanced' diet has wider appeal than vegan or vegetarian diets. Many people are already reducing their meat and dairy consumption and are willing to reduce it further. To scale up any intervention, potential adoption rates need to be considered and support mechanisms for the already willing need to be put in place. Sustainable labels may only have small effects on consumers' behaviour, but could help shift manufacturer practices by revealing a product's environmental impact (Behavioural Insights Team, 2023).
- Field-studies are needed that are co-designed with stakeholders in order to design a coherent and effective intervention portfolio. Currently, real-world trials and insights on how to engage with different groups are limited.
- The UK needs a coherent vision of what its future food system might look like. More political leadership is required to facilitate and communicate Net Zero compatible diets.

6.1 Overview of evidence

This section synthesises the key findings from research on diet change. We identified 58 sources, 53 journal articles and five grey literature reports. The section predominantly draws on seven systematic reviews of behaviour change interventions (Kwasny et al., 2022; Graves & Roelich 2021; Meier et al., 2022; Aguirre Sánchez et al., 2021; Taufik et al., 2019; Bianchi et al., 2018; Graça et al., 2019), which cover a total of about 352 empirical studies. Most studies cover interventions that aim to reduce meat consumption (N = 184) or increase plant-based food consumption (N = 55), with some studies combining the two (N = 110) or focusing on organic food, food waste, meat alternatives, food miles, or food packaging. Additional studies contribute to further understanding of factors influencing diet change.

All studies included in this section were conducted since 2001 and predominantly took place in the UK and other countries of the global North (e.g. Europe, the US, Australia) with only a few studies from South America or Asia and none from African countries. The samples represented in the studies included student samples or consumer samples across methods of online studies, lab studies and field studies (e.g. in university canteens, restaurants, supermarkets). Most studies used quantitative methods (e.g. surveys) with a few mixed-methods and qualitative methods represented.

Measures of behaviour change included both self-reported behaviours (e.g. meat reduction), attitudes (e.g. attitudes towards meat consumption), intention (e.g. intention to increase plant-based food consumption), and also actual behaviours (e.g. sales data). The most common design was quasi-experimental although some studies used a natural experiment or a randomised control trial design.

The reviewed studies used a variety of theories underpinning their intervention designs and types of factors that were assessed in relation to behaviour changes. Most interventions focussed on personal factors (e.g. emotions), interpersonal factors (e.g. social norms), and environmental factors (e.g. choice architecture) drawing on psychological theories.

6.2 Interventions

6.2.1 Interventions targeting individual determinants

Information provision, increasing awareness, and other knowledge-based interventions tend to be based on the information deficit model (Suldovsky, 2017) – a communication model that assumes individuals' behaviours, attitudes and perceptions can be changed by filling the knowledge gap about the impact of a specific behaviour.

A lack of knowledge about the environmental impacts of different foods is a barrier to diet change (Graves & Roelich, 2021). Hence many interventions aimed at reducing meat or increasing plant-based food consumption are focused on providing information. Many interventions, focused on knowledge, use different messages around the health, environmental, or animal welfare impact of meat consumption to appeal to different audiences or develop tailored educational programmes. Knowledge-based interventions are effective in increasing knowledge and individuals' intention to reduce their meat consumption or increase their fruit and vegetable intake (Kwasny et al., 2022). Combining different message framing, e.g. health, environmental, or animal welfare issues is more effective than focusing on just one. However, alone, knowledge-based interventions tend to have a very low effect on individuals' meat consumption or motivation to change their diet (Graves & Roelich, 2021; Bianchi et al., 2018). Interventions that used environmental labelling are not very effective in reducing meat consumption (Kwasny et al., 2022), although promoting vegetarian and vegan options through message framing has been linked to increased sales (Rosenfeld et al., 2022). A large-scale field experiment found that carbon labels decreased the probability of selecting a high-carbon meal by approximately 2.7% (Lohmann et al., 2022).

Another barrier to diet change is a lack of skills and procedural knowledge, for example how to cook vegetarian meals. Interventions aimed at improving people's skills tend to last several weeks and often include activities around how to plan and prepare plant-based foods. Combining these with information on the various impact of low-carbon diet increases the effect of interventions (Carmody et al., 2008; Flynn et al., 2013).

Activating either positive or negative emotions is a persuasion technique often used in interventions. Activation of negative emotions tends to include fear, guilt, sadness, or disgust while positive emotions include, for example, pleasure, evoked by images. On the one hand, negative emotions related to meat reduce the desire to eat meat (Kwasny et al., 2022). Meat attachment is a barrier to reducing meat consumption (Graves & Roelich, 2021). Strong attachment to meat is linked to a negative response to interventions and low openness to the information provided as people would often be opposed to the idea of reducing meat consumption (Kwasny et al., 2022).

On the other hand, positive emotions, for example towards animal welfare or the environment, could influence how open people are to information provided in an intervention (Kwasny et al., 2022). Activation of positive emotions, for example by labelling vegetables indulgently, resulted in 25%-35% more vegetable consumption in a canteen experiment by Turnwald et al. (2017). Similarly, calling plant-based foods 'meat free' reduces consumers tendency to choose the meal (Vennard et al., 2019).

Other interventions draw on a phenomenon called cognitive dissonance whereby being faced with a behaviour that is inconsistent with ones' values, attitudes or beliefs is experienced as uncomfortable. For example, when a person is reminded they love animals but also eat animals this can create an experience of dissonance that can be resolved by changing behaviour (e.g. reducing meat consumption) or dissociating from the animals they eat (see e.g. Rothgerber 2014, 2020). Used in interventions, messages or pictures related to living animals reduced willingness to eat meat, especially when people had empathy towards animals, however actual effects on reducing meat consumption are less clear (Kwasny et al., 2022)

Values and attitudes are overarching guiding principles that influence behaviour and decision making, thus it is important to tailor messages of interventions closely to people's attitudes and values (Graves & Roelich, 2021). Overall, the reviewed studies showed that messages tailored to individuals' values and attitudes changed attitudes and preferences towards meat but did not change actual meat consumption (Kwasny et al., 2022). Furthermore, interventions purely based on targeting values and attitudes are not effective in reducing meat consumption. Instead, these should be combined with other intervention mechanisms.

Next, identifying as a vegetarian, vegan, or meat-eater is a way many people extend their dietary preferences and make this part of their identity. Identity has been shown to be an important driver for food choices, especially related to reducing meat consumption (Rosenfeld et al., 2019; Kwasny et al., 2022). More importantly, identity can determine how individuals receive an intervention aiming at reducing meat intake. An intervention aligned with people's identity is more likely to be successful and can even lead to spillover effects; for example, from a workplace intervention to diet choices at home (Verfuerth et al., 2021). Similarly, when an intervention conflicts with one's identity, people are unlikely to change their behaviour and may see this as a threat to their identity (Verfuerth et al., 2019; Randers et al., 2020). For example, an intervention framed around healthy and sustainable food would align with a person's identity of being a person caring both about their health and the environment. Similarly, when an intervention conflicts with one's identity, people are unlikely to change their behaviour and may see this as a threat to their identity (Verfuerth et al., 2019; Randers et al., 2020). For example, one study found that when an individual identifies as a 'meat-eater' they are less willing to reduce

meat consumption and perceive meat reduction messages as less legitimate (DeGroeve et al., 2019). While interventions targeting identity alone are not very effective, tailoring interventions to identities and more importantly minimising risks of identity conflict are important.

Goal setting and implementation intention are other commonly applied techniques in the domain. As part of those interventions, individuals are encouraged to set a goal for behaviour change (e.g. reducing meat consumption, increasing vegetable intake) or set an intention to change behaviours. Generally, goal setting and implementation intention are effective ways to increase vegetable intake and, especially in combination with monitoring one's progress, these tend to be successful in reducing meat consumption (Bianchi et al., 2018). A nine-week online programme aiming at reducing meat consumption combined self-monitoring, goal setting, action planning, and health and environmental feedback and successfully reduced participants meat intake (Stewart et al., 2022).

6.2.2 Interventions targeting interpersonal determinants

Finally, information interventions could also be delivered using social norms (e.g. normative messaging). For example, a message can include information about other people's diet choices (e.g. 80% of British people consider reducing their meat consumption). However, this approach has showed varying success, with some studies observing an increase in vegetable consumption while others found no effect (Taufik et al., 2019). While social norms and prosocial incentives can be supportive in promoting vegetarian food choices (Lange et al., 2023), these approaches tend to be less effective on their own in comparison to environmental and personal determinants (Taufik et al., 2019). For example, some studies found significant vegetable intake in a workplace canteen when social norm messaging approaches were used (Thomas et al., 2017), but other studies could not replicate these findings (e.g. Verkooijen et al., 2015).

Lifestyle counselling delivered through health professionals over multiple sessions on an individual basis were successful in changing peoples' diets (Bianchi et al., 2018). For example, in a clinical trial with healthy working-class individuals and multi-ethnic groups, motivational interviews by health professionals led to significant increases in fruit and vegetable intake and a reduction in meat consumption (Emmons et al., 2005). To scale-up these intervention approaches, larger-scale trails with different groups are needed to get insights and learnings into what works best with different groups. For instance, responses to normative messaging depends on the target audience's attitudes and values in relation to the behaviour that would be changed. A baseline survey, for example, that assesses attitudes and perceptions towards an intervention and messages could help in the design of messages that are more tailored and are therefore more likely to be received positively. Similarly, individual support, for example through coaching from health professionals, may not be taken up by everyone. As such, an initial scoping of who might be interested in this and who would be trusted providers of the coaching are needed in order to scale this approach. For policy-level scaling up, funding allocated to develop trials and evaluations would be an effective first step.

6.2.3 Interventions targeting environmental determinants

Nudge-type interventions

Another popular way of achieving behaviour change is through nudge-type interventions, effectively reducing behavioural barriers without engaging people in conscious deliberation. Making vegetarian and plant-based food more visible and available has been shown to be amongst the most successful ways to reduce meat intake and increase vegetable consumption (Taufik et al., 2019; Kwasny et al., 2022). So-called 'nudges' have been tested successfully in restaurants (e.g. Kurz, 2018), canteens (Garnett et al., 2019), and supermarkets (e.g. Coucke et al., 2019). Mandatory vegetarian days increased vegetarian dishes consumed on meat-available days over time (Lombardini & Lankoski, 2013). Making vegetarian or plant-based food the default is another version of increasing accessibility, which has also been shown to be successful. For example, when vegetarian food was made the default (e.g. in a café, restaurant), interventions achieved a significant reduction in meat consumption of up to 65-85% (Meier et al., 2022), although the median effect size of nudges across different contexts is 21% (Hummel & Maedche, 2019). When the portion size of meat was reduced and the portion size of vegetables was increased, this also led to a significant reduction in meat intake (Meier et al., 2022).

In supermarkets, nudge-type interventions showed mixed results. For example, a randomised control trial in a large supermarket chain in the UK found that positioning meat-free products in the meat aisle did not reduce sales of equivalent meat products (Piernas et al., 2021). While sales of meat products decreased in both the intervention and the control groups (approximately −6% and −5%, respectively), sales of meat-free products increased significantly in the intervention condition by about +31% in comparison to the control condition (+6%) (Piernas et al., 2021). A field experiment in a European supermarket found similar results, however, when the nudge was removed, the positive sales effects of plant-based products disappeared (Coucke et al., 2022).

A key limitation of these nudge approaches is that they are very context specific, and the results are context dependent. Hence, there needs to be caution when generalising these findings (Hummel & Maedche, 2019). Where people are more positive towards the nudged behaviour (e.g. reducing meat consumption), nudges tend to be more effective (Lehner et al., 2016). While nudge-based interventions are a cost-efficient and effective way to influence diet-related consumer choices, behaviour changes do not last when the nudge is removed,

which means long-term diet change strategies need to integrate other approaches to achieve sustained effects. Similarly, some studies reported unintended consequences and backfire effects (see Hummel & Maedche, 2019) and multiple reasons for failed nudge interventions have been identified. Some of these include (1) causing confusion, (2) being limited to short-term effects, (3) causing reactance (e.g. bringing meat to a workplace canteen after it has been reduced on the menu; Verfuerth, 2019), (4) producing compensating behaviour resulting in no behaviour change (Sunstein, 2017). Taken together, while nudges can be very effective tools for changing meat and vegetable consumption, nudge-based interventions need to be designed carefully and should ideally take personal and interpersonal factors into account.

Financial interventions

Using incentives (e.g. price reduction) to promote diet change and fruit and vegetable intake have been shown to be effective (Meier et al., 2022). For example, a 30% financial incentive on fruit and vegetables was effective in increasing fruit and vegetable purchases among consumers (Taufik et al., 2019). Similarly, a health-focused study compared vegetable intake between a consumer group who received financial incentives for healthy food with a control group who did not receive an incentive and found that those with the incentive significantly increased their vegetable intake (Kral et al., 2016). However, not all participants receiving the incentive changed their behaviour and the intervention groups' energy intake (i.e. consumed calories) did not differ to the control group. Another experiment manipulated the prices of both meat and vegetarian meals in a student canteen (reducing the price of a vegetarian meal by £0.20 and increasing a meat meal by £0.20) (Garnett et al., 2021). The study found that sales of vegetarian meals increased by 3.2% during the 9-week period of the intervention, however, sales of meat meals did not change (Garnett et al., 2021). This indicates that while financial incentives can be useful to increase vegetable intake, they might be limited in supporting a reduction in meat consumption and more generally a diet shift towards a balanced diet, which is characterised by reduced energy intake.

There has been some research comparing different socio-economic groups' response to financial incentives. It indicates that incentives could be very useful especially for households that are price-sensitive when making food choices. For example, lower income households have been found to be less likely to buy online, and more driven by price than environmental considerations. Similarly, motivation triggered by food labelling, or meal boxes, are considered more successful to support diet change among higher earning households (Vos et al., 2022). Although price and incentives are useful tools to support diet change, other barriers need to be considered when designing interventions. For example, when designing interventions for vulnerable and food-insecure households, multiple barriers linked to poverty and multi-layered problems around mental health need to be addressed in addition to financial incentives (see e.g. Verfuerth & Sanderson Bellamy, 2022).

6.2.4 Interventions using a combination of approaches

A combination of situational factors ('nudging'), tailored information and message framing that are aligned with individuals' values, emotions, and attitudes and also target habit change are the most effective way of reducing meat consumption and increasing vegetable consumption (Aguirre Sánchez et al., 2021; Graves & Roelich, 2021). Taken together, the evidence suggests that a combination of both personal and environmental factors is needed to design a successful intervention (Taufik et al., 2019). For example, interventions focused on skill building alone (newsletters) were not effective, but a combination of price promotion and skill building were more effective than price reduction alone (Ball et al., 2015; Banerjee & Nayak, 2018).

Structural and cultural changes to the food environment will be needed to facilitate long-term change at scale (Trewern et al., 2022). For example, innovation around meat alternatives in meals such as Sunday roast or barbeques could support a cultural shift towards both meat and non-meat options being accepted. These could be trialled in public sector settings or in collaboration with private sector companies to assess the most desirable and feasible approaches. However, it is important to account for identified barriers such as health concerns about a meat reduced diet, and cultural acceptability (Reynolds et al., 2020). An integrated approach combining changes in the physical and social environment can help to reduce meat consumption. Using intervention frameworks such as the COM-B framework (Michie et al., 2011) can support the combination of intervention components (Trewern et al., 2022; see also case study 2).

6.3 Engaging with different groups

In addition to considering personal and interpersonal factors and environmental context, successful interventions need to include considerations of different groups. Socioeconomic status (SES) of a household has been shown to play an important role in what intervention components are more successful (Vos et al., 2022). A study comparing higher and lower SES households found that intervention features focused on saving time, convenience (e.g. online recipe platforms linked to ingredients), and improving cooking skills were preferred by both higher and lower SES households (Vos et al., 2022). In addition, higher SES households preferred intervention features that reduce choice stress (e.g. a product bundle), save time (e.g. home delivery), while lower SES households were more price sensitive and preferred features that reduced recipe prices and generally included price promotions. However, there are major gaps in the understanding of how to engage with different groups when it comes to encouraging diet change.

A systematic review of sustainable diets found that younger women were more likely to reduce their meat consumption, although younger vegetarians were also more likely to substitute meat for ultra-processed plant-based foods (Reynolds et al., 2022). For many people in the UK, meat is considered culturally important across demographics (Reynolds et al., 2022). Many social and ethnic groups see diet as part of their identity and draw on it when justifying continued meat consumption even in the face of growing discourses about the impact of meat consumption on health, the environment, and animal welfare (Oleschuk et al., 2019). Religious identity can also play an important role when making diet choices, especially when these may be considered as related to religious beliefs (Ali, 2015).

6.4 Research gaps and limitations

Currently in the UK about 2-3% identify as vegan and 5-7% as vegetarian – a number that has been increasing in the past years (YouGov, 2021). While over 70% identify as meat eaters (YouGov, 2023), 68% of "flexitarians" in the UK are actively trying to reduce meat consumption (YouGov, 2021). This is a positive trend, but more drastic diet changes across the population are required in order to reduce diet-related carbon emissions. While many studies focus on vegetarianism and veganism, the important question is how to reduce overall meat consumption. A 'less but better' approach to meat consumption has been proposed as a sensible strategy, especially in Western diets such as the UK's (De Boer et al., 2014). A systems approach to diet change suggests that, in addition to widespread behaviour changes by individuals, a transformation of the current food system is needed in order to meet the challenge of the climate emergency (Clark et al., 2020).

Going fully vegan or vegetarian is seen by many people as too restrictive and involving too much change, although a minority have had positive experiences and could imagine adopting either diet (CAST, 2022). A balanced diet, for example in the form of a Mediterranean[1] or flexitarian[2] diet tends to be more desirable and is considered more likely to be adopted (CAST, 2022; Allenden et al., 2022). When thinking about scalability, the likely adoption rate across the population for different diet types needs to be considered together with the emissions reduction potential (Akenji et al., 2019).

While the current body of research provides sufficient evidence for designing interventions as outlined above, efficacy testing and real-world trials, especially those using a combination of intervention techniques, are often limited to pilot studies with small samples. Larger scale trials are needed in multiple real-world settings with different groups in order to sufficiently advise further up-scaling and dissemination to a population level (Indig et al., 2018). These trials should be sensitive to other societal risks and contextual factors, such as the cost-of-living crisis, and the distributional effects of economic measures.

6.5 Intervention case studies

Case Study 1 – Accessible Veg: Community-supported agriculture for food-insecure households

This project explored the effects of Community Supported Agriculture (CSA) memberships on people's diets and wider health benefits. CSAs play an important part in community food initiatives and are a grassroot movement that aims to transform people's diets and the food systems from the bottom up.

In a first part of the study, CSA members' (N = 46) diet was compared with a control group of people (N = 67) who purchase their food in supermarkets. Through semi-structured interviews and food diaries, the diets were examined and compared with the EAT-Lancet Commission's dietary guidelines.

In a second part of the study, CSA membership was trialled with food-insecure households. Financial barriers had previously been identified as preventing especially low-income and food insecure households from having access to sustainable and locally grown food.

In total, 16 households participated in pre- and post-intervention interviews and received free weekly veg bags. They were also added to online community groups linked to the CSA, received recipes, and were given opportunities to visit the farm.

[1] Definition: No processed meat; small amounts of red meat (beef, lamb, pork; one serving per week); moderate amounts of fish, seafood, poultry, eggs and dairy (2–3 servings per week); plant-based foods (fruits, vegetables, whole grains, legumes, nuts, and olive oil) (Allenden et al., 2022).

[2] At least three meat-free days per week; no processed meat; small amounts of red meat (beef, lamb, pork; one serving per week); moderate amounts of fish, seafood, poultry, eggs, and dairy (2–3 servings per week); plant-based foods (fruits, vegetables, cereals, legumes, and nuts) (Allenden et al., 2022).

Result highlights:

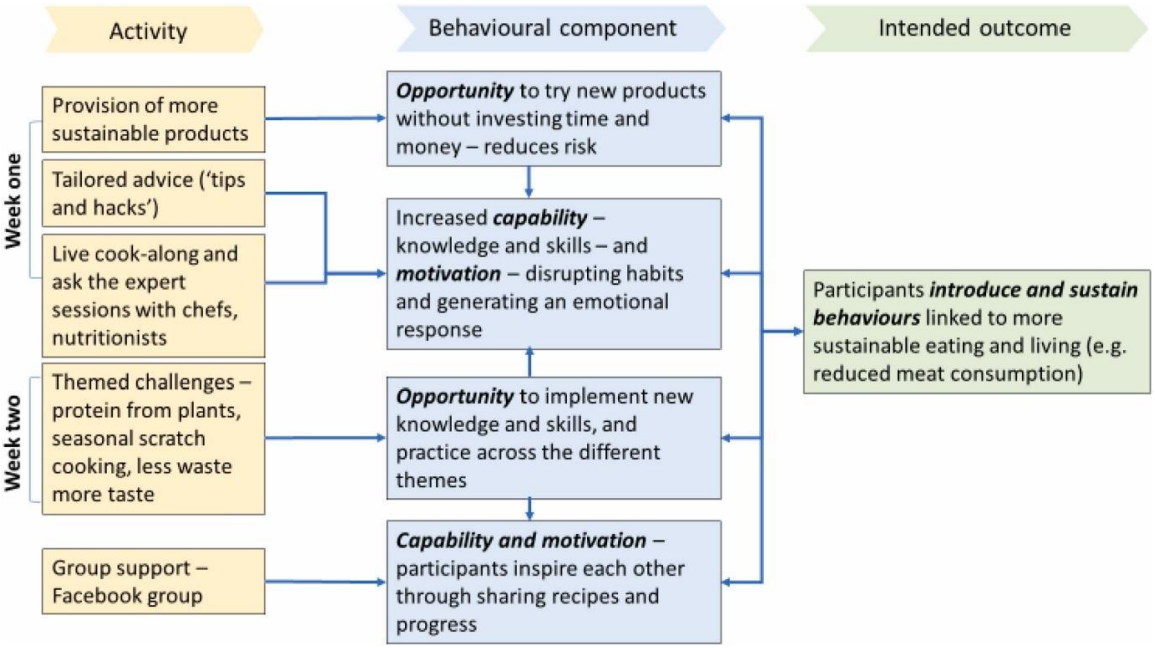
- CSA membership was linked with a diet closer to the EAT-Lancet guidelines. CSA members consumed significantly fewer calories from meat and dairy, and more from vegetables and legumes than the control group (Mills et al., 2021).
- CSA membership was linked to benefits beyond food security including improved wellbeing and sense of community.
- There are multiple barriers for food-insecure households to CSA membership. While money is a key issue to accessing veg bags in the first place, there are further barriers to consider when upscaling. However, widening participation in CSAs, for example through supportive policies, could contribute to a shift in the environmental sustainability and healthfulness of UK diets.
- Many of the barriers to making use of CSA veg bags were linked to underlying poverty and health issues that were often linked to limited access to transport and kitchen tools, and a general sense of incapability to prepare the vegetables received in the veg bags.

For full report, see: https://tgrains.com/

Case Study 2 – Sparking Change intervention: Combining multiple approaches to change diets

Informed by the COM-B framework (Michie et al., 2011) this intervention by a large UK food retailer combined multiple components to bring about consumer behaviour change in meat and plant-based consumption, food waste, and cooking from scratch (see Figure 3). The components of the intervention included: product hampers, tailored advice including 'tips and hacks', live expert webinars with nutritionists and chefs, and a private Facebook group where the participants could ask questions, interact with each other, and share their progress. The behaviours were targeted one after another and for each, a two-week programme was designed including capacity building activities that took place in week one, followed by a 'challenge' in week two, where participants were given the opportunity to implement new knowledge and skills from week one. The mixed-methods approach included N=68 participants and took place over nine weeks plus a follow-up three months later.

Figure 3: Theoretical framework for the 'Sparking Change' intervention, based on the COM-B behaviour change framework from Trewern et al. (2022)



Result highlights:

- The combination of intervention approaches successfully contributed to people changing to a more sustainable diet.
- Over the course of the intervention, meat intake reduced for pre-family participants from 86% to 64%, for families from 94% to 37% and for pensioners from 90% to 60%.
- Fruit, vegetable, and wholegrain intake increased from 29% to 64% for pre-family participants, 40% to 49% for families, and 50% to 90% for pensioners.
- The most impactful intervention components were the online community, 'ask the expert' videos, and product samples.

7 Reducing end-user consumption

This section focuses on household consumption behaviours such as recycling, avoiding food waste, and reducing end-user consumption (reusing/repairing items, buying second-hand goods). Household consumption will need to change to reduce embodied emissions and emissions from waste. Around 2.1bn tons of waste are generated every year, however, the CCC's 'Balanced Net Zero Pathway' predicts that emissions from the waste sector could be reduced by 75% by 2050 relying on greater waste prevention, recycling, and higher landfill methane capture rates. Another way of reducing consumption is through a reduction in end-user consumption such as reusing and repairing goods. The Sixth Carbon Budget report by the CCC (2020) estimated that reducing end-user consumption by 5% to 10% by 2035 could cut emissions per 3MtCO_2 per year in 2035. However, repairing activities seem to have declined in recent decades (Cooper et al., 2018), perhaps due to the greater availability of cheaper goods. Around Europe 38% of customers buy a new electronic device when their previous one breaks down (Kantar, 2020) while Diddi and Yan (2019) found that 55% of US participants had never or rarely repaired clothing items. Changing such habits would be key for the concept of a circular economy (Svensson-Hoglund et al., 2020). This highlights the important role of changing various consumption behaviours in reaching Net Zero targets as part of the pathways modelled by the CCC.

Key findings & implications

Factors that influence end-user consumption

- Socio-demographic factors such as income, age, and having children affect end-user consumption. Older people, those with children, and those with higher incomes consume and waste more.
- Values, attitudes, and social norms could be key for engaging in recycling, and reducing food waste and material consumption (Punzo, 2019).
- Skills, more time, access to equipment, and knowledge of legal rights are key for increasing people's engagement with repairing items (Fischer et al., 2008; Armstrong et al., 2015) as only 54% of people in the UK would prefer to repair rather than replace a piece of technology when it breaks (YouGov, 2021).
- Repairing electronics might be dependent on the product category, for instance surveys show that 80% of people are likely to try to repair white appliances compared to 49% for smartphones or tablets, and only 14% for small household items such as kettles, toasters, etc. (Consumer Reports, 2022).
- People with higher incomes and those who identify as White or Asian appear to be more likely to replace their electronics instead of repairing them (Consumer Reports, 2022).
- Financial incentives have delivered mixed results in reducing food waste and increasing recycling (Tian et al., 2022; Xia et al., 2023), while more research is needed to inform their application in the domain of material consumption.
- Food labels alone might not reduce food waste, but they could be more effective when combined with additional information (WRAP, 2022).
- Information provision related to reducing material consumption has been successfully applied in lab settings (Ölander & Thøgersen, 2014). Less is known on its real-world application.
- Nudge-type interventions such as prompts might reduce food waste (Shearer et al., 2017) especially when these are combined with additional information (Tiefenback, 2017).

Considerations for scaling up interventions

- Real-world trials in end-user consumption, more specifically material use, are very limited due to the difficulty and cost of designing such trials.
- Moments of change could be key for behaviour change relating to end-user consumption (Verplanken & Roy, 2016).
- Changes to recycling infrastructure around the UK should be considered in order to create a more unified system.
- Ease of implementation should be considered when designing interventions, incorporating consultations with people who engage in the proposed behaviours.

7.1 Overview of evidence

The next section reviews papers on household consumption behaviours and behaviour change. We identified 64 articles in total with six review articles, 53 empirical papers. In addition, we also used information from 11 grey literature reports. The literature in the domain is mostly focused on reducing food waste behaviours or improving waste management such as recycling, with less sources available on tackling end-user consumption of materials. This is evident in the greater number of behavioural interventions related to recycling and food waste. Thus, one of the main findings of our review relates to the lack of research on ways to reduce consumption of manufactured goods.

Behavioural interventions in the sphere of household consumptions began in the late 1970s. However, the number of publications saw a decline at the beginning of the new millennium, followed by a very steep rise after 2010, which continues today, due to the wider attention given to environmental problems. Therefore, the review articles mostly capture literature after 2010 with fewer older entries. In addition, most of the publications come from North America, Europe, and Australasia with very few papers from South America or Africa.

The review articles usually had a specific focus on one of the behaviours stated above with only one review article focusing on both recycling and composting (Sewak et al., 2020). However, similar intervention techniques were applied to achieve behaviour change. For example, Xia et al. (2023) performed a meta-analysis on 279 behavioural interventions focusing on waste recycling, while Tian et al. (2022) conducted a meta-analysis on 58 papers aimed at achieving behaviour change related to food waste. In both review articles the authors concluded that the most used techniques for intervening were campaigning, modifications to the physical environment, information provision, feedback on behaviours, incentives, prompts, and commitment interventions.

One of the biggest limitations in the domain is the inability to test long-term effects of the interventions due to studies either not conducting follow-ups or these being very short-term. This ties in with another limitation, which is the stronger reliance on control-experimental approaches rather than on research with a pre-post design. Finally, the focus on self-reported behaviours rather than direct measurements of behaviours is also a limitation, due to a potential social desirability effect (i.e. people wanting to appear 'greener' than they are; van Berkel et al., 2020).

7.2 Barriers and drivers

There are certain factors that could influence people's household consumption behaviours.

Socio-demographic factors. Relevant socio-demographic factors include income, age and the presence of children (Bilska et al., 2020). Income is one of the strongest drivers of consumption, with those on the highest incomes consuming far more than those on the least (UNEP, 2020). Conversely, financial considerations such as saving money by wasting less food could play a role in reducing household consumption, although health and food safety concerns could be a barrier to using food near to its expiration date (Simoes et al., 2022). Older people tend to waste less (Dai et al., 2017) while households with children tend to waste more (Knickmeyer, 2020). Moreover, the proportion of those aged between 35 and 54 years who recycle (70%) is higher than of those aged 16 to 34 years (49%) (Oluwadipe et al., 2022). In addition, a higher level of education might be particularly important for being more aware of recycling and better understanding recycling communications (Seng et al., 2018).

Psycho-social factors. Further to these demographic characteristics, psycho-social factors also play an important role. For instance, specifically regarding food waste, people who perceive food as comforting or associate it with positive social interactions tend to waste less food and value it more (Minton et al., 2020). However, certain food items such as fast food or side dishes might be seen as less valuable to consumers, thus these tend to be wasted more (Nikolaus et al., 2018). In addition, people's values could play a big role, for example, those with higher levels of self-transcendence values seem to engage in more environmentally friendly household consumption behaviours (van der Werff et al., 2013; Whitmarsh et al., 2017) including within the UK (Punzo et al., 2019).

Social norms. Social norms – i.e. what others are believed to do and approve of – could be an important factor in pro-environmental household consumption behaviours (Fishbein & Ajzen, 2009). In some cases, people might perceive food waste as a financial loss (Wakefield & Axon, 2020). In other cases it might be seen as a sign of financial stability, i.e. being able to afford to waste food (van Geffen et al., 2020) or a cultural trait where food abundance is part of the norm (Aschemann et al., 2019). Studies in the domain of recycling have also identified social norms as a driving force (Byrne and O'Regan, 2014; Knickmeyer, 2020).

Infrastructure. Even if people have strong motivations to reduce waste or consumption, one of the most important barriers identified in past studies remains a lack of supporting infrastructure (Oluwadipe et al., 2021). This could be especially important for younger generations who believe that local authorities have the greatest responsibility to enable sustainable household consumption behaviours such as recycling (Watts, 2017).

There are several important factors to consider regarding barriers relating to extending the lifetime of goods (e.g. clothing or electrical appliances specifically). Overall, the most common barriers for both categories include lack of time, skills, and equipment (Armstrong et al., 2015). Other barriers were identified in research by Defra (2019) involving a survey asking about technology repair behaviours. Barriers included repair inconvenience such as lack of availability to repair services or lack of information about third party repairs, together with lack of time and access to tools and spare parts. The report also stated that the perceived cost of repair and the perceived remaining lifespan are barriers, together with lack of trust in repair shops, product age, lack of knowledge on how to repair, or assuming that the item cannot be repaired (Defra, 2019). The product category might also influence repairability actions; other survey research found 80% of people are likely to try to repair white appliances compared to 49% when it comes to smartphones or tablets and only 14% for small household items such as kettles, toasters, etc. (Consumer Reports, 2022).

Surveys also show that those who identify as 'White' or 'Asian' are less likely to repair items and more likely to replace them (Consumer Reports, 2022). Fast fashion is another major barrier as it has altered people's beliefs that the wide availability of clothes makes it less useful to repair given the effort needed (Zhang et al., 2022). Furthermore, there might be social pressure to buy new items given the lack of social norms around repairing and repurposing (Sung, 2020) and aspirations to have the latest technological advances (Laitala et al., 2021). Psychological barriers such as lack of emotional attachment are another factor as consumers do not assign the same value to refurbished or repaired items compared to new items (Atasu et al., 2008), however, higher levels of personal attachment to an item could drive repairability (Defra, 2019). Finally, customers might lack knowledge about the length of their warranty or what their legal rights might be related to repairs (Hernandez et al., 2020).

7.3 Interventions

7.3.1 Information-based interventions

The literature on interventions related to recycling and food waste reveals that information-based interventions are most popular when trying to achieve behaviour change. This includes education-based interventions that deliver systematic knowledge on the subject through various means such as educational videos, focus groups, and guides (e.g. WRAP, 2020). In the meta-analyses by Xia e al. (2023) and Tian et al. (2022) interventions featuring education had the highest level of success in changing household consumption behaviours. One potential explanation is the higher information intensity that is gained from education interventions, therefore they could be viewed as overlaying multiple information interventions techniques (Kowalewska & Kołłajtis-Dołowy, 2018). In addition, the process of education also usually includes a social element, thus the inclusion of social norms could further strengthen the effects of such programs (Zheng et al., 2019; Kumar, 2019). Other social informational interventions include road shows and door-to-door visits. They have a strong degree of interpersonal interaction and were found to have moderate to high levels of effects in changing people's behaviours in the meta-analysis by Xia et al. (2023).

In another review of interventions related to household consumption, Simoes et al. (2022) identified 18 papers focusing mainly on information provision and raising awareness on recycling and food waste. They found that face-to-face interventions were still the most preferred communication channel for information interventions. However, Wojciechowska-Solis and Smiglak-Krajewska (2020) point out that the consumer target audience should be considered, for example, young people might be more influenced by the use of media or social networks.

In addition, some information-based intervention experiments rely on presenting and linking together different types of information. For instance, Collart and Interis (2018) presented people with information on date labels, food waste and its environmental impact. Their findings suggest that simply educating people on how to interpret food date labels is not enough to make people change behaviours as they still prefer to buy products before their expiry date. However, when people receive additional information related to food waste and its environmental impact, they tend to show indifference between expired and unexpired food. This could have important implications in reducing food waste. In another study by Wilson et al. (2017) the researchers found that food waste might be higher when the label on products says "Use by" compared to when the label says "Sell by". This is further implied by grey literature sources, for instance a report by WRAP (2022) suggests that removing "Best Before" labels from fresh produce could significantly reduce food waste especially when this is paired with advice on how to store these items. Food waste could be further reduced by selling produce loose instead of in packaging (WRAP, 2022).

When it comes to reducing end-user consumption, the evidence seems to be more limited. For example, Goworek et al. (2012) conducted focus groups discussing sustainable clothing, purchase decisions, laundering and disposal of clothes in the UK. This was followed by workshops looking into how people might have changed their behaviours after receiving the information during the focus groups. The findings indicated that only a small portion of people indicated they planned to alter their shopping habits by purchasing less clothes or selecting clothes made from organic materials. We should also note that this was a qualitative study,

therefore there are limitations related to the generalisability of the results given the small sample size of 29 participants. In another qualitative study, McEachern et al. (2020) conducted focus groups, workshops aimed at teaching people how to repair clothes (e.g. sewing; tufting, sashiko), and had participants attend contemplative theatre performances titled "Clouds in the Cotton Weave, which outlines the life-cycle of an imaginary but possible tee shirt: from cotton plant to African landfill". They concluded that overall the response was very positive as people felt inspired and empowered by the workshops and emotionally affected by the performances. However, no follow-ups were conducted to track actual changes in behaviours.

Finally, an experiment by Ölander and Thøgersen (2014) with energy labels on TVs found that when efficiency was presented on a scale from A to G people were eight times more likely to choose a more efficient TV, while when the scale ranges from A to A+++, this likelihood increased only 3.6 times. This is related to consumers associating the letter A with energy efficiency and attaching less significant to differences in the number of "A-pluses" than they attach to differences on the A to G scale (Ölander & Thøgersen, 2014). However, we should note that the results were based on a hypothetical scenario rather than real-world experiment. Nevertheless, energy data labels with a scale from A to G have been implemented in the UK since the 1st of October 2021.

7.3.2 Nudge-type interventions

There are different categories of nudging that have been used to achieve pro-environmental behaviour change related to household consumption, including environmental alterations based on cognitive bias and changes to choice architecture. Studies in this domain have been found to have moderate effects on behaviour change (Tian et al., 2022; Xia et al., 2023). These experiments remove external barriers and alter the structure of the environment in which people make choices. For instance, the placement of recycling bins could help with more people engaging in waste separation (Leeabai et al., 2019; Rosenthal & Linder, 2021).

Another form of nudging is providing feedback or informing the subjects of how their behaviour compares to the standard. This has been effective in promoting energy saving and pro-environmental behaviours (Tiefenbeck et al., 2019). However, when it comes to household consumption, providing behavioural feedback does not seem to be very successful in changing behaviours (Tian et al., 2022; Xia et al., 2023). Providing prompts is also a popular way to nudge consumers (e.g. messages, newsletter, etc.). In an experiment by Shearer et al. (2017) with more than 60,000 participants, those who received a visual prompt reminder, i.e. a sticker on their food waste bin, increased their food waste recycling compared to a control group. This technique is widely used in the domain because it involves low economic and time costs. However, better results might be achieved when the prompts are direct and are combined with extra information (Tiefenback, 2017).

Nudge-type interventions have also been conducted for end-user consumption, however, these are rather limited. For instance, Thorman et al. (2020) examined how social norms and pledges could be used to decrease behaviour intentions for consumption of goods. In the social norms condition, the participants were either given information about consumption and climate change or were given a statement about people who have reduced their consumption behaviour. Pledges were also divided into two groups (1) participants had to sign a pledge and commit to reducing their own consumption (advocacy group) or (2) sign a pledge and show how their current behaviours might be contradicting it (hypocrisy group). The results showed that social norms and inducing hypocrisy did not have an effect on intention, however, the advocacy group increased their intentions to reduce consumption (Thorman et al., 2020). In another study, BIT (2021) tested the effect of different framing techniques on the intention to buy second-hand items with an online experiment. The results revealed that people's intentions were higher when using a cost frame or environmental frames compared to just giving out information. We should note that the two experiments tested above did not measure real-world purchases, nevertheless their results are encouraging.

Finally, Frick et al. (2021) worked with an online clothing shop to develop an intervention using the hashtag #lessismore displayed on the company's website for a week and a newsletter, social media posts. This was seen by everyone visiting the website. In addition, before the intervention participants were recruited via the company's newsletter to take part in a survey. During the survey, participants reported on the amount of new and second-hand clothes purchased in the four weeks prior. In a second survey a week later, participants were asked if they had seen the hashtag, the newsletter, or the social media posts. Those who had not were used as a control group, while those who did were used as an experimental group. The results revealed that both groups reduced their consumption behaviours four weeks later, therefore, the authors concluded the intervention had no effect on consumption behaviours.

7.3.3 Financial interventions

The literature on providing incentives related to household consumption seems to be mixed. On the one hand, the meta-analysis by Tian et al. (2022) of 279 papers concluded that there was a discernible but not strong effect of incentives (e.g. lottery tickets, coupons, rewards) in changing food waste behaviours, while Xia et al. (2023) showed a weak effect in their meta-analyses of 58 papers. One potential explanation is the fact that incentives are seen as an inadequate way to influence low-impact behaviours such as recycling and could even

result in potentially crowding-out people's pro-environmental motivations (Lin & Zu, 2021). It should be noted that evidence is mixed and there could be a path to achieving 'crowding in' through incentives (Rode et al., 2015).

On the other hand, Sewak et al. (2020) established a positive behavioural effect of incentives in their review, though they focused on fewer studies. For example, Boonrod et al. (2015) found that when participants could receive US$7 for every tonne of organic waste, their recycling practices improved. Similarly, Li et al. (2017) offered their participants green points, which could be exchanged for store credit, if they separated their organic waste. This resulted in an increase in recycling. Zhou et al. (2021) saw a big increase in recyclable waste collection when residents were given the opportunity to exchange recyclable materials for financial resources. Further, deposit return schemes (DRS) are very popular in increasing recycling around Europe, especially in Germany, Denmark, and Estonia (European Parliament, 2011) with plans being developed in the UK (Oluwadipe et al., 2021). Some European countries have reduced the value-added tax on repair services (Meysner & Urios, 2022). However, the direct effect of this on end-user consumption of manufactured goods has not been tested. Finally, direct penalties (e.g. fines, sanctions) could also have an impact as indicated by Ogiri et al. (2019) or the plastic bag tax introduced in the UK (Defra, 2020).

Overall, financial incentives in the domain of material consumption seem to be lacking. This is an interesting finding in itself and presents an opportunity for future research. Literature in the health domain has shown that interventions with financial elements could change undesirable behaviours. For example, conditional cash transfers have been shown to be effective in school enrolment and visits to clinics (de Walque, 2020) while sobriety incentives have resulted in reducing alcohol use Schilbach (2019). Nevertheless, research is needed to establish whether such interventions could be applied in the environmental domain.

7.4 When to intervene? Moments of change in relation to consumption behaviours

Everyday consumption behaviours are highly habitual. Habits are memory-based tendencies that are automatically cued by particular situations or environmental contexts (e.g. lunch at a restaurant). Habits represent a significant barrier to change (Graves & Roelich, 2021) but offer potential for behaviour change interventions because habits might be more malleable when there is context disruption (Verplanken et al., 2018). Such instances are known as 'moments of change' and could be used to foster pro-environmental behaviours.

For example, Verplanken and Roy (2016) conducted an intervention with people who had either recently moved house or not. It consisted of tailored information, sustainable everyday items, interviews, and a newsletter. They found that eight weeks after the intervention those who had moved house engaged in more pro-environmental behaviours including behaviours relating to household consumption. Other research shows that young adults start developing new diet habits when they leave the parental home (van den Berg et al., 2022). This indicates that behaviour change interventions could target moments of change, as policy recommendations tend to focus on information provision, 'nudging' (e.g. placements of products), and incentives (e.g. tax).

A further barrier to achieving positive outcomes of interventions remains lack of consistent infrastructure, including uniform waste collection systems (Defra, 2019). This situation could result in confusion, especially for people who relocate from one local authority to another. Thus, when designing interventions aimed at recent movers, tailoring the information to the characteristics of the local area should be prioritised.

7.5 Research gaps and limitations

There is considerable evidence on information-based interventions, and some on the role of financial incentives to promote low-carbon consumption. However, there remains a lack of real-world interventions related to decreasing material consumption. While some evidence exists it is limited to behavioural intentions rather than changes to actual consumption. Furthermore, financial incentives to reduce material consumption have been underexplored, as have changes in habits. Another research gap is the lack of focus on underrepresented groups, as most studies employ student samples or the general public. There is a lack of experimental evidence on the long-term effects of interventions, and more precise tracking indicators would be beneficial for food waste, recycling activities, and end-user consumption. Finally, when designing services or products related to household consumption there has tended to be a lack of engagement with the target audience in intervention design.

7.6 Recommendations and conclusions

Our literature review suggests that successful interventions usually combine several behavioural intervention techniques in their design. The focus should be on both enhancing drivers and minimising barriers.

Consideration should be given to additional factors that influence positive intervention outcomes: timing, ease of implementation, audience characteristics, and moments of change.

8 Aviation demand

Aviation accounts for 7% of UK's total emissions as flying has expanded continuously over the last 30 years, notwithstanding the temporary effect of the COVID pandemic. While it is viewed as a challenging sector to decarbonise, aviation has high potential for behaviour-related emissions reductions. Indeed the IPCC's (2022) analysis found that reducing the number of long-haul flights has the greatest mitigation potential of all "avoid" measures (i.e. those that involve reductions in an activity) across *all* sectors and services (Dobruszkes et al., 2022). Despite this, research shows that existing international climate policies for aviation will not deliver any major emission reductions (Larsson et al., 2019).

Key findings & implications

- Behaviour change can involve *avoidance and substitution* where people choose to fly less; *greener choices,* which include such behaviours as travelling in seats that require less space (for instance economy rather than business or first class); and choosing to buy *carbon offsets* (Gössling & Dolnicar 2023). Note: the CCC does not view the purchasing of offsets as suitable for its demand reduction pathway.
- There is a reluctance among many air travellers to fly less (Gössling & Dolnicar 2023).
- People tend to place responsibility on governments and industry to reduce emissions from aviation (Gössling & Dolnicar 2023).
- Concern about climate change often does not correspond with behaviour change when it comes to flying (Alcock et al., 2017).
- Flying behaviour is often closely associated with pleasure, success, identity, aspiration, social capital, freedom, progress, economic growth. This makes it a particularly challenging area for behaviour change to occur (Gössling & Dolnicar, 2023).
- Flying is heavily promoted and incentivised by industry, governments, and through cultural signals such as the celebration of celebrity lifestyles, compounding the intransigence of behaviour change (Gössling, 2019; Cohen et al., 2022).
- Behaviour change by individuals alone is unlikely to lead to substantial reductions in aviation emissions unless it is accompanied and incentivised by multilateral international agreements and national legislation (Higham et al., 2019; Logan et al., 2022; Gössling & Dolnicar 2023).
- Perceived fairness of policies to reduce aviation demand is a key consideration for acceptability (UK Climate Assembly 2020).
- A Frequent Flyer Levy or a Frequent Air Miles Tax have the potential to be effective in reducing aviation demand and to be perceived as fair by the public (UK Climate Assembly 2020; Ipsos CAST 2022; Büchs and Mattioli 2022).
- Social norms around flying may be changing, and this process has more potential as moral considerations come to the fore (Wormbs & Wolrath Söderberg, 2021; Gössling et al., 2020).
- Improving the information available to customers could lead them to choose more efficient airlines, planes and routes (Baumeister 2020).
- A jet fuel tax has been found to be effective in Japan, apparently suppressing demand for jet fuel by 10% (González & Hosoda, 2016).
- The effect of Air Passenger Duties at current levels on UK flight demand have been found to be "marginal" (Larsson et al., 2019).
- Uptake of offsets by customers is low, at 1-3% of passengers, and depends on: attitudes, values, identity, social norms, perceived efficacy, guilt avoidance, and the choice architecture during ticket purchase – for instance "opt in" or "opt out" (Gössling & Dolnicar 2023). Behavioural 'nudges' that suggest a default purchase option can promote the uptake of offsets (Berger et al., 2022).
- Short haul flights have been banned in France, and this is under consideration in other countries, with the potential to drive modal shift and signal the importance of avoiding flights (Dobruszkes et al., 2022).

- There is a lack of evidence on the effectiveness of interventions to reduce aviation demand, and on the scale of changes that may be possible (Wynes et al., 2018).

Considerations for scaling up interventions

- If behaviour change is to make a significant contribution to emissions reductions from aviation, it is likely to require the alignment of action from multiple parties: consumers, governments, policymakers, cultural leaders, and the aviation industry (Gössling & Dolnicar 2023).

8.1 Overview of evidence

This section reviews evidence relating to aviation and behaviour change. We identified 37 sources in total, with four relevant review studies (Gössling & Dolnicar, 2023; Gössling & Lyle, 2021; Larsson et al., 2019; Baumeister 2020) and 29 further published papers, one pre-published paper, and three grey literature reports. The studies cover aviation policies that may reduce emissions by influencing demand through such measures as financial signals, technology improvements, regulation, and social factors.

There is considerable evidence on people's attitudes towards flying, their motivations for doing so, and the potential for behaviour change in the shape of flying less, greener choices (such as opting to fly with more efficient airlines), and the uptake of carbon offsets. While flying less has the greatest potential to reduce emissions, evidence suggests this is not something that individual consumers are keen to do voluntarily.

There are important barriers to flying less, including the lack of affordable or practical alternatives for long-distance travel, along with the desirability of flying and associated social capital, which is amplified by advertising and cultural signals. Crucially, there is a general lack of evidence on the efficacy of interventions to encourage demand reduction in aviation (Wynes et al., 2018).

Summary of review articles

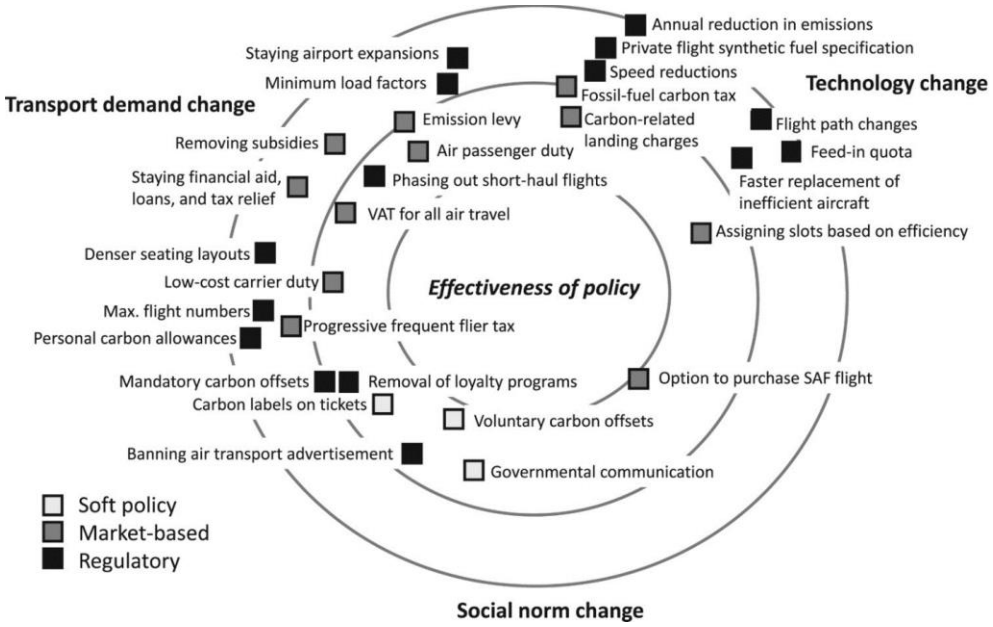
Gössling and Dolnicar's (2023) review analyses aviation-related behaviour in the context of people's internal motivations and external factors. Examples of internal motivations are the purpose of the travel and the social values attached to it. External factors are such things as price, taxes, frequent flyer incentives, and choice architecture (nudge) designs. They conclude that "changing air travel behaviour is challenging. There is complexity in motivations, and affective values of air transport make voluntary change unlikely."

In a slightly different vein, Gössling and Lyle (2021) evaluate 30 policies classified as voluntary (or 'soft'), market-based, and regulatory (Figure 4). Their assessment is set within the context of aviation's highly unequal demand distributions between and within countries, highlighting that a minority of the population fly a great deal while many do not fly at all. The shortcomings of the industry's voluntary CORSIA scheme (intended to limit emissions from aviation) are described in detail, including CORSIA's heavy reliance on offsets that would apply to only about 25% of aviation emissions from 2021-2035. The 30 policies in the review are assessed for their effectiveness in changing demand for aviation, bringing forward new technologies, and changing social norms.

Larsson et al. (2019) present evidence that carbon taxes and distance-based air passenger taxes can reduce demand via behaviour change and achieve greater emissions reductions than existing international climate policies, which "will not deliver any major emissions reductions". Baumeister (2020) reviews the evidence of behaviour change within the airline industry, and also greener choices from consumers that do not involve flying less (see below).

Overall, the reviews and articles provide evidence that attempts to change flying behaviour are much more likely to be successful if they consist of a collective, multi-stakeholder approach that addresses the broad societal context within which flying takes place, in contrast to isolated initiatives aimed at specific behavioural factors.

Figure 4: Policies evaluated for effectiveness and area of influence. Policies towards the outer edges are judged to be more effective. The figure was created in collaboration with expert transport policy researchers (Gössling & Lyle, 2021)



8.2 Different types of aviation-related behaviour change

Behaviour change, in the form of flying less or choosing other modes of transport (a.k.a. "modal shift"), has been identified as having great potential for reducing aviation emissions, but has received much less attention in academic research than other measures such as technological changes, operational changes, and regulatory changes (Baumeister, 2020). Indeed, using the "Avoid, Shift, Improve" framework, aviation emissions have been mostly addressed using the *Shift* and *Improve* approaches, rather than *Avoid*, whereas Avoid has the greatest potential (Dobruszkes et al., 2022). This may be because the presumed social benefits of aviation (such as leisure and business travel, cultural exchange, and economic growth) preclude efforts to reduce demand.

Gössling and Dolnicar (2023) define three classifications of the options for voluntary action: *avoidance and substitution,* where people choose to fly less; *greener choices,* which include such behaviours as travelling in seats that require less space (for instance economy rather than business or first class); and choosing to buy *carbon offsets*, which seek to mitigate the climate impact from flying by investing money in schemes that are intended to reduce carbon emissions elsewhere. (Note: the CCC does not view the purchasing of offsets as suitable for its demand reduction pathway.) While these are voluntary actions, climate policies have the potential to influence these choices. For instance, taxes or price mechanisms that affect airlines' pricing systems may influence people to fly less or choose alternative ticket options, while incentive schemes and nudge techniques can increase the uptake of carbon offsetting (see below).

8.3 What are the drivers of and barriers of aviation behaviour?

As well as providing valued travel and career opportunities, flying taps into people's identities, aspirations, and social capital. Flying sustains connections between distant friends and family, and has become embedded in the lives of many people, often being portrayed as glamourous and aspirational via the "hypermobile" lifestyles of some figures in business and celebrity culture (Gössling, 2019; Cohen et al., 2022). A great deal of flying is therefore elective rather than strictly necessary, representing the fulfilment of "wants" rather than "needs" (Gössling & Dolnicar, 2023). These factors present a substantial challenge to initiatives intended to change people's flying behaviour, and are perhaps why policies to do so are largely absent due to their anticipated unpopularity.

Several studies have revealed an expressed unwillingness among air travellers to fly less, sometimes due to perceptions of "sacrifice". Research with a large UK dataset reveals that even high levels of environmental awareness and concern do not necessarily translate into reduced flying activity (Alcock et al., 2017). Similarly, enacting pro-environmental behaviours at home does not mean people will also reduce their air travel behaviour (Barr et al., 2011). That said, "most people are not aware of the actual footprint of aviation against distance flown and compared to everyday travel" (Dobruszkes et al., 2022), while attitudes, subjective norms

and self-identity have been shown to predict intentions to fly less (Morten et al., 2018). Frequent flyers tend to be less supportive of policies to reduce flying, with responsibility instead being assigned to airlines, manufacturers, and legislators. Support for industry-focussed policies tends to be higher than support for policies to change behaviour (Gössling & Dolnicar, 2023). Research with British citizens has revealed that policies with the least negative or most positive effect on consumers are rated highest, while fairness is also important. Pro-environmental beliefs and flying behaviour best predict support levels for policies (Kantenbacher et al., 2018).

A general finding is that, instead of relying on individuals to make behaviour change decisions, achieving emissions reductions from aviation will require governments and industry actors to take the lead with a coordinated and consistent response. This will include policies to make alternatives to flying preferable and practical, along with information, price signals and appropriate messaging (Higham et al., 2019; Logan et al., 2022; Gössling & Dolnicar, 2023). This collective and coordinated approach is also supported by evidence from the UK Climate Assembly, which agreed with the need to reduce the rise in aviation demand. *"Assembly members resoundingly rejected a future in which air passenger numbers would rise by as much as 65% between 2018 and 2050, labelling it "counterproductive". Instead, assembly members sought to find an acceptable balance between achieving the Net Zero target, impacts on lifestyles, reliance on new technologies, and investment in alternatives."*

Notwithstanding people's desired freedom to fly, recent studies suggest social norms around flying may have the potential to shift, or be shifting already. Greta Thunberg's school strikes and subsequent Fridays-For-Future movement led to the so-called "flight shame" effect, with evidence of German and Swedish air travellers avoiding or substituting flights on moral grounds (Gössling et al., 2020). Studies involving those who have stopped flying because of climate change suggest that information about flying's contribution to climate change *is* important when combined with other personal drivers such as the influence of children "as educators or moral guides", along with role models and social support for flying less (Wormbs & Wolrath Söderberg, 2021). The influence of role models is evidenced by survey research suggesting that around half of people who know someone who has given up flying because of climate change say they fly less as a result of the other person's example, an effect that increases if the role model has higher social status (Westlake, 2017). Indeed other research has concluded that flying should not be viewed as an "individual" activity, due to the multifaceted social and collective meanings associated with air travel (Luzecka, 2016). This has implications for how behaviour change can be stimulated.

Recent research with German citizens found the strongest positive predictors of intentions to refrain from flying and policy support were the perception of alternative travel options, efficacy beliefs that avoiding air travel contributes to climate change mitigation, and intergenerational justice concerns. Pro-travel attitude was a negative predictor. The authors conclude that "*raising awareness of the impacts of climate change on future generations and developing strategies to promote people's concern for intergenerational justice might motivate people to reduce air travel and thereby contribute to a liveable future for new generations*." (Berneiser et al., 2022).

8.4 Interventions

8.4.1 Information provision and learning

As mentioned already, pro-environmental attitudes and knowledge about emissions from aviation do not necessarily translate to people changing their behaviour. That said, information provision can influence social and moral norms around flying, with potential ripple effects if communicated and modelled by trusted messengers (Wormbs & Wolrath Söderberg, 2021; Westlake, 2017).

There are several ways that greener choices by passengers can reduce emissions, for instance selecting a different class of travel, or choosing to fly with a more efficient carrier. Gössling and Dolnicar (2023) cite evidence from the World Bank that "compared to economy class, business-class flights have three times, and first-class flights nine times larger carbon footprints." Furthermore, two planes on identical routes can have substantially different per-passenger emissions due to the type of plane or the number of passengers on board. This highlights the need for improvements in the information available to passengers, with Baumeister calling for "an instrument to bring green offer and demand together" (Baumeister, 2020). Further evidence from choice experiments has shown that providing information on the comparative climate impact of flights via eco-labels results in greater willingness to pay for greener options (Baumeister et al., 2022).

While the "information deficit model" of behaviour change has been deemed insufficient on its own for pro-environmental behaviour in general, recent research suggests that knowledge of the effectiveness of a behaviour, such as flying less, can lead people to opt for high-impact rather than low-impact behaviours (Cologna et al., 2022). When considered alongside the aforementioned research into people who have stopped flying because of climate change, this suggests there may be a shift occurring with people's awareness of the impact of flying and their willingness to adjust their behaviour, for some people at least (Wormbs & Wolrath Söderberg, 2021).

8.4.2 Incentives

Taxes on flying – including Frequent Flyer Levy. The Frequent Flyer Levy has been proposed as a progressive (i.e. not harming the less well off) and effective way to bring about behaviour change without penalising those who fly less often. Research in the UK examined four air travel taxation models – Air Passenger Duty (APD), Flight Emissions Tax, Frequent Flyer Levy, and Frequent Air Miles Tax – and found all to be less regressive than taxing home energy or motor fuels. The most progressive option is the Frequent Air Miles Tax, which combines a tax on emissions with the number of flights taken. The second most progressive option is the Frequent Flyer Levy. The researchers conclude that "carbon taxes on air travel can be defended from a justice perspective" (Büchs & Mattioli 2022).

Other research found that a Frequent Flyer Levy in the UK has the potential to be more progressive *and more effective* at reducing emissions than a carbon tax, both in the short and long term (Fouquet & O'Garra, 2022). Less recent research suggests that aviation taxation results in welfare losses to consumers (Mayor & Tol, 2010). The UK Climate Assembly came out 80% in favour of a similar model to the Frequent Air Miles Tax, and 70% in favour of a Frequent Flyer Levy (UK Climate Assembly, 2020), a position that appears consistent with the Assembly's desire that climate policies prioritise fairness. In polling by CAST and Ipsos Mori, the Frequent Flyer Levy was the most popular Net Zero policy relating to behaviour change, with 68% approval. The polling report said: "Older people were more supportive of frequent flyer levies (74%), as were those who voted for Labour (76%) or the Liberal Democrats (77%) at the last General Election, and those who are more engaged with climate change issues (81%). However, people from the least deprived households (73%) or rural areas (76%) also supported this policy more strongly" (Ipsos CAST, 2022). That said, the framing and messaging around such policies are likely to be crucial to public acceptability.

Tax on jet fuel. Almost all countries tax fuel for road vehicles, but few do the same for aviation. Exceptions are Japan and Norway (Larsson et al., 2019). Jet fuel taxes are not permitted under current international agreements unless two countries form a bilateral agreement and reserve the right to do this in relation to the relevant ICAO resolution (Larsson et al., 2019), so they could only be applied to domestic flights. This limits their relevance to reducing emissions because the UK's domestic flights contribute only 7% of its overall aviation emissions (CCC, 2020). A jet fuel tax has been found to be effective in Japan, apparently reducing demand for jet fuel by 10% (González & Hosoda, 2016).

Taxes on jet fuel can in theory incentivise airlines to use fuel more efficiently and reduce demand for flights due to higher costs (Larsson et al., 2019). However, evidence from Australia suggests a relatively low tax on fuel ($23.00AUD (FY, 2012) to 24.15 (FY, 2013) per tonne of CO_2 equivalent) did not lower demand for flights, although it is uncertain if the tax was passed through to customers (Markham et al., 2018). The UK's Air Passenger Duty (see below) is set at a higher rate. Furthermore, a jet fuel tax that is not passed on to the consumer, and is instead borne by the airline, can still decrease emissions since the business case for each route will be less favourable, resulting in fewer flights per week (Larsson et al., 2019).

Distance based air passenger tax. The UK has had an Air Passenger Duty (APD) that varies according to distance travelled since 1994. From April 2023, there will be three bands instead of the current two (at time of writing): Band A (0–2000 miles); B (2001–5500 miles); C (over 5500 miles). However, research has found "the effectiveness of APD [in terms of reducing emissions] has been *marginal*. Travelers are prepared to pay more in the main and ignore the wider issues of environmental pollution" (Seetaram et al., 2014, emphasis in original).

Tradable personal carbon allowances. The idea of personal carbon allowances (where, for example, a nation's carbon budget is divided equally between its individual citizens who then decide on which consumption activities they want to "spend" their allowances, while trading any surplus or shortfall) gained some traction in the first decade of the 2000s, but has had little attention since. Flying's high carbon footprint means such a scheme could influence aviation behaviour particularly among frequent flyers (Jagers et al., 2010; Larsson et al., 2019). The idea was described as "ahead of its time" and "too radical, too different from current trends and mainstream thinking to be accepted at the time it was first put forward" (Fawcett, 2010). A recent paper suggests it could prove more workable with the advent of AI, and be more publicly acceptable as public perceptions of a climate crisis increase (Fuso Nerini et al., 2021).

Offsets. Extensive research has been carried out on the passenger uptake of carbon offsets, although a small fraction (1% to 3%) of air travellers voluntarily choose this option, and the efficacy of offsets has been questioned. For instance, a study commissioned by the European Commission found that 87% of 5,500 evaluated offsetting projects were not additional and were not delivering the CO_2 reductions that they were certified for (Cames et al., 2016). Factors that influence the uptake of offsets include attitudes, values, identity, social norms, perceived efficacy, guilt avoidance, and the choice architecture during ticket purchase – for instance whether customers opt in or opt out of buying offsets (Gössling & Dolnicar, 2023).

Recent research raises the possibility that the purchase of carbon offsets could lead to moral licencing and a rebound effect where people feel justified in taking more flights, although this requires more research (Kerner & Brudermann, 2021). Further research indicates that the use of nudge techniques that alter the default option can be effective in promoting the uptake of offsets. Customers generally stayed close to the default setting for the purchase of carbon offsets, even when this was not the least expensive option (Berger et al., 2022).

Limits or bans on short haul flights. France has legislated a ban short-haul flights (with other countries exploring the idea) where alternative rail travel is available (see Table 2). Short-haul flights are more energy intensive per km, but the greater distances of long-haul flights make for a much greater climate impact, limiting the effectiveness of bans on short-haul flights. For instance, in 31 European countries, flights of less than 500km accounted for 6% of fuel burnt, compared to 47% for flights over 4000km (Dobruszkes et al., 2022). That said, a short-haul flight ban could signal both the need to reduce emissions from aviation and governments' commitment to tackling climate change.

Table 2: Initiatives to ban short-haul flights

Table 1
Initiatives to ban or discourage super short-haul flights. Source: authors' elaborations based on newspapers and official journals.

Country	Market targeted	Scheme	Routes affected based on the 2018 timetable	State (as for April 2022)
Austria	Both domestic and international	Tax per passenger of €30 on flights shorter than 350 km (excluding connecting trips) against €12 for all other flights*	18 domestic and international routes that serve mostly Vienna, then regional airports (150–349 km)	In force (September 1, 2020)
Austria	Domestic	Ban of air services when the rail alternative is within three hours	Vienna-Graz (150 km) and Vienna-Salzburg (267 km)	In force
Belgium	International (de facto)	Extra tax per departing passenger of €10 on flights shorter than 500 km, €2 on other flights within the EEA, to the UK and Switzerland** and €4 otherwise, excluding connections	Flights between Brussels and surrounding large hubs or regional airports including into a Birmingham–Hamburg–Zurich–Paris polygon; flights between Antwerp and some regional /secondary airports	In force (April 1, 2022)
France	Domestic	Ban of domestic air services when the rail alternative is direct, operated several times a day, and within 2.5 h, excluding connecting flights	Typically routes between Paris Orly Airport and Bordeaux, Nantes and Lyon, and some regional routes, subject to future implementing decree	Part of law 2021–1104. To be in force from the last Sunday of March 2022, but the application decree is still awaited.
The Netherlands	Domestic	Overall ban	Mostly leisure flights that are mutualised within the Netherlands, 43–251 km (see Section 2)	Proposed by the PM in 2013 but no political agreement
The Netherlands	Brussels-Amsterdam route	Ban	Brussels-Amsterdam route (156 km)	Motion voted by the MPs but rejected by the government

Distances are great-circle distances. *For those domestic flights submitted to VAT, VAT deduction means €26.10 and €10.44, respectively. ** EEA: European Economic Area.

8.5 Research gaps and limitations

In general, research is lacking on the effectiveness of behavioural interventions to reduce emissions from aviation, perhaps because such interventions themselves are rare or absent. In a review article of the effectiveness of behaviour change policies, Wynes et al. (2018) found no relevant studies on behavioural interventions for aviation.

Novel taxation such as the Frequent Flyer Levy would benefit from further research to assess the trade-offs on the supply-side (e.g. protection of regular customers, dynamic efficiency) and related to implementation (e.g. data privacy, the role for revenue recycling) (Büchs & Mattioli, 2022). There is great potential for research into the effect of social and moral norms, including the influence of friends and family who model behaviour change, but also leaders such as politicians, celebrities, and business leaders – i.e. those with high socio-economic status and social capital, along with decision-making power (Nielsen et al., 2021; Westlake, 2017).

8.6 Recommendations and conclusion

Reducing emissions from aviation will require significant behaviour change and cannot rely on new technology or voluntary industry initiatives. According to Gössling and Lyle (2021): *"transition policy mixes should consider the roles of all regime actors, as well as the mechanisms through which these influence the transition. This may be envisioned as a self-reinforcing process: consumer-citizens influence demand, through their choices and policy support, and they create society's wider social norms regarding the desirability of air travel. This increases pressure on policymakers to introduce low-carbon legislation, which then forces the aviation sector to embrace technology change. The cost of innovation influences demand, and affects the social norms surrounding air travel."*

Researchers have suggested promising policies to reduce aviation demand including: introducing carbon tax with annual increase, subsidy removal to increase ticket prices, frequent flyer levy, carbon labelling on air tickets, limit airport capacity and stop expansions, mandate denser seating layouts and removing premium class, banning loyalty programs, and restricting advertising for air travel (Gössling & Dolnicar, 2023).

9 Adaptation

Even if all global commitments to emissions reduction are met, the UK will experience considerable impacts from climate change (CCC, 2023). Climate adaptation is defined as a process of change with the idea of reducing or avoiding the negative impacts of climate change (Betts & Brown, 2021; IPCC, 2014). Climate adaptation actions are of utmost importance as these can protect individuals and businesses from direct threats such as floods, droughts, heatwaves, or other natural disasters. Climate change adaptation behaviours can be undertaken both at a household-level and a business-level and range from household protective action during heatwaves, droughts and floods, and preventive action to make homes more heat and flood resilient; to agricultural management practices to adapt to the effects of climate change. This wide variety of adaptation behaviours means the literature we review in this section is more diverse than those within the preceding sections that focus on a single area of behaviour change.

9.1 Overview of evidence

This section reviews papers on adaptation behaviour and behaviour change. From our research, we identified nine review articles and a further 55 articles, along with 23 from the 2021 IPCC review and five from our grey literature search, for a total of 68 sources. Studies cover behavioural responses to multiple or single risks, primarily flooding, heat stress and drought. All studies were conducted since 2005 and span a range of countries, including developed and developing contexts. Where possible we prioritise UK evidence, given the importance of contextual factors in shaping adaptation responses; however more adaptation research has been conducted in other countries.

Van Valkengoed and Steg's (2019) meta-analyses of 106 studies in 23 different countries found a focus on individual-level factors (e.g. perceptions), rather than wider social or structural drivers of adaptation behaviour. Koerth et al. (2017)'s systematic review again finds a focus on individual-level drivers of coastal adaptation by households. Specific risks, namely flooding and hurricanes, are more studied than others. Similarly, certain behaviours (preparedness behaviours) are studied more than other (emergency response and recovery) adaptation behaviours. Most evidence is quantitative and correlational (Koerth et al., 2017; Hass et al., 2019). Moreover, there are very few intervention evaluation studies; of these, methodology is generally weak (e.g. convenience samples, focus on intentions not behaviours) with limited longitudinal studies (Boeckmann & Rohn, 2014; McLoughlin et al., 2023; Piggott-McKellar et al., 2019).

Key findings & implications

- Adaptation behaviours are not widespread, and awareness of adaptation is lower amongst the public than about mitigation (Power et al., 2020).
- Households are less likely than land managers to undertake permanent protective measures (e.g. modifications to their property) in preparation for climate events (Power et al., 2020).
- Factors known to shape behavioural adaptation responses include individual, economic, physical, cultural, and institutional factors (IPCC, 2022; McLoughlin et al., 2023). Power et al.'s (2020) UK review of adaptation behaviours found age, direct experience, and social norms were the most common factors driving behavioural change among households; income was also a barrier or enabler of adaptation.
- Experiencing extreme weather, such as drought, can encourage adaptation (or maladaptation) behaviours, suggesting such events could create windows of opportunity for effective adaptation (e.g. water-saving) policy initiatives (Liu et al., 2022).
- The way in which the media frames climate risks (e.g. extreme heat as health risk versus 'fun in the sun'; O'Neill et al., 2022) is likely to shape public adaptation responses and acceptability of resilience policies.
- There is little evidence of effective adaptation behaviour change interventions, and most of what does exist is methodologically weak, so the scale of behaviour change cannot be quantified (McLoughlin et al., 2023).
- Most interventions so far focus on information provision (which can exacerbate inequalities); although some financial interventions (e.g. loans) have been tested, particularly amongst farmers (e.g. Power et al., 2020).
- Effective risk communication is tailored to specific risks, provides clear behavioural advice, is framed to audience needs/values, applies visuals and demonstrations, and uses trusted communicators (McLoughlin et al., 2023; Seebauer & Babcicky, 2017).

- Information and advice on effective adaptation measures are needed, along with upstream interventions (e.g. regulations, incentives) to remove behavioural barriers.
- There are evidence gaps relating to types of risks, with flood risks more researched within the UK context than other climate risks (Power et al., 2020).

9.2 What adaptation behaviours are taken?

Adaptation behaviours cover a range of actions: Carmen and Zint (2020) undertook a systematic review of 75 papers to create a comprehensive definition of personal and household adaptation behaviour that considers its purpose (i.e. preventing harm or gaining benefits), timing (i.e. proactive or reactive), time scale (i.e. short-term or long-term), as well as who acts (i.e. the individual alone or with others) and who is affected (i.e. the individual, other people, or the environment). Behaviour is classified as civic engagement, consumption, coping, household protection, learning, lifestyle changes, migration, and self-protection. Studies suggest adaptive behaviours are not yet widespread, either amongst the public or stakeholder groups (Whitmarsh, 2009; Tompkins et al., 2010; Blennow & Persson, 2009). For example, one British interview study of private forest owners (Lawrence & Marzano, 2018) found few believe they should adapt to climate risks; while of the actions taken, species choice is the principal focus of adaptation activities. Research with farmers similarly suggests there is limited understanding of and adaptation to climate risks (Hallam et al., 2012; Wheeler & Lobley, 2021).

Research (involving a literature review and expert interviews) conducted for CCRA3 (Power et al., 2020) on behavioural responses to climate risks in the UK found a total of 86 unique adaptation behaviours in the following categories: hazard reduction (1), vulnerability reduction (50), preparedness for response (11), coping during crisis (21), preparedness for recovery (2). The types of behaviours taken vary according to factors such as type of climate risk, with extreme cold and heat events more often eliciting *reactive* coping responses while flooding adaptation includes more proactive vulnerability reduction and preparedness actions. Few households undertook permanent modifications to their property in preparation for climate events, while agricultural land managers are more likely than other groups to undertake permanent protective measures. Box 1 shows the most impactful household behaviours to adapt to climate change. Some of these also apply to professional groups, although specific adaptation actions available to farmers include using new technologies, farm, and crop diversification, improving soil health and water management, and using crop varieties or livestock breeds that are more resilient to climate extremes (Wheeler & Lobley, 2021).

Box 1. Most impactful household adaptation behaviours currently undertaken in the UK (Power et al., 2020, for CCRA3)

- Flooding: applying tanking (a process in which a liquid coating bonds to damp masonry to form a waterproof barrier when it dries) to all ground floor walls; routine clearance of drains; online data back-up; moving vulnerable items within the house as well as static items like sockets up walls; and purchasing flood insurance.
- Extreme heat: Seeking shady areas; drinking more water to stay hydrated; keeping windows open at night; changing clothing, reducing physical activity; and in some cases installing air conditioning in offices where passive cooling methods would be ineffective (though air conditioning can be maladaptive in terms of energy use and expelling waste heat into the environment, see below).
- Drought: planning for longer periods of peak water demand; water-efficient landscaping; implementing water saving practices; and climate-smart agriculture.
- Extreme cold: Changing clothing; insulating buildings; changing outdoor work practices to minimise outdoor time.
- Storms: Installing surge protectors; turning off mains power; unplugging electronic devices; tying down potentially loose objects; having salt or sand ready for snowstorms.

9.3 What are the drivers of and barriers to adaptation behaviour?

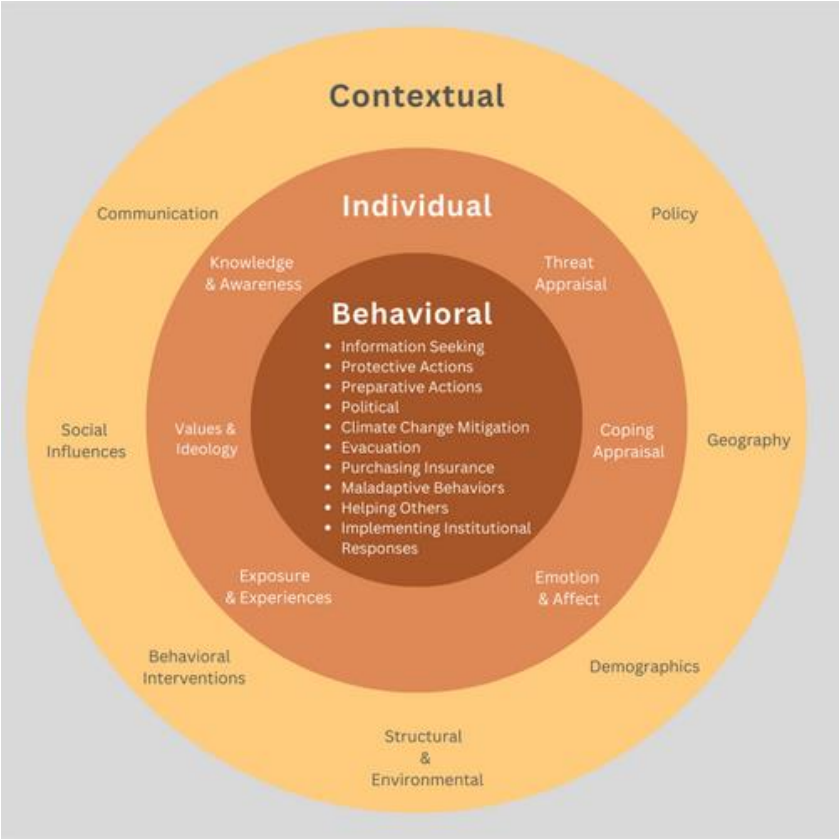
Factors known to shape behavioural adaptation responses include individual, economic, physical, cultural, and institutional factors (Gifford, 2011; Adger et al., 2012; Krüger et al., 2015; Brink & Wamsler, 2019; Hallam et al., 2012). McLoughlin et al. (2023) group these factors into individual and contextual (see Figure 5). Power et al.'s (2020) UK review of adaptation behaviours found age, direct past experience, and social norms were the most common factors driving behavioural change among households; income was also a barrier or enabler of adaptation.

At the individual level, in line with Protection Motivation Theory, 'risk appraisal' and 'adaptation appraisal' are both important (Grothmann & Patt, 2005; Murtagh et al., 2019), which are in turn influenced by knowledge of available adaptation strategies (Blennow & Persson, 2009); descriptive norms (i.e. what is seen as 'normal'),

negative emotions, perceived self-efficacy and outcome efficacy (belief that the adaptive actions will have intended benefit) of adaptive actions (Valkengoed & Steg, 2019; cf Moser, 2014; Burnham & Ma, 2017). Prior experience also predicts adaptation for certain risks, such as flooding (Koerth et al., 2017; Ali et al., 2022; Whitmarsh, 2009; cf. Burningham et al., 2007) and heat risk (McLoughlin et al., 2023). Lower perceived personal responsibility has been found to be negatively associated with adaptive behaviours (Valkengoed & Steg, 2019; Koerth et al., 2017). Maladaptation appears to be influenced by unproductive cognitive responses, including fatalism, denial, and wishful thinking (Grothmann & Patt, 2005), reduced trust in collective actions and institutions (Niemeyer et al., 2005), cultural norms (Murtagh et al., 2019), or limited availability of alternatives options (Kim, 2018). Qualitative research from the Netherlands suggests varied rationales for adaptation (flood) action (Karin et al., 2019) but adaptation generally appears to be more driven by self-interest (in line with the Theory of Planned Behaviour) than by pro-environmentalism or altruism (in line with the Value-Belief-Norm model, and in contrast to mitigation behaviours; Zhang et al., 2020).

In addition, cultural factors including place attachment appear to be important for climate adaptation (Valkengoed & Steg, 2019; Power et al., 2020), particularly in regions where livelihoods may be threatened by climate change impacts (Adger et al., 2012). Adaptation practices may be carried and modified when people move to new cultures (Strengers & Maller, 2017). Other studies show income and financial resources are important drivers of household, farmers', and firms' adaptation (Meierová & Chvátalová, 2022; Paudel et al., 2022; Sadebo et al., 2021; Hallam et al., 2012). Demographic (e.g. age, education), physical (e.g. housing type), and geographic (urban-rural; exposure to climate risks) factors also predict adaptation behaviours (e.g. Murtagh et al., 2019; McLoughlin et al., 2023).

Figure 5: McLoughlin et al.'s model of adaptation (heat risk) behaviour – showing types of adaptation behaviour in the centre and drivers around them



There is also literature on barriers to adaptation (e.g. Hansen et al., 2022). In the UK, public lack of awareness of the effectiveness of different behaviours is a major barrier to adaptation behaviours (Power et al., 2020). Competing motivations can also be a barrier to heatwave adaptation (Cornes & Cooke, 2018). Amongst farmers, barriers to adaptation include informational, social, financial, and infrastructural (Piggott-McKellar et al., 2019; Sorgho et al., 2020). For example, an interview study with UK farmers found lack of awareness about specific climate risks and of the type and cost-effectiveness of potential adaptation options, along with a preoccupation with short-term business survival and profitability, were key barriers to adaptation action (Wheeler & Lobley, 2021).

9.4 Interventions

9.4.1 Information provision and learning

Bartelet et al.'s (2022) review of household investment adaptation behaviours found of the 80 papers reviewed, 57 different public policy interventions intended to support adaptation were discussed; informational provision was the most prevalent (33%). Yet such approaches may exacerbate inequalities: *"Adaptation strategies based on individual preparedness, action and behaviour change may aggravate health and social inequalities due to their selective uptake, unless they are coupled with broad public information campaigns and financial support for undertaking adaptive measures*" (Paavola, 2017). The wider public health literature similarly shows that downstream measures tend to exacerbate existing inequalities (PHE, 2018).

Wirth et al.'s (2014) review of 278 types of adaptation communication found a lack of evidence comparing the effectiveness of different communication formats, yet a strong preference for uni-directional communication (rather than participatory designs). They define effective adaptation communication as aiming to raise awareness and knowledge, motivate action, and increase support for policy. Their review suggests effective communications combine solid content (based on sound scientific data, translate climate change into daily life, frame for target group), "soft" factors (e.g. emotions, norms and values), and trusted messengers or peer-to-peer formats. McLoughlin et al.'s (2023) review of heat risk communication similarly highlights the importance of messaging framing and of trusted messengers, but also notes "*no studies to date have yet tested experimentally how far different "messengers" influence reception of heat risk interventions [and] little existing literature which has directly tested different message framings and narratives".* Power et al.'s (2020) review similarly concludes: *"ensuring tailored and focussed climate risk communication is extremely important, and should be better-targeted, framed appropriately and make use of visuals."*

Flood risk communication has been found to influence risk adaptation. Ali et al.'s study (2022) for example found a strong correlation between flood risk perception and risk communication in Pakistan, although this may be due to those who are more aware of the flood risk being more likely to seek risk communication information. Levels of trust in those who are communicating flood risk can affect outcomes: in Austrian research, older volunteers were more trusted and likely to induce intended adaptation action (Seebauer & Babcicky, 2017). Neither of these studies measured actual behaviour change, however.

Hine et al. (2016) tested different framed adaptation messages amongst the Australian public and found messages that included strong negative emotive content or provided specific adaptation advice increased adaptation intentions in all three audience segments ('alarmed', 'uncommitted', and 'dismissive'). Omitting mention of climate change and emphasising local impacts increased intentions to adapt in dismissive audiences. Experimental research with Spanish students shows flood risk framing (as a personal loss or not) influences investment decisions (Markanday & Galarraga, 2021). Nguyen et al. (2018) found TPB-framing shaped school-children's adaptation in Vietnam. Social norm framing in an experimental setting also influenced intended adoption of flood insurance amongst households (Robinson et al., 2022).

Heatwave education, heat risk warning systems, and cues to action by health professionals have also been found to promote adaptation behaviours in non-UK contexts (see reviews by McLoughlin et al., 2023 and Boeckmann & Rohn, 2014). For example, Das (2016) studied the impact of Indian government heat risk information campaigns and found regular use of television appeals was most effective in reducing deaths, followed by newspapers and radio. An Indian awareness campaign on "dos and don'ts" during heat wave conditions was also found to be effective (Das & Smith, 2012). Their and Lin (2022) in a convenience sample of US students found "solutions journalism" (credible stories about responses to societal problems) increased perceived behavioural control and in turn support for collective climate change adaptation.

Visualisation tools, if coupled with specific adaptation solution advice and costed options, can also help communicate climate risks and promote engagement with adaptation, as they help localise climate impacts, link to personal experience, make individual action more explicit, and show how acting can make a difference to reducing risk (Glaas et al., 2021).

Social approaches, such as demonstrating new behaviours or discussions with peers, can also be effective, particularly amongst farmers. Hallam et al.'s (2012) review of farmers' climate action concludes: "Since farmers are influenced by their social networks, desired behaviours in the innovator/early adopter group need to be encouraged, endorsed and promoted". In developing countries, community approaches (e.g. farming field schools, environmental action groups) are being trialled to encourage farmer adaptation (Matsvange et al., 2016). Piggott-McKellar et al.'s (2019) review of the grey literature on community-based adaptation (CBA) in the Global South finds this an increasingly common approach to adapting to climate risks and protecting livelihoods, but little evaluation of these projects. McCrum et al. (2009) found deliberative workshops could enhance social learning about climate change adaptation among land managers; while other work with school children shows discussing climate change with friends and family predicts climate adaptation (Valdez et al., 2018).

Although there are knowledge gaps regarding adaptation action, information provision alone appears to be limited without wider measures (Wirth et al., 2014). For example, Saini et al. (2015) found adaptation education

for slum-dwelling women in India was effective in raising knowledge and changing attitudes but not in changing behavioural intentions, due to a lack of enabling factors. Yet, as Wamsler (2016) notes "*City authorities rarely pay sufficient attention to financial and structural aid for individual adaptation. Conversely, the available municipal support for individual adaptation has little take-up by members of the public". Hass et al.'s (2021) review concludes that what is needed is "a more integrated approach to refining risk communication strategies that result in a behavioral change and incorporates the individual, social, and cultural components of impactful group-based or community-wide interventions".*

9.4.2 Financial measures

We found no studies testing financial interventions with households, whereas several studies have examined the efficacy of financial measures with stakeholder groups, such as farmers (Hallam et al., 2012). Di Falco and Sharma (2018) found that hypothetical financial incentives (farming micro-loans) were effective in promoting intended adaptation investment behaviour. Similarly, studies in developing countries indicate access to credit and climate information/training predict farmers' adaptation (Gebrehiwot & Van Der Veen, 2013; Fedushi et al., 2019). One German experimental survey (Buelow & Cradock-Henry, 2018) with farmers found that economic incentives did not automatically increase adaptation intentions; rather, their effectiveness was dependent on farm structures, extreme weather experience, and social norms. Along with information, financial interventions were seen as critical adaptation behaviour change measures in the CCRA3 review (Power et al., 2020); however, it also notes "*the limits of financial support for encouraging behaviours, demonstrating the importance of considering other factors such as social norms, stakeholder pressure and clear policies and regulations".*

9.4.3 Structural measures and nudges

Upstream measures, such as regulation or infrastructure investment, tend to be effective in delivering widespread behaviour change (BIT, 2023), but such measures have rarely been examined in the context of adaptation behaviour change. Our review found that regulatory measures to deliver adaptation behaviour change had been examined only for farmers, but not for householders. Hallam et al.'s (2012) review on farmers' climate action concludes that regulation "*works best in situations where the target group is already, or can quickly be, persuaded that the regulated actions fall below an acceptable 'reference level' of responsible farming practice".* Similarly, we found no evidence on using nudges for adaptation behaviour change.

There is some evidence that government investment in 'hard' adaptation measures, such as flood defences, undermines communities' sense of responsibility or willingness to take household adaptation action (Power et al., 2020). Similarly, research on Vietnamese SMEs find government support (in contrast to strong local ties) undermines willingness to act collectively to reduce flood risk (Leitold et al., 2020). Moreover, there is much lower public awareness of behavioural adaptation measures (e.g. drinking water in hot weather) compared to 'hard' measures, leading Power et al. (2020) to conclude that *"the misconception that adaptation only includes structural or property adjustments could be deterring greater action".*

9.5 When to intervene - moments of change

Windows of opportunity to intervene to foster adaptation action include extreme weather events. Although previous experience of overheating does not directly influence protection behaviour (Murtagh et al., 2019; Iglesias et al., 2021), drought experience apparently does. Sustained drought in Australia (2006-2010) led to water saving behaviours, though more in gardening practices than showering (Lyndsay & Supski, 2017). Where water restrictions were imposed, these reduced self-reported water use (whereas policy responses to maintain water availability through desalination did not; Lindsay et al., 2017). Similarly, a study (Liu et al., 2022) in Oklahoma found that water scarcity experiences could create windows of opportunity for effective water-saving policy initiatives, since only those who experienced drought took (mostly no-cost) measures to reduce their household water waste. However, this effect may vary across groups; those with pro-social orientations and certain garden types may be more likely to respond to disruptions, such as hosepipe bans (Chappells et al., 2011). There is weak and inconsistent evidence that exposure to recent extreme weather events increases support for adaptation policy (Ray et al., 2017). Power et al. (2020) conclude that "*the propensity for past experience to drive behaviour may mean that some behaviours will become more widely adopted as the frequency and severity of climate impacts increase".*

Other windows of opportunity may also be relevant, such as relocation or renovation; at these points, householders may be more receptive to implementing structural resilience measures (Verplanken et al., 2018). In the case of farmers, Hallam et al.'s (2012) review notes that farmers often work to long timescales, so "once they commit to decisions, they are often tied into specific actions for years". However, there are certain 'moments of change' when it is easier to alter farm management practices, such as when farmers plan to exit, diversify, extend, or intensify production.

9.6 Research gaps and limitations

While there is good evidence of factors driving and inhibiting adaptation behaviours (albeit more from non-UK contexts than from the UK), there is much less on effective adaptation behaviour change interventions, and most of what does exist is methodologically weak so the scale of behaviour change cannot be quantified. While non-UK evidence can be helpful in suggesting effective interventions, cultural, economic, political, or other differences between countries may mean findings cannot necessarily be translated to the UK context, highlighting the need for further UK-specific studies. Most interventions focus on information provision; although some financial interventions have been tested, particularly amongst farmers. There are also evidence gaps relating to types of risks, with flood risks more researched within the UK context than other climate risks.

9.7 Recommendations and conclusion

Although by itself the effectiveness of information for changing behaviour is limited and may exacerbate inequalities (e.g. by not addressing financial barriers), information provision can have some effects (particularly since public awareness of adaptation action is low). Initial studies suggest effective climate risk communication is tailored to specific risks, provides clear behavioural advice, is framed to audience needs/values (e.g. productivity framing for farmers, avoid climate framing for 'dismissive' publics), applies visuals and demonstrations, and uses trusted communicators.

Upstream measures are needed alongside downstream, in order to remove behavioural barriers. Power et al.'s (2020) CCRA review concludes: "*People want to know more about the effectiveness of different adaptation measures that they can take, and want support to take the best actions. Public and private sector support is necessary for encouraging adaptation measures*." Upstream actions could include, for example, reducing up-front costs to structural measures (e.g. via interest-free loans), or reducing the need for behavioural change by building more climate resilient homes and communities via housing standards and planning regulations. Hallam et al.'s (2012) review of farmers' climate behaviours similarly concludes that information provision (e.g. demonstrations by other farmers) should be provided alongside interventions to enable and encourage behaviour change, including regulation, financial measures, and standards. Timing is also important: interventions are more likely to be effective for householders and farmers if timed to coincide with 'moments of change', such as when householders are renovating, or farmers are making long-term investment decisions.

Far more evidence is needed on what works to change or promote adaptation behaviours amongst the public and professional groups (e.g. farmers). However, while field experiments would be helpful, there are ethical considerations; it would not be acceptable to assign some participants to a control group without any protective measures or advice, so different measures that all provide some protection would need to be compared. More generally, upstream and system-level interventions require non-experimental designs to assess their efficacy and benefits (Swinburn et al., 2011).

10 Net Zero skills and careers

Behaviour change is necessary not only in personal contexts but also in professional settings. Therefore, this section focuses on Net Zero skills and careers, which are essential for the transition to a 'green economy', to facilitate climate change mitigation and adaptation, and to help manage natural assets (Green Jobs Taskforce, 2021). The literature tends to include Net Zero skills and careers within the broader 'green skills/careers' category. Green skills are defined as the practical application of knowledge and abilities to reduce the impact of human activities on the environment and environmental degradation (Nurdiansyah et al., 2019). Green skills can be technical, related to the design, construction, and assessment of buildings and technology usually mastered by technicians and engineers. There are also more generic green skills, such as management and people skills, which can be used to implement organisational and cultural changes needed to drive business sustainability (White et al., 2022). However, a clearer definition might be needed including a set of skill standards. Besides striving for organisational changes towards Net Zero, there already exist green jobs and careers, which are defined by the UN as "work in agricultural, manufacturing, research and development, administrative, and service activities that contribute substantially to preserving or restoring environmental quality" (UNEP, 2017).

In this section we focus on Net Zero skills for workers and factors that could be influential for engaging in Net Zero skills training (e.g. knowledge, attitudes); the availability of training; and techniques used by organisations to increase participation in training by employees. Additionally, we also discuss factors associated with pursuing a Net Zero career specifically for young people.

Key findings & implications

- Environmental awareness, i.e. the conscious perception of how an organisation is harming the environment, together with knowledge about climate change or position-specific technical knowledge (e.g. in the energy or manufacturing domain), and positive attitudes for the preservation and utilisation of natural resources are key for workers' initial engagement with Net Zero skills training opportunities (Cabral & Dahr, 2020).
- The farming community tends to be older; 70% are over the age of 59 (Gitting, 2019), and may not prioritise climate change (Hyland et al., 2015). Self-training or informal training is common in agriculture.
- In comparison to other developed nations, the UK is underperforming both in regard to investment in training and measures of skills (UK 2070 Commission, 2020). Thus, more innovative training and skills regimes are needed.
- Information provision is key for young people choosing a green career (Plan International, 2022).
- Better definitions for the terms 'Net Zero skills' and 'Net Zero careers' are needed to provide clarity for policymakers, researchers, and the labour market.
- Young people believe their employers should do a lot to tackle climate change and want to feel proud of their employer (Heath & Yarick, 2021).
- There is a lack of diversity in the green careers sector (e.g. landscape design) as 97% identify as 'White British' and only 1 in 10 are women (Groundwork, 2022).
- Lifelong learning is key to adapting to technological advances.
- Transferable skills are important for engaging in upskilling. Lack of information on green careers could hinder young people's choices (White et al., 2021).
- Those living in rural or remote areas could be more primed towards green careers due to close relationship between green jobs and nature protection or agriculture (Sulich et al., 2020).

Considerations for scaling up interventions

- Gamification (e.g. badges, leader boards, earning points) could be key in engaging employees with training activities, however, studies have only focused on general training opportunities rather than green ones (Meister, 2013; Stanculescu et al., 2016).
- Engaging a whole organisation is important for successful upskilling initiatives (Ramsarup & Ward, 2017).
- Education at school on Net Zero careers could increase their uptake (White et al., 2021).
- Limited evidence on behaviour change interventions exists in relation to green skills and careers.

10.1 Net Zero skills

Governments around the world have established that limiting the rise in temperatures and tackling climate change will require a swift transition to a 'green economy' (Kwauk & Casey, 2022). One of the most important factors for a successful switch to a green economy is the development of workers' green skills. The Green Jobs Task Force recognised that to an extent, every job will need to be a 'green job', thus green skills development is becoming a very current and prevalent topic. The following section will present evidence on factors that could influence employees' decisions to upskill in the area of green skills and to participate in green skills training.

10.1.1 Overview of evidence

We identified 29 documents in total with one review articles, 16 empirical papers and 12 grey literature reports. We should note that when discussing green career choices of young people, we mainly rely on grey literature as there is a lack of peer reviewed academic research.

The reviewed literature focuses mainly on using qualitative methods such as interviews (e.g. Brown, 2015; Cobban & Visser, 2017; Ibrahim et al., 2020) quantitative methods such as surveys (White et al., 2022; Plan International, 2022) or literature synthesis (e.g. Cabral & Dhar, 2020). Therefore, a main limitation of the present section is the lack of behavioural interventions in the domain. However, one could argue that it might be difficult

or not feasible to apply intervention techniques to people's careers. Nevertheless, we will discuss potential barriers and drivers as well as offer some insights into what businesses and policymakers could do to help upskill workers' green skills and to help young people choose a green career.

10.1.2 Net Zero skills: barriers, drivers and opportunities to intervene

In their review of green competencies, Cabral and Dahr (2020) identified that within green human resource management green skills would be placed under the category of green competencies or referred to as green training. Besides green skills, this category includes other constructs such as green awareness, green knowledge, green attitudes, and green behaviour. The authors also suggest that these constructs are interconnected and stimulate each other for the successful implementation of employees' involvement in pro-environmental behaviours.

One obstacle to upskilling might be low environmental awareness, i.e. workers might not have a conscious perception of the impact their organisation has on the environment. For instance, employees could lack awareness of the impacts of their actions on the environment, or simply not be aware of environmental problems or sustainability at all. This could lead to workers' unfamiliarity with the idea of green skills necessary for their positions, limiting the potential for lowering the environmental footprint of organisations, especially those in energy and materials sectors. In contrast, Brown (2015) showed that raising employees' awareness through different training courses focusing on the longer-term savings, higher profits, and the ways greener actions could improve the wellbeing and health of communities, could be beneficial for employees.

Lack of environmental knowledge, or lack of relationship to nature and ecosystems could also hinder people's upskilling (Cabral & Dahr, 2020). For example, in a survey by Kite Insights (2022) conducted in several countries including the UK, 77% said they felt uninformed or not confident in their knowledge of climate change.

Net Zero skills could also refer to green technical knowledge, which is especially important in the energy domain to achieve low-carbon, resilient, and resource-saving models. Technical knowledge is very important for those working in the electrical vehicles sector as they will need skills for motor assembly, control devices, etc. (White et al., 2022). In their review of 45 documents on the topic of green skills, Nurdiansyah et al. (2019) found that green knowledge could be increased through various learning methods at work such as workshops, seminars, and training sessions. However, for the proper acquisition of green skills, practical activities should also be implemented. Extracurricular activities are very important for the development of green skills of students, especially those who are part of engineering degrees (Nurdiansyah & Sucita, 2019).

From a psycho-social perspective, two categories of 'green attitudes' could play a crucial role in developing green skills. The first category is preservation, which is related to conserving nature. The second category is the utilisation of natural resources for the benefit of the planet and humanity, which is related to anthropocentric concerns (Cabral & Dahr, 2020). As other sections of this report have established, green attitudes can be important for engaging in green behaviours. However, if an organisation does not provide its workers with the ability to engage in green behaviours at the workplace, employees might be less interested in developing their green skills (Cabral & Dahr, 2020).

Cobban and Visser (2017) published a report specific to South Africa on green skills in agriculture, based on interviews. These revealed that many farmers are usually self-trained or informally trained, especially those who have inherited family-owned businesses. This is a major barrier for green upskilling, but presents an opportunity for governments and external organisations to intervene, for example by using extension services that could provide much-needed training opportunities for farmers in areas where there are skill shortages, for example, compliance with environmental policies.

Cobban and Visser (2017) also point out that new farmers sometimes find a great deal of value in mentoring schemes led by experiences farmers. Such activities, for example in the form of training, could encourage engagement with more sustainable and green farming practices. More research is needed to establish the likely success of such schemes.

Other findings suggest that farmworkers believe leading by example is important for the engagement in sustainable programmes, and that managers have responsibility for providing the space, time, and resources for their staff to develop green skills (Cobban & Visser, 2017). However, such leadership is currently lacking, with White et al. (2022) reporting that only 25% of leaders and 20% of managers in the UK are able to address sustainability agendas.

The European Centre for the Development of Vocational Training (Cedefop) strongly recommends that green skill development is integrated into wider training rather than being seen as a separate subject (Cedefop, 2019). This is very important given that rapid technological advances often require employees to continuously learn new skills or upgrade existing ones - a process known as lifelong learning (Li, 2022). For example, the World Economic Forum has estimated that 50% of employees would need training related to reskilling in order to adapt to new technologies (Schwab & Zahidi, 2020). Research offers some insights regarding the factors that might contribute to employees engaging in upskill trainings. For instance, ensuring that employees can transfer any acquired knowledge is related to higher employee engagement in initiatives (Eldor & Harpaz, 2016). In

addition, knowledge sharing between employees has been identified as crucial in helping workers to upskill (Malik, 2018).

A common strategy to increase employee participation in training is through gamification. This is defined as "the use of game elements and game-design techniques in non-game contexts" (Werbach et al., 2012, p. 26). For example, IBM used leaderboards and badges to motivate their employees to engage in general training activities. The results showed that these activities resulted in higher engagement with learning activities (Stanculescu et al., 2016). Similarly, Deloitte developed the 'Deloitte Leadership Academy' where people could earn points and badges, and were placed on a leaderboard. This resulted in a 37% increase in user engagement and in an increase in completing company training (Meister, 2013). Finally, SAP introduced mission-based badges, ranking, and levels of training and found a 1113% increase in community engagement in mission-related activities (Lusher, 2013). However, the application of these approaches to Net Zero training has not been tested.

Cedefop (2019) also suggests a push for greater environmental awareness (as stated above) and connectedness with nature. This was further corroborated by a report by Groundwork (2022) on green careers where they highlight the importance of workers' understanding of climate change issues by embedding carbon literacy as a core skill in job descriptions. However, at the moment green skills are hardly present in the education curriculum and occupational standards (White et al., 2022); this is despite 59% of employers requiring green skills now or in the future.

The engagement of a whole organisation in green activities seems to be one of the most important factors that promotes worker upskilling. This is evident from a report by Ramsarup and Ward (2017) who state that different green skills would be necessary for different groups of employees. The authors reported on a case study at Tesco PLC.

Case Study 1 – Tesco's climate change strategy to curb carbon dioxide emissions from its business.

- Tesco PLC saw an opportunity to position itself as a leading business in relation to climate change and simultaneously deliver changes to its business operations.
- Evaluations revealed three major sources of GHG emissions: energy consumption in buildings; energy consumption in the distribution of goods; and fugitive emissions of refrigeration gases.

Implemented changes:

- Renewable energy generation.
- The reduction of hydrofluorocarbon (HFC) refrigerant gas emissions.
- The implementation of performance management tools to incentivise energy efficient operations.
- Optimising truck loads.
- Minimising mileage travelled.
- Maximising fuel efficiency.

Changes to related to Net Zero skills:

- New green jobs
  - Team of climate change experts, policy advisors and environmental specialists.
- All jobs within the property team were transformed by upskilling employees to achieve carbon reductions.
- Truck drivers were trained in fuel efficient driving skills.
- Shop and warehouse workers were educated on the carbon footprint linked to their work.

Results:

- Tesco UK reduced its absolute emissions by 5%.
- Tesco UK's business grew by 7%.
- £200 million yearly savings in global energy costs.

Engaging with green skills is a complex process that likely depends on several personal factors such as knowledge, green awareness, and green attitudes. However, situational factors are also very important, such as managers leading by example, training opportunities, or simply including carbon literacy in job descriptions. Furthermore, green upskilling could be sector-specific, with more time and effort required in some sectors. Those with lower levels of education (primary and secondary) may lack knowledge related to green skills compared to those with higher levels of education, and women could also be at a disadvantage in this regard. For instance, women comprise almost 50% of the workforce in agriculture but are often limited in their access

to training opportunities (Plan International, 2022). In addition, highly educated workers are more likely to receive training than less qualified workers. Similarly, those earning a higher salary could be at an advantage (Felstead, 2010). Working for a smaller enterprise and/or working part-time significantly reduces the likelihood of receiving training (Arumpalam & Booth, 1997), while ethnicity and age could also play a role in whether or not employees receive training (Felstead, 2010).

10.1.3 Green careers: barriers, drivers, and opportunities to intervene

The transition to a green economy has created opportunities for various green career paths that have been embraced by younger generations. In this section we present some of the determinants that guide young people's decision to pursue green careers.

Generation Z, those born in 1997 and after, believe their jobs should have a social impact and consider 'good' employers to be those that care about sustainability issues (Heath & Yarick, 2021). Furthermore, feeling proud of their organization is essential for young people today, as well as matching their own values to the values of their organisations. Thus, they seek employers and careers that will do more than the bare minimum of environmental compliance, being especially drawn to companies that strongly embrace various green activities.

The push towards a green economy and the creation of green jobs is said to have many potential benefits for young people, who were disproportionately affected by the economic crisis of 2009–14. This is especially true for young people living in rural areas as they are at risk of being excluded from the labour market due to lack of business development. Given the close relationship between green jobs and nature protection or agriculture, a career in the green sector could prove useful for individuals living in more remote places (Sulich et al., 2020).

The increased interest in green jobs could also be associated with young people's increased overall engagement with green actions over the last years. For example, the last few years of the 2010s saw an increase in young people's concern and activism related to climate change and the environment, such as "Skolstrejk för klimatet" ("School strike for climate") and #FridaysForFuture (Fisher, 2019), inspired by Greta Thunberg. Observing or taking part in these protests could have been a turning point for young people, with a logical next step to influence change coming via their professional careers. This could be seen by them as a stronger and more influential alternative to volunteering or donating funds to green causes (Heath & Yarick, 2021). This aligns with data showing that 71% of young people are inspired to pursue green careers because they want to combat climate change, while 62% said it was due to their passion for sustainability (White et al., 2022).

However, a report from Groundwork (2022) identified that there seems to be a lack of information on green jobs as young people do not know where to look for opportunities. In addition, another barrier is the lack of diversity in the sector. For example, 97% of environmental professionals and 94% of workers in landscape design identify as "white British". In addition, only one in 10 people employed in large grounds maintenance were women. These characteristics of the labour market might put off young people from pursuing green careers (Groundwork, 2022).

Education at school and university could be a driving factor in young people's desire to pursue green careers. In addition, job placements could help teenagers gain important skills and experience in the green sector, and could encourage young people to find long-term employment in a similar area (Groundwork, 2022). This is especially important as around 40% of young people believe they lack the necessary skills and knowledge for green careers (Plan International, 2022). In addition, White et al. (2022) reported that 63% of young people had never heard of green skills, with this number being even higher amongst women (72%), and 40% did not know how to acquire such skills. Groundwork (2022) advocates that early access to information on green careers could help guide young people in the direction of working in the sphere of sustainability. This stems from their long and successful work of providing pathways for people to develop their green career skills through waged work placements, job brokerage support, tailored information advice and guidance, and additional support.

Furthermore, young people in late adolescence (e.g. ages 16–24) are in a developmental stage characterised by defining commitments and structure, autonomous decisions, and identity formation (Drake et al., 2016). This could be treated as an important 'moment of change' offering possibilities to influence sustainable choices. Thus, policymakers could work with career consultants at schools and universities to develop useful practices and guide young people towards green careers.

10.2 Research gaps and limitations

Given the recent focus on, and demand for, green skills and green careers, there is a need for more evidence to support some of the claims made in this section. It is interesting to note, however, that there seems to be a useful balance in the use of quantitative and qualitative research methods. Research on barriers to green skills seems to be rather limited to the agriculture and energy sectors, thus broadening it to other areas would be valuable. There is an abundance of literature and research on young people's career choices, however, a specific focus on green careers more generally would be beneficial.

10.3 Recommendations and conclusions

Our literature review revealed that there might be substantial gaps in people's understanding of green skills, and more importantly how to acquire them. This seems crucial not only for current employees who are struggling to upskill but also for young people who are just entering the workforce and might want a green career. This might be more evident in women, people from rural areas, and those with lower levels of education. Thus, the focus should be on educating society and raising awareness around these concepts in an inclusive manner, with the potential to speed up the transition to a green economy.

11 Business leaders

This section relates to the transition of businesses to sustainability through 'eco-innovation'. This concept is defined as a process of creating novel and competitively priced goods, services, systems, and processes using minimal natural resources and producing minimal GHG emissions for the benefit of society and quality of life (Peng & Liu, 2016). Businesses will be crucial players in achieving Net Zero targets, with two-thirds of UK emissions currently coming from the business sector (CCC, 2020). This highlights the importance of understanding the factors driving corporate eco-innovation.

Key findings & implications

Factors that influence the transition to a green economy

- Governmental regulations and cost-saving practices are driving factors for businesses to become more sustainable (Horbach et al., 2022).
- Managerial awareness of climate change and its impacts is key for transitioning to a more sustainable business model (Gadenne et al., 2019).
- Competitors' actions might also drive change; however, more evidence is needed as findings are mixed. Li et al. (2014) found competition to be a driving force, while Tsendsuren et al. (2021) found that when competition becomes too strong, there could be a reduction in environmental efforts.
- Customer demand for eco-friendly practices could also influence business' decisions, but concrete data is lacking.
- Non-governmental organisations (NGOs) could help push businesses to become more sustainable through helping organisations comply with environmental standards (Berrone et al., 2013).
- Family-owned or family-run businesses might be more likely to become green but have fewer resources to invest in eco-practices (Bammens & Hünermund, 2020).
- Social norms and the company's legitimacy in the eyes of the consumer might also push businesses into sustainability.
- Extreme weather events could be crucial in managers' decisions related to climate change Horbach et al. (2022).
- Policies aimed at market-based regulations could be more successful in making businesses more sustainable compared to command-and-control regulations.

11.1 Overview of the evidence

We identified 25 empirical articles, with the majority published in the last ten years with only a few from the 2000s. Research comes from diverse contexts, with studies conducted in Europe, North America, and Asia (including the Middle East). The reviewed literature focuses more on the theoretical side of behavioural science together with evidence from quantitative and qualitative research (e.g. Li et al., 2014; Peng & Liu, 2016; Al-Swidi et al., 2022). Thus, one of the main limitations, as with the previous section, is the lack of evidence from behavioural interventions.

11.2 Drivers enabling the transition towards sustainable businesses

Some of the key drivers that have been identified as causing a switch to more sustainable business practices are pressure from governments, competitors' actions, customer intentions, strategic motivation, behavioural intent of managers, managerial awareness of climate change, extreme weather, and family/non-family business.

11.2.1 Government regulations and financial policies

Regulations set by central and local governments are the most important driver for the implementation of sustainable business practices. For example, regulations are at the forefront of restricting the use of non-renewable energy (Rehman et al., 2021). Non-compliance with regulatory standards could prove to be financially costly for businesses, whereas abiding by them could shelter firms from being closely monitored or from the introduction of even stricter rules in the future.

Research has demonstrated that command-and-control regulations might be less favourable than market-based regulations. The latter might be more successful in triggering behavioural shifts towards greener businesses (Horbach et al., 2022). This is mainly because market-based instruments could be more beneficial for productivity growth, which would then lead to an increased desire for firms to invest in innovation (Wang et al., 2019). There are various other interventions that governments could apply to achieve behaviour change. Many of these are in the form of incentives, for instance tax breaks or capital improvements, which could be crucial for following ISO14001 standards specifically in the supply chain domain (Ikram et al., 2020).

A study by Berrone et al. (2013) analysing environmental patents from 326 firms in the US reported that non-governmental organisations (NGOs) could also play a role. NGOs are influential in the creation of environmental standards, and they could also push companies to go beyond meeting only the minimum regulatory requirements (Berrone et al., 2013). Furthermore, the same study argued that compliance is related to the growing need for legitimacy as organisations very often compare themselves to their closest competitors. Therefore, as with other behaviours discussed in this report, social norms could be an important driver (Berrone et al., 2013).

11.2.2 Competitor actions

The actions of competitors are also reported as one of the drivers of the green business transition. For example, Li et al. (2014) collected data from 148 manufacturing companies in China and concluded that pressure from competitors was one of the main drivers of decisions related to environmental practices. This is related to companies' strategies to use their environmental commitment as a differentiation tool to attract new customers. This might be especially true for the automotive industry in the current shift to EVs, but was also observed in the 1970s when Japanese car makers pushed for more fuel-efficient cars due to new standards (Li et al., 2014). However, other studies report that there could be a reduction in environmental efforts when competition for market share becomes too strong (Tsendsuren et al., 2021). Therefore, this is an area where the evidence is uncertain and would benefit from further research.

11.2.3 Customer demand

Customer demand and approval are a driving force behind companies' decisions to become more sustainable (Jum'a et al., 2021). For example, a study conducted in Brazil with an electrical business, showed that their customers' expectations of eco-design practices were very influential in driving the overall operations of the company to become more sustainable (Govindan et al., 2013). Customer pressure for eco-friendly services or products could also encourage companies to invest additional resources into innovative sustainable practices (Zhang & Zhu, 2019). Moreover, customers have the power to boycott businesses that do not align with the green agenda. This is especially true for manufacturing businesses as reported by a study in India conducted with 257 manufacturing SMEs (Al-Swidi et al., 2022). However, some studies warn that green products are usually more expensive, which might be a barrier for customers with lower incomes. Therefore, the transition to green product innovation could be seen as negative because it might result in the loss of customers (Rehfeld et al., 2007). This indicates that more research may be necessary to explore the role of customers in pushing businesses towards sustainability.

11.2.4 Type of business

The type of company could also influence environmental decisions. Family-owned and family-run businesses are more likely to become green. One of the main reasons for this is the higher value they put into their reputation, once again perhaps related to social norms and presenting a more positive image. This was confirmed in a study by Bammens and Hünermund (2020) who found a positive relationship between eco-innovations and family ownership in German firms. However, other authors argue that while they could strive to be more environmental, family-run businesses have less resources to invest in pollution prevention-strategies compared to bigger corporations (Fan et al., 2021). The authors say that these findings could be limited due to the study being conducted in a developing country (China) rather than a developed one.

11.2.5 Strategic motivations

Managers could also decide to implement eco-innovation measures due to efficiency strategies such as cost-saving. Sustainability practices could lead to more efficient production, which could then lead to monetary returns invested further in other eco-innovation initiatives. A study by OECD focusing on data from seven countries discovered that using cleaner production technologies resulted in larger cost savings (Johnstone, 2007). Similar results were also reported by Demirel and Kesidou (2011) who conducted a study specific to the UK using DEFRA data. They concluded that besides environmental regulations, another big determinant of transitioning to a greener business model was the cost saving potential of improving the efficiency of their machinery and equipment.

11.2.6 Managerial awareness

In most big corporations only individuals within top management could make decisions about eco-innovation strategies (Stimpert, 1999). This makes environmental awareness among senior managers one of the key factors influencing such decisions. Individuals with higher levels of environmental awareness are more likely to notice environmental issues. This is important as such issues might require more commitment and attention (Ramus & Steger, 2000). Furthermore, these managers could also have more knowledge of the environmental effects of their company and of the different laws related to best practices (Gadenne et al., 2019). These factors could contribute to introducing better manufacturing processes, improving existing products or even introducing greener ones (Peng & Liu., 2016). In addition, managers with these personal qualities could also strive to cut emissions further than the minimum requirement by the government as they choose more proactive approaches and strategies (Liu et al., 2015). Evidence also points out that having a positive outlook on climate change could result in more innovation related to tackling it, while a negative outlook might be more likely to result in more adaptation behaviours (Gasbarro et al., 2016). The latter could also be connected with considering the social, financial, and business risks connected with climate change (Haigh & Griffiths, 2009). This was corroborated in a study by Todaro et al. (2021) who found that managerial awareness of climate change was indirectly connected with climate action through perceived exposure to climate risks. Thus, raising managers' awareness of climate change could result in changing business activities. However, empirical tests on the effects of environmental awareness have been very limited (e.g. Peng & Liu, 2016), thus leaving room for further research in the area.

11.2.7 Extreme weather

Another factor that could have implications for managers' decision for the green business transition is extreme weather. For instance, over the last decades we have witnessed an increase in events such as heatwaves, floods, droughts, etc. From an organisational point of view these could severely disrupt routines and performance as there could be negative effects on supply chains, infrastructure, energy/water sources (Haney, 2017). These represent major challenges for companies that have to optimise planning and deal with uncertainties. A recent study from Horbach et al. (2022) who used World Bank data, determined that experiencing extreme weather events three years prior was a significant factor in pushing companies to engage in environmentally friendly practices. Therefore, governments could try to influence companies by highlighting the importance and business benefits (e.g. cost savings) of adapting to adverse weather. However, the literature in this domain is very limited as the field has only recently started to develop.

11.3 Research gaps

The literature on factors that influence businesses to become sustainable seems to be more focussed on small or medium-sized enterprises and less on bigger corporations. Further, the focus in the sources we identified seemed to be mainly on manufacturing and agriculture; therefore expanding this further could present a more complete picture. In addition, there seems to be a lack of generalisability of the findings to the UK context as some of the studies focused specifically on other countries (e.g. US, China). Finally, the lack of behavioural science insights allows for conclusions to be made relying more heavily on theoretical or correlational studies rather than experiments showing causality.

11.4 Recommendations and conclusions

Future work could focus specifically on researching the effects on competitiveness and customer demand as these two areas seem to indicate mixed results. However, governmental regulations, more specifically market-based measures, as well as managerial awareness, seem to be key for switching to more sustainable business practices. These are important results that indicate that there should be a stronger focus on instruments related to productivity growth as well as on educating high ranking individuals and business leaders on the impacts of climate change and how these might be tackled.

12 Land use and farming

The preceding section had a general focus on businesses and what influences their switch to more sustainable operations. However, agriculture specifically and changes to its management could have a vital role in tackling climate change. Globally, agriculture is responsible for one-third of all GHG emissions, while in the UK it is around 10% of all emissions (DEFRA, 2019). The CCC has established that over the past decade these emissions have remained relatively unchanged as progress has been quite slow (CCC, 2020). Therefore, behaviour change in this domain will be crucial for meeting the UK's climate targets and will require efforts from farmers, landowners, and farmworkers. One of the most important behaviours is the switch from carbon intensive practices such as livestock rearing towards low-carbon practices such as afforestation. For example, annual afforestation rates would need to reach 50,000 hectares by 2030 and 70,000 hectares by 2035 in order to reduce emissions by 5-6Mt in 2035 (CCC, 2020), making afforestation an important area for the development of governmental policies and a main focus for the present review. We should note that during our literature search we identified a published comprehensive review on the topic by Staddon et al. (2021) commissioned by Natural England. The findings of that document informed a major part of the section below; however, additional sources were also used where necessary.

Key findings & implications

Factors that influence the transition to sustainable agriculture

- Family-owned businesses, especially farms, could be more open to sustainability initiatives.
- Extreme weather events are important in farm owners' decisions to invest in climate change mitigation and adaptation.
- Older farmers might be less likely to change behaviours (Staddon et al., 2021).
- Attitudes, worldviews, values and beliefs, and age are important factors to consider.
- Financial incentives and subsidies are important, however, grant applications are seen as complex and bureaucratic by farmers, which reduces their willingness to apply (Confor, 2020).
- Classifying land as something other than 'agricultural' could hinder afforestation due to farmers' identity being connected to agriculture. Research shows that the word 'agroforestry' could elicit negative responses from the farming community even if there is support for tree planting (Irwin et al., 2022).
- Risk-aversion could hinder the adoption of new and sustainable practices (Dessart et al., 2019).
- Perceived loss of control over land when using grants could also be a problem for farmers, thus working together with farmers is key (Westaway et al., 2023).
- The identity of farmers has also been linked to their engagement with sustainable agriculture. For example, a productivist identity, defined by short-term profits and maximizing outputs, has been linked to lower engagement. A conservationist identity considers the long-term values of the land and seeks to improve soil health, and is connected with higher likelihood of engaging with sustainable farming practices (Dixon et al., 2021)

Considerations for scaling up interventions

- Social and descriptive norms (for example through demonstrations by innovative farmers) could be relevant for achieving behaviour change related to the process of afforestation.
- Incentives in the form of grants should emphasise that there will be no loss of control over land, while the grant application process should be made clearer and simpler. This could be beneficial for increasing engagement and subsequent behaviour change.
- Information campaigns and training are vital, especially when focusing on profitability and engaging larger portions of the farming community.

12.1 Overview of evidence

This section of the report reviews research on behavioural change practices, barriers, and drivers towards long-term land use change to increase tree cover. We identified 16 pieces of work in total, with three review article, five grey literature report, and seven standalone empirical papers.

We identified a recent report published by Nature England in October 2021 titled "Encouraging woodland creation, regeneration and tree planting on agricultural land: A literature review" (Staddon et al., 2021). The authors conducted a detailed review of the literature on social and behavioural science related to the creation of woodland in farmed environments. They focused their evaluation of behaviour interventions by using the Behaviour Change Wheel (BCW). We deemed the report a comprehensive review of research published in this domain, therefore here we present key findings from the publication by Nature England, introducing additional sources where appropriate.

12.2 Barriers and drivers for behaviour change of farmers

There are several social factors that might influence positive behaviour change related to woodland creation. For example, past positive experience with woodland is a strong determinant especially for small private landowners. This is especially true for farmers who believe that their livestock might thrive in a more natural environment. Social norms are another driver, as tree planting might become more desirable if neighbouring farms have already engaged in similar practices. For instance, discussions with other farmers, or even community-wide campaigns engaging regional farms could encourage afforestation. This finding on the effects of social norms was corroborated by other papers in our review (e.g. Messer et al., 2016) noting the likelihood of bidding for funding related to agriculture would be higher for more popular practices.

Next, a farmer's age was found to be a factor in woodland creation. For instance, older farmers might have less of a tendency to adopt new practices because they would not see benefits in their lifetime. In contrast, older farmers with heirs could be more open to behaviour change as this might be seen as enhancing a future family asset. In addition, older farmers approaching retirement could be more likely to sell their land for planting purposes, presenting a potential moment of change at which to intervene.

Finance-related problems and concerns are another big factor influencing behaviour change among farmers. Government grants related to the Net Zero transition are an important factor, but they are seen as not sufficient to encourage tree planting. This is mainly because such incentives might be more favourable towards large woodland owners rather than smaller holdings. A major concern is the potential loss of control over property, especially when grants focus on public access to land. Therefore, compensation needs to be higher given the potential problems that might arise from visitors accessing private property, such as littering and vandalism. There are other non-financial issues associated with grants. For instance, grant applications are seen as a complex and complicated, which is a major barrier to potential applicants. This was also seen in other research from our literature review. Westaway et al. (2023) highlighted that scheme simplicity together with less bureaucracy, additional promotion and information on availability are necessary to increase the uptake of grants. For instance, Confor (2020) found that after a 2016 review and simplification of forestry applications, tree planting more than doubled in Scotland. Nevertheless, oversimplification should also be avoided to prevent inappropriate planting or corporate buy-up of land with the intention of reaching Net Zero targets through tree planting.

Farmers' attitudes, worldviews, values and beliefs could also influence their openness to behaviour change. For example, a study has shown that farmers in Cumbria tend to be highly opposed to the idea of rewilding their lands (Staddon et al., 2021). The choices farmers make could be influenced by their personal satisfaction levels when taking environmental actions, and by their environmental consciousness. Furthermore, attitudes based on long-standing family traditions, especially for those born into the farming community, could be another barrier. Farmers' doubts about whether climate change is linked to farming, or its overall urgency, could also hinder behaviour change. For instance, Hyland et al. (2016) reported that Welsh farmers do not see climate change as their top priority.

Farmers' identity could also be linked to sustainable practices and afforestation. A productivist self-identity seeks to increase profits in the short-term and locate climate change responsibility with other industries, meaning those with such an identity are less likely to engage in climate-friendly practices (Dixon et al., 2021). A productivist desire to maximize outputs is amplified by governmental policies that stress the importance of increasing output in the national interest (Hyland, 2016). In contrast, a conservationist identity, defined by a care towards the wildlife or the soil, could make someone more likely to show concern for climate change and to engage in sustainable practices (Dixon et al., 2021). Thus, customisable recommendations might prove successful in the long term when taking into account farmers' various identities.

Finally, tree planting and management is connected with a few risks such as storms, fire, and pests and diseases, which cause additional problems for farmers. Thus, those who have more risk-averse attitudes tend to be less likely to adopt new practices. Research suggests that farmers have a relatively low tolerance to risk (Dessart et al., 2019). This is closely connected with another issue seen as a major barrier - the prioritisation of

planting over the management of new trees. Therefore, grants and incentives should also cover management costs and post-planting advice to ensure successful implementations of strategies.

12.3 Interventions

The review by Staddon et al. (2021) also evaluated some useful behavioural intervention techniques related to decision-making by farmers. Incentives should be primarily focused on reducing potential future financial risks such as financial loss due to taking land out of production. Next, applications for grants should be kept simple to increase farmers' understanding of the schemes. Inclusive conversations with farmers that take into account their opinions on policies and grants are also likely to facilitate behaviour change. Other types of incentives such as auctioned contracts, carbon trading schemes, and tax concessions and relief could also be considered. However, the effectiveness of incentives has been called into question (Ambrose-Oji et al., 2018). The most common reason for failure is insufficient funding resulting in loss of income if land is taken out of production (Coyne et al., 2021). Another possible reason for the lack of success of behaviour change incentives is the high level of bureaucracy associated with such schemes. Therefore, intervention design should prioritise ease of application and awareness among farmers (Moseley et al., 2014).

Policymakers should also consider that some farmers might prefer lump sum payments while others prefer instalments (Moseley et al., 2014). Better regulatory systems could also help with behaviour change. Staddon et al. (2021) state: *"It is argued that some grant regulations, such as felling licences, replanting requirements and restrictions to reconversion can amplify the landowners' perceptions that woodland creation involves long-term loss of control over land management."* Further, clarifying legal definitions and giving reassurances that there would be no loss of subsidies could also be helpful.

Persuasion can also lead to behaviour change among landowners. For instance, Duesberg (2014) suggested that using images showcasing the various benefits of planting trees could be beneficial. These could include (1) economic benefits such cash surpluses (2) biodiversity benefits, which have been said to evoke a sense of pride for farmers (3) community benefits such as contributing to a reduction in flood risk or (4) carbon sequestration benefits. It should be noted that some studies have reported that tackling climate change might not be a motivating factor for some landowners, which could inform the benefits that are emphasised (Lawrence & Marzano, 2014). Duesberg et al. (2014) suggest that the communication of benefits should be combined with an informational campaign about monetary gains. This approach resulted in higher effectiveness of a tree planting scheme in Ireland. Finally, Staddon et al. (2021) suggests that persuasion could be achieved by better utilising existing communication pathways such as using unions or farmer partner organisations. In addition, paper-based communication might be more appropriate given its ease of dissemination amongst the farmers themselves. Language and terminology should be understandable and avoid confusing or ambiguous claims.

While incentives are important, the Staddon et al. (2021) review also established that farmers might lack the knowledge and skills associated with behaviour change related to woodland creation. Thus, education and training practices could be provided. These could focus on the potential profitability of woodland as studies have identified that farmers might see woodland as unprofitable (Rois-Diaz et al., 2018). In order for education to be effective, it should be delivered through trusted sources (Moseley et al., 2014). There could also be a focus on community-wide education practices as this might lead to more peer-to-peer exchange, incentivise cooperation, and lead to changes in social norms.

Descriptive or injunctive social norms (i.e. what others are thought to be doing or what they approve of) could be more effective for some landowners than financial incentives. For instance, the activities of peers could be a driver to plant more trees (i.e. relying on a descriptive norm). Evidence reviewed by Ruseva et al. (2015) suggests that providing the opportunity for discussions between group farmers on their tree planting experiences increases woodland creation. Social approval could incentivise behaviour change, e.g. when planting trees is considered beneficial by the local community (i.e. invoking injunctive/subjective norms). However, subjective norms have not been widely studied in the literature, therefore strong conclusions about their effectiveness in this context cannot be drawn. Nevertheless, studies have shown that subjective norms are important for behavioural intention related to soil health (Bartkowski & Bartke, 2018). Further research would be beneficial here.

Another intervention technique is to provide examples of woodland creation through modelling or demonstration. This could be very useful as farmers seem to change their behaviour when they observe peer activity. However, demonstration projects are lacking "*partly because of the long-term nature of silvoarable agroforestry which makes it difficult for an individual farmer to trial, due to the long-term commitment of land, labour and capital*" (Staddon et al., 2021). This represents a research gap that policymakers may wish to fill.

12.4 Research gaps and limitations

Research into the effectiveness of different message framing has been limited in the context of woodland creation, and presents an opportunity for future studies. Modelling and demonstration techniques could also be

the focus of valuable research, although these require costly and time-consuming experimental designs. Finally, research into the effects of subjective norms on tree planting behaviour is lacking, as research so far is limited to exploring their influence on behavioural intentions and less so on behaviour change.

12.5 Recommendations and conclusion

The means by which farmers and landowners can transition to low-carbon practices such as afforestation are complex. Changes seem to be influenced by farmers' attitudes, motivations, values, and social pressures. In addition, financial incentives do not seem to motivate behaviour change as there are concerns over loss of control and bureaucracy related to grant applications. However, social factors could play an important role in changing behaviour, by way of social and descriptive norms. Climate change considerations seem to have a lesser effect on farmer's decisions to engage in woodland creation, so multifaceted approaches are likely to be needed to achieve behaviour change.

13 Policy acceptability

Beyond individual action, collective action is essential to mitigate the effects of climate change. A key type of collective action is the support of, and participation in, pro-environmental policies (Lorenzoni et al., 2007). Public opinion is a significant determinant of policy efficacy, with public opposition to climate policies being a key reason for policy failure, withdrawal, or redesign (Howarth et al., 2020). To design and implement well-accepted climate policies, the diverse viewpoints of multiple societal groups must be considered.

This section explores the determinants of mitigation and adaptation policy acceptability across demographic groups and discusses potential ways to maximise public policy support. These include framing, co-benefit communication, policy bundles, and participatory policy design.

13.1 Overview of evidence

This section synthesises evidence from three academic reviews, 65 empirical papers, and five pieces of grey literature. Of the academic literature, it draws on three meta-analyses and reviews, which explore the determinants of policy acceptability (Bergquist et al., 2022; Drews & van den Bergh, 2016; Maestre-Andrés et al., 2019). The reviews cover a total of 189 studies across at least 33 countries. Most of these studies explore the acceptability of carbon taxes and cap and trade schemes, with fewer measuring other types of climate policies.

Where no reviews were available, this chapter draws upon empirical literature. Regarding the impact of framing, five recent empirical papers were explored (Bernauer & McGrath, 2016; Dasandi et al., 2022; Feldman et al., 2018; Fesenfeld et al., 2021; Rossa-Roccor et al., 2021). Regarding adaptation policies, key studies included five large-scale empirical studies (Dessai & Sims, 2010; Lim et al., 2022; Noll et al., 2022a; Noll et al., 2022b; Singh et al., 2017). Select examples were drawn to exemplify policy acceptability across different sectors (*End-user consumption*, Demski et al., 2022; *Land use*, Westaway et al., 2023; *Aviation*, Larsson et al., 2020; *Diet change*, Pechey et al., 2022).

This section also draws upon relevant grey literature, including Lancaster University's public engagement report (Lancaster University, 2022), Climate Assembly UK's (2021) report, Ipsos's Net Zero Living report (Brisby & Whitmarsh, 2022) and a working paper by the OECD (Dechezleprêtre et al., 2022).

Key findings & implications

Factors that influence climate policy acceptability

- Perceptions of how fair a policy is across all societal groups is one of the most important determinants of acceptability (Bergquist et al., 2022). Generally, the public favour policies that distribute the costs based on needs and responsibility (Hammar & Jagers, 2007; Bechtel & Scheve, 2013), protect the disadvantaged, and fairly redistribute revenue into environmental initiatives, such as renewable energy development (Rotaris, 2017), and public transportation initiatives (Bristow et al., 2010).
- Perceived policy effectiveness is amongst the most important determinants of acceptability (Bergquist et al., 2022), and this can increase once a policy has been implemented (when benefits are directly experienced, rather than when the benefits are only imagined prior to implementation) (Santos, 2004).
- Communicating the efficacy and urgency of an adaptation response may increase policy acceptability (Lim et al., 2022).

- Policies are favoured when sufficient information about a policy is provided (Holmes & Clark, 2008), and decision-making processes are 'procedurally just', i.e. open, transparent and fair (Jagers et al., 2017).
- Policies are favoured if they are not perceived as coercive or infringing on one's personal freedom and have some societal benefit (Drews & van den Bergh, 2016). For adaptation policies, autonomy in decision-making is vital to support (Dessai & Sims, 2011).
- Climate concern is more related to adaptation policy acceptability than to mitigation policy acceptability (Hagen et al., 2016). For mitigation, heightened perceptions of climate risk and seriousness are moderately linked to higher policy support, and increased knowledge is weakly linked to higher acceptance. Adaptation policy acceptability is influenced by climate change belief, concern, experience, risk perception, and psychological distance from impacts (de Jalón et al., 2013).
- Policies may be better accepted when implemented by trusted leaders and organisations (Bergquist et al., 2022), and by trusted sources for adaptation policies (Hagen et al., 2016).
- Socio-demographic factors do not reliably predict acceptability alone, but there are differences in acceptance between social groups.
- Framing policies around health, environmental and moral co-benefits may boost support (Rossa-Roccor et al., 2021; Behavioural Insights Team, 2022), especially if multiple (Wolstenholme et al., 2020) or tailored (Jennings et al., 2020) co-benefits are communicated.
- Showing how individual policies are connected (in 'policy bundles') may bolster public support (Bergquist et al., 2020).
- Including the public in policy design through participatory and deliberative processes can result in more effective and accepted mitigation and adaptation policies (Lancaster University, 2022).

13.2 Determinants of policy acceptability

Existing research has sought to understand the characteristics that explain support for climate policies. These are generally categorised into four categories: (1) policy-specific beliefs, (2) climate change evaluations, (3) psychological factors and (4) socio-demographic factors (Bergquist et al., 2022). Overall, a policy's perceived *distributive fairness* and *effectiveness* are cited as the most important determinants of acceptability. The relative importance of the varying determinants are illustrated in Figure 6.

In this section, we predominantly focus on policy *acceptability*, which conceptually differs from *acceptance*, since individuals have not yet experienced the proposed measures (Kyselá et al., 2019). In practice, their determinants are similar, but policies are generally better accepted after implementation, though the reasons for this are debated (see Börjesson et al., 2016; Jagers et al., 2017).

13.2.1 Policy-specific beliefs

Distributive fairness

Previous literature has generally found that perceived fairness of a policy is the strongest determinant of climate policy acceptance (Bergquist et al., 2022; Dechezleprêtre et al., 2022). Fairness is particularly important for policies involving regulations (e.g. bans to regulate behaviours; r = 0.78; large effect size), compared to price-based policies (e.g. taxes; r = 0.57; large effect size).

Distributive fairness, defined as people's perception of how policy burdens are distributed between or within societal groups, has a particularly strong effect on policy acceptance (r = 0.73; large effect size). For example, a transport charging zone that charges more polluting, typically cheaper, vehicles, may disproportionately impact lower-income households and thereby have unfair distributional impacts. Research has noted high concern for the uneven distribution of policy impacts, with a particular focus on disproportionate effects on poorer people.

Maestre-Andrés et al. (2019) found that policies with neutral cost distributions, defined as all citizens paying the same *proportion* of their income towards a policy cost, were better accepted than policies with regressive distributions, in which all citizens pay the same. Other research has echoed this 'equality principle', finding that support for a carbon tax is higher if everyone is perceived to be equally impacted by the policy (Hammar & Jagers, 2007). Similarly, progressive cost distributions, in which higher-income citizens pay more, can result in higher acceptability if the policy costs follow a 'needs-based principle'. For example, Hammar and Jagers (2007) found that carbon tax acceptability increased if those required to reduce their emissions were those who needed their cars the least, i.e. who had access to public transportation. This approach mirrors the well-accepted 'polluter pays' principle, in which those who are most responsible pay the most (Bechtel & Scheve, 2013). No research to date, however, has compared the effectiveness of neutral and progressive cost distributions. Overall, the public favour policies that distribute costs based on need and responsibility and protect those that are disadvantaged.

Relatedly, fair redistribution of policy-generated revenue (e.g. from carbon taxation) can substantially increase policy support and increase perceptions of distributive fairness (Drews & van den Bergh, 2016). Previously, reinvesting revenue from climate taxes in environmental initiatives (e.g. renewable energy development) has

garnered high support for climate tax policies (e.g. Gevrek & Uyduranoglu, 2015; Rotaris, 2017). Funding public transportation has also increased policy acceptability (Bristow et al., 2010), as well as funding improvements to infrastructure such as roads (Kaplowitz & McCright, 2015). In some instances, redistributing revenue to vulnerable groups (e.g. low-income or elderly individuals) has increased policy acceptability (Carson et al., 2010; Saelen & Kallbekken, 2011), but other research notes no relationship (Baranzini & Carattini, 2017). Using revenue to reduce existing taxes and labour costs has yielded mixed results, though tends to note reduced acceptability (e.g. Jagers et al., 2018) or no relationship (Carattini et al., 2017).

Personal fairness

Perceptions of how personally fair a policy is are generally weakly linked to acceptability (r = 0.17; small effect size; Bergquist et al., 2022). Some studies estimate that perceived lower purchasing power is the most commonly perceived personal fairness violation, and is associated with a 15% lower probability of accepting policies (Baranzini & Carattini, 2017). Perceptions of potential job losses due to carbon pricing policies has also been seen to negatively influence acceptability (O'Connor et al., 2002), but this effect was not noted in all studies (Carattini et al., 2017). Perceptions that the policy will result in lower personal comfort or wellbeing also limits acceptability (De Groot & Schuitema, 2012).

Procedural fairness

Research generally finds that policy acceptability increases with higher procedural fairness, defined as fairness in policy decision-making processes. Previous literature in UK samples has noted a desire for environmental policies to be more transparent (Holmes & Clark, 2008), and reported that citizens do not feel satisfied with the level of information provided prior to policy implementation. Both quantitative (Carattini et al., 2017; Carson et al., 2010) and qualitative (Klok et al., 2006) studies have found that policy acceptability increases when people are satisfied with the level of information provision, though these studies were based outside the UK (Australia, Carson et al., 2010; Denmark, Klok et al., 2006). Whilst further work should seek to replicate these findings in the UK, results are likely to be similar owing to their comparable Western contexts. Public participation in policy decisions typically increases perceptions of procedural fairness, as policies are deemed to be more open and transparent (Liu et al., 2020; see section 13.3.4 for discussion).

Perceived effectiveness

A policy's perceived effectiveness to fulfil its aims has been reported as the second strongest determinant of public opinion about climate policies (r = 0.54; large effect size; Bergquist et al., 2022), with a stronger relationship found for regulations (r = 0.73) than price-based policies (r = 0.49). In the transportation sector, perceived effectiveness of congestion charges played the most important role in determining acceptability, after climate concern (Eliasson & Jonsson, 2011). Differences in perceived effectiveness has been cited as a reason why 'push' policies are often less well-accepted, perhaps due to being viewed as ineffective (Eriksson et al., 2008).

In a meta-analysis of 45 studies, Reynolds et al. (2020) noted a 4% increase in support when a policy's effectiveness was communicated (50% to 54%), and 6% decrease in support when ineffectiveness was communicated (50% to 44%). Overall, these findings iterate that when implementing climate regulations, policies must be perceived as effective.

Policy costs and benefits

Generally, climate policies with a direct monetary cost or adverse employment outcome are more poorly-accepted, due to being perceived as coercive, and infringing on people's personal freedom (Drews & van den Bergh, 2016). Perceptions of coerciveness differ between groups, depending on how a policy affects the individual or group. For example, people who are car-dependent are more likely to be opposed to measures such as congestion charges. Informational policies, which impose fewer personal costs, are preferred over taxes or regulations (Brisby & Whitmarsh, 2022). Conversely, policies seen to be beneficial for society (e.g. by reducing air pollution or congestion) tend to receive more support (Fürst & Dieplinger, 2014).

Similar findings emerge from literature on adaptation policies, such as residential water use restrictions. Relatively little research has been conducted in this area, but existing work finds that people are generally more inclined to accept restrictions than agree to pay more for their water supply (Dessai & Sims, 2011). Policies to minimise the impact of wildfires are better supported when they allow people to make their own decisions, and government restrictions such as permits and regulations are opposed. For example, mandates for rebuilding areas affected by wildfires and relocating properties to safer places were generally well-supported. In contrast, restricting residential or commercial development in wildfire-prone areas was generally opposed (Hui et al., 2021).

13.2.2 Climate change evaluations

Many types of climate change evaluations have been linked to policy acceptability, although the links are stronger for climate adaptation policy than mitigation policy. In Bergquist et al.'s (2022) meta-analysis, climate

change concern was strongly related to more positive public opinion about climate mitigation policies, but was insufficient for support in itself (r = 0.48; medium-large effect size). Perceptions of climate change seriousness and risk showed medium-sized effects (r = 0.31; r = 0.29). Overall, climate change belief had minimal impacts on climate policy acceptability (r = 0.23; small-to-medium effect size), alongside both objective and subjective knowledge (r = 0.16; r = 0.13), indicating that informational approaches alone are inconsequential to policy support.

Climate adaptation policies appear to be more strongly linked to climate change perceptions. Specifically, factors known to increase the acceptance of adaptation policies include: (a) Belief in climate change and higher environmental commitment (de Jalón et al., 2013); (b) Concern about climate change impacts (Hagen et al., 2016); (c) Moral evaluation of the impacts (Doran et al., 2019); (d) Personal experience of extreme weather events (Ray et al., 2017); (e) Greater perception of risks to remote places (Brügger et al., 2015); and (f) Reduced psychological distance from climate impacts (Haden et al., 2012). In contrast, perceived threat of economic loss (de Jalón et al., 2013) and climate change scepticism (Brügger et al., 2015) are among the factors found to negatively predict policy support. Trust in the information sources, perceived responsibility, and self-reported knowledge of climate change and adaptation policies also each play a role in adaptation policy acceptance, with some cross-country differences (Hagen et al., 2016). Some research has distinguished between acceptance of climate adaptation policies and taxes – finding differing determinants (Houser et al., 2022). Some factors (e.g. threat appraisal, perceived effectiveness, & risk perception) directly predicted both outcomes, whilst others (e.g. social norms) only impacted adaptation policy support.

13.2.3 Psychological factors

Values are generally related to support for environmental policies, such as congestion charges and energy policies (Hiratsuka et al., 2018; Nilsson et al., 2016). Bergquist et al. (2022) noted that higher self-transcendent values (the extent to which people prioritise altruistic or biospheric values) is reasonably related to increased support for climate policies (r = 0.26; small-to-medium effect size). Conversely, higher self-enhancement values (the extent to which people prioritise authority and social power) relates to lower policy support (r = -0.09; small effect size). Some research has suggested that increasing the salience of self-transcendent values in certain situations can increase policy support, for example using informational campaigns (de Groot & Steg, 2009). However, such individual-level nudges may not be effective when individual costs of acting pro-environmentally are high. In these scenarios, interventions need to ensure self-enhancement behaviours appear more compatible with pro-environmental behaviours. For example, pro-environmental actions or policy support could be made more attractive by using incentives.

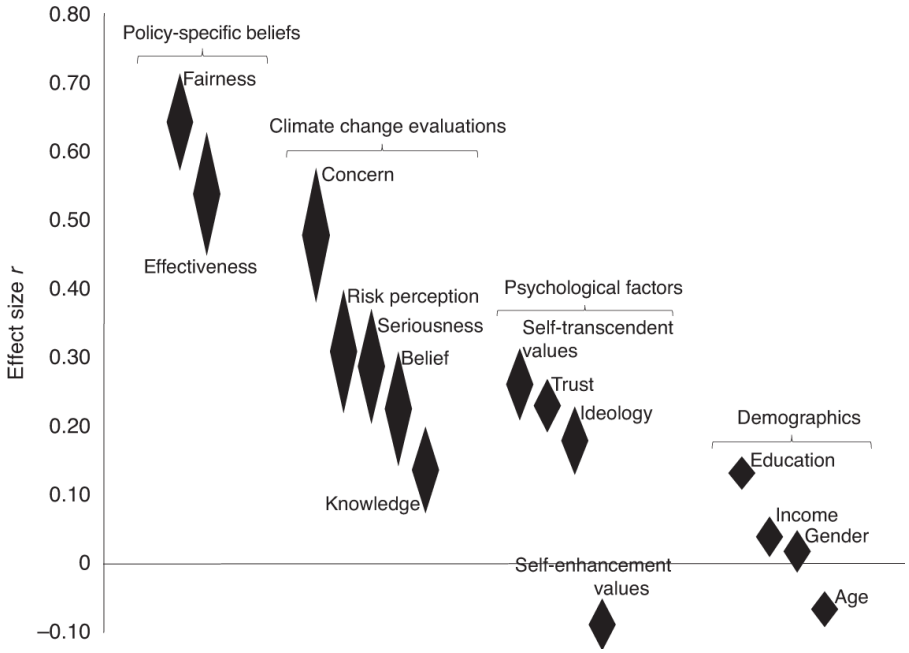
Trust in the institution implementing a policy is also a relatively important, direct determinant of policy support (r = 0.23; small-to-medium effect size; Bergquist et al., 2022). Several studies have found that people who have higher governmental trust are more willing to accept carbon taxes (Rhodes et al., 2017). Policies may therefore be better accepted when communicated by trusted leaders.

Beyond trust, process legitimacy, defined as perceptions that the decision-making process was open, democratic, and just, has been directly linked to policy acceptance (Jagers et al., 2016). It is also possible that these legitimacy perceptions indirectly influence acceptability, via perceptions of procedural fairness. Relatedly, perceptions of how fair others view a policy influences acceptability. For instance, support for carbon taxes have been shown to fall when people are told only a minority of citizens support the tax (Bolsen et al., 2013). In this way, social norms play a role in promoting pro-environmental behaviours.

13.2.4 Socio-demographic factors

After accounting for policy-specific and psychological factors, demographics alone do not reliably explain differences in policy acceptance. However, acceptance of climate policies does vary across socio-demographic groups. In a meta-analysis spanning 33 countries including the UK, Bergquist et al. (2022) found that having higher income and education was weakly associated with higher acceptance (r = 0.13; r = 0.07; small effect size). Support of climate policies is also correlated with more availability of public transportation and lower reliance on cars (Dechezleprêtre et al., 2022). Some work notes that practical factors, such as rurality, are determinants of acceptability (Brisby & Whitmarsh, 2022). This is potentially because these factors influence people's needs and abilities, thereby impacting their perception of the policy's coerciveness and fairness. Having a left-leaning political ideology is associated with higher climate policy support, though the effect size tends to be relatively small (r = −0.18; Bergquist et al., 2022). Those more engaged with climate issues, and more affluent groups, are generally more supportive. Geographical trends are less consistent, but generally indicate that policies are less well-accepted when impacts are perceived to affect ones' local area or community. For example, people living in rural areas are more accepting of transport policies such as Low Traffic Neighbourhoods. Regardless of differences, Brisby and Whitmarsh (2022) show that lower income, ethnic minorities, and older people are felt to benefit less from Net Zero policies than, emphasising a need for the better communication of policy benefits across societal groups.

Figure 6: The relative importance of determinants of policy acceptability (Bergquist et al., 2022)



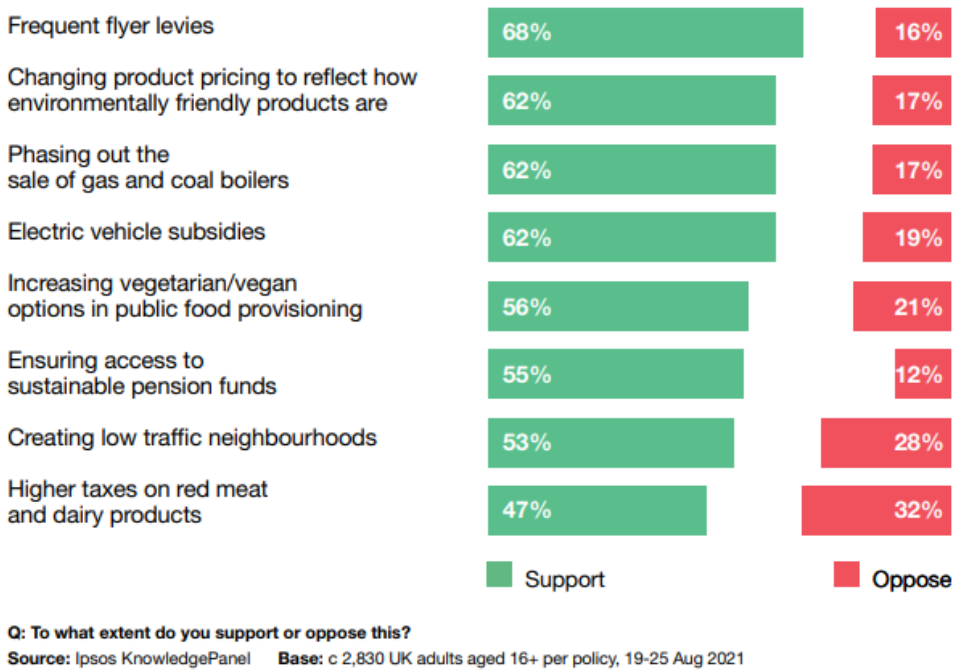
Note. The higher the effect (*r*), the stronger the determinant of policy acceptability. Geometrical centres of the diamond shapes represent mean values and endpoints represent ±95% confidence intervals. Effect size (*r*) indicates the directionality of the relationship, with negative effects indicating an inverse relationship.

For climate adaptation policies, socio-demographic variation also emerges. Barriers to engagement include poor water-related knowledge. Willingness to pay to avoid water shortages, a proxy for acceptance, is higher amongst people with gardens, and on higher incomes (Cooper et al., 2011). Similarly, willingness to pay is higher amongst those living in cities with histories of severe water restrictions.

13.2.5 Differences across sectors

A recent report by Ipsos (Brisby & Whitmarsh, 2022) noted widespread support for a broad range of climate policies across five areas (travel, heating homes, consumption, diet, and finances; Figure 7), of which most were supported by the majority of people.

Figure 7: Public support for different Net Zero policies (Brisby & Whitmarsh, 2022)



Diet change policies

Policies to reduce the consumption of high-carbon foods, such as meat and dairy can be viewed as coercive if not implemented carefully. A set of qualitative focus groups by Demski et al. (2022; *N* = 46) noted that policies to swap red meat for white meat and eating a balanced diet with reduced meat consumption were deemed achievable for most people. Conversely, policies that restrict the availability, or increase price, of meat products have met with more resistance, as they are perceived as regressive and an infringement on personal freedom. In a large UK-based quantitative study (*N* = 2215; Pechey et al., 2022), fewer than half of participants supported meat reduction policies. Informational policies were most accepted (e.g. 48% in favour of labelling; 45% in favour of media campaigns), with increasing prices of products the most opposed (16% in favour).

End-user consumption policies

Research by Demski et al. (2022) noted that public opinion towards policies to reduce material consumption is generally positive. For example, support for policies aiming to increase the sharing economy (products being borrowed or rented) was high. Policies to improve product standards and lifetime are generally well-accepted, as people desire more durable products and believe businesses should share responsibility for reducing carbon emissions. Despite this, trust in businesses to pioneer this change was low, with consumers believing costs would be passed onto them.

Aviation policies

As observed in the general acceptance literature, less coercive, regulatory measures targeting the aviation industry are more well-accepted by the public (Larsson et al., 2020). Such measures include providing flying alternatives such as high-speed night trains, and mandates to use biofuels. This is compared to market-based policies aiming to change individual aviation behaviour, for example air passenger taxes or frequent flyer levies. Policy-specific factors, such as fairness, effectiveness, and trust perceptions were most strongly associated with overall policy support.

Land use policies

A review of 84 papers by Westaway et al. (2023) found that the acceptability of land use policies, for example tree planting regulations, is largely dependent on the pre-existing interests and values of the farmer and may not alone encourage behaviour change. Scheme complexity, insufficient incentives, and scheme inflexibility have also been noted as barriers to the success of such policies.

13.3 Shaping public acceptability

13.3.1 Framing

A sizeable body of research has investigated how framing, in which some information is presented more saliently to influence interpretation, may boost climate policy acceptance. Generally, research finds that positively framed messages, focusing on health and environmental issues, alongside global and immediate frames, bolster the most public support (Dasandi et al., 2022). Specifically, positive and health frames were most likely to increase the likelihood of support. This finding was mirrored by Rossa-Roccor et al. (2021), who argued that health framing makes climate change appear local, short-term, and personal, increasing acceptability. Alternative frames centred on air pollution and energy security, have also been seen to increase climate policy support amongst US Republicans (Feldman and Hart, 2018). Relatedly, recent UK-based research (Behavioural Insights Team, 2022b) found that environmental and 'moral liberal' framings, in which the moral imperative of climate policies to prevent harm to all were highlighted, most effectively increased people's intention to engage with policies at COP26. However, this work also noted that framings generally only increase people's policy support by around 2-3% from already high levels, highlighting the limits of framing approaches alone. Moreover, framing does not universally boost support (Bernauer & McGrath, 2016). Some research notes that urgency framing of high-cost climate mitigation policies does not increase support (Fesenfeld & Rinsheid, 2021). This work argues that people are exposed to many climate-related frames in their everyday life (e.g. media; friends), making experimental framing effects inconsistent and difficult to detect.

Very little UK-based research has sought to understand what types of communication bolster support for adaptation policies. A meta-analysis across the US, China, Indonesia, and the Netherlands (*N*=3,789; Noll et al., 2022a) noted that climate change worry and social influence were the biggest drivers of household adaptation intentions, indicating that personalised communication appealing to one's emotions and social expectations may prompt household adaptation behaviour. Further work across similar countries showed that a higher perceived threat of climate change motivates adaptation policy support (*N*=4,688; Noll et al., 2022b). Notably, this work found that support for one adaptation measure is linked to support for others. For example, various structural modifications to one's home were often considered in tandem due to possible co-benefits between actions. This implies a type of 'spillover effect', in that communicating and providing incentives for one type of construction adaptation, could lead to the adoption of further adaptation actions or support of multiple policies.

Preliminary research has begun to explore how private vs social benefits framing may encourage people to seek out adaptation information. Byerly-Flint et al. (2022a) found that message framing highlighting the social, rather than private, benefits of wildfire mitigation did not affect engagement with risk information and wildfire programmes. However, property owners who were recently in a wildfire evacuation zone were more likely to seek out socially-framed information, than private. These potentially limited impacts of framing have been noted in other research, showing that homeowners who received a postcard showing negative wildfire imagery were no more likely to visit a wildfire risk webpage (Byerly-Flint et al., 2022b). Growing research supports the idea that the more distant climate change impacts are perceived to be, the less likely a person is to support an adaptation policy. Research by Singh et al. (2017) found that the more temporally, socially, and spatially distant climate change impacts were perceived to be, the lower the support for adaptation policies. This research suggests that greater support for climate adaptation may be achieved by framing climate change impacts as happening now, here, and as affecting similar people to the target audience.

13.3.2 Communicating benefits and co-benefits

Some work (e.g. Lim et al., 2022) has found that communicating a policy's response efficacy, i.e. ability to reduce risks and achieve desired consequences, was the most reliable way to increase support for many different adaptation policies (e.g. enforcing restrictions for buildings in wildfire areas; providing tax incentives for preventative measures; providing long-term mitigation loans for those who take preventative measures). This is in line with wider evidence that communicating the efficacy (i.e. benefits) of policies can increase support (Reynolds et al., 2018).

In addition, research has noted that communicating the co-benefits of climate policies, such as safety, health, or job creation, can increase support (Brisby & Whitmarsh, 2022; Dechezleprêtre et al., 2022). Whilst climate concern is generally high (43.3% of people 'extremely' or 'very' worried; Whitmarsh et al., 2022), previous literature notes that it is insufficient alone to motivate policy support. When considering Low Traffic Neighbourhoods, Brisby and Whitmarsh (2022) found that road safety and health co-benefits were the most convincing in fostering policy support, and claims of benefits to local businesses were least favoured. When considering increasing vegetarian and vegan food provision in the public sector, people were most convinced by the creation of new jobs, and concerned about loss of agricultural jobs. Across most policies, people resonated most with cost being a primary argument against a policy, confirming the importance of emphasising financial support. In the UK specifically, recent research has noted that the most compelling co-benefits of climate policies were related to healthcare and the National Health Service (NHS), but that co-benefits around the economy, poverty and inequality, and housing were also high-priority areas of concern (Jennings et al., 2020). This work also noted that city-level and regional-level governments are best placed to incorporate co-benefits into their decision making, as benefits are most obvious to the public on this scale. This research confirms that people's preferences for co-benefits depend on their individual priorities (e.g. NHS, energy security), and thereby speak to the importance of tailoring co-benefits framing to the specific population being addressed.

Research has also noted that communicating multiple co-benefits is more effective than communicating one benefit. For example, Wolstenholme et al. (2020) found that combined health and environmental framings resulted in more behavioural change than either frame alone.

13.3.3 Policy bundles

The deployment of climate policies will likely have disruptive consequences on people's lifestyles. Existing literature suggests that policies involving high financial and lifestyle costs may be poorly accepted (Brisby & Whitmarsh, 2022). A possible mechanism to boost policy support are policy bundles, in which climate policies are rolled out alongside other social and economic reforms. Early research by Bergquist et al. (2020) has found strong evidence that including these social and economic programmes expands support for climate policies. Specifically, including a social policy (e.g. affordable housing) in a policy bundle increased overall support by 11%, and including an economic policy (e.g. a job guarantee) increased support by 12%.

Including a social policy item increased support the most amongst low-income groups. Additionally, social policies – particularly health insurance and free education – built the strongest support amongst ethnic minorities. This research notes that some social commitments (e.g. government-run health insurance and free education) saw bigger differences between groups, while others (affordable housing and a $15 minimum wage) were more consistent across groups in increasing support. It should be noted, however, that this study was based on an American sample.

13.3.4 Public engagement with climate policy

Engaging with the public at the early stages of policy planning and design is a key mechanism to ensure the public feel policies are fair, effective, and beneficial to all societal groups. Research suggests that deliberative and participatory processes, in which the public learn about and inform policy decision-making processes, may be key to achieving this (Brisby & Whitmarsh, 2022). Key examples include citizens assemblies, citizens juries,

and deliberative polling. These processes provide insights into people's lived experiences and have been seen to create a stronger sense of ownership over policy decisions. These are comprehensively outlined in Lancaster University's (2022) evaluation of deliberative methods to increase policy support, commissioned by the Climate Change Committee. In short, these methods increase public trust, give policymakers a mandate to act, increase process legitimacy, diffuse conflict, road-test potential policies and gather diverse views. A key example of a deliberative process is the Climate Assembly UK (2020), which invited 110 people to examine UK climate policies, and consequently suggested key changes to proposed policies. These changes included an earlier shift to electric vehicles and improvement to public transport, reducing aviation growth, and a greater reduction in meat and dairy consumption.

Empirical literature has also noted the importance of participatory processes. Bernauer and Gampfer (2013) noted that the presence of civil society actors in international climate negotiations increased policy support. Similarly, allowing public deliberation on preferences about national climate policy increased acceptability of a carbon tax in an Australian study, by allowing people to consider a greater number of motives for their policy preferences (Lo et al., 2013). Evidence also suggests that participatory decision-making can increase support for adaptation policies and enhance their effectiveness (Cvitanovic et al., 2019). In line with this, some work has highlighted the importance of planning adaptation measures alongside citizens to enhance perceptions of procedural fairness, policy ownership and effectiveness. Successful examples of this have been seen in Quito, Ecuador (see Chu et al., 2015).

13.4 Research gaps

13.4.1 Methodological gaps

This section's conclusions are potentially limited since most studies have focused solely on the acceptability of carbon taxes and cap and trade schemes (Bergquist et al., 2022; Maestre-Andrés et al., 2019), with fewer measuring policy support as a general index of various climate policies (Drews & van den Bergh, 2016). Further, different proxies for acceptability are adopted in different studies. For example, some use willingness-to-pay for taxation policies, which may differ conceptually from subjective evaluations of policy support.

Importantly, existing work has predominantly focused on mitigation policies, with little work having explored the acceptance of adaptation policies. Some of the gaps in understanding in this domain include little understanding of how determinants of support can be translated into better designed, well-accepted policies. Future work would benefit from exploring the relative impact that different ways of communicating adaptation policies have on acceptability, and how adaptation policies may differentially impact different social groups.

13.4.2 Conceptual gaps

Thus far, there is substantial evidence exploring the factors driving mitigation policy support, with these determinants having been somewhat quantified using effect sizes (Bergquist et al., 2022). However, much less literature has studied the most effective ways to remove barriers to support, or better communicate policies to bolster acceptability. Indeed, little research has directly compared how different interventions (e.g. different types of framing, policy bundles, or structural changes) differentially influence climate policy acceptability. This has resulted in difficulty quantifying the efficacy of different methods to improve acceptance (e.g. types of framing, compared to communicating co-benefits, or using policy bundles). Similarly, whilst existing work highlights the ways policies should be perceived (e.g. fair to all, effective, beneficial), it has not explicitly investigated how this can be achieved (e.g. via framing of cost distributions). Importantly, research has not determined which progress indicators should be used to monitor changes in acceptability over time, and between populations. Considering group differences in acceptability, existing work has identified which socio-demographic variables are generally linked to higher policy support but has not determined if different social groups may be more likely to support a policy depending on how the policy is communicated. Relatedly, existing work has predominantly focused on individual-level determinants and communication, necessitating a need for future work to determine if these differs in households and businesses.

13.5 Recommendations and conclusion

A policy's perceived distributional fairness and effectiveness are important predictors of climate policy acceptability. Policies that do not impose personal costs are also more favoured. Climate change evaluations shape adaptation policy support, but less so mitigation support. There are also differences in policy support according to people's values and demographics. Climate policy acceptability may be shaped by communication (e.g. co-benefit framing, highlighting policy bundles), but more participatory processes can result in both greater acceptance and better designed policies. More evidence is needed to test communication and engagement interventions in this area, particularly for climate adaptation policies.

14 Conclusion

This review of the literature in the domain of behavioural science identified important factors that might influence people's decisions to engage in pro-environmental actions. We found that studies most often incorporate information-based interventions in their designs, followed by nudge-type interventions and financial incentives. This is in line with the broader behaviour change evidence base, which is biased towards 'downstream' interventions that target individuals rather than populations or systems (Swinburn et al., 2011).

However, our review also established that interventions work better when several techniques are combined and targeted to the needs/contexts of different groups. For example, people's values, attitudes, emotions, and identities should all be considered in intervention design. Specific intervention techniques that might be more effective in the consumption domain include message framing, financial incentives, labelling together with informational campaigns, and focusing on personal benefits (e.g. health, convenience, saving time). There is further evidence that interventions might be more successful during windows of opportunities known as 'moments of change' (e.g. moving home), however, more research is needed to establish the best time(s) to intervene. Limitations of the currently available research include a lack of evidence on the long-term effects of interventions, and the frequent use of self-report measures instead of more precise tracking indicators. More research could also be conducted on social norms and the influence of leaders (e.g. politicians, celebrities).

Our review also established that adaptation behaviours are not widespread as people seem to be less aware of such practices. Furthermore, households seem to be less likely to adapt their homes for climate events compared to land managers and farmers who take more protective measures. When adaptation behaviours are taken, these tend to be influenced by individual, economic, physical, and institutional factors. The behavioural interventions relating to adaptation again mostly consist of informational campaigns, meaning there is an opportunity to test other techniques such as financial incentives or regulation. The existing evidence for adaptation behaviours is generally methodologically weak.

In relation to behaviours in the professional domain and the transition to a green economy, our review concluded that personal factors such as environmental awareness, knowledge and attitudes could be crucial for acquiring green skills, together with training opportunities focusing on education and information-provision. Young people seem very interested in green careers, but they also struggle to find relevant information. Businesses, including those in the agriculture domain, are more likely to become green when pushed by governmental regulations, grant availability, social norms, cost-saving or profitability motives, or first-hand experience with extreme weather. Research has focused mainly on small and medium sized enterprises in manufacturing and agriculture with other sectors seemingly less represented.

The final aspect of our review was policy acceptability. We established that perceived distributional fairness and perceived effectiveness of policies are amongst the most important factors driving acceptability, while climate change concern and risk perception tend to have more impact on adaptation policy support than mitigation. There could also be personal factors influencing acceptability such as high self-transcendence values. Other routes to policy support include framing policies around health and environmental co-benefits and including the public in policy design. Research that tests and compares different techniques for policy communication is lacking, especially for adaptation policy acceptability. Overall, there is a lack of evidence on how to best scale up interventions that target specific behaviours to cut GHG emissions.

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16 Appendix

Appendix 1 – List of the search terms used for the literature review.

Consumption

Search terms	Behaviour change AND	Behavioural intervention AND	Net-Zero AND	Pro-environmental behaviour AND	Environmental policy AND
Aviation					
			Flight Air travel Air transport Frequent flyer Flight tax Offset emission Flying Aviation		
Diet/Food					
			Meat Meat consumption Meat intake Low carbon diet Sustainable diet Plant based diet Vegetarian Vegan Increase vegetable intake Decrease animal protein intake Calorie-controlled diet Local food Seasonal food Diet		
Reduction in consumption					
			Recycling Household waste Domestic waste Manufactured goods Reusing Food waste Second-hand		

Climate adaptation

Search terms	Climate adaptation AND	Environmental policy AND	Climate change adaptation AND
		Natural disaster Extreme weather Drought Agriculture Agriculture management Heat Heatwave Severe storm Tsunami Farm Farming	

Green Economy

Search terms	Behaviour change AND	Behavioural intervention AND	Net-Zero AND	Pro-environmental behaviour AND	Environmental policy AND
			Land Use		
			Land use Farmer Farming Agriculture Livestock Afforestation Nature conservation Deforestation Conservation		
			Business leaders		
			Workplace Organisational Employee Workforce staff members Net zero skills Manager Leader		
			Net zero skills		
			Employee skills Workplace skills Organisational skills Upskill Career Development		

Search Terms	Career choice AND	Career development AND	Net Zero career AND	Green career AND
		Young people Late-adolescence Teenager Adolescence Emerging adulthood Early adulthood		

Public acceptability

Search Terms	Climate policy AND	Policy support AND	Adaptation policy support AND
	Attitude Attitude change Society Inequality Equity Minority Demographic Social group Framing Policy Bundles Policy Packages Policy support	Adaptation policy Co-benefits Participatory process Deliberative process Policy packages Policy bundles	Adaptation planning support Wildfire Adaptation policy support Restrictions policy support