# Net Zero Societal Change Analysis:

# WP1 – Behavioural Systems Mapping

Delivered by:


September 2020

**Authors:**

Stuart McKinnon (stuart.mckinnon@es.catapult.org.uk), Rose Chard, Rowanne Fleck, Vilislava Ivanova, Scott Milne (all from Energy Systems Catapult)

With contributions from Lewis Bowick, Kathryn Chambers and Amal Anaam ( all from Energy Systems Catapult).

With thanks to Richard Carmichael (Imperial College) and David Shipworth (UCL Energy Institute) for input.

**About the Energy Systems Catapult**

Part of a world-leading network of innovation centres, Energy Systems Catapult (ESC) was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth.

ESC is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia and research – with around 200 staff based in Birmingham and Derby with a variety of technical, commercial and policy backgrounds.

ESC takes a whole system view of the energy sector – from power, heat and transport to industry, infrastructure and consumers – helping us to identify and address innovation priorities and market barriers to decarbonise the energy system at the lowest cost.

To overcome the systemic barriers of the current energy market, ESC work to unleash the potential of innovative companies of all sizes. Helping them to develop, test and scale the products, services and value chains required to achieve the UK's clean growth ambitions as set out in the Industrial Strategy.

**Disclaimer**

This study was commissioned by the Department for Business, Energy and Industrial Strategy (BEIS) and the Department for Environment, Food and Rural Affairs (Defra). The conclusions and recommendations do not necessarily represent the view of BEIS or Defra.



Any enquiries regarding this publication should be sent to us at:
enquiries@beis.gov.uk

# Contents

# Executive Summary

This report covers the outcomes of Work Package 1 of the Net Zero Societal Change Analysis project. The project was undertaken by Energy Systems Catapult (ESC) for Her Majesty's Government (HMG) (primarily BEIS and Defra).

In June 2019 the UK government implemented a legally binding target of Net Zero for UK greenhouse gas (GHG) emissions by 2050. Achieving this target will have implications across the whole of the economy and society. Major changes are required to the upstream energy infrastructure that is typically hidden from consumers, but other changes will affect people more directly. We will need to adopt a variety of low carbon technologies to do the things we do today, but also be prepared to think and act differently about how we get around, how we heat and power our homes, and what we consume.

It has been estimated that over 60% of changes needed to achieve Net Zero will involve either behaviour change or a combination of behaviour change and technology solutions[1]. In order to make informed policy decisions that encourage change supportive of Net Zero, an in depth understanding of the implications, costs and feasibility is required.

Overall this Net Zero Societal Change Analysis project will provide significant evidence to support that understanding. The aims of this particular work package – Work Package 1: Behavioural Systems Mapping – are to:

- identify and map the priority behaviours that are likely to have an impact on the UK's ability to achieve the Net Zero target ("Behavioural Mapping");
- provide a light touch assessment of the distributional impacts that may be associated with a shift in these behaviours ("Distributional Impacts");
- identify how current policy impacts on people's ability to undertake these behaviours ("Policy Mapping"); and
- explore the immediate and possible long-term impacts of COVID-19 on these ("COVID-19 Impacts").

Overall, this work package is intended to be a relatively high-level piece of analysis and is not intended to be a comprehensive review of the available literature.

[1] Carmichael, R. (2019). Behaviour change, public engagement and Net Zero. A report for the Committee on Climate Change. https://www.theccc.org.uk/publication/behaviour-change-public-engagement-and-net-zero-imperial-college-london/ (Accessed: Aug 2020)

# Insights

## Behavioural Mapping

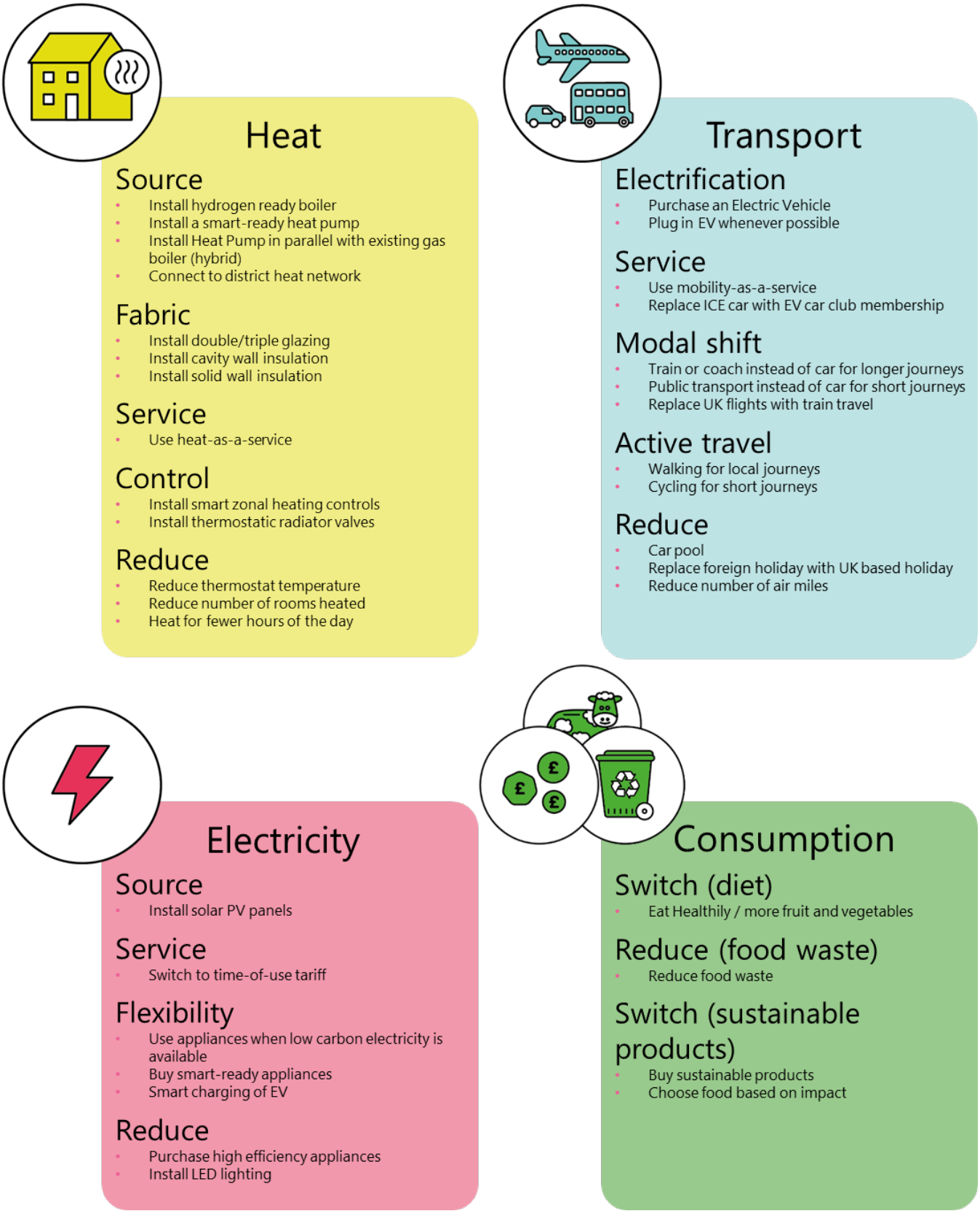



**Figure 1: Prioritised behavioural changes and categories**

In total, over 130 individual behaviours were identified across four sectors, along with 11 societal changes (as set out in Appendix 3). These behaviours were then prioritised based on their emission reduction potential, consumer acceptability and potential impact on the UK's ability to achieve Net Zero. This process resulted in 36 priority behaviours which were categorised and are shown in Figure 1. This shows the prioritised change categories listed in order of priority from high (top) to low (bottom) as well as the individual behaviours within them.

As can be seen, there are a number of key themes which run throughout the sectors – a general reduction in demand, where possible, as well as changes in the way we buy things (services) and what we buy (source, electrification, etc.).

It is also clear that the behaviour changes related to Net Zero are wide ranging and relate to many areas of people's lives. This is further evidenced by the Behavioural Map (see Appendix 1) which shows all of the individual behaviours identified and how they interact with each other.

## Distributional Impact

A framework was developed and used to assess how the prioritised behaviour changes might affect key groups of the population. A range of groups who might struggle to engage in Net Zero behaviours were considered: those living in rural locations, low income, living in privately rented properties, living with disabilities, of pensionable age, the digitally excluded, and those who have been disproportionally affected by COVID-19. The key insights from the distributional impact work are:

- People in all of the vulnerable situations considered are at an increased risk of experiencing barriers to adopting the behavioural changes identified as being key to achieving Net Zero. Table 1 highlights this broad impact.
- People living on a low income may face the challenge of access to financial capital (including through borrowing). Without access to capital it will be difficult to take up a number of the behaviours needed to achieve Net Zero. How much money is needed to participate and the nature and size of the risk varies across the different Net Zero behaviours. To help alleviate these risks, policy can be put in place to make low-cost finance available to those that need it.
- People living in rural areas face particular challenges in adopting some of the transport and heat-related behaviours (for example, modal shift to public transport and access to certain energy vectors/networks). Some of these challenges cannot be tackled through policy, therefore, alternative methods of accounting for that impact must be considered.
- Some people have less freedom to participate in some of the behaviour changes (e.g. tenants can't change their property; people with cognitive impairment may struggle to understand the choices). Again, some of these challenges cannot be tackled through policy, therefore, alternative methods of accounting for that impact must be considered.

- Significant, complex change will be required to the way we heat our homes, the way we move around, how/when we power our appliances and what we consume, if we are to achieve Net Zero. Access to information and support for decision-making is a challenge for many of the household types. During the COVID-19 pandemic, many of those who had previously struggled to access information, were able to find it. This suggest that measures can be put in place to tackle some of these challenges.

| | | Prioritised Behaviour | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Heat | | | | | Transport | | | | | Electricity | | | | Consumption | | |
| | | Source | Fabric | Service | Control | Reduction | Electrification | Service | Modal shift | Active travel | Reduction | Source | Service | Flexibility | Reduction | Healthy diet / more fruit and veg | Less food waste | Sustainable products |
| Type of Household Vulnerability | Rural | | | ● | | ● | | | ● | ● | ● | ● | ● | ● | | | | |
| | Low income | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Privately renting | | ● | ● | ● | ● | | | | | ● | ● | ● | ● | ● | | | ● |
| | Residents with disabilities | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Pensionable age residents | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Digitally excluded | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Those disproportionally affected by Covid-19 | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | ● |

**Table 1: Summary of Distributional Impacts ('dots' indicate that the vulnerable household type face challenges in participating with the prioritised behaviour)**

Overall, this work has shown that there are many types of distributional impacts that need to be considered alongside the societal change that is required for Net Zero. These go far beyond simply where the allocation of financial costs fall. It has also shown that it is not just the distributional impact of policies that matter, but also the distributional impact of the pathway taken.

## Policy Mapping

The achievement of the Net Zero target by 2050 will require bold and well-integrated policies to allow a higher speed and larger scale of transition. Policy information was gathered and mapped against the prioritised behaviours to identify policy gaps. The key insights from the policy mapping work are:

- Having a clear, long-term policy framework has been highlighted as key for managing costs and maximising opportunities from the transition[2]. To date, policy focus overall has been more on supply-side measures, but demand-side policies to encourage a shift to alternative behaviours are increasingly recognised as critical factors for the transition and to enable behaviour change. A portfolio of policy instruments working together is likely needed to address behavioural barriers and drive change at scale.
- In transport, switch to electric vehicle (EV) use and active travel provide useful examples of integrated use of policy levers to target specific behavioural change. For other behaviours, such as modal shift (switching from private car travel to public transport), the landscape is more fragmented.
- In heat, a significant number of economic measures (e.g. grants, loans) are in place to support building improvements and potential change of heating source with regulatory standards playing an important role. Other solutions (e.g. heat networks) benefit from direct investment but are not supported via end-user policies. Despite the multitude of policies in place, significant gaps remain in terms of scope, speed of delivery, policy integration and funding needed to achieve a Net Zero transition.
- In electricity, policies extensively focusing on supply-side measures have been successful in reducing carbon intensity of electricity supply. Beyond direct support for small-scale renewable generation, demand-side policies are relatively few and dominated by regulatory instruments linked to smart meter roll out and the associated technical requirements.
- In consumption, direct information and education campaigns play a prominent role, especially in relation to diet (e.g. Eatwell Guidance, food labelling) and food waste (e.g. Love Food, Hate Waste campaign). Circular economy packages are currently under development across all UK nations to develop new frameworks for sustainable consumption.
- Service-led behaviour change options (e.g. mobility as a service, car clubs, car-pools, energy- or heat-as-a-service) face the least amount of direct policy support across all sectors, likely linked to their relatively recent development. Detailed assessment of policy gaps to encourage service uptake and understand behavioural barriers can be a beneficial step towards future development.
- While overarching public campaigns exist (e.g. Year of Climate Action, Scotland's Climate Week), these are typically limited in scale and longevity. Consistency in messaging and a comprehensive plan on public engagement to raise public awareness and encourage behavioural change across sectors is still required[3].

[2] Ekins, P. (2019). Report to the Committee on Climate Change of the Advisory Group on Costs and Benefits of Net Zero. https://www.theccc.org.uk/wp-content/uploads/2019/05/Advisory-Group-on-Costs-and-Benefits-of-Net-Zero.pdf (Accessed: Aug 2020)
[3] CCC (2020). Reducing UK emissions: 2020: Progress Report to Parliament. https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/ (Accessed: Aug 2020)

## COVID-19 Impacts

The spread of COVID-19 and the resulting measures put in place in early 2020 had significant and wide-reaching implications for many aspects of people's lives. The impact of COVID-19 on the key behaviours was mapped out through a literature and data search. The key insights from this work are:

- The impacts of COVID-19 have affected many of the behaviours identified as priorities for behavioural change, particularly around transportation and the use of electricity and heat in the home.
- Many of the changes have already, or are expected to, return to pre-COVID-19 levels when the restrictions on people's lives reduce.
- There may be lasting implications as a result of the expected persistence of a raised level of home working.

Going forward, it will be important to track this and provide a more comprehensive assessment of any lasting impact of COVID-19 on behaviours related to achieving Net Zero.

## Summary

This work has reiterated the important role that societal and behavioural change has on the prospect of achieving Net Zero and some of the important considerations that need to be taken into account. It is a complex and multi-faceted challenge. The long list of behaviours developed and the map showing their interactions highlights how wide reaching and interconnected they are the consideration of the distributional impact brings into focus the need to consider the implications of the changes on everyone in society including those in vulnerable situations; mapping the current policies to the behavioural changes has highlighted that there are gaps in the policy landscape and revealed the importance of broad, coordinated policy frameworks to tackle the issues from multiple angles; the consideration of the impact of COVID-19 has revealed just how significantly collective behaviour can change when the situation calls for it. However, it is key to ensure that future sustainable behaviour change is achieved not because of restrictions on people's lifestyle, but because the alternatives are better.

This was a relatively small, exploratory piece of work, and the hope is that it will form a step in the further investigation of these important issues.

# Introduction

This report covers the outcomes of Work Package 1 of the Net Zero Societal Change Analysis project. The project was undertaken by Energy Systems Catapult for multiple bodies from Her Majesty's Government (HMG) (primarily BEIS and DEFRA) following a successful proposal in response to a competitive tendering process for the work.

## Context

Following the recommendation by the Committee on Climate Change (CCC), in June 2019 the UK government implemented a legally binding target of Net Zero for UK greenhouse gas emissions by 2050. Whichever pathway is taken to achieve this target, there will be far reaching implications for the whole energy system and beyond, into areas of our lives that have traditionally been largely outside the scope of such work. While many of these implications fall on the way we produce energy and the pipes and wires that deliver it to the consumer, the fabric of our society and the behaviour of those within it have a significant impact on the chances of meeting the target.

It has been estimated that over 60% of changes needed to achieve Net Zero will involve either behaviour change or a combination of behaviour change and technology solutions[4]. In order to achieve this, it will be necessary to support the change of some of those actions and choices. In ESC's Innovating to Net Zero work [5], detailed modelling was conducted on some of the potential pathways to delivering Net Zero. This showed that there are fewer options than there were for delivering the previous 80% target. Therefore, the actions and choices that are made by individuals have an even more prominent impact on the levels of greenhouse gas emissions. In order to reduce those emissions such that the Net Zero target is reached, it will be necessary to introduce mechanisms to support the change of some of those actions and choices. Much of which will be through decisions on policy.

Although significant behaviour change is required in order to meet Net Zero, there is variation in what impact those changes will have on the people making them. Some changes will result in the same outcomes being delivered in a slightly different way. For example, with the installation of a hydrogen heating system to replace a natural gas heating system, it is mainly the disruption from the in-home installation which would cause the biggest impact, and the need to co-ordinate the changes in large numbers of homes simultaneously. The outcome to the user and how they interact with it is anticipated to be very similar. If adopted, other behaviour changes would result in a more significant difference in the experiences people have (e.g. flying less, taking public transport rather than private car, changing diet). It should be

[4] CCC. (2019). Net Zero – The UK's contribution to stopping global warming. https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/ (Accessed: Aug 2020)
[5] ESC (2020). Innovating to Net Zero. https://es.catapult.org.uk/reports/innovating-to-net-zero/ (Accessed: Aug 2020)

noted that not all of the behaviours discussed in this report are likely to be necessary to reach Net Zero – this depends on the pathway that is taken to reach the target.

In recent decades, there have been trends in behaviour which have been detrimental to the efforts of reducing emissions. These include more people flying further and more often, increasing private car use (numbers of vehicles and distances travelled), and increasing indoor temperatures in homes. Measures will be needed to counter the emissions resulting from these trends. In some cases, this will be through one-off behaviours such as the uptake of low carbon technologies, in others it may be a combination of this and habitual behavioural change. There are yet others where it may be necessary to challenge the demand growth altogether.

People have different values, behave in different ways and live in different situations. This means that it is easier for some to change their behaviour (and therefore reduce emissions) than others. For example, someone living in a rented property is likely to be less able to make material changes to their home than an owner-occupier is to theirs.

Another aspect to consider is the huge influence of wider socio-technical system factors on the effectiveness of any behaviour changes. For example, the impact on emissions of switching from a natural gas heating system to an air source heat pump-based system depends on the carbon intensity of the national electricity supply. Wider system factors also affect the level of impact on people's lives. For example, when switching from petrol and diesel cars to electric vehicles (EVs), the disruption will be less significant if vehicles are available that meet the needs of users, and charging infrastructure is widely available and able to charge at high speed.

There is also the role of the feedback loop with socio-structural change. There are path dependencies between what changes society will socially licence, and what services and technologies are subsequently developed and offered[6].

In the end, people will pay to upgrade the energy system, whether through taxes, bills or other ways. It will be easier to win public support if it remains easy to use the energy to get the things people want. It is important, therefore, that citizens are engaged in the process, and that technology developers, energy suppliers, network companies, policy makers and regulators all work together to ensure that people enjoy low carbon behaviour as much as, or ideally more than, what they are already doing.

As discussed, some of the changes required are at an individual level, with people doing something different tomorrow to what they do today. These are referred to here as 'behavioural changes' and include actions such as taking public transport rather than driving a car, changing diet, choosing to insulate their home, purchasing and using different technologies etc. Broadening the perspective, it is important to think about how we change collectively, as a society. The population is aging, home working is increasing (particularly in light of COVID-19), and we are becoming increasingly conscious of climate change. Such societal norms can, in

[6] For example, see considerations within Individual, Social and Material (ISM), and Behaviour change wheel approaches

turn, influence how easy it is for individuals to make changes. All these factors have a significant impact on costs, routes and ability to meet the Net Zero target.

# Aims and Objectives

The above section highlights the importance of behavioural and societal change in reaching Net Zero. To date there is a considerable amount of work considering individual changes in behaviour (e.g. moving to electric vehicles, reducing energy demand in the home). However, there is a significant gap in terms of work that is looking more holistically and collectively at the behavioural and societal change that may be required to reach Net Zero. The 'Net Zero Societal Change and Analysis' project seeks to provide evidence to support that understanding.

The overall objectives of the project are to:

1. Set out the possible implications of Net Zero for people.
2. Identify and assess how different levels of societal and behavioural change can affect the feasibility and cost of transitioning to Net Zero.
3. Identify how and where cross-cutting interventions could be implemented to support the societal and behavioural changes necessary for Net Zero.

The wider project consists of two parallel workstreams. The first (WP1 and WP2) will build a robust evidence-base through behaviour mapping and an international review. The second (WP3 and WP4) will scope and build methods for improving the representation of behaviours in whole systems models. The primary focus of the work package discussed in this report (WP1), will be to address objective 1, above, as well as feed into the understanding of objective 3 (together with WP2).

# Approach

This work package was separated into a number of individual tasks undertaken by subject matter experts from across ESC. These tasks were developed in consultation with HMG stakeholders and are detailed in the individual sections of this report.

The first section covers the work carried out to compile a list of behavioural and societal changes across four sectors – Heat, Transport, Electricity, and Consumption. A high level assessment is made of how much impact those changes could have (in terms of potential greenhouse gas reduction, consumer acceptability and level of applicability), which allows the selection of those with the highest priority.

The next section explores some of the distributional impacts envisaged across society of participating in those prioritised behavioural changes. This is followed by an analysis of the current policy instruments in place which have an influence on the prioritised behavioural changes. Finally, the impact of the current COVID-19 pandemic on low-carbon behaviours is considered.

# Behavioural Mapping

## Introduction

The initial task of the work package involved the identification and prioritisation of the behavioural and societal changes which have an impact on the UK's ability to achieve Net Zero. In this context, "behavioural changes" are considered to be individual behaviour (e.g. switching to electric vehicles for transportation) and lifestyle changes (e.g. installing an air source heat pump for domestic heating or turning a room thermostat down by 1°C). These individual behavioural changes could be one-off decisions/purchases or habitual everyday behaviours. In many cases, participation of these individual behaviours are heavily influenced by wider societal changes. These cover aspects such as the makeup of society (population growth, ageing population, etc.) and changes in social norms (increased home working, increased environmental awareness, greater prevalence of service-oriented transactions, etc.). The interdependencies between behavioural and societal changes are, of course, two way. In many cases, an individual's behavioural change encourages change in others, and that mass behavioural change could constitute societal change. There are additional links and feedback loops connecting the actions and behaviours of individuals and society which permit larger structural changes and drive technology and service development.

When considering the sectors in which to investigate and capture behaviours, an approach similar to that adopted in the ESC publication Living Carbon Free [7] was used. This was commissioned by the CCC to support their Net Zero advice to Government [8]. The ESC's work reviewed household emissions since 1990 and provided a series of recommendations across six sectors or activities: heat, transport, electricity use, aviation, diet and waste. Figure 2 shows the relative impacts of these sectors on average household emissions historically, today and in the CCC's demand led Net Zero scenario. This gives an indication of the relative importance of each sector.

[7] ESC (2019). Living Carbon Free. https://es.catapult.org.uk/reports/net-zero-living-carbon-free/ (Accessed: Aug 2020)
[8] CCC (2019). Net Zero – The UK's contribution to stopping global warming. https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/ (Accessed: Aug 2020)

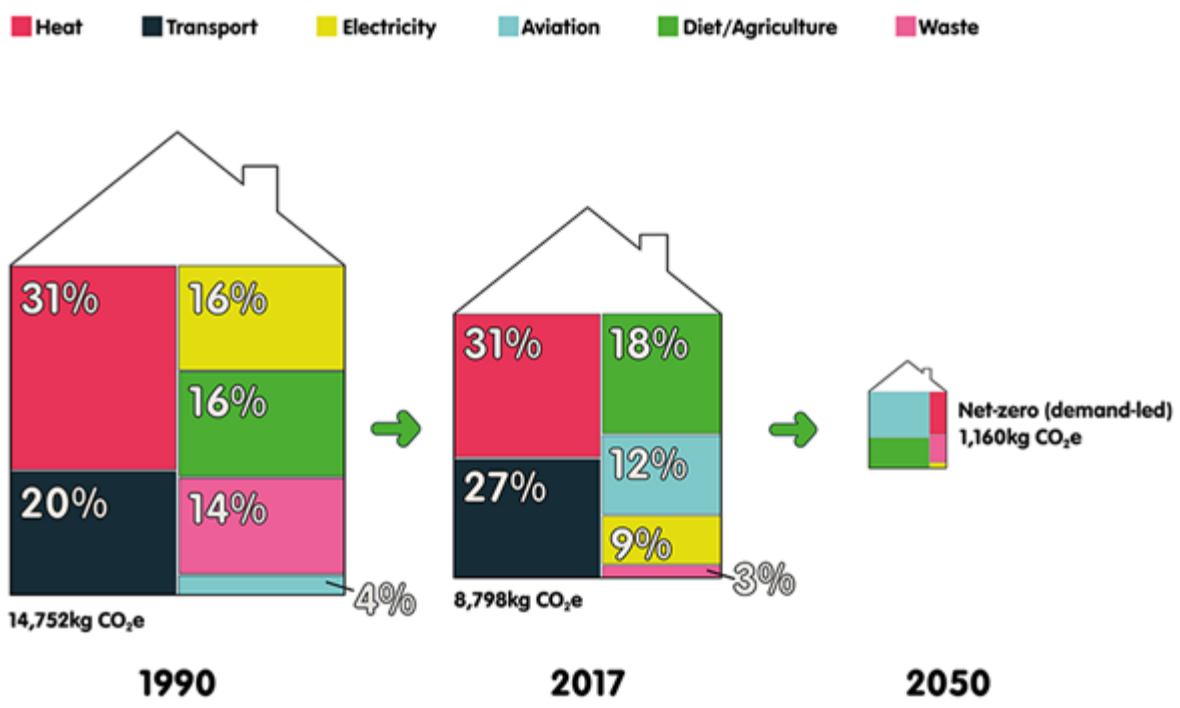



**Figure 2: Infographic of UK average household emissions with historical shares (edited from previous ESC publication for CCC[9])**

For this work package, the sectors were reframed slightly to those shown in Figure 3. Here, aviation has been incorporated into transport, and waste and diet/agriculture have been considered together. To broaden the scope of behaviours captured in this final sector, it was reframed as 'consumption'.

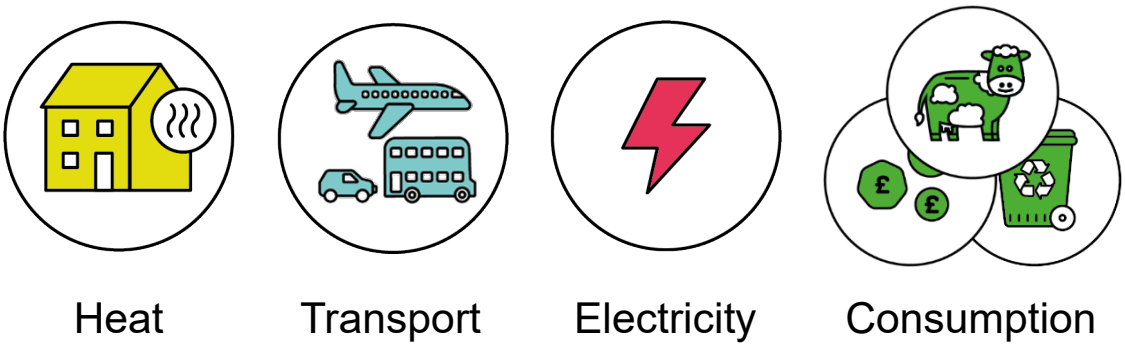



**Figure 3: The sectors used in this work: Heat, Transport, Electricity, and Consumption**

[9] ESC (2019). Living Carbon Free. https://es.catapult.org.uk/reports/net-zero-living-carbon-free/ (Accessed: Aug 2020)

Discussed below is the methodology followed to identify and prioritise the behaviours and the insights that can be gleaned from the work. The behaviours prioritised during this task were the focus of the subsequent tasks looking at the impact of current policy, the distributional impacts and the impact of COVID-19.

# Methodology

A Framework was developed to identify the societal and behavioural changes which are important to achieving Net Zero. For each of the sectors discussed above, a table was prepared to allow researchers to enter each behavioural change along with a number of other fields, as discussed below. As well as the individual sector tables, an additional list of non-sectoral/societal changes was created. This was done to allow the impact on multiple sectors to be considered from a single more general trend/change. A summary of the completed Framework can be found in Appendix 3.

The fields included in the behavioural change tables were:

**Change:** Short title for the behavioural change under consideration.

**Description/Assumptions:** Further detail to describe the change under consideration and any key assumptions on which the completion of the subsequent fields is based.

**Actor:** Identifying who within society could make the change.

**One-off/habitual:** Allows the change to be distinguished between one which requires a habitual, ongoing change in behaviour, or one which is a one-off decision.

**References:** External evidence leading to the inclusion of the change and the subsequent assessment.

Along with these descriptive fields, an assessment of the importance of the change was also carried out. The following three assessment criteria were used to identify the most important behavioural changes. Greenhouse gas reduction potential was taken as the primary criterion, with subsequent consideration given to the other two.

**Greenhouse Gas Reduction Potential:** An assessment of the impact on emissions if the behaviour was adopted.

**Consumer Acceptability:** An assessment of the likely acceptability of the change and the potential impact on the people making the change.

**Proportion of households able to adopt:** An assessment of how many people could potentially make the change.

The tables were populated by a wider team within ESC who have expertise from consumer insight, systems engineering, modelling and strategy. Each member of this team created entries in the tables using two approaches. Either from a bottom up perspective, through the

direct identification of behavioural changes which are known to be required to achieve Net Zero. Or, through a top down approach, where the larger systemic changes required to achieve Net Zero were considered, and the preceding actions traced back to individual behaviours required. An example of this second approach is shown in Figure 4.

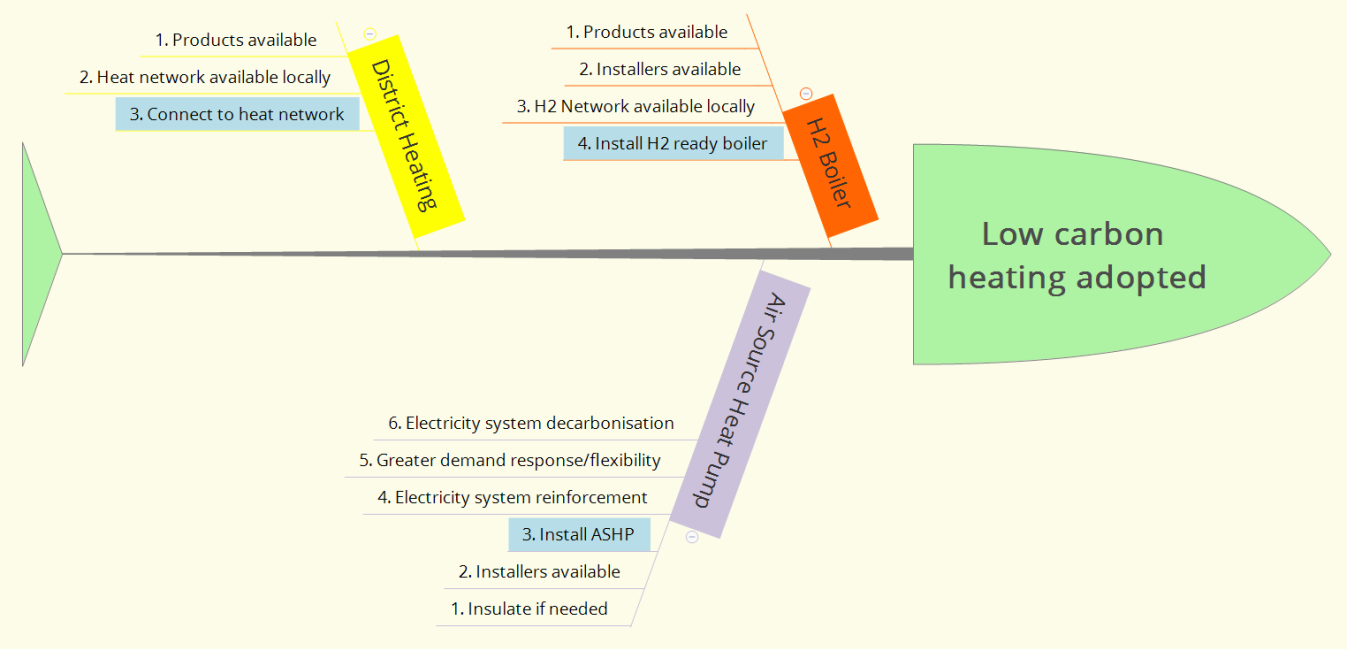



**Figure 4: Example cause and effect diagram used to identify steps required to achieve the systemic change of the wider adoption of low carbon heating systems including individual behaviours (highlighted)**

Much of the information used to complete the tables was brought by expertise within the team, which was backed up by evidence where appropriate. However, this was a largely qualitative process.

Three subsequent quality control steps were taken to validate the assessments made and the data entered in the tables:

- A workshop was held for the team completing the work, to normalise their assessments and discuss any areas of contention.
- Following this, the tables were reviewed by senior members of the wider ESC team.
- Finally, the tables were reviewed by HMG to ensure that the behavioural and societal changes that had been captured, covered the areas of interest.

With the tables completed for each of the four sectors and the societal/non-sectoral changes cross referenced where appropriate, the prioritised changes were identified. These were selected primarily to ensure those with the highest perceived greenhouse gas reduction potential were captured, but also taking into account the other assessment criteria (consumer

acceptability and the proportion of households able to adopt), and the need to have a broad coverage of behavioural changes across the sectors.

Within each sector, the individual behavioural changes were grouped in categories of change. This allowed individual behaviours which lead to the same outcome, or complement each other, to be considered together.

As well as the identification of priority changes to be taken through to the subsequent task in this work package, all of the changes identified were mapped out on a Behavioural Map (see Appendix 1). This was developed to show the changes grouped into sectors and to indicate the dependencies and links between them. It also shows the influence of the societal changes on the individual behaviours.

The focus during identification was largely on direct behaviours (rather than the practices that shape and drive those individual behaviours). In addition to these, there are many 'micro' behaviours such as closing windows, switching off appliances, using online healthcare services that were not included as their individual contribution to emissions reductions was minimal. It is acknowledged, however, that the combined effect of these low impact changes may be important. There is also significant uncertainty in the future of technology developments and shifts in societal norms (e.g. behaviours around autonomous vehicles were not considered). Therefore, the work does not provide an exhaustive view of all behavioural changes that will be required to achieve Net Zero.

# Insights

In total, over 130 individual behaviours were identified across the four sectors, along with 11 societal changes. Figure 5 shows those which were prioritised. The detailed breakdown of the behavioural and societal changes can be seen in the Behavioural Map shown in Appendix 1. This map also shows how the individual changes interact with each other (within and between sectors).

One of the key insights from this work has been to confirm that the influence of societal and behavioural changes on our ability to achieve Net Zero is wide reaching and complex. Although the primary focus of the prioritisation was on the greenhouse gas reduction potential, other changes were seen as being key to reflecting a society made up of individuals who have a higher awareness of the impact of their actions on achieving Net Zero. For example, someone who has gone vegan or started cycling and now identifies themselves as 'green', may go on to buy a heat pump or holidaying in the UK every other year[10]. Similarly, adopting smart tariffs for electric vehicle (EV) charging could lead to greater willingness to adopt smart flexible solutions for heat. As well as this spill-over[11] from one behaviour onto further

[10] This could, of course, also result in the opposite effect. E.g. a household who live a vegan lifestyle, drive an electric car and live in a well-insulated home with a heat pump may reward themselves for their 'good' behaviour with a holiday in the Caribbean – thus nullifying the other behaviours.

[11] P. Lanzini, J. Thøgersen (2014). Behavioural spillover in the environmental domain: An intervention study. Journal of Environmental Psychology, Volume 40. https://doi.org/10.1016/j.jenvp.2014.09.006 (Accessed: Aug 2020)

behaviours, there is the social normative effect of behaviour change on other people. This applies to both specific behaviours (e.g. dietary change) and cumulatively (being 'greener' generally).

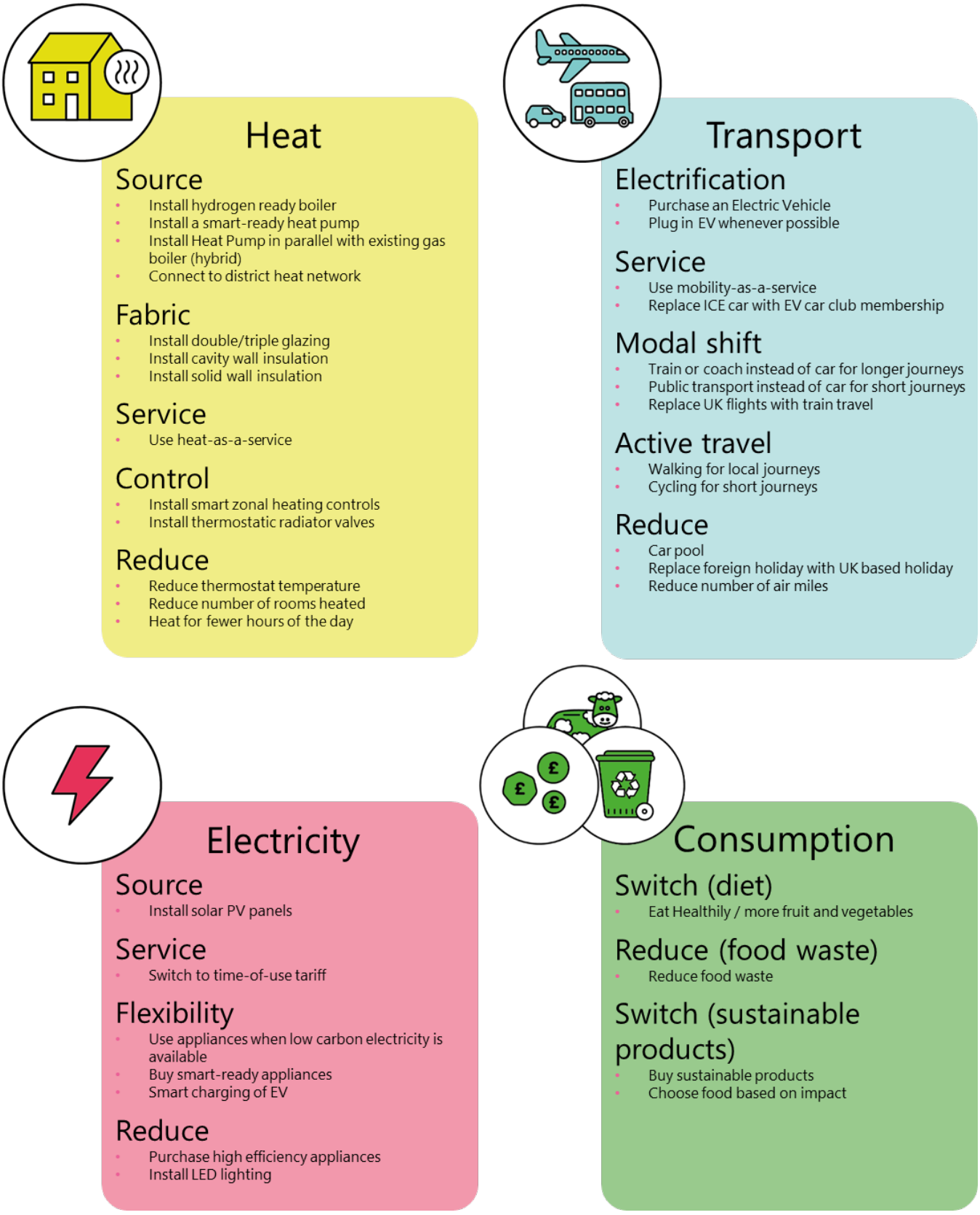



**Figure 5: The prioritised behavioural changes and categories within each sector**

This social normative effect can be seen in the consumption sector. Although it could be argued that many of the changes prioritised here have a lower impact on greenhouse gas emissions for most households than those in, for example, the transport sector, the broader 'buy sustainable products' behavioural change represents a shift in awareness. Even within the 'Consumption' sector, many of the behavioural changes which are known to have a high impact on emissions are grouped into more general categories. For example, the reduction in red meat consumption – which many organisations see as a key opportunity for reducing emissions[12], especially given the co-benefits of improved health – has been grouped within the general 'Eat healthily/more fruit and veg' category.

During the assessment, it was clear that for many of the changes there was a temporal component to take into account as well as wider considerations to be made. For example, when looking at behavioural changes which reduce the demand for electricity, the greenhouse gas reduction potential will lessen as more low carbon generation enters the system, lowering the carbon intensity of the national electricity supply. However, if demand is not reduced (through efficiency measures, for example), there will be implications in terms of wider system capacity, complexity and cost. This is another example of the difficulty of considering any aspect of the system in isolation and leads back to the need for a whole system approach. Work package 4 of this project will start to look at the greater integration of many of these behavioural and social system aspects into whole energy system techno-economic modelling. The best actions identified by a whole energy systems approach may not reflect the best actions in a behavioural/social-systems approach.

[12] E.g. ESC, CCC, etc.

# Distributional Impact

## Introduction

Not everyone has the same ability to change their behaviour, and those changes will affect different people in different ways. This can be referred to as the distributional impacts. This section discusses the distribution of impacts on different people with a range of vulnerabilities when faced with making the behavioural changes identified in the previous task.

It is already well-acknowledged[13] [14] that different people's ability to use and buy energy is influenced by their income levels, energy needs, energy efficiency of the property and the cost of energy to them. This task looks at broader aspects that may influence whether people can undertake the low carbon behaviours needed to get to Net Zero.

This is important because all households will experience changes as the UK moves towards meeting the Net Zero target. There is a risk that some of the changes required could exacerbate inequalities and disproportionately affect some households. The perception of fairness in support for moving to Net Zero is also important to public engagement and policy acceptability[15]. According to the IPCC, "*Public acceptability depends on the individual's evaluation of expected policy consequences, the perceived fairness of the distribution of these consequences, and perceived fairness of decision procedures*." [16]

There is time to design the UK transition in a way that includes all consumers and ensures no one is left behind. It will be much easier to design the transition to Net Zero in an inclusive way from the outset, than try to address problems that emerge later, over time. By understanding the barriers to people changing behaviour and acknowledging the disparity between perceptions of fairness and objective fairness, we can find ways to support them so everyone can participate and live fulfilling lives in an inclusive future Net Zero world.

[13] BEIS (2015). Cutting the cost of keeping warm A fuel poverty strategy for England. https://www.gov.uk/government/publications/cutting-the-cost-of-keeping-warm (Accessed: Aug 2020)
[14] Cambridge Economic Policy Associates (CEPA) (2017). Distributional impact of time of use tariffs - Final report for Ofgem. https://www.ofgem.gov.uk/publications-and-updates/distributional-impacts-time-use-tariffs (Accessed: Aug 2020)
[15] Climate Assembly UK (2020). The path to net zero – Climate Assembly UK full report https://www.climateassembly.uk/report/read/ (Accessed: Aug 2020)
[16] IPCC. (2018). Global warming of 1.5°C - An IPCC Special Report. https://www.ipcc.ch/sr15/ (Accessed: Aug 2020)

# Methodology

## Description of the Framework Developed

There is no standard way for determining the distributional impacts of Net Zero behavioural change. Where it has been carried out, the existing work has focussed primarily on financial cost implications. Therefore, a framework was developed to allow for a systematic examination of how easy it would be for different individuals or households to engage in Net Zero behaviours. There are two parts to the framework, as depicted in Figure 6.

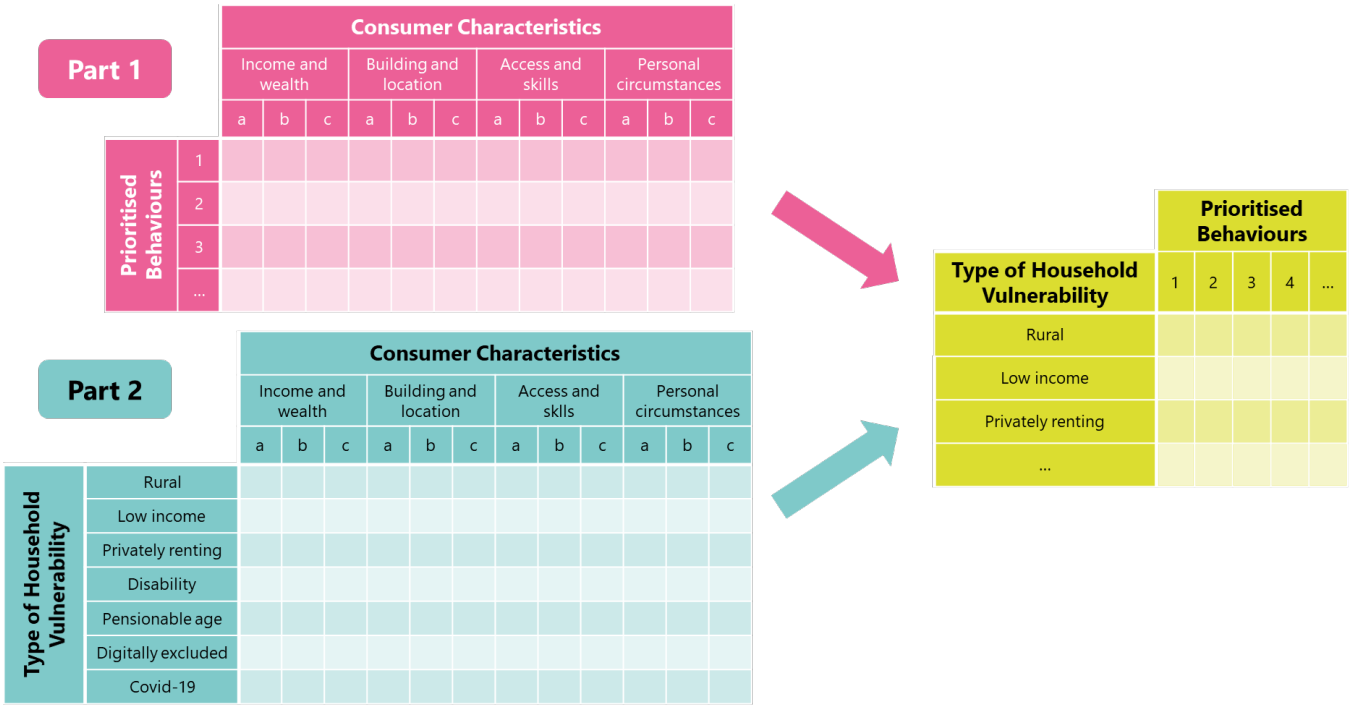



**Figure 6: Distributional Impact Framework Outline**

**Part 1** is an assessment of how various consumer characteristics could affect consumers being able to participate in each of the proposed Net Zero behaviours. When exploring how people may be able to participate in Net Zero behaviours, four groups of characteristics were considered: income and wealth, building and location, attitudes and engagement, and personal

circumstances. These were informed through previous research with people in vulnerable situations and consumer-centred energy systems[17] [18] [19] [20]. In detail:

- Income and wealth: those who have low or no savings will have limited ability to raise financial capital, not everyone has a good credit rating or is eligible for financial support, not all households have a stable, regular income.
- Building and location: this includes factors such as whether households have permission to make changes to their property (may not be the case for those renting, sharing or in areas with planning restrictions), have available space for additional technology or equipment (including suitable indoor/outdoor space, off-street parking etc.), or have access, due to location, to a fuel type (e.g. gas network) or service (e.g. public transport).
- Access and skills: covers aspects such as whether people can access information about alternative options (e.g. if required, do they have a broadband connection or internet enabled device?), or would have the skills to access the new services and technologies required to make the changes.
- Personal circumstances: includes how stable their current personal situation is (moving house regularly, pregnancy and redundancy is the cause of transient vulnerability) and any health issues or other limiting personal factors.

**Part 2** is an overview of which of the characteristics are more or less likely to be present in households in different vulnerable situations. A range of groups who might struggle to engage in Net Zero behaviours were considered (including those who have relevant legally protected characteristics[21]): those living in rural locations, low income, living in privately rented properties, living with disabilities, of pensionable age, the digitally excluded, and those who have been disproportionally affected by COVID-19. These groups were selected as they were considered to be the ones that are likely to find it hardest to engage in the changes identified. What is not considered explicitly in this work is the effect of layering multiple vulnerabilities within a single household. For example, unique challenges may be presented to a household which is rural, low income and living with disability. The effect of layering multiple vulnerabilities is likely to be in relation to the extent of the barriers, but is unlikely to add new barriers, as the majority are faced by most of the groups.

[17] ESC (2020). Fuel poverty in a smart energy world. https://es.catapult.org.uk/reports/fuel-poverty-in-a-smart-energy-world/ (Accessed: Aug 2020)
[18] ESC (2020). Understanding Net Zero: A Consumer Perspective. https://es.catapult.org.uk/reports/net-zero-a-consumer-perspective/ (Accessed: Aug 2020)
[19] ESC (2018). SSH1: How Can People Get The Heat They Want At Home, Without The Carbon? https://es.catapult.org.uk/reports/how-can-people-get-the-heat-they-want-at-home-without-the-carbon/ (Accessed: Aug 2020)
[20] B. Sovacool et. al. (2019). Temporality, vulnerability, and energy justice in household low carbon innovations. https://www.sciencedirect.com/science/article/pii/S0301421519300102 (Accessed: Aug 2020)
[21] Equality and Human Rights Commission. https://www.equalityhumanrights.com/en/equality-act/protected-characteristics (Accessed: Aug 2020)

Combining these two parts of the framework enables the examination of how easy it would be for different vulnerable household types to engage in the Net Zero behaviours.

### Process followed to populate framework

**Part 1** (Completed version shown in Table 7, Appendix 2) was completed independently by six experts at the Energy Systems Catapult. This included members of the Consumer Insight, Systems Engineering, Strategy and Modelling teams. For each cell in the table they selected yes, no, or not sure as to whether they thought the characteristic would impact on being able to make the behaviour change. Answers were collated into the final table. Where at least five people gave the same answer, this answer was added to the table, otherwise the majority answer (followed by the number of people giving this answer) was entered. Where equal numbers of answers were yes and no, this was entered as 'maybe'. The literature was examined to find further evidence where experts disagreed. It is recognised that much further work is required in this area given its importance, however, this approach was felt to be appropriate given the limited resource available for the task.

**Part 2** (Completed version shown in Table 8, Appendix 2) was completed with reference to evidence from previous ESC work, ONS reports and recent academic papers. A characteristic was estimated to be less likely, more likely or as likely to be present for each vulnerable household, in comparison to UK national average, based on available evidence.

Finally, the two parts were cross-referenced to highlight the main risk characteristics for the vulnerable consumers considered, the impact on their ability to participate in the prioritised Net Zero behaviours, and the ways in which they might struggle to participate (Table 2, below). A 'dot' in this table indicates that there is a likelihood that the vulnerable household type in question would have additional challenges in participating with the behavioural change compared to the average population.

## Barriers to participation for vulnerable households

The work highlights several areas where those in the vulnerable situations discussed are at increased risk of experiencing barriers to participating in the Net Zero behaviours identified. Many of these can be mitigated through policy and other mechanisms.

| | | Prioritised Behaviour | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Heat | | | | | Transport | | | | | Electricity | | | | Consumption | | |
| | | Source | Fabric | Service | Control | Reduction | Electrification | Service | Modal shift | Active travel | Reduction | Source | Service | Flexibility | Reduction | Healthy diet / more fruit and veg | Less food waste | Sustainable products |
| Type of Household Vulnerability | Rural | | | ● | | ● | | | ● | ● | ● | ● | ● | ● | | | | |
| | Low income | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Privately renting | | ● | ● | ● | ● | | | | | ● | ● | ● | ● | ● | | | ● |
| | Residents with disabilities | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Pensionable age residents | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Digitally excluded | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● |
| | Those disproportionally affected by Covid-19 | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | ● |

**Table 2: Summary of Distributional Impacts ('dots' indicate that the vulnerable household type face challenges in participating with the prioritised behaviour)**

Table 2 shows that there is broad impact on the ability of vulnerable households to participate in the prioritised behavioural changes. The following sub-sections go into a little more detail on where this impact is negative. There is obvious heterogeneity within each of these household types and it would be possible to form different narratives in many cases. This highlights the need for more evidence to determine what holds true and for whom.

## Rural Homes

**KEY RISKS:** Transport; Heat

Earnings in rural/non-rural areas are similar overall[22], as are levels of poverty, though those living in rural areas spend more of their available income on transport[23]. There is now little difference in access to the internet in rural versus non-rural areas[24], and so access to information and available services is not likely to be a key concern for these households

[22] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/868755/Earnings_February_2020.pdf (Accessed: Aug 2020)

[23] ONS (2011). Rural and Urban Areas: Comparing Lives Using Rural/Urban Classifications

[24] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/868755/Earnings_February_2020.pdf (Accessed: Aug 2020)

because of their rural location. Those in rural areas are also more likely to be more stable in terms of where they live, with fewer renters and less moving between rental properties[25].

These households are most likely to be adversely affected by limited access to fuel type or service. This could impact on ability to participate in some behaviours (e.g. connecting to heat network and hydrogen networks), though of greatest concern would be limited access to transport services and energy services as these are dictated by location. Previous research has shown that those living in rural areas are much less likely to switch to public transport in comparison to those living in urban areas[26], suggesting this is currently difficult for many.

## Low Income Households

**KEY RISKS:** Heat; Electricity; Transport – buying EVs; Consumption– buying sustainable products

Those on low incomes will have less ability to invest, or access credit, to make changes that require up-front equipment or buying more expensive alternatives. They are more likely to be susceptible to transient vulnerability (due to less stability in work - except those on pensions). This will have wide ranging impacts on their ability to participate in behaviour changes across the board, in particular heat and electricity behaviours which often require initial investment in energy saving measures or new technologies. However, there are opportunities for time-of-use tariffs, for example, to provide significant cost savings (that are more significant as a proportion of a low income vs high) but this too will depend on household characteristics - notably occupancy patterns and appliance ownership (e.g., electric cooker, direct electric heating and heat storage such as storage heaters and hot water storage tanks). In addition, some actions related to reducing waste, like buying more sustainable products, could be more expensive and less accessible.

Other vulnerable households are also more likely to have lower incomes than average. For example renters have lower than average earnings than those who own their own properties (see below), the percentage of homes with internet connection increases with income[27] (meaning those on lower incomes might have less access to information about alternatives) and more people who suffer from health and limiting personal circumstances are likely to have lower incomes[28].

[25] J. Rugg and D. Rhodes (2018). The Evolving Private Rented Sector: Its Contribution and Potential. http://eprints.whiterose.ac.uk/135787/ (Accessed: Aug 2020)
[26] ESC (2020). Understanding Net Zero: A Consumer Perspective. https://es.catapult.org.uk/reports/net-zero-a-consumer-perspective/ (Accessed: Aug 2020)
[27] ONS (2019). Exploring the UK's Digital Divide. https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/articles/exploringtheuksdigitaldivide/2019-03-04 (Accessed: Aug 2020)
[28] ONS (2019). UK Private Rented Sector: 2018. https://www.ons.gov.uk/economy/inflationandpriceindices/articles/ukprivaterentedsector/2018 (Accessed: Aug 2020)

## People Living in Privately Rented Properties

*(Much of this section is also relevant to those in socially rented properties and leasehold properties, although the focus was on those in privately rented properties)*

**KEY RISKS:** Heat; Electricity; Transport (which require changes to property).

Those in private rentals have limited control over making changes to their property and sometimes goods in it (e.g. fridge/freezer, washing machine etc.). This could affect their ability to make changes to their heating system, improve insulation, and make use of electricity services. Having or building a driveway and installing charging for an EV could also be problematic. People who rent often move home more often than owner-occupiers leading to a lack of stability. In addition, private renters, on average, have lower earnings or household income than people who own their own homes. They spend more of their gross household income on rent (34%) than owner-occupiers spend on mortgage payments (18%)[29]. Therefore, they are also more likely to be affected by issues related to low income and capital, for example being able to afford to invest in changes that require up-front equipment or buying more expensive alternatives. Combined with a lack of stability, this may make them less willing and able to invest time and money in changes to their current property that they may not be able to take with them, or that may be unsuitable or unnecessary in their next home.

## People Living with Disabilities

**KEY RISKS:** Heat – use less, source; Transport; Electricity.

Average earnings for those with disabilities (in the widest sense - physical, sensory, cognitive) are lower than for those without[30]. People living with disabilities can often find it more difficult to get a job and are more likely to be out of work again within a year when they do[31]. They are also less likely to own their own home[32]. Therefore, they are also at higher risk of being on low incomes and having a lack of stability in terms of income, work and place of residence. By definition, they suffer from health or limiting personal circumstances. Finally, a larger proportion of disabled than non-disabled adults are digitally excluded and report a lack of skills or knowledge as a reason for not buying goods and services online[33].

[29] ONS (2019). UK Private Rented Sector: 2018. https://www.ons.gov.uk/economy/inflationandpriceindices/articles/ukprivaterentedsector/2018 (Accessed: Aug 2020)
[30] ONS (2019). Disability Pay Gaps in the UK: 2018. https://www.ons.gov.uk/releases/disabilitypaygapsintheuk2018 (Accessed: Aug 2020)
[31] Joseph Rowntree Foundation (2020). Enduring Economic Exclusion: Disabled People, Income and Work. https://www.jrf.org.uk/file/36489/download?token=0zsykXWv&filetype=full-report (Accessed: Aug 2020)
[32] ONS (2019). Disability and Housing, UK: 2019. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/disability/bulletins/disabilityandhousinguk/2019 (Accessed: Aug 2020)
[33] ONS (2019). Exploring the UK's Digital Divide. https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/articles/exploringtheuksdigitaldivide/2019-03-04 (Accessed: Aug 2020)

Health and limiting personal circumstances could impact their ability to participate in prioritised transport behaviour changes, as alternative options may not be accessible. They may also struggle to use less heating due to the health impacts of living in a colder home and the increased likelihood that they will spend more time at home due to disability or illness. When combined with other vulnerabilities such as low income, access to services, etc. the risk can be exacerbated.

## People of Pensionable age

**KEY RISKS:** Transport and heat. Also, electricity and potentially consumption through a lack of awareness and skills. Some issues related to low income and disability.

Median disposable income for people living in retired households is lower than that of people living in non-retired households[34]. This means that some will have less ability to invest in changes that require up-front equipment or buying more expensive alternatives, e.g. for heating and electricity services, or purchasing an EV. However, more people over 65 own their own homes than in younger age groups, so those of pensionable age are less likely to be renting or to move home regularly. As the highest proportion of internet non-users is over 65[35], there may be an issue with them accessing information about alternatives, and they may also lack the skills to access new services and technologies. This could limit their ability to participate in most of the prioritised behaviours. Those of pensionable age are more likely to suffer from health and other limiting personal circumstances, making it harder for them to use less heat or participate in transport related behaviour changes due to limited accessibility.

## People who are Digitally Excluded

**KEY RISKS:** Heating, Transport, Electricity, (consumption).

Lack of money, lack of skills or that access is not needed are often given as reasons for not having access to the internet. Those who are economically inactive (e.g. homemakers, students, carers, temporarily sick and disabled), on lower incomes, are over 65 (esp. over 75), or disabled are more likely to be digitally excluded[36]. These people may not have the necessary information about alternatives, and they may also lack the skills to access new services and technologies that are needed for participation in most Net Zero behaviour changes.

[34] ONS (2020). Average Household Income, UK: Financial Year Ending 2019. https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/bulletins/householddisposableincomeandinequality/financialyearending2019 (Accessed: Aug 2020)
[35] ONS (2019). Exploring the UK's Digital Divide. https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/articles/exploringtheuksdigitaldivide/2019-03-04 (Accessed: Aug 2020)
[36] ONS (2019). Exploring the UK's Digital Divide. https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/articles/exploringtheuksdigitaldivide/2019-03-04 (Accessed: Aug 2020)

### People Disproportionally Affected by COVID-19

**KEY RISKS:** Heat, Electricity, Transport – buying EVs & public transport use, Consumption– buying sustainable products.

The vulnerabilities discussed above are all likely to be considerations throughout the transition over the next 30 years when we are due to hit Net Zero. The current COVID-19 situation is much more of a temporary aberration. Many of the vulnerabilities created by it are already captured in the other groupings, such as low income. However, given the current context, and its impact on lifestyles and behaviours, it is important to consider as part of the analysis.

Many people have faced loss of income during the pandemic, and many (parents, carers, disabled people whose disability has a large impact on their day-to-day life, and those who previously shielded more so than other groups) are now facing financial challenges. This results in them having considerably less ability to afford to invest in changes that require up-front equipment or buying more expensive alternatives. The ongoing instability and uncertainty in their situation also make it unlikely that they will be willing or able to invest in non-essential, costly property specific changes and upgrades. Longer periods of time at home makes it harder to use less heat and electricity.

Finally, many of those disproportionally affected by COVID-19 have underlying health conditions and disabilities which compound their ability to participate in the prioritised behaviours such as being more reluctant to use public transport.

Further analysis on the current impact of COVID-19 is included later in this report.

## Insights

The key messages from this work are:

- In this work, vulnerabilities have been considered individually. However, there is an inevitable interaction between them. It has been shown, for example, that many of the characteristics seen in low income households are reflected in other groups.
- Vulnerability is a multi-faceted issue and it is common for multiple risk factors to appear together. Where multiple vulnerabilities are present in a household, there is a compounding effect on their ability to participate in the behaviour changes required for Net Zero.
- People living on a low income may face the challenge of access to capital (including through borrowing). Without access to capital it will be difficult to take up the behaviours needed to achieve Net Zero. How much money is needed to participate and the nature

and size of the risk varies across the different Net Zero behaviours. Policy can be put in place to make low-cost finance available to those that need it.

- People living in rural areas face particular challenges in accessing some of the transport and heat service-based behaviours (for example, modal shift to public transport and access to certain energy vectors/networks). Some of these inherent challenges cannot be tackled through the implementation of policy, therefore, alternative mechanisms to address the impact must be considered.
- Some people have less freedom to make the decisions that lead to the behaviour concerned (e.g. tenants can’t change their property).
- Significant, complex change will be required to the way we heat our homes, the way we move around, how/when we power our appliances and what we consume, if we are to achieve Net Zero. Access to information and support for decision-making is a challenge for many of the household types.

# Policy Mapping

## Introduction

The achievement of the Net Zero target by 2050 will require bold and well-integrated policies to allow a higher speed and larger scale of transition combined with faster phase out of existing systems that may lock-in carbon emissions[37]. Alongside increased global cooperation, achieving Net Zero is expected to require more stringent economy-wide targets, larger sector coverage (e.g. aviation and land use), much lower energy and carbon intensity, much higher carbon prices, increasing climate finance and implementation of initiatives by non-state actors. A portfolio of policies will be needed, both on the supply and demand side, to create robust and integrated frameworks and enabling conditions to drive low carbon energy and economic transformation.

Policy measures can take different forms – demand pull (e.g. via subsidies like Feed-in-tariffs), supply push (e.g. via R&D investment) or systemic (e.g. collaborative research or systemic knowledge exchange). To date, significant policy interventions have successfully supported supply-side measures and technology solutions. Notable examples include support for renewable power generation, introduction of efficiency standards for car and appliance manufacturers, waste management regulation, taxes diverting waste from landfill, and strong domestic standards phasing out non-condensing boilers from buildings[38]. Demand-side policies are increasingly recognised as critical enabling factors for reducing the overall cost of transitioning the energy system. Such policies can include increasing energy efficiency or limiting energy demand; driving the expansion, efficiency and provision of high-quality energy services; reducing the need for transport, encouraging the shift to alternative transport modes; and encouraging climate-friendly diets and sustainable consumption lifestyles, among others[39].

This section discusses mapping of the current UK policy against the priority behavioural changes identified earlier in the work. This will allow the identification of possible gaps in the policy landscape.

[37] IPCC (2018). Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. https://www.ipcc.ch/report/sr15/mitigation-pathways-compatible-with-1-5c-in-the-context-of-sustainable-4-development/ (Accessed: Aug 2020)
[38] CCC (2020). Reducing UK emissions: 2020 Progress Report to Parliament. https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/ (Accessed: Aug 2020)
[39] IPCC (2018). Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. https://www.ipcc.ch/report/sr15/mitigation-pathways-compatible-with-1-5c-in-the-context-of-sustainable-4-development/ (Accessed: Aug 2020)

# Methodology

Policy information was gathered through internal ESC databases, review of key strategic government documents and non-government agency reports, policy databases (e.g. International Energy Agency policy database, covering transport, heat and electricity sectors) and input from government stakeholders. Policy instruments were classified in line with standard approaches[40]:

- Regulatory instruments (e.g. standards, building codes, obligations)
- Economic/fiscal instruments (e.g. tax incentives, liabilities, subsidies, loans, grants, charges)
- Information & education (e.g. education programmes, labelling, information campaigns, training, guidelines, rating systems)
- Direct investment (e.g. capital funding)

In line with similar research[41], mapping generally excluded supply side policy (aimed at reducing production emissions and targeting upstream supply chains) unless they fall into a grey area (e.g. mobility planning). Examples of what is not included are policies relating to food and energy production, construction of transport infrastructure, interoperability standards, etc. To manage scope, focus was placed on major policies which fall within the relevant economic sectors, and wider policies with potential impact on demand were excluded (e.g. visa arrangements, initiatives to promote domestic tourism). The mapping was complicated by the fact that policy levers are devolved to varying degrees to the Scottish, Welsh and Northern Irish governments, while some are reserved for UK Government. The policy list aims to cover a number of key policies within devolved governments but should not be considered exhaustive.

Due to the nature and variety of prioritised behaviour changes and the range of policies which can have indirect impact on them, it was not possible to capture all policies. There will be policies outside the Net Zero remit that will have an influence on the behavioural changes under consideration here.

# Findings

## Heat

The largest number of policy measures are in place to support building improvements and to a lesser degree support a change of heating source. They target some barriers to uptake (e.g. upfront investment costs). As heat policy is largely devolved, policy design varies between

[40] European Commission (2018). Better Regulation Toolbox – TOOL #18: The Choice of Policy Instruments. https://ec.europa.eu/info/files/better-regulation-toolbox-18_en (Accessed: Aug 2020)
[41] G. Dubois, et al. (2019). It starts at home? Climate policies targeting household consumption and behavioural decisions are key to low-carbon futures. Energy Research & Social Science 52. https://doi.org/10.1016/j.erss.2019.02.001 (Accessed: Aug 2020)

nations, both in terms of policy instruments used (e.g. loans, grants), and in terms of value of financial support, target customer groups, eligibility criteria, technology solutions supported and information campaigns. Regulatory measures, such as Minimum Energy Efficiency Standards also differ, being more stringent in Scotland than elsewhere.

Some technologies (e.g. hydrogen-ready boilers) are not directly supported at present, but due to co-dependency on relevant hydrogen infrastructure development, an integrated strategy is more appropriate. Other less familiar solutions (e.g. heat networks) benefit from direct infrastructure investment but are not supported via end-user policies (e.g. information and education campaigns). Flexibility/improvement in heating control and reducing consumption via different heating patterns are closely related. They can be supported indirectly via funding for heating controls provided through energy efficiency programmes, and information provision (e.g. via in-home displays on smart meters).

Despite the multitude of policies in place, there remain gaps in terms of scope, speed of delivery, and the funding needed if we are to achieve a Net Zero transition. Key areas where further ambition has been indicated include funding for energy efficiency and low carbon heating solutions, strengthening building standards for new buildings via proposed Future Homes Standard, and supporting retrofit across the whole building stock (incl. owner-occupier, social and private-rented homes)[42]. The integration of separate policies in a holistic framework would be critical to encourage the uptake of low-carbon solutions, which are likely to require combined changes to heating system, insulation and controls. Coordinating demand-side policies with supply-side measures (including network infrastructure investment and planning, skills and supply chain development) is also key to support end-user choices.

[42] CCC (2020). Reducing UK emissions: 2020: Progress Report to Parliament. https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/ (Accessed: Aug 2020)

| Behaviour | Economic/Fiscal | Information & education | Regulatory | Direct investment |
|---|---|---|---|---|
| **Change source (hydrogen-ready boiler)** | n/a | n/a | *Gas boiler ban in new built homes after 2025<br>* Phasing out high carbon fossil fuel installations off-gas grid (E)<br>*Ban on domestic coal and wet wood | n/a |
| **Change source (heat pump)** | Renewable Heat Incentive (E)<br>Clean Heat Grant (E)<br>Green Homes Grant (E)<br>Home Upgrade Grant (E)<br>Warmer Homes (S)<br>Nest fuel poverty scheme (W) | Green GB & NI week<br>Energy Labelling Regulation (focus on heating technologies)<br>Simple Energy Advice (S) | As above | Home Energy Efficiency Programmes Scotland (HEEPS) (S)<br>Arbed area-based programme (W) |
| **Change source (DHN)** | Energy Company Obligation (connection, extension or heat meter) (S,W,E) | n/a | As above<br>Heat network market framework (E&W) & similar regulation (S) | Home Energy Efficiency Programmes Scotland (HEEPS) (S)<br>Heat Networks Investment Project (HNIP) (E, W) |
| **Improve building (insulation & glazing)** | Clean Heat Grant, Green Homes Grant, Home Upgrade Grant (E)<br>Energy Company Obligation (S,W,E)<br>Energy Efficient Scotland programme, Home Energy Loan Scheme, Energy Efficiency Programme pilots, Warmer Homes (S)<br>Nest fuel poverty Scheme (W)<br>Affordable Warmth Scheme (NI) | Energy Performance Certificates (all)<br>Simple Energy Advice<br>Energy Efficient Scotland, Home Energy Scotland (S)<br>Energy Savings Trust best practice programme and advice (all) | Minimum Energy Efficiency Standards for the private rented sector (regional versions)<br>Future Homes Standard (building standard)<br>Part L Building regulation requirements (regional versions)<br>Decent homes programme | Home Energy Efficiency Programmes Scotland (HEEPS) Area Based Schemes<br>Social Housing Decarbonisation Fund (E) |
| **Flexibility (better control)** | Clean heat grant (include controls) (E)<br>Energy Company Obligation (all)<br>Warmer Homes (S)<br>Nest fuel poverty Scheme (W)<br>Northern Ireland Sustainable Energy Programme (NI) | Energy Efficient Scotland and other advice providers cover smart heat controls | Boiler Plus Scheme requires control installation<br>*Secure by Design (impact on smart controls)<br>*Smart data review (impact on consumer protection) | n/a |
| **Use less (fewer rooms or hours, lower temperature)** | *Programmes above funding controls | Advice providers as above<br>Climate week (S), Year of Climate Action (all) | *Smart metering implementation programme (incl. feedback loops to customer) | *Smart metering innovation trials and tools |

**Table 3 (previous page): Overview of key policies affecting emission-reducing behaviour in the area of heat decarbonisation (*marks indirect impact; green marks policies with likely positive impact for the behaviours; red indicated policies with likely negative impact; grey marks policies, which have been announced but not yet implemented at the time of writing; (E), (S), (W), (NI) denote England, Scotland, Wales and Northern Ireland specific policies)**

## Transport

The policy mapping identified active travel and switch to EV as the areas where the policy framework at present is most integrated, deploying a combination of economic and fiscal incentives, information and education campaigns, direct investment and regulatory approaches alongside a range of other measures. The policy framework to encourage reduction in consumption, service uptake and modal shift is less comprehensive. Reducing and encouraging modal shift from air travel in particular is not well targeted, with incentives such as reduced rate VAT for domestic flights potentially having negative impact on incentives to change behaviour or switch to alternative modes of transport. Behaviour change and demand side ambitions are clearly featured in the Transport Decarbonisation Plan (England), Cycling and Walking Investment Strategy (England) and National Transport Strategy (Scotland), but policy proposals are still under development, including comprehensive strategies to encourage public transport, coach and train travel.

Although much policy is in place for transport, there are certain areas where further development is required [43] – walking and cycling infrastructure investment, active travel support schemes, public transport investment, reducing car travel demand (car sharing and mobility as a service) and infrastructure connectivity to lock-in positive behaviours (e.g. home working). We anticipate a comprehensive policy framework for aviation (incl. not only demand but supply-side measures) that is needed if changes in this behaviour are to contribute to a transition to Net Zero. No policies directly targeting the development of services were identified, including for car sharing, carpools, mobility as a service. Local-level policies such as parking planning and charges, clean air zones, congestion charging and indirect policy impact on cost of ownership and maintenance of vehicles are likely to affect uptake, but further research is required to understand developments.

[43] CCC (2020). Reducing UK emissions: 2020: Progress Report to Parliament. https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/ (Accessed: Aug 2020)

| Behaviour | Economic/Fiscal | Information & education | Regulatory | Direct investment |
|---|---|---|---|---|
| **Reduce (carpool)** | * Local Congestion charging & road pricing initiatives<br>* Clean air zones | n/a | * Proposed ban on sale of petrol/ diesel vehicles | n/a |
| **Reduce (air travel)** | Air passenger duty<br>Fuel tax exemptions (see note, below) | n/a | n/a | n/a |
| **Active travel** | *Local Congestion charging & road pricing initiatives<br>*Parking levies/charges<br>Cycle to work scheme<br>Fix Your Bike scheme | Walk to School Outreach<br>Bikeability training<br>Big Bike Revival social marketing campaign<br>PlusBike guidance on taking bikes on trains | Proposed Highway code review | Access Fund<br>Cycling and walking to work fund<br>Cycle Ambition Cities programme<br>* HS2 Road Safety Fund<br>Rail Cycle infrastructure |
| **Modal shift (train, couch, public transport)** | Concessionary travel schemes<br>Smart ticketing (single or multi modal)<br>* Parking charges/levies | *Community rail partnerships | n/a | Major rail infrastructure projects: High Speed 2, Great North Rail, Crossrail, Merseyrail<br>Local public transport schemes |
| **Services (mobility as a service, car club membership)** | * Exemption congestion zone (London)<br>* Local Congestion charging and road pricing initiatives<br>* Charging clean air zones<br>* Incentives via fuel duty, VED, vehicle taxation<br>* Parking charges/levies | n/a | Proposed Mobility as a Service Code of Practice' | n/a |
| **Switch to EV (and adopt smart charging)** | EV home charge scheme & On-street Residential ChargePoint Scheme (ORCS)<br>Plug in Grants<br>* Incentives via fuel duty, VED, vehicle taxation<br>Reduced VAT on electricity consumption | Fuel Economy & CO2 labels for cars<br>Go Ultra Low campaign<br>Smarter price comparison tools | Proposed ban on sale of petrol/ diesel vehicles<br>* Smart charging & smart metering programmes (e.g. Automated & Electric Vehicles Act; Smart by design; Smart data review; technical standards) | Charging infrastructure investment (multiple funds)<br>* Road investment strategy |

**Table 4: Overview of key policies affecting emission-reducing behaviour in the area of transport decarbonisation (*marks indirect impact; green marks policies with likely positive impact for the behaviours; red indicated policies with likely negative impact; grey marks policies, which have been announced but not yet implemented; (E), (S), (W), (NI) denote England, Scotland, Wales and Northern Ireland specific policies)**

**(Note: Fuel tax exemptions are a requirement of the International Aviation Convention, not a UK policy decision)**

## Electricity

Power sector decarbonisation plans are aligned with Net Zero ambitions, and policy to date has been successful in supporting the realisation of significant carbon reductions, with policies extensively focusing on supply side measures, including subsidies for renewable electricity generators, electricity market reforms, and carbon pricing via the EU ETS and Carbon Prices Support. Electricity policy is largely reserved, apart from Northern Ireland which has devolved control over energy as well as heat sectors. Differences in policy for the remaining nations are less pronounced than in the area of heat and transport, although they have progressed at different speeds[44].

Demand-side policies are relatively few and dominated by regulatory instruments. Regulatory action has focused on roll-out of smart metering (via smart metering implementation programme led through energy supply obligations), more recently shifting towards the wider enabling framework, including proposals to develop smart appliances regulatory requirements and technical standards, cyber security and consumer protection measures. Information and education tools are relatively limited, aside from ongoing development of price comparison websites that will support switching to smart time-of-use tariffs and potentially, bundled offerings (e.g., EV lease + EV tariff). Direct investment is also generally not utilised beyond funding for economic/fiscal measures to support PV deployment.

Further policy mechanisms to encourage demand side flexibility from electric heat and electric vehicle users are needed to limit the need for network and generation investment.

[44] Scotland leads the UK on rate of power sector decarbonisation, with renewables making 90% of gross electricity consumption in 2019, Wales is a net exporter with large gas-generation capacity. Ref: CCC (2020). Reducing UK emissions: 2020: Progress Report to Parliament. https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament (Accessed: Aug 2020)

| Behaviour | Economic/Fiscal | Information & education | Regulatory | Direct investment |
|---|---|---|---|---|
| **Reduce (purchase high efficiency appliances, install LEDs)** | Northern Ireland Sustainable Energy Programme (funds LEDs) (NI only) | n/a | *Energy labelling regulation<br>*Energy efficiency regulation<br>*EU Ecodesing directive | n/a |
| **Flexibility (smart appliances, smart charging, use appliances with low-carbon electricity)** | n/a | n/a | Smart metering implementation programme<br>*Smart meter enabled time of use tariffs (enabled via Half Hourly Settlement Reform)<br>*Smart appliances regulatory requirements<br>* Technical standards EV smart charging and smart appliances<br>*Secure by Design (cyber security, smart devices)<br>* Smart Data review (consumer protection) | n/a |
| **Service (Switch to time of use tariff)** | n/a | *Price comparison websites for new tariffs | n/a | n/a |
| **Change source (install solar PV)** | Smart Export Guarantee (E)<br>Feed-in- Tariffs (E, S, W) - existing installations<br>The Home Energy Scotland Loan Scheme (S)<br>Home Energy Efficiency Programmes Scotland (HEEPS) (S)<br>Warmer Homes (S)<br>Nest fuel poverty Scheme (W)<br>Arbed scheme (W) | n/a | n/a | n/a |

**Table 5: Overview of key policies affecting emission-reducing behaviour in the area of electricity decarbonisation (*marks indirect impact; green marks policies with likely positive impact for the behaviours; red indicated policies with likely negative impact; grey marks policies, which have been announced but not yet implemented at the time of writing; (E), (S), (W), (NI) denote England, Scotland, Wales and Northern Ireland specific policies)**

## Consumption

Consumption policies stem from a mix of reserved and devolved responsibilities, however the implementation of EU Waste Directives and Circular Economy Packages result in similarities in approaches across nations. Consumption is an area where voluntary, third sector and public-private partnerships are most pronounced as explicit policy instruments, and information and education campaigns play the most prominent role. However, circular economy policies are currently under development across all nations[45]. Packages include aspects around the prevention of avoidable food waste by adopting whole supply chain approaches, active work with communities and businesses to promote prevention and re-use, eco-design initiatives, supply chain partnerships, government procurement, third sector and business engagement, improvement in data and monitoring, and R&D. The Committee on Climate Change highlights that policies are still needed to accelerate the move to a circular economy, with more ambition on waste reduction, re-use and recycling during the 2020s, particularly in England and Northern Ireland.

The Eatwell Guide[46] is the most prominent information and education tool targeting healthy eating and balanced diet habits. Although not focused on carbon emissions, many of the recommendations in the guide are expected to lead to a reduction in the environmental impact of UK diets. Initial policy review suggests limited use of other policy instruments such as economic/fiscal measures, direct investment and regulatory instruments to encourage healthy eating and reduction of meat/dairy consumption beyond a focus on foods high in fat, sugar or salt. On the supply side, the Agriculture Bill currently under development has potential to incentivise lower-carbon food production methods, which could support end-user choice of lower-carbon foods and lower-impact producers in future (e.g. if combined with parallel policies (e.g. information campaigns, labelling)).

[45] National Food Strategy and Food White Paper (England), Towards zero waste and new circular economy strategy (Wales), New Waste Management Strategy (Northern Ireland), Circular economy and waste policy (Scotland).
[46] NHS Eatwell Guide. https://www.nhs.uk/live-well/eat-well/the-eatwell-guide/ (Accessed: Aug 2020)

| Behaviour | Economic/Fiscal | Information & education | Regulatory | Direct investment |
|---|---|---|---|---|
| **Reduce (food waste)** | n/a | * new labelling approaches (best before)<br>Love Food Hate Waste campaign (regional coverage); Behaviour change campaigns - Crushing it (UK, post Covid-19)<br>*provide information on retailer food waste practices (E) | *Annual reporting of food surplus and waste by food businesses, seeking legal powers for waste targets and surplus reduction obligations (E) | * funding for pilot schemes for food waste (third sector) |
| **Switch (sustainable products)** | *Deposit Return Scheme for drinks containers (S,E,W)<br>*Environmental charging (S) | *Include warranties into labelling, for example a 5-year warranty label (E)<br>*Ecolabels (E) - e.g. info regarding products' recycling<br>*Eco-schools programme and engagement with young people (W) | Extended Producer Responsibility (all)<br>*Bans/restrictions to certain single use plastics (all, regional implementation)<br>*Mandatory disclosure of expected product lifetimes, mandatory extended warranties | Eco-design initiatives (all)<br>Local authority partnerships on e.g. recycling (W only one with targets)<br>*Support consumer campaigns to promote reusable alternatives (E) |
| **Switch (diet)** | n/a | * review "traffic light" label<br>* cut-off home businesses to add calorie labels<br>* calorie labels for alcohol<br>EatWell | * Legislating to end the promotion of foods high in fat, sugar or salt (HFSS) (E)<br>* Banning the advertising of HFSS products (E) | n/a |

**Table 6: Overview of key policies affecting emission-reducing behaviour in the area of consumption (*marks indirect impact; green marks policies with likely positive impact for the behaviours; red indicated policies with likely negative impact; yellow marks policies, which have been announced but not yet implemented at the time of writing; (E), (S), (W), (NI) denote England, Scotland, Wales and Northern Ireland specific policies)**

# Insights

- The achievement of the Net Zero target will require bold and well-integrated policies to allow higher speed and larger scale of transition combined with faster phase out of existing systems that may lock-in carbon emissions. Having a clear, long-term policy framework has been highlighted as key for managing costs and maximising opportunities from the transition[47]. The order in which policies are implemented will also affect the cost-benefits and the engagement of stakeholders, this warrants careful consideration (as will be discussed in more detail in WP2: International Review).
- To date, overall policy focus has been placed more on supply-side measures (e.g. renewable electricity subsidies, energy efficiency standards for manufacturers, landfill tax aimed at change of waste disposal), but demand-side policies to encourage shift to alternative behaviours are increasingly recognised as critical enabling factors for the transition. A portfolio of policy instruments is likely to be needed to address behavioural barriers and drive change at scale.
- There are a few useful examples of integrated use of policy levers to target specific behavioural change in the transport sector: e.g. supporting EV-uptake through a combination of charging infrastructure investment, EV purchase grants, information campaigns and regulatory standards. Similarly, active travel has seen increased support through direct funding, social marketing and education campaigns, and direct and indirect economic incentives (e.g. Fix your Bike and Cycle to work Schemes, congestion charging). For other behaviours, such as modal shift to train, coach or public transport, the landscape is more fragmented. Reducing and encouraging modal shift from air travel in particular is not well targeted, with incentives such as reduced rate VAT for domestic flights potentially having negative impact on incentives to change behaviour or switch to alternative modes of transport. Certain areas where policies exist require strengthening.
- In heat, a significant number of economic measures (e.g. grants, loans) are in place to support building improvements and potential change of heating source. Regulatory standards (e.g. building regulation and energy efficiency) are also in place, with visible differences between devolved nations. Some technologies (e.g. hydrogen-ready boilers) are not directly supported at present, but due to co-dependency on relevant hydrogen infrastructure development an integrated strategy is more appropriate. Other less familiar solutions (e.g. heat networks) benefit from direct investment but are not supported via end-user policies (e.g. information & education campaigns). Flexibility (better control) and reducing consumption (different heating patterns) are closely related and can be supported indirectly via available funding through energy efficiency programmes, and information provision (e.g. via in-home displays). Despite multitude of policies in place, significant gaps remain in terms of scope, speed of delivery, policy integration and funding needed to achieve a Net Zero transition.

[47] Ekins, P. (2019). Report to the Committee on Climate Change of the Advisory Group on Costs and Benefits of Net Zero. https://www.theccc.org.uk/wp-content/uploads/2019/05/Advisory-Group-on-Costs-and-Benefits-of-Net-Zero.pdf (Accessed: Aug 2020)

- In electricity, policies extensively focusing on supply side measures have been successful in reducing carbon intensity of electricity supply. Beyond direct support for small-scale renewable generation, demand-side policies are relatively few and dominated by regulatory instruments. Regulatory action has focused on roll-out of smart metering (via smart metering implementation programme led through energy supply obligations), more recently shifting towards the wider enabling framework, including proposals to develop smart appliances regulatory requirements and technical standards, cyber security and consumer protection measures. Information and education tools are relatively limited, aside from price comparison websites for new tariffs which can support switch to time of use tariffs.
- In the area of consumption, voluntary, third sector and public-private partnerships are most pronounced as explicit policy instruments, and information and education campaigns play a more prominent role (e.g. Love Food, Hate Waste campaign, Eatwell Guidance, food labelling). Circular economy policies are currently under development across all nations, with proposals for additional economic incentives (e.g. Deposit Return Scheme), information tools (e.g. eco labelling, new food labels), and to a lesser degree additional direct funding (e.g. food waste pilots and sustainable consumption campaigns). The Committee on Climate Change has highlighted that policies are still needed to accelerate the move to a circular economy, with more ambition on waste reduction, re-use and recycling during the 2020s, particularly in England and Northern Ireland.
- Service-led behaviour change options (e.g. mobility as a service, car clubs, car-pools, energy- or heat-as-a service) face the least amount of direct policy support across all sectors, likely linked to their relatively recent development. Detailed assessment of policy gaps to encourage service uptake and understand behavioural barriers can be a beneficial step towards future development.
- While overarching public campaigns exist (e.g. Year of Climate Action, Scotland's Climate Week), these are typically limited in scale and longevity. Consistency in messaging and a comprehensive plan on public engagement to raise public awareness and encourage behavioural change across sectors is still required[48].

[48] CCC (2020). Reducing UK emissions: 2020: Progress Report to Parliament. https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/ (Accessed: Aug 2020)

# COVID-19 Impact

## Introduction

The spread of COVID-19 and the resulting measures put in place in early 2020 had significant and wide-reaching implications for many aspects of people's lives. The work from home orders, non-essential shops, cafes, restaurants and leisure facilities, and the restrictions on leaving our homes meant that people were travelling less, buying less, and therefore spending their time differently than they would have otherwise.

Many of the prioritised behavioural changes identified in this work have been impacted by the COVID-19 pandemic. The available evidence was analysed to understand the impact of enforced behavioural change in these areas and to ascertain whether the changes experienced are likely to be temporary or structural in nature. Or, indeed, whether they have already returned to normal (at the time of analysis – August 2020).

## Methodology

The approach taken was to work through each of the prioritised behaviours within each of the sectors and carry out a search for literature or data on any impact from COVID-19. For many of the behaviours, this involved analysis of raw data to identify any difference between 2019 and 2020 (for example, BEIS Domestic RHI data to give an indication of installations of low carbon heat sources). Along with this, reference was made to existing literature and analysis to show additional implications.

## Heat

The use and occupancy of domestic buildings was significantly impacted by COVID-19. Particularly during the initial national 'lockdown period'. While there is a general return to the pre-COVID status, there are some longer lasting implications, such as those resulting from the ongoing increase in home working. This is both in the energy use and emissions associated with heating those buildings, and with the rate of installation of new systems which are required to achieve Net Zero.

### Heating use

The introduction of lockdown in late March 2020 resulted in significant changes to the daily routines of a large proportion of the UK population. Daytime occupancy of homes increased while there was a reduction in travelling to work and for leisure. This is shown by some of the transport statistics discussed below. The result of this was an increase in domestic energy consumption and a change in demand profiles[49]. The direct impact on domestic gas

[49] https://octopus.energy/blog/domestic-energy-usage-patterns-during-social-distancing/ (Accessed: Aug 2020)

consumption (taken as a proxy for heat demand) has been less pronounced. This is, in part, thanks to the time of year that the pandemic hit, with the UK emerging from the height of the heating season.

The impact on vulnerable households, and particularly those in fuel poverty, is important to consider going forward. There will be further challenges if there are further increases in COVID-19 cases, and restrictions continue through the winter heating season. Adding to this, 17% of households reported that they were worried about falling behind on energy bills due to lost income during the pandemic[50].

## Installation of equipment

The other behavioural change which has been impacted by COVID-19 is the installation of insulation measures and low carbon heat sources. BEIS RHI Monthly Deployment Data gives a clear indication of a reduction in system accreditations. In January and February 2020, 62% more systems were accredited than the average of the previous 4 years, which followed the upward trend seen over the previous year. For March and April, this dropped to 14% above the 4-year average, and by April and May, it was 4% lower (see Figure 7). This is likely to be a direct result of the restrictions imposed during lockdown and the inability of installers to carry out installations.

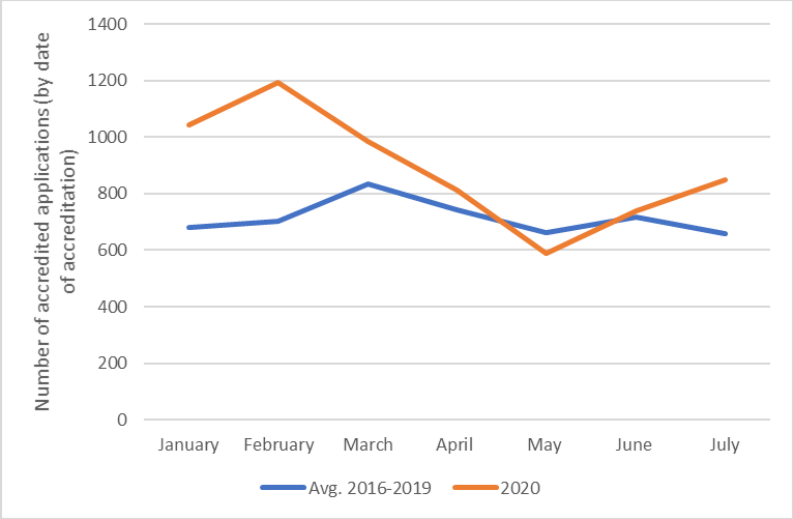



**Figure 7: Number of accredited applications (by date of accreditation) to the Domestic Renewable Heat Incentive (RHI) Scheme (data source: BEIS RHI Monthly Deployment Data)**

[50] OFGEM (2020). Consumers' Experiences with Energy During the Covid-19 Pandemic Summary of Research Findings. https://www.ofgem.gov.uk/publications-and-updates/consumers-experiences-energy-during-covid-19-pandemic-summary-research-findings (Accessed: Aug 2020)

# Transport

COVID-19 has had a significant impact on all forms of travel, with usage levels initially plummeting during lockdown. The subsequent recovery in activity, has been highly variable across different modes. Using provisional government statistics[51] and wider media commentary, an indication of the short-term impacts is provided below.

## Surface transport

Following lockdown in late March, the use of cars dropped to about 30% of normal levels during the month of April. However, given advice on social distancing (specifically to avoid public transport where possible) car use then recovered to around 90% of normal levels by August.

Rail and bus travel fell away to much lower levels, respectively 5% and 10% of normal levels for April. Social distancing advice has inhibited the recovery for these modes, with August levels remaining low: 35% for rail and 43% for bus travel.

It was not possible to obtain evidence on the level of car sharing during the pandemic, but intuitively it would be expected that shared vehicle occupancy by members of multiple households has declined significantly due to social distancing advice. The prevalence of single/reduced occupancy vehicles is therefore likely to be playing a part in the recovery in private car use (measured by vehicle count), even as workplace attendance etc remains below normal levels.

Active travel has increased significantly during the pandemic. Statistics for cycling show journeys by bike were double the normal level during weekdays, and three times higher than normal on weekends. While this represents a clear health benefit at least, the extent to which these journeys are substituting for car journeys is unclear. In many cases, people will be choosing active travel over public transport, given social distancing advice, so the emissions reduction benefit will be that much lower. In other cases, these will be purely additional journeys taken for exercise/leisure.

In the medium term, while the pandemic is ongoing, it is highly likely that public transport use will remain out of favour for those with the option of working from home, travelling by car, or for short journeys where active travel is an option. Where people opt for increased private car use, at a time when the majority of cars are still petrol/diesel fuelled, this will clearly impact on emissions levels.

The pandemic has accelerated a pre-existing trend towards more flexible working. Companies and their employees have been forced to adapt, experiment and innovate almost overnight, and many have discovered that the new arrangements are perfectly viable, productive and in

[51] https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic (Accessed: Aug 2020)

many cases preferable to office working. As a result, an initial CIPD survey[52] suggests that employers now expect two fifths of employees to continue working from home post-COVID-19, compared to one fifth before. There will be inevitable differences between sectors, however, this gives an indication of the scale of change.

The long-term impact on travel from these shifts in working patterns is complex and uncertain. Less travel overall seems as though it ought to lead to a reduction in transport emissions, yet as has been shown, in the near term there has been a rebound in private car use in particular. Post-pandemic, any emissions reduction from new working patterns may be less significant than anticipated if it is mainly public transport users who opt to forego the daily commute. This is not inconceivable if public transport infrastructure and services deteriorate as a result of the economic impact of sustained low demand.

For drivers, a general reduction in traffic volumes may reduce congestion and make commuting by car less stressful than before, causing a slight increase in levels of driving. Also, it has long been suggested that households with a second car would make ideal candidates for EV adoption, given the limited duty cycles these vehicles typically perform. Many of these households may now question the need for a second car altogether (while retaining long-range as a requirement for their primary car, reducing the overall car parc[53], but slowing the adoption of EVs in particular). These points are all speculative, but speak to the fact that in the present moment, the future of travel behaviour is hard to predict and may contain a number of surprises yet.

## Aviation

During the immediate lockdown period, the aviation industry was effectively grounded. Since then, the market has cautiously reopened for travel via air bridges to selected 'safe' regions, but against a backdrop of continuing advice from HM Government against all but essential travel.

The International Civil Aviation Organisation (ICAO) estimates the global impact for the year 2020 will amount to a reduction in air travel of approximately 50%[54].

In terms of leisure travel, holidaymakers have been forced to adapt this year and opt for staycations over foreign travel (one of the priority behaviours drawn out from our wider analysis). It is too soon to tell whether this will lead to an enduring change in attitudes and preferences (positive or negative), but it is important to note that the UK has experienced strong growth in aviation demand for some decades now, with almost 4% per annum growth since 1990[55]. Although there is evidence that the market may have started to mature, and growth rates started to slow, it is quite another thing to imagine that the reduction in demand

[52] People Management (2020). Home Working Set to Double Post Coronavirus Crisis, Survey Finds. https://www.peoplemanagement.co.uk/news/articles/home-working-set-to-double-post-coronavirus-crisis (Accessed: Aug 2020)
[53] Car parc is term for the total number of registered vehicles in a region, the UK in this case.
[54] ICAO (2020). Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis. https://www.icao.int/sustainability/Pages/Economic-Impacts-of-COVID-19.aspx (Accessed: Aug 2020)
[55] DfT (2017). UK Aviation Forecasts 2017. https://www.gov.uk/government/publications/uk-aviation-forecasts-2017 (Accessed: Aug 2020)

due to the pandemic represents a new equilibrium that people will accept going forward. Rather, estimates regarding demand recovery have suggested that within 3-5 years things may return to where they were pre-COVID-19[56]. Forecasts such as this suggest we are some way away from observing a meaningful and enduring shift from foreign holidays towards staycations, in support of Net Zero.

One of the more enduring consequences of the lockdown period may be the realisation by companies of just how much business can be effectively conducted remotely, translating to fewer business journeys in the longer term, but this was out of scope in our study.

# Electricity

## Electricity Demand

As with heat, the changes in people's lives as a result of the COVID-19 restrictions had implications for both the amount of electricity used and the profile of that use in homes. On a national scale, the result of this was that electricity consumption reduced by 24% between w/c 9th March and w/c 6th April (compared to a maximum of 5% over the same period in 2019)[57]. This was primarily due to schools, shops, factories and offices closing, but this was slightly offset by an increase in domestic consumption as people spent more time at home.

Shell Energy reported that analysis of Smart Meter data from their domestic customers suggested that home electricity consumption increased by 15% in the 4 days following the announcement that the UK would enter a period of Lockdown[58]. In addition to this, analysis by Octopus Energy of data from some of their customers showed a significant change in when electricity was being used by some[59]. As shown in Figure 8, they identified customers whose usage profiles suggested that they were spending more time at home (only 15% of customers at that time of analysis as this was before the start of formal lockdown and only resulted from government advice to avoid social contact). This indicates that the measures taken resulted in much more electricity being used during the day than beforehand.

[56] Flight Global (2020). Demand for Air Travel to Remain Low Until 2023: S&P. https://www.flightglobal.com/airlines/demand-for-air-travel-to-remain-low-until-2023-sandp/138613.article (Accessed: Aug 2020)
[57] Frontier Economics (2020). How is COVID 19 Impacting the UK Electricity System?. https://www.frontier-economics.com/uk/en/news-and-articles/articles/article-i7214-how-is-covid-19-impacting-the-uk-electricity-system/ (Accessed: Aug 2020)
[58] https://www.shellenergy.co.uk/about-us/media-centre/press-releases/changing-habits-during-lockdown (Accessed: Aug 2020)
[59] https://octopus.energy/blog/domestic-energy-usage-patterns-during-social-distancing/ (Accessed: Aug 2020)

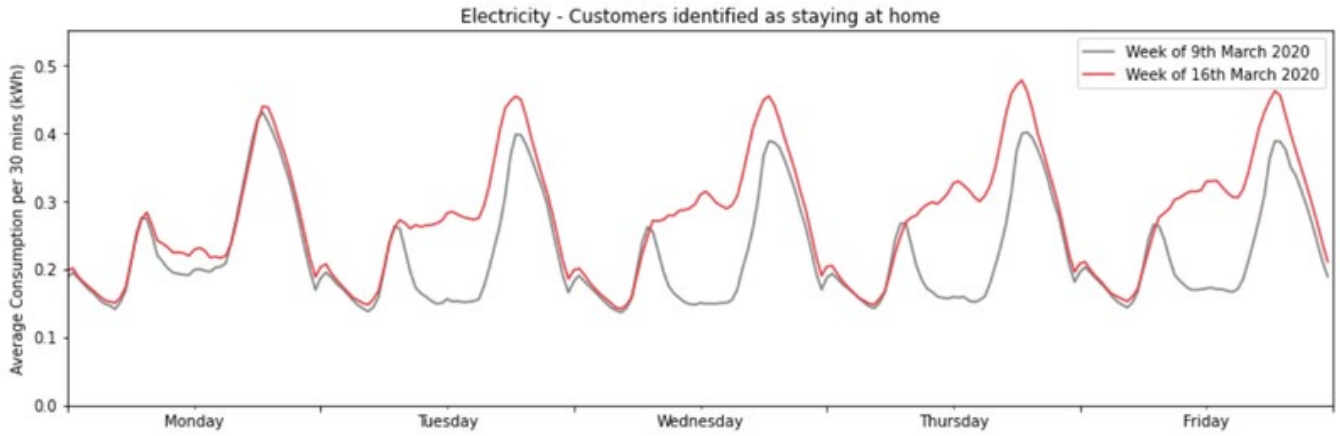



**Figure 8: Comparison of electricity consumption profiles for w/c 9th Marth and w/c 16th March for customers identified as staying at home, Source: Octopus Energy[60]**

The analysis by Octopus Energy also suggested that the total electricity consumption for customers identified as staying at home increased by 30%. This is more than the average reported by Shell Energy and indicates that there is some clear variation in the impact. As with the impact on heating, those whose lives were less impacted – retirees, essential workers, household that had daytime occupancy before the lockdown – show a smaller change in their electricity demand.

A wider implication of this change in how much (and when) electricity is used in homes, is that the traditional peaks in demand were less pronounced. The degree of this change is likely to have lessened as people slowly returned to some form of normality, however, the indication that the prevalence of home working will remain higher than pre-COVID levels indicates that there may be some lasting impact[61]. This may impact some of the thinking around Time of Use (ToU) tariffs going forward and have implications for business models looking to exploit them. However, as discussed at the start of this section, the larger impact on the wider electricity system was from outside the domestic sector, and the impacts of schools, factories, offices and shops re-opening are likely to outweigh those in homes.

An indirect impact of COVID-19 on the electricity (and gas) behaviours results from the wider implications for the economy and levels of unemployment. Ofgem polling of domestic energy consumers in May 2020 suggested that "*nearly half of 16-24 year olds surveyed (48%) were worried about falling behind on energy bills due to reduced income*"[62].

[60] https://octopus.energy/blog/domestic-energy-usage-patterns-during-social-distancing/ (Accessed: Aug 2020)
[61] People Management (2020). Home Working Set to Double Post Coronavirus Crisis, Survey Finds. https://www.peoplemanagement.co.uk/news/articles/home-working-set-to-double-post-coronavirus-crisis (Accessed: Aug 2020)
[62] Ofgem (2020). Consumers' Experiences with Energy During the Covid-19 Pandemic - Summary of Research Findings. https://www.ofgem.gov.uk/publications-and-updates/consumers-experiences-energy-during-covid-19-pandemic-summary-research-findings (Accessed: Aug 2020)

### Solar PV installation

To give an indication of the impact of COVID-19 on the installation of PV systems in homes, BEIS data[63] has been analysed as shown in Figure 9. This shows that systems in the capacity range up to and including 4kW (which should capture most domestic installations) dropped dramatically in April, May and June 2020. This has started to recover, however the latest data available is for July 2020, so we are yet to see a return to pre-COVID-19 levels.

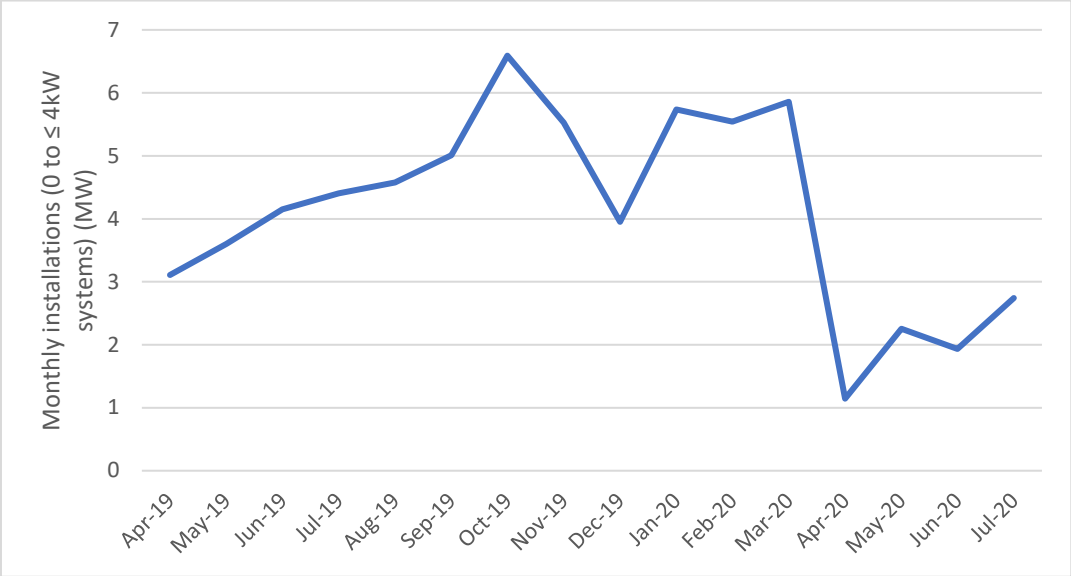



**Figure 9: Monthly installation of solar PV systems of 0 to ≤ 4kW, Data source: BEIS**

## Consumption

### Reducing food waste

Two surveys by WRAP, the UK's waste advisory body, detail the impact of COVID-19 on food waste. The first was published in May in the midst of the lockdown, and the second in July as restrictions started to ease. The initial survey found that people were "*managing their food better in lockdown, including more pre-shop planning, better in-home food management and using creative approaches to cooking*"[64].

Aspects of our food purchasing behaviour may have been initially skewed due to fear and uncertainty over the full extent of the lockdown, with increases in the purchase of longer life products. Other changes may be more reflective of how we choose to live when under less time pressure from daily commuting, including more fresh food and less ready meals. Crucially, this increase in fresh produce does not appear to have caused a corresponding increase in

[63] BEIS (2020) Solar Photovoltaics Deployment in the UK, July 2020, Table 1. https://www.gov.uk/government/statistics/solar-photovoltaics-deployment (Accessed: Aug 2020)
[64] WRAP (2020). Citizens and food during lockdown. https://www.wrap.org.uk/content/citizens-and-food-covid-19-lockdown (Accessed: Aug 2020)

food waste, in fact the Wrap survey suggests the opposite, with "*a reported 34% reduction in waste of potatoes, bread, chicken, and milk*".

The follow up survey in July revealed a continued aspiration towards better food management, but reported an uptick in levels of food waste as the lockdown began to ease[65], see Figure 10. This represents a 30% increase in food waste in June relative to April.

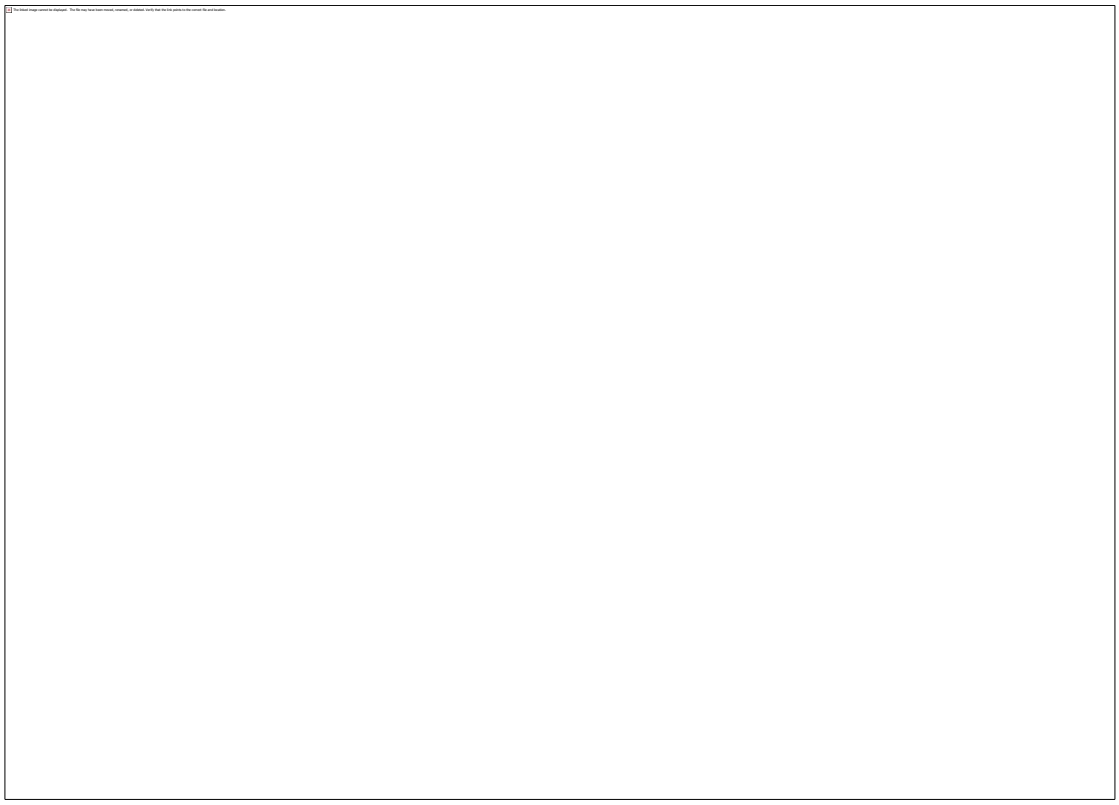


**Figure 10: 'Levels of food waste are creeping up' as lockdown eases, Source: WRAP[66]**

## Eating healthily

An August article in the British Medical Journal, focusing on the impacts of food poverty and using data from the UK's National Food Strategy review, points to a reduction in fruit and vegetable consumption among children, especially poorer children[67]. The article highlights the challenge of obtaining quantitative data on food consumption and health impacts during the pandemic, and indeed other survey data would seem to be inconsistent with their own.

[65] WRAP (2020). Citizens and food waste as lockdown eases. https://wrap.org.uk/content/citizens-and-food-waste-lockdown-eases (Accessed: Aug 2020)
[66] WRAP (2020). Citizens and food waste as lockdown eases. https://wrap.org.uk/content/citizens-and-food-waste-lockdown-eases (Accessed: Aug 2020)
[67] BMJ (2020). Fears grow of nutritional crisis in lockdown UK. BMJ 2020;370:m3193. https://www.bmj.com/content/370/bmj.m3193 (Accessed: Aug 2020)

For example, a survey by Obesity Action Scotland in June explored the impact of lockdown on Scottish diets[68]. In this Scottish survey, around a third of people reported eating more fruit and vegetables, as well as fewer ready meals and takeaways. While 'more fruit and veg' is a positive, in terms of the environmental benefit it is important that this is substituting for other more carbon intensive food products. Concerningly, most people reported they were simply eating more in general (and around half are eating more cakes and confectionary, while a third are drinking more alcohol). There was no evidence provided on levels of meat or dairy consumption specifically.

As the lockdown has started to ease, a public engagement campaign ('Better Health') has been launched to encourage British people to lose weight to fight coronavirus, but it is too early to tell whether diets have changed or will change, whether in response to this campaign or due to more general concerns.

## Buy sustainable products

In normal times, households actively looking to buy more sustainable products and services have two main options. First, they can reallocate spending from more to less carbon intensive categories of goods and services, e.g. from flying abroad to staycations. Second, within a given category, they can shift spending from more to less carbon intensive goods of that type, e.g. a different brand of clothing, made of different materials, manufactured locally vs overseas etc.

Apart from the obvious impact of the COVID-19 pandemic on reducing overall incomes (due to job losses and furloughing), the lockdown and social distancing rules have inevitably caused some reallocation of spending across categories. According to the Institute for Fiscal Studies[69] around 25% of normal household spending is on goods and services prohibited or discouraged as part of the immediate COVID-19 response (including travel, leisure and eating out). There is an important distributional element to this. Wealthier households typically spend a higher proportion of their income on these discretionary goods, and so will have experienced a more significant reallocation of spending. The corollary of this is that poorer households typically spend a higher proportion of their income on essentials, meaning that any reduction in income is harder to absorb by scaling back discretionary spending.

As and when lockdown rules begin to ease and life returns to normal, much of this discretionary spending is arguably likely to return, although the allocation across categories may well be different, due to increased working from home etc. In terms of the associated carbon impact, some of the more pertinent cases are covered elsewhere in the discussion around specific behaviours such as travel, diet, and home heating.

For other goods and services, it is possible that COVID-19 - not to mention other geopolitical drivers - will lead to a change in patterns of global trade, with much discussion around

[68] Obesity Action Scotland (2020). Lockdown Having Mixed Impacts on Scots Diet and Health. https://www.obesityactionscotland.org/news/lockdown-having-mixed-impacts-on-scots-diet-and-health/ (Accessed: Aug 2020)
[69] IFS (2020). Household spending and coronavirus. https://www.ifs.org.uk/publications/14795 (Accessed: Aug 2020)

improving the resilience of supply chains through 'onshoring' of activities that had previously moved offshore as part of the trend towards globalisation. This has little to do with people's conscious behaviours perhaps, but is still an example of how the wider social experience of COVID-19 might impact on our carbon footprints. Quite how this kind of shift would support a UK Net Zero target is unclear. These ‘offshore’ emissions currently do not count towards the UK emissions accounts, so onshoring them – even if it reduced carbon from a global perspective – will lead to an increase in UK activity needing to be decarbonised.

Less immediately obvious is how the pandemic might have impacted on consumer choices between goods of the same type. Much of the discussion around sustainable consumption in recent years has related specifically to plastic packaging, but the immediate impact of the pandemic has been a surge in the use of single-use plastic as a means of protecting against transmission of the virus. In any case, packaging is just one element, and not necessarily the most significant, contributing to the embedded emissions of goods and services. A more substantive effort to support a shift in consumption towards less carbon intensive goods will rely on increasing the traceability and transparency of emissions data across the whole supply chain, to enable each actor along that chain to make evidence-based decisions on sourcing of materials etc. One such initiative between Google and WWF sees the launch of an environmental data platform for the fashion industry[70].

## Insights

The spread of COVID-19 and the resulting measures put in place in early 2020 had significant and wide-reaching implications for many aspects of people’s lives. The key insights from this impact work are:

- The impacts of COVID-19 have affected many of the behaviours identified as priorities for behavioural change, particularly around transportation and the use of electricity and heat in the home.
- Many of the changes have already, or are expected to, return to pre-COVID-19 levels when the restrictions on people’s lives reduce.
- There may be lasting implications as a result of the expected persistence of a raised level of home working.

Going forward, it will be important to track this and provide a more comprehensive assessment of any lasting impact of COVID-19 on behaviours related to achieving Net Zero.

[70] https://cloud.google.com/press-releases/2020/0610/wwfandgoogle (Accessed: Aug 2020)

# Summary

This work collected evidence of the behavioural and societal changes which may have the biggest impact on achieving Net Zero. This drew on the ESC's interdisciplinary expertise and external evidence, and employed systems mapping techniques to determine the interaction between the changes and their relative importance. This included analysis of how much impact those changes can have, the current policy instruments which influence them, and the distributional impacts of those policies. The work also considered which of the priority behaviours have been affected in reaction to the current COVID-19 pandemic.

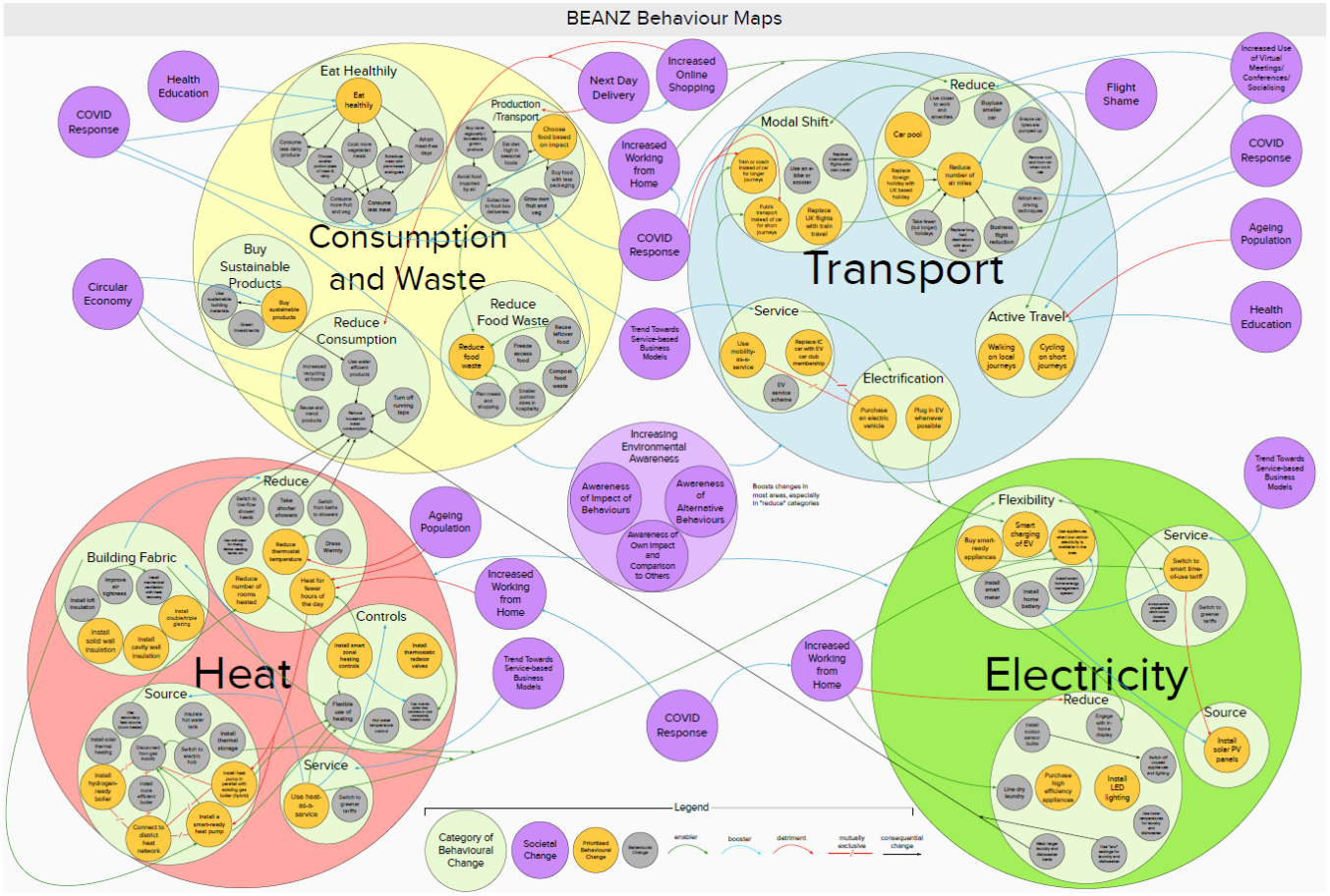
It is known that significant behavioural and societal changes are needed for the UK to successfully achieve Net Zero greenhouse gas emissions by 2050. It has been demonstrated here how complex and challenging those changes are likely to be. These is considerable interdependence between them and with the wider system. Different sections of society will face different challenges when faced with making them. The policy landscape needs to go through wide reaching changes with impact coming from a range of different policy areas.

This work has largely been the result of drawing on the expertise of a diverse group of individuals from across the Energy Systems Catapult, backed up by established techniques and literature where possible. This has not been a systematic review of all relevant literature, nor does it provide a structure for assessing the scope of actions rooted in the wider research or theory. The insights that have emerged indicate the extent of further work required to build up a robust evidence base going forward.

The work being undertaken in work package 4 of this project will start to incorporate some of these behavioural and societal system aspects into established whole energy systems modelling to assess their relative impact on emissions reduction.

# Appendix 1: Behavioural Map

See attachment.



# Appendix 2: Distributional Impact Framework

| | Income and capital | | | Building and location | | | Access and skills | | Personal situation | |
|---|---|---|---|---|---|---|---|---|---|---|
| Behaviour | capital for initial purchase of technology | credit rating and eligibility for financial support | stability of income | permission to make change to the property | availability of space for technology and equipment | availability of fuel type or service | Access to information about alternative optio | Skills to access new services and technology | Stability and permanence | Health and limiting personal circumstance |
| Heat - Use Less | no | no | no | no | no | no (4) | yes (4) | maybe | no | yes |
| Heat - Control (e.g. simple TRVs or smart heat | yes | yes | no (4) | yes (4) | no | yes (3) | yes | yes (4) | no (4) | no (3) |
| Heat - Service | no | yes | yes (4) | no (4) | no (4) | yes (4) | yes (4) | yes (4) | yes (4) | no |
| Heat - Building (fabric) | yes | yes | maybe | yes | yes | no (3) | yes | yes (4) | yes | no (4) |
| Heat - Boiler | yes | yes | maybe | yes | yes | yes | yes | yes (3) | yes | maybe |
| Transport - Reduce | no | no | no | no | no | no (3) | yes | yes (4) | no (4) | yes |
| Transport - Active Travel | no | no | no | no | maybe | maybe | yes (4) | yes (3) | no (4) | yes |
| Transport - Modal Shift | no | no | no | no | no | yes (3) | yes | yes (4) | no | yes |
| Transport - Service | no | maybe | maybe | no | no | yes (4) | yes | yes | no (4) | no (3) |
| Transport - Car (IC-EV) | yes | yes | yes | yes (3) | yes | yes | yes | yes | maybe | no (4) |
| Electricity - Reduce | yes | yes (4) | no (3) | maybe | yes (4) | yes (4) | yes | yes (4) | no (4) | no (3) |
| Electricity - Flexibility | yes | yes | no (3) | yes (3) | yes (4) | yes (4) | yes | yes | no | maybe |
| Electricity - Service | yes (3) | yes (4) | yes (3) | maybe | no (4) | yes | yes | yes | yes (3) | no (3) |
| Electricity - Source | yes | yes | maybe | yes | yes (4) | yes (3) | yes | yes (3) | yes (4) | no |
| Con + Waste - Eat more fruit + veg | yes (3) | no | no | no | no | maybe | yes (4) | maybe | no | no (3) |
| Con + Waste - reduce food waste | no | no | no | no | no (4) | no | yes (3) | yes (3) | no | no (4) |
| Con + Waste - buy sustainable products | yes (4) | maybe | yes (4) | no | no | no (4) | yes | yes | no | no (4) |

**Table 7: Final Behaviour + Participation**

| | Income and capital | | | Building and location | | | Access and skills | | Personal situation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Household type | capital for initial purchase of technology | credit rating and eligibility for financial support | stability of income | permission to make change to the property | availability of space for technology and equipment | availability of fuel type or service | Access to information about alternative | Skills to access new services and technology | Stability and permanence | Interest in change | Health and limiting personal circumstances |
| Rural | as likely | as likely | as likely | more likely | more likely | less likely | as likely | as likely | as likely | as likely | as likely |
| Low income | less likely | less likely | less likely | as likely | as likely | as likely | less likely | as likely | less likely | as likely | more likely |
| Privately renting | less likely | less likely | as likely | less likely | as likely | as likely | as likely | as likely | less likely | as likely | as likely |
| Residents with disabilities | less likely | as likely | less likely | less likely | as likely | as likely | less likely | less likely | less likely | as likely | more likely |
| Pensionable age residents | less likely | as likely | more likely | more likely | as likely | as likely | less likely | less likely | more likely | as likely | more likely |
| Digitally excluded | less likely | less likely | less likely | as likely | as likely | as likely | less likely | less likely | as likely | as likely | more likely |
| Those disproportionally affected by Covid-19 | less likely | less likely | less likely | as likely | as likely | as likely | as likely | as likely | less likely | as likely | more likely |

**Table 8: Households + Participation**

# Appendix 3: Behaviour Change Capture Spreadsheet

See attachment.

This publication is available from: www.gov.uk/beis

If you need a version of this document in a more accessible format, please email enquiries@beis.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.