TRANSPORT FOR THE South East

Decarbonisation Pathways

Report

Version 3.0

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Contents

TRANSPORT FOR THE South East

1. Purpose, process, jargon buster and data sources

Background to the report

Transport for the South East (TfSE), in their role as the Sub National Transport Body for South East England, have commissioned this Decarbonisation Pathways work to quantify both the scale of the TfSE area's transport decarbonisation challenge, and the scale of impact of different types of measures available to national, regional and local government.

Study purpose

TfSE and its constituent authorities are committed to decarbonisation. All authorities seek to reach net zero by 2050 in line with central government commitments; some have more ambitious targets. This study is intended to:

- **Quantify the scale of the transport decarbonisation challenge.** This means understanding not only the scale of transport emissions and how far and how fast they need to reduce over time, but also what types of journeys and vehicles are emitting the most carbon.
- **Identify trajectories to net zero** using different approaches based on national policy using regional transport models, as well as other national and local trajectory tools.
- **Identify and model options and scenarios that will decarbonise surface transport in the TfSE area.** Assessing their impact in delivering emissions reductions and following identified trajectories.
- **Qualitatively assess the impacts of those policies on people, places and movement in the South East.** Having identified the policies that are necessary to achieve net zero, the external impacts of these policies on the economy and land use of the South East will be assessed at a high level.

Background to the report

Technical Scope

This decarbonisation assessment covers tailpipe emissions of surface transport in the TfSE area. This means that neither embodied carbon – the emissions generated in the process of building transport infrastructure such as roads and cars – nor non-surface transport emissions (e.g. from aviation and maritime), are included. These are out of TfSE's scope for this study. Similarly, emissions caused by the generation of electricity that is then used to power vehicles is not included in the scope of this work: the work is predicated on the energy sector reaching net zero by 2050 using renewable energy.

Surface transport emissions are produced by the vehicle kilometres travelled within the South East by short and long-distance journeys that start, finish or pass-through the South East, whether by motorcycle, car, van or lorry. They include freight, business, leisure and commuting journeys.

This study only looks at greenhouse gas emissions, which cause climate change. For the transport sector, carbon dioxide accounts for about 99% of total greenhouse gas emissions. These emissions are therefore referred to throughout this report as carbon dioxide, carbon, CO_2 and CO_2e (CO_2 equivalent). Other emissions which lead to poor air quality, such as PM2.5, are not part of this work.

Geographical Scope

TfSE covers 16 constituent authorities in the South East of England, including eleven unitary authorities (Bracknell Forest, Brighton & Hove, Isle of Wight, Medway, Portsmouth, Reading, Slough, Southampton, West Berkshire, Windsor and Maidenhead, and Wokingham) and five upper tier authorities (Hampshire, East Sussex, Kent, Surrey, and West Sussex).

Surface transport carbon emissions are a function of:

Number of trips

x

Vehicle kilometres

x

CO_2 emissions per km by type of vehicle / engine

x

Speed factor

To calculate surface transport carbon emissions, we need to understand:

- How many trips are made in the TfSE area
- How long these trips are
- What type of vehicles are making these trips (motorcycles, cars, vans, lorries, trains)
- What fuel these vehicles are using and how efficient the engines are
- What speed the vehicles are travelling (this can be approximated from the type of road vehicles are driving on)

Structure of the report

Structure and Contents

The report is set out as follows:

- **Chapter 1** outlines the purpose of the work, explains the process behind the results, data sources, and provides a jargon buster.
- **Chapter 2** describes the national and regional background to this report and how it was developed.
- **Chapter 3** covers Stage 1 and Stage 2 work, which together sets the decarbonisation challenge that TfSE faces. This chapter assesses transport's total contribution to emissions, identifies what actions to reduce emissions are already under way from central government and quantifies the gap between the impact of these actions and the reductions required. The output is a series of policy objectives that, taken together, are necessary to decarbonise transport.
- **Chapter 4** covers Stage 3 work, where policy packages are developed to meet these objectives, and modelled into scenarios.
- **Chapter 5** presents Stage 4 work, evaluating these policy packages against people, place and movement types across the TfSE area.
- **Chapter 6** sets out key findings and recommendations

Chapter 1: purpose, process and jargon buster

Chapter 2: national and regional context

Chapter 3: setting the decarbonisation challenge for the South East

Chapter 4: identifying policies to meet the challenge

Chapter 5: assessing impacts of policies on people, places and movement

Chapter 6: Recommendations and Next Steps

Project process

This report provides a summary of the work undertaken to quantify the decarbonisation challenge for the TfSE area. Figure 1.1 below shows the four stages and steps that this work involved.

Figure 1.1: Overview of the Decarbonisation Pathways process

1. Baseline assessment	2. Policy gaps	3. Options identification, assessment, iteration	4. Application to people, place, movement	5. Recommendations and next steps
Baseline assessment	Identify key national and regional policies	Suggest scale changes to national / regional policies	Develop people, place, movement hierarchy	
Define core Trajectory	Test policies	Suggest options and assess against Multi Criteria Assessment Framework	Reporting	
Define alternative trajectories	Quantify gap between impact of existing proposed policies and carbon targets	Quantify emissions impacts through SEELUM		

Project process

Stages 1 & 2: Baseline assessment and policy gaps

The first two stages of work were aimed at understanding the scale of the decarbonisation challenge that the TfSE area faces. They answered a series of questions:

- How much carbon is surface transport in the TfSE area likely to emit between now and 2050?
- What types of journeys drive these emissions?
- How effective are current policies likely to be in reducing those emissions?
- If current policies are insufficient, what future policy objectives are required to reach net zero?

To answer the Stage 1 & 2 questions, we formulated five trajectories, with different policy assumptions.

Stage 3 & 4: Options identification and application to people, place and movement

Emissions reduction option identification included an examination of:

- How existing areas of intervention/policies could be adjusted/extended to reduce emissions further
- How new interventions/policies could be introduced and scaled
- Interventions/policies phasing and wider delivery (e.g. geography/rate of delivery).

These options have been collated into coherent policy packages, recognising the interdependencies between them.

The packages of options ("pathways") have been tested to assess how each package supports the region in achieving each trajectory.

TfSE's analytical framework has been used to:

- assess policy options by priority and timescale; and
- develop and assessed packages of options – "Scenarios" – using the South East England Economy and Land Use Model (SEELUM).

Model outputs will then be converted into quantum of tailpipe emissions using DEFRA's Emissions Factors Toolkit, where appropriate.

Different areas within TfSE's geography will have different opportunities/challenges and needs regarding decarbonisation. Different areas or places will have different "legacy" carbon emissions which are already embedded into their transport network and movement patterns, some areas remain heavily carbon intensive while other areas have progressed substantially down their own decarbonisation "pathway". Different socio-demographic groups might have different emission profiles and differing potential to reduce emissions from their travel and connectivity. Different movement types (e.g. longer distance orbital movements across the regions vs. inter-urban travel) have different constraints and potential when it comes to their ability to deliver net zero emissions.

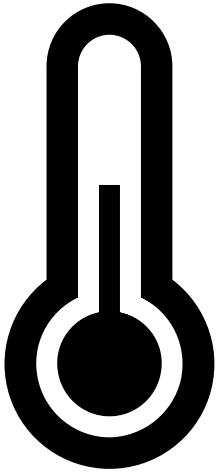
As such, the assessment will consider how interventions' potential (e.g. scale of impacts or relevance) differs for different people, places, and movement types. This report presents a decarbonisation hierarchy, or framework, bringing together:

- People: using the personas developed for TfSE's Future Mobility Strategy.
- Place: using up to six place types building on previous TfSE work (e.g. Transport Strategy and Future Mobility Strategy) and wider work from organisations such as the RTPI.
- Movement: categorisation of journey types used in the TfSE Transport Strategy.

Finally, further consideration of the deliverability, costs and revenues of implementing different localised options for demand management involving pricing mechanisms.

Jargon buster

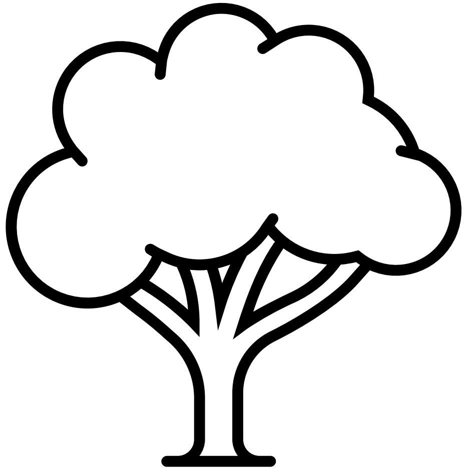
Some terms will be referred to frequently throughout this report. These include:



Carbon, carbon dioxide/CO_2, CO_2e

Carbon is a chemical element which forms a vast range of compounds, including carbon dioxide (CO_2). CO_2e is the emission of this greenhouse gas through the combustion of fossil fuels, with its properties partially responsible for continued global warming.

Transport constitutes the greatest proportion of greenhouse gases by sector[1] and as such policies and initiatives to reduce both the number and length of journeys by low-occupancy vehicles emitting high levels of carbon are required.



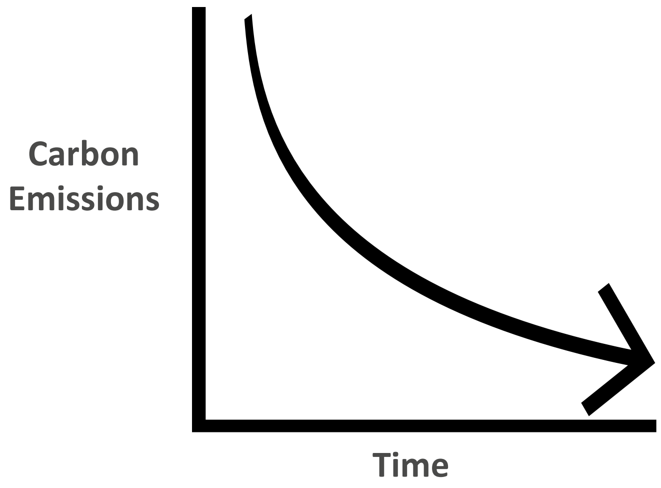
Decarbonisation

This refers to the suite of measures by which the transport sector will reduce its carbon footprint and enable local authorities to work towards net zero. This includes private cars, commercial and freight vehicles and rail.

The challenge in decarbonising the transport sector varies greatly between development contexts and demographics, journey and vehicle types. The shift to electric cars in the UK is continuing to take place but this needs to accelerate. The challenge for a shift to electric commercial and freight vehicles continues due to technological infancy.

Jargon buster

Some terms will be referred to frequently throughout this report. These include:



Trajectory

A curve identifying how future levels of carbon emissions need to be reduced to meet a carbon budget or an identified zero emissions target date.

Trajectories can either show an extrapolation of carbon emission trends or be designed to meet a carbon budget target, such as those produced by the Climate Change Committee and the Tyndall Centre.

The area underneath these trajectories is as important as the start and end point: the area underneath represents the total carbon that will be emitted over time.

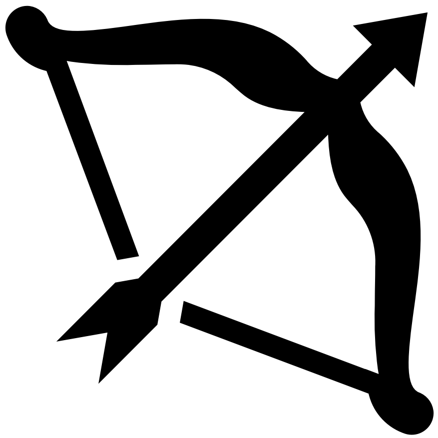
Pathway

An action plan detailing what policies are required and when they need to be introduced in order to meet a defined trajectory.

In the TfSE context, this includes local and regional policies identified in the parallel thematic studies, as well as 'global' interventions (e.g. national road charging, 'global' local interventions).

Jargon buster

Some terms will be referred to frequently throughout this report. These include:

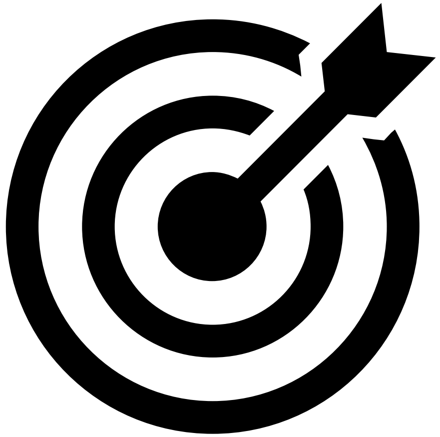


Policy

Policies are principles of action set by local, regional and national government.

In this context, they can include:

- Investing in infrastructure (e.g. electrifying railways)
- Subsidising certain modes of transport (e.g. community bus services)
- Charging for certain behaviours (e.g. parking charges, road user charging).
- Banning certain activities (e.g. sale of internal combustion engines).



Policy objective

Policy objectives are the aims that the policies are trying to achieve.

For example, the policy objective of introducing bus priority measures it not just reduce bus journey times but to encourage greater usage of sustainable modes of transport.

In this work, Stage 1 and 2 identify the policy objectives that need to be achieved; Stage 3 identifies the policies that could be introduced to meet those objectives; and Stage 4 considers their external effects.

Jargon buster

Some terms will be referred to frequently throughout this report. These include:

Fleet mix

The fleet mix describes what percentage of total vehicles is made up of what type of vehicle.

We need to understand what powers vehicles (electricity, hydrogen, petrol, diesel etc.), what type of vehicles there are (cars, vans, lorries, heavy goods vehicles) and their size as well as on average how far each of these vehicles is driven, in order to estimate total carbon emissions.

Carbon budget

The amount of carbon that can be emitted while meeting identified carbon reduction commitments such as following a pathway that aligns with Paris Agreement objectives.

The objectives aim to keep global temperature rise this century well below 2 degrees Celsius above pre-industrial level and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

This concept means that the earlier reductions start, the later we can reach net zero with a fixed spending limit of carbon. Like a credit card, if we spend some of the carbon budget now it means we have to spend less in the future.

At current emissions rates, the UK has approximately 6 years of carbon budget left, according to Tyndall Centre analysis.

Data sources - empirical

National Travel Survey

The National Travel Survey is conducted every year by the Department for Transport (DfT). It is a household survey, meaning it provides empirical data.

We have used the National Travel Survey (NTS) data from 2015-2019, before travel patterns were significantly impacted by the COVID-19 pandemic, to understand the type, purpose and mode of journeys that cause the most emissions currently.

The NTS gives much more detailed data for household travel for trips, mode and purpose than National Highway's South East Regional Transport Model (SERTM), and being empirical rather than modelled, is likely to be more accurate.

As historical data, it does not contain forecasts of future travel. For future forecasts we have, therefore, used SERTM and SEELUM for this purpose.

Furthermore, this survey lacks in several key areas, such as excluding most freight trips, it being difficult to get raw data / cross-tabulate, and not being reliable at local authority level due to sample sizes.

DfT Road Traffic Statistics

Database consisting of highway-based traffic data split by region and local authority.

Further disaggregation into vehicle kilometres by mode, and by road type.

Uses Annual Average Daily Flow counts and link-lengths published in a web-based tool by the DfT.

BEIS Local Authority Emissions Data

The Department for Business, Energy and Industrial Strategy (BEIS) publishes a yearly inventory of both recorded and projected annual greenhouse gas emissions and split by Local Authority, facilitating them to monitor progress against any local level targets.

This emissions data is subsequently disaggregated by sector, and for transport: road type, rail and maritime.

Data sources – transport model / emissions calculators

South East Regional Traffic Model

The SATURN-based South East Regional Traffic Model (SERTM) was created by Highways England (now National Highways) in 2015, to understand the impact of the Road Investment Strategy 2 (2015-2020). It is Transport Analysis Guidance "compliant".

This model estimates use of the Strategic Road Network in 2021, 2026, 2031, 2036, 2041 and 2050. It includes all A and B roads, and those C roads that play an important role in feeding the main network.

We have used SERTM to understand the number and type of journeys made in the future on the road network. This allows us to calculate the number of vehicle kilometres travelled by type of vehicle, which when cross-referenced with the Emissions Factor Toolkit (see next page) gives us the amount of carbon emitted by vehicle and journey type.

DEFRA Emissions Factors Toolkit

The Emissions Factors Toolkit is published by the Department for Environment Food & Rural Affairs (Defra) to assist local authorities in carrying out Review and Assessment of local air quality as part of their duties under the Environmental Act 1995.

The Emissions Factors Toolkit has been designed to allow users to calculate road vehicle pollutant emission rates for oxides of nitrogen (NOx) and Particulate Matter (PM10 and PM2.5), for a specified year, road type, vehicle speed and vehicle fleet composition. Carbon dioxide (CO_2) emission rates can also be calculated for petrol, diesel and alternative fuelled vehicles.

We took the fleet mixes available in the EFT and applied an average factor for each vehicle type based on average speeds from DfT data. These averages were then applied across all journeys by that vehicle mode.

For the purposes of this study, carbon dioxide equivalent (CO_2e – which in addition to carbon dioxide includes a conversion of methane and other "greenhouse gases" in carbon dioxide equivalents in terms of impact) was the pollutant category of focus when calculating the level of emissions and potential impacts relating to the introduction of various schemes compared to estimated baseline values.

Although we have been verbally assured that the latest Emissions Factor Toolkit (version 11 released in November 2021) includes the ban of sale of internal combustion engines in 2030, by 2050 this toolkit estimates only 44% of vehicles are electric. This would mean over half the car fleet is over 20 years old, which we do not think credible. We have therefore used the EFT on the assumption that it does not include the ban of sale of internal combustion engines.

Data sources – transport model / emissions calculators

South East Economic & Land Use Model

SEELUM is a bespoke transport and land use model that simulates the interaction of transport, people, employers and land-use over periods of time.

SEELUM is a customised application of Steer's Urban Dynamic Model (UDM), which was originally developed over twenty years ago to explore the relationship between transport and economic activity and regeneration. The UDM has been applied widely in the UK, including for Transport for the North, West Yorkshire, Leeds City Region, Merseyside, Humberside, North East Scotland, and the Oxford to Cambridge corridor.

The UDM's primary use is to test how investment in transport, sometimes coupled with changes to land-use policy, will affect the economic performance of a region, city or urban area. It does this by simulating how changes in connectivity affect how attractive different locations are for employers and/or households to locate in, how they respond, and what the consequences are (see Figure 1.2 overleaf).

For example, if travel costs rise in a particular area (say, due to an exogenous input), depending on the other options available, people may change their mode of travel, change where they live or change where they work. In the extreme, if there are no other viable options to access work, people can become unemployed. Similarly, businesses can relocate to an area if transport costs reduce, increasing their accessibility to the potential workforce.

SEELUM includes internal models of highways, bus and rail services, walk and cycle, all connecting places together and influencing their relative advantages as places to live or work. It incorporates planned land-use changes and investment in transport infrastructure or services.

SEELUM generates a set of outputs allowing detailed examination of how and why conditions change in the simulated area. This includes travel patterns, volumes and mode shares and the changes on CO_2 emissions from transport activity.

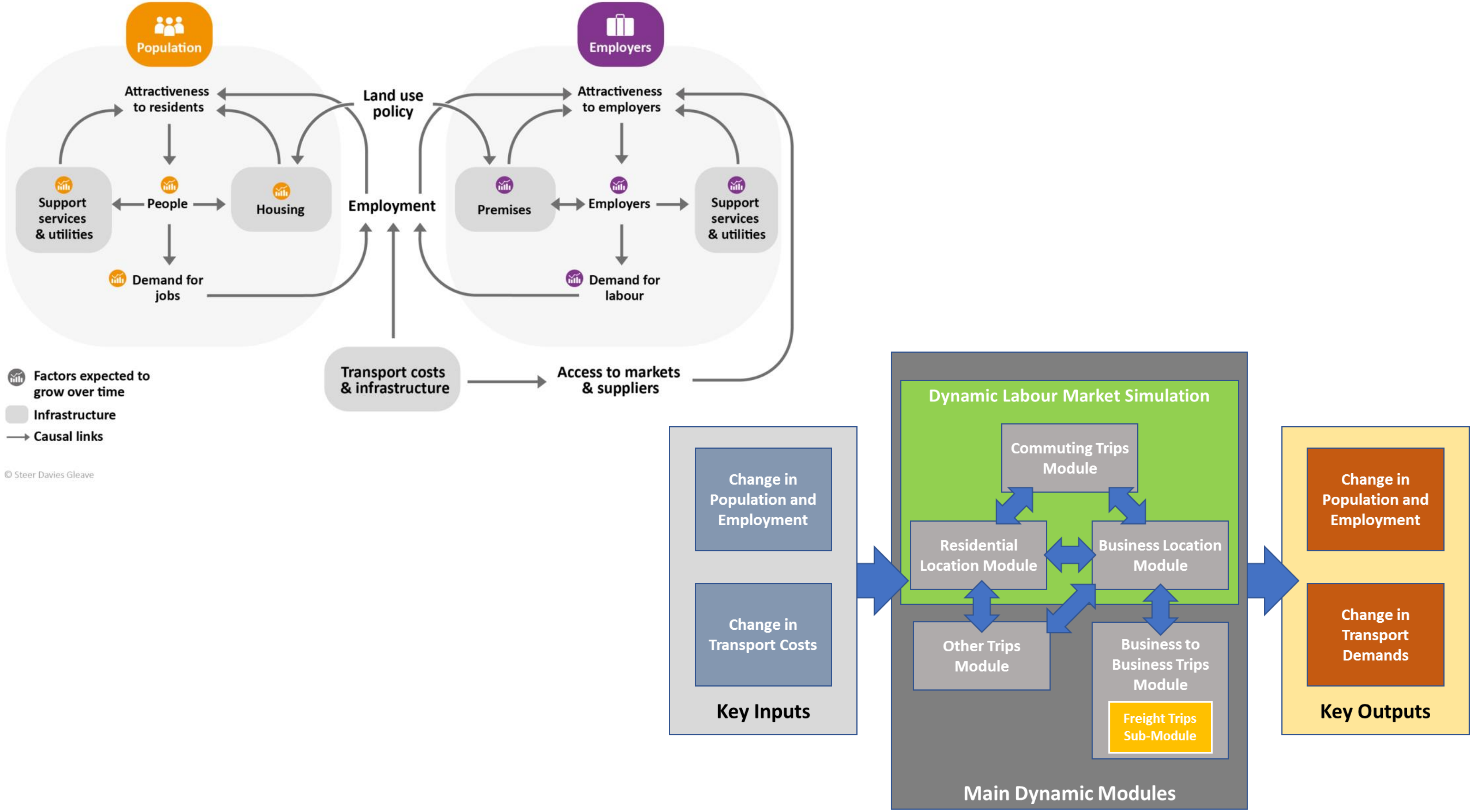
The images on the next page show an approximation of SEELUM's internal workings.

In Stages 1 and 2, we have used a combination of SEELUM and SCATTER to understand the effect on carbon emissions of meeting transport policy objectives, such as mode share targets, trip reduction targets and fleet mix changes.

Stages 3 and 4, then identify policy options that can be used to achieve these objectives, and assess their impact on people, place and movement throughout the South East.

Data sources – transport model / emissions calculators

Figure 1.2: SEELUM internal workings



Data sources – "budget" based trajectories

Committee on Climate Changes 6th Carbon Budget Balanced Pathway

The UK government has legally committed to the 6th carbon budget (total emissions limit for the 5-year interval from 2033 to 2037). Meeting the budget will require a reduction in all sector emissions of 63% between 2019 and 2035. In their Balanced Pathway, the CCC suggest that the transport sector's contribution to this reduction should include a reduction of 70% in surface transport emissions between 2019 and 2035, with more limited reductions from aviation and shipping

Their balanced pathway utilises UK budget-based trajectories to reach net zero carbon by 2050, limiting global temperature rise to below +2˚ Celsius.

It also utilises disaggregated data for surface transport emissions, split by vehicle type and km driven.

DfT's Transport Decarbonisation Plan

The DfT's Transport Decarbonisation Plan was published in July 2021 and showcases the DfT's pathway to net zero via a combination of multi-modal transport decarbonising and 'key enablers'. Those relevant to TfSE and local authorities include the promotion of alternative fuels and improved vehicle efficiencies, greater efficiencies in the freight and logistics sectors and enhanced integrated land-use and transport planning.

The strategy set outs several trajectories for each mode, which consist of published GHG emissions and followed by forecasts derived from modal-specific policy impacts and demands. For the purposes of this report the sum-totals have been utilised from the subsequent net zero strategy – for the upper and lower bounds.

Tyndall Centre for Climate Change Research

The Tyndall Centre is a partnership of UK universities bringing together researches across disciplines to develop sustainable responses to climate change.

They have developed a Carbon Budget Tool for use by all local authorities, which presents climate change targets based on commitments in the United Nations Paris Agreement. Carbon budgets are an estimate of the total quantity of CO2-equivalent emissions that can be allowed in order to stay within the Paris Agreement target of capping global warming at 1.5 degrees Celsius this century. For each authority, a total carbon budget is set and subsequent % reduction in annual emissions required to reach net zero based upon the recommended pathway.

Total emissions per authority varies based on several factors, including geographic and demographic size alongside levels of carbon-intensive strategic road, rail and port-related infrastructure.

SCATTER Tool

SCATTER is a local authority focussed emissions tool, built to identify pathways to zero carbon emissions. This allows local authorities to set targets in line with the Paris Climate Agreement.

It generates a greenhouse gas emissions inventory following the Global Protocol for City-wide Greenhouse Gas emissions for a local authority area.

The use of this tool helps to develop an understanding and development of a credible decarbonisation pathway in line with emissions reduction targets.

2. National and Regional Context and Baseline

Decarbonising Transport: national context

UK legislation commits government to reducing greenhouse gas emissions to zero by 2050. Transport currently accounts for approximately one third of all emissions, and is the only sector whose emissions have not declined since the late 1990s.

UK Climate Change legislation

In 2019, an amendment was made to the Climate Change Act of 2008. This amendment legally committed the UK to achieving net zero greenhouse gas emissions by 2050.

In June 2021, the Climate Change Committee (CCC), an independent body created as part of the Climate Change Act to ensure the government delivers on its legal commitments, stated that:

"the willingness to set emissions targets of genuine ambition contrasts with a reluctance to implement the realistic policies necessary to achieve them."[1]

This decarbonisation report presents a detailed analysis of what those "realistic policies" are in the context of transport in the TfSE area.

The CCC identifies the scale of change required to reach these objectives, quantifying a total 70% reduction in surface transport emissions is required between 2019 – 2035.

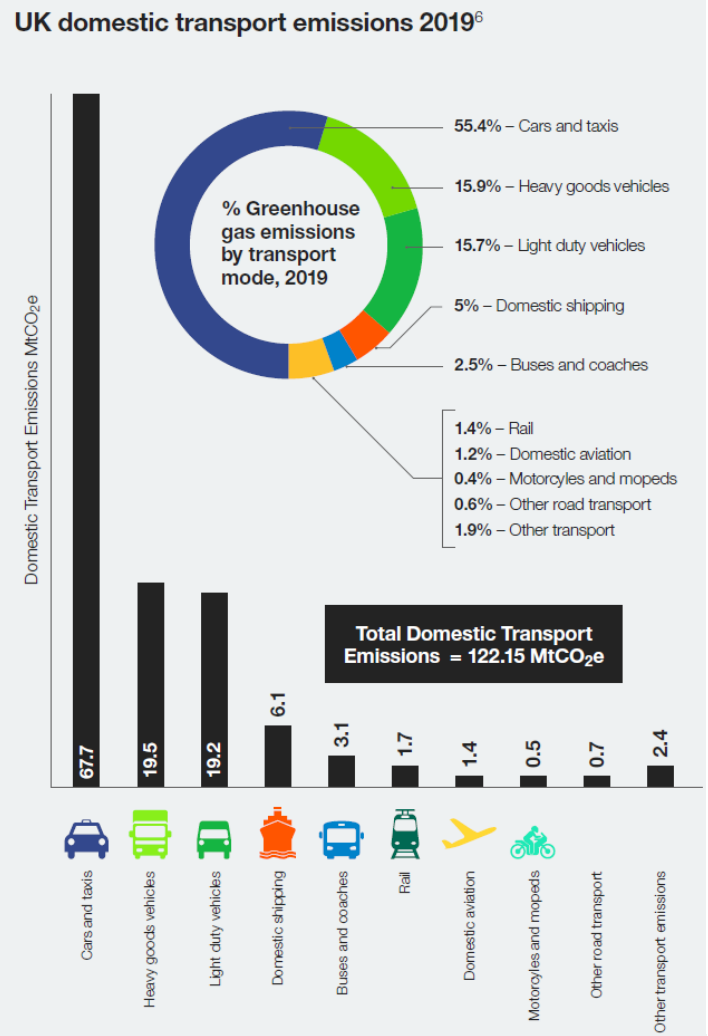
Transport's contribution to greenhouse gas emissions

Transport as a sector in 2019 was responsible for 27% of the UK's greenhouse gas emissions, making it the most significant contributor to UK emissions. This figure does not include international shipping and aviation, which would increase it yet further.

Whereas other sectors, such as the energy sector, have reduced their emissions significantly since the 1990s, emissions from transport remained roughly level before the COVID-19 pandemic. Better engine efficiency has been offset by heavier cars and more travel.

Since the pandemic began, car use has recovered much quicker than public transport, resulting in higher transport emissions per trip than before the pandemic.

Figure 2.1 UK Domestic Transport Emissions (2019)



Source: Decarbonising Transport, (DfT , 2021)

1 Source: Progress in reducing emissions – 2021 Report top Parliament (Committee on Climate Change, 2021)

Decarbonising Transport: regional context

While key stakeholders in the TfSE area East recognise the need to decarbonise their transport systems, this is not happening fast enough.

The trajectory shown in Figure 2.2 to the right is taken from TfSE Area Studies evidence base. This work showed at a very high level that the TfSE area will not reach a position of net zero carbon emissions by transport by 2050 based on historic rates of decarbonisation in transport (between 2005 and 2019) extrapolated to 2050.

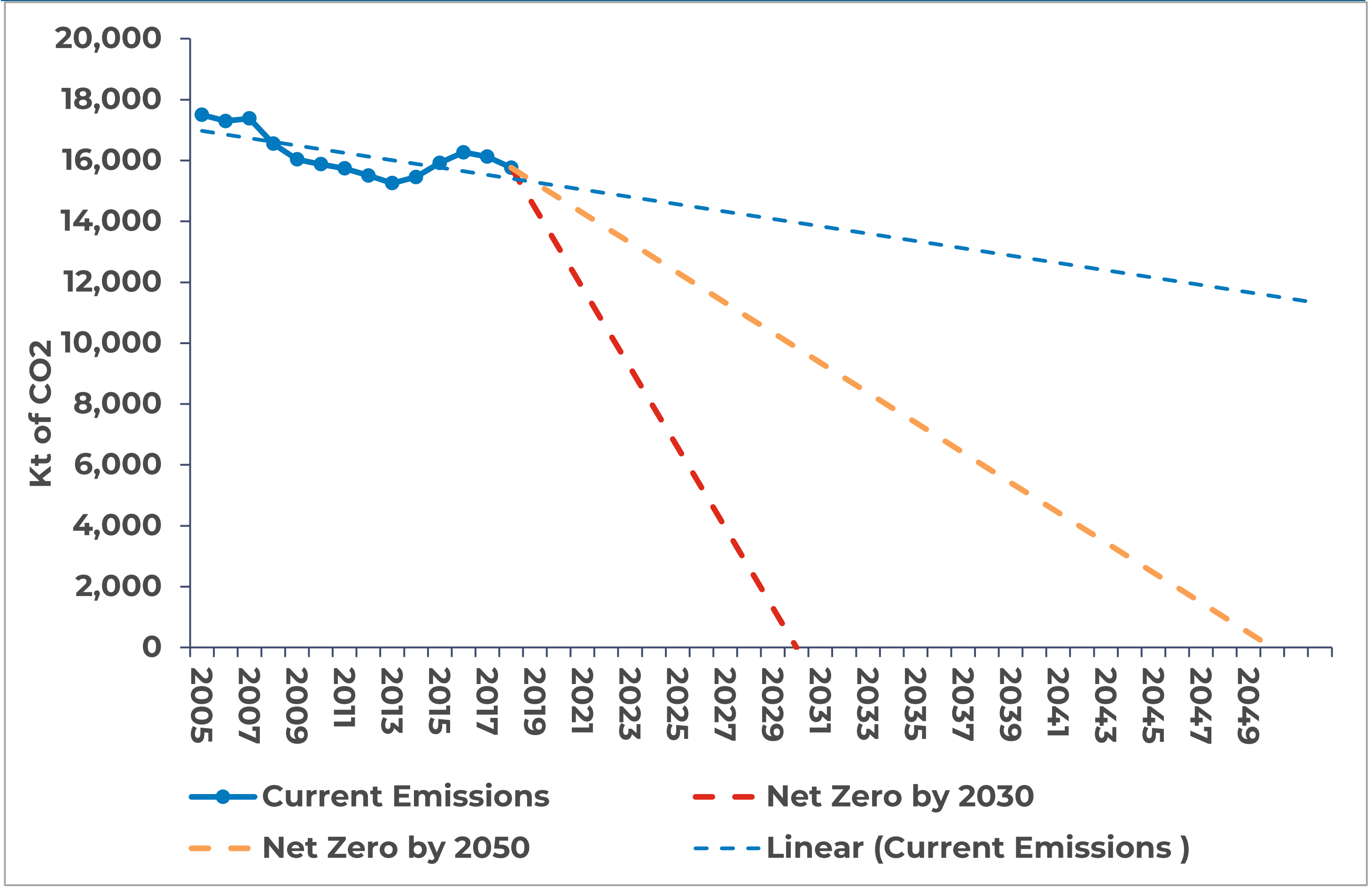
TfSE has set a target in line with Central Government of net zero carbon no later than 2050. This aligns, also, with many Local Transport Authorities, with some committed to more ambitious decarbonisation targets, the most ambitious as reaching net zero by 2030.

The Area Studies identified high level policy objectives that a step change in the electrification of highway transport and modal shift away from fossil fuel transport to electric/healthy transport is needed if the area is to reach its climate commitments.

The rail network across the TfSE area, on the other hand, is almost entirely electrified and is therefore well placed to help achieve these ambitious targets.

However, to understand gaps and options for decarbonisation in more detail, further disaggregation of the scale of the challenge is required. Overleaf, we look at the Local Transport Authority distribution of domestic transport emissions, and then on the reasons and ways we travel.

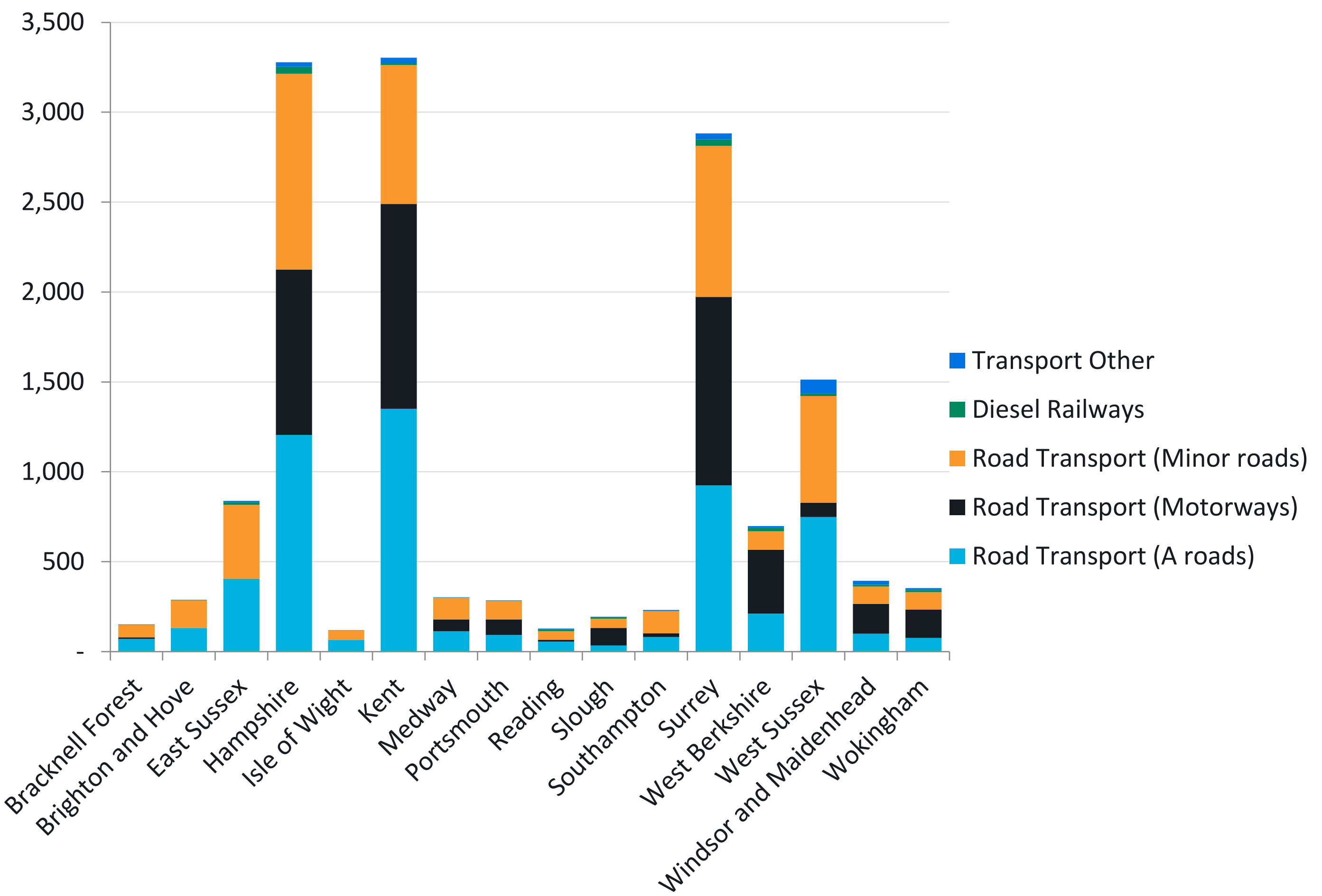
Figure 2.2 Carbon emissions trajectories for the Transport for the South East area (unbudgeted)



Source: BEIS Local Authority and Regional Carbon Dioxide Emissions National Statistics (2021)

Baseline – tailpipe emissions

Figure 2.3 Local Transport Authority 2019 transport emissions (KTCO$_2$e)



Source: BEIS Local Authority and Regional Carbon Dioxide Emissions National Statistics (2021)

Location of travel emissions

Analysis of domestic transport emissions (including assumptions for energy production and transmission) by Local Transport Authority area broadly follows population and employment levels. In addition, the split by network types (e.g. diesel railways, motorways) follows the proportion of network type in each authority. As such, Hampshire, Kent and Surrey with their large populations, high number of jobs, and relatively dense transport networks, have the highest levels of emissions.

Baseline – surface transport trips

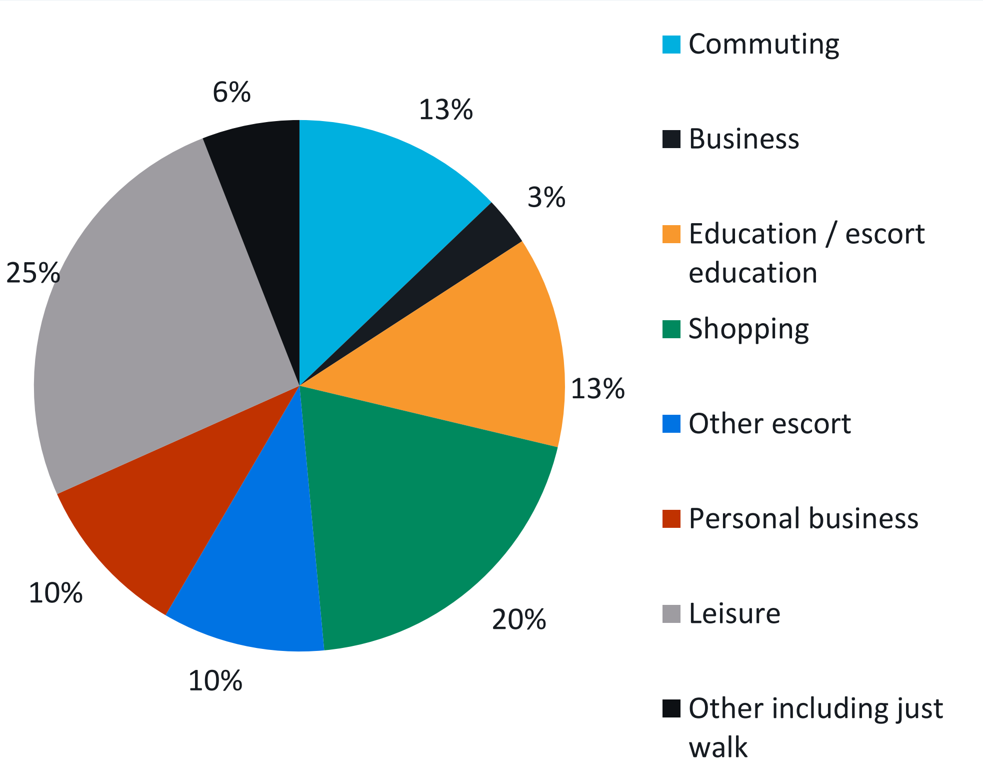
Journey Purpose

Data accessed from the NTS illustrated in Figure 2.3 below shows that only 13% of trips are related to commuting purposes, with greater proportions relating to leisure and shopping. This exemplifies key challenge in decarbonising transport – with a typical focus on commuting, business trips, and occasionally education, which account for only a little under a third of all trips.

Journey Mode

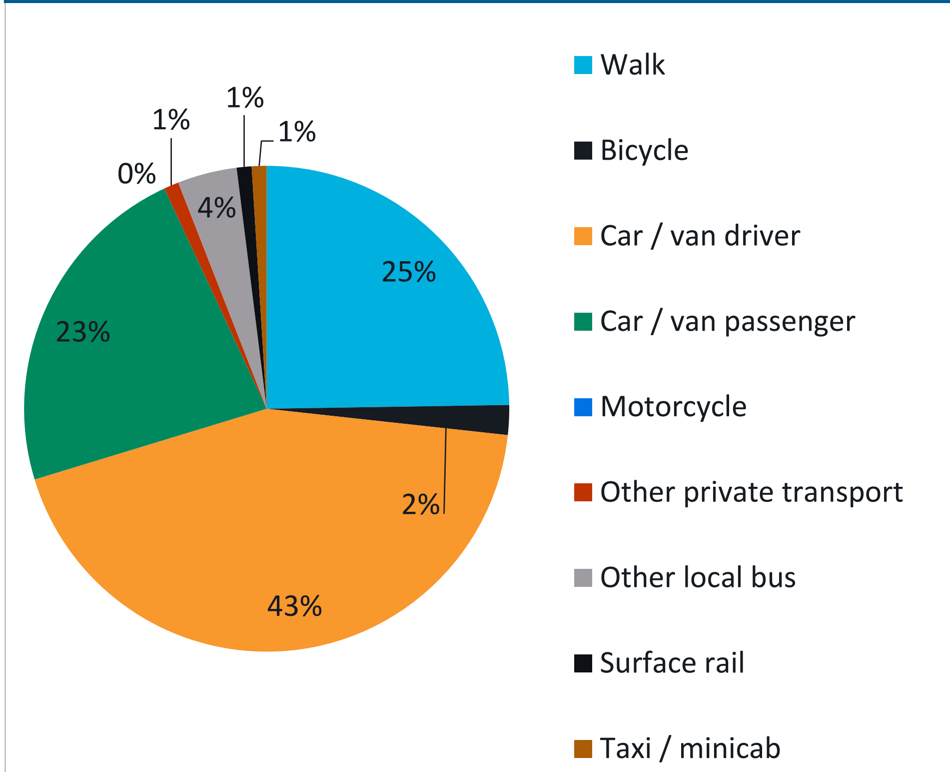
In terms of mode share, a similar analysis of data from the NTS displayed in Figure 2.4 shows that about two thirds of trips in the South East are undertaken as either a car / van driver or passenger, with only a minor number of trips taken by public transport or cycling. This identifies the importance of facilitating modal shift away from private car / van usage towards lower or zero carbon-emitting modes.

Figure 2.4 Trips disaggregated by journey purpose (% of total)



Source: DfT NTS (2018)

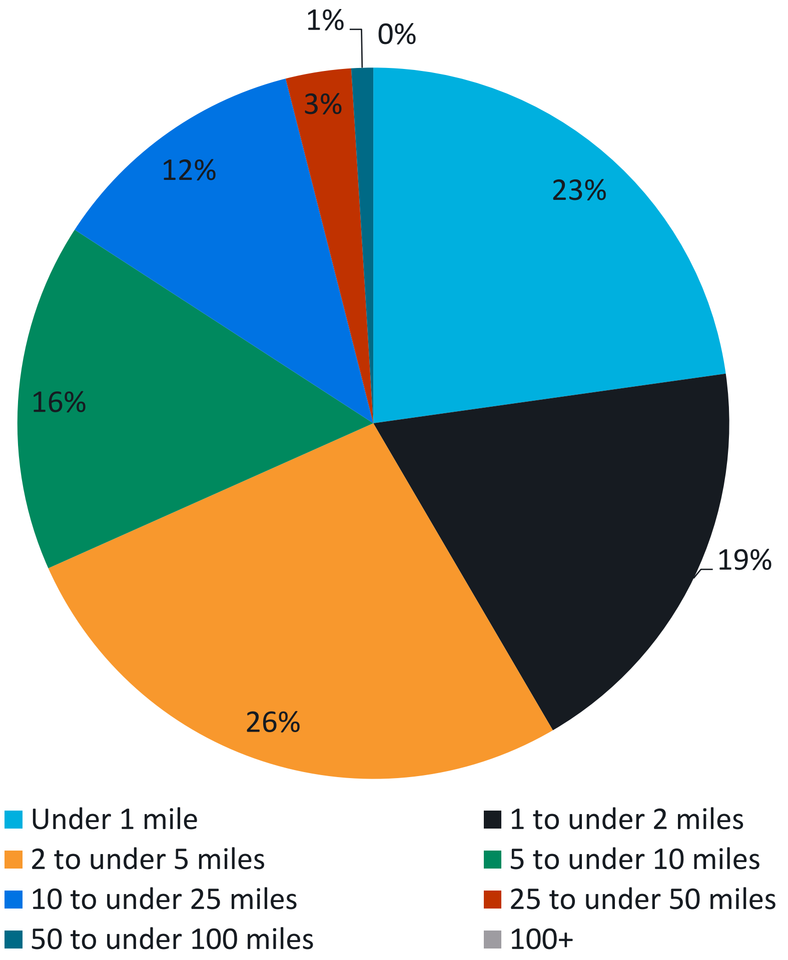
Figure 2.5 Trips disaggregated by journey mode (% of total)



Source: DfT NTS (2018)

Baseline – surface transport trips

Figure 2.6 Trips disaggregated by journey distance (% of total)



Source: DfT NTS (2018)

Journey Distance

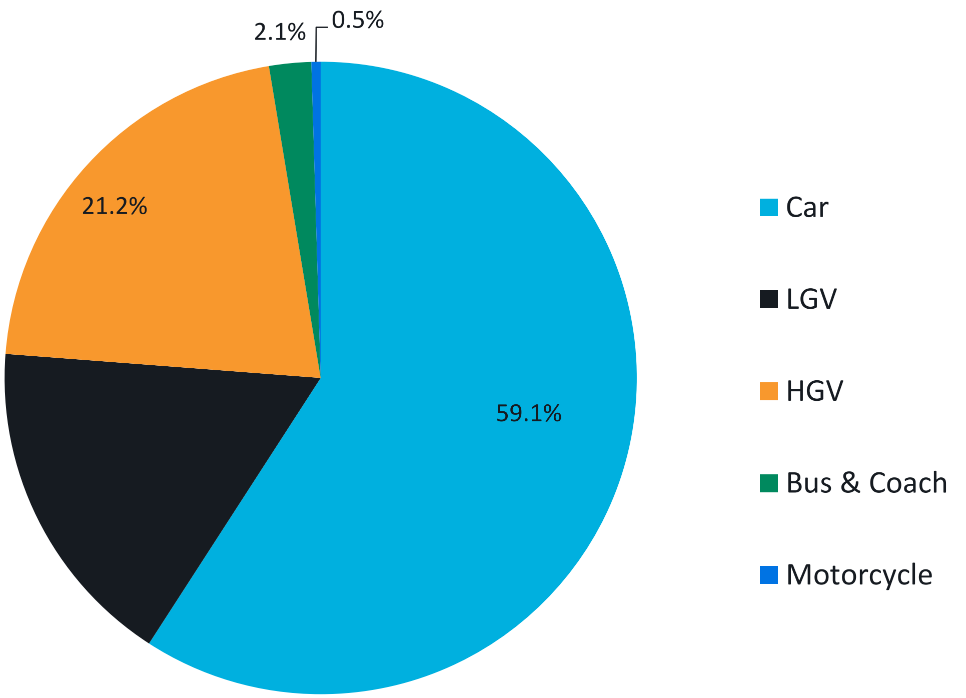
Analysis of NTS for the TfSE area, shown in Figure 2.5, illustrates that just over two thirds of trips are under five miles in length. Shorter distance trips are typically more "switchable" to more sustainable modes of transport such as walking, cycling and bus travel. Only 4% of trips are longer than 25 miles in length where cycle and bus services become unviable.

Baseline – tailpipe emissions

Journey Mode

Combining DfT Statistics of vehicle kilometres by surface transport mode for the South East and EFT data from 2021, allows a breakdown of emissions by vehicle type as shown in Figure 2.7. This determines that for the baseline almost two thirds of emissions result from car trips, and just over a third pf emissions are from road freight. Bus and motorcycle travel emissions are, relatively, very low. Rail and non-surface transport modes are excluded from this analysis.

Figure 2.7 Emissions disaggregated by vehicle type (% of total)

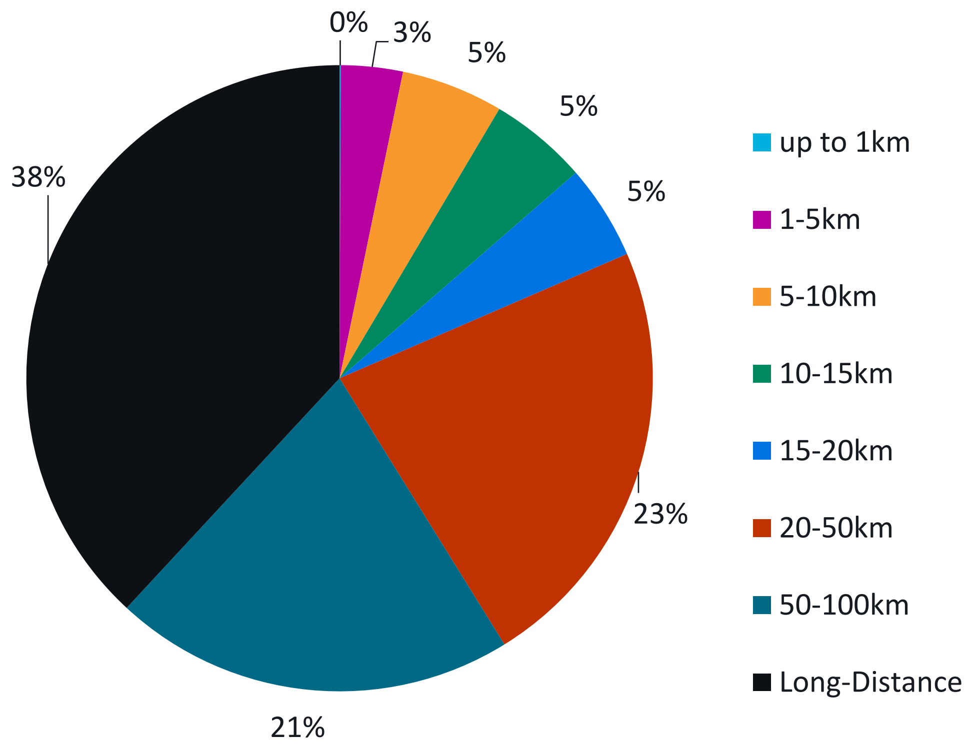


Source: DfT Statistics Table TRA0206 (2019 Base Year) / DEFRA EFT v11

Journey Length

In comparison to the NTS data, the analysis of emissions by journey distance band for the baseline year in Figure 2.8 shows that over 80% of emissions result from journeys over 20km in length. This contrasts with the NTS data illustrating that only a small number of total trips are short distance. For trips with the highest probability of shifting to active and public transport, those less than 5 kilometres in length, only 3% of emissions result from these trips.

Figure 2.8 Emissions disaggregated by journey length (% of total)



Source: National Highways SERTM (2018 Base Year) / DEFRA EFT v11

Baseline – conclusions

Long distance trips account for more emissions than short distance trips

Half of all trips are under 10km, however, these short-distance trips only produce 7% of emissions. By contrast, only 13% of trips are over 50 kilometres, but they produce 66% of emissions.

Shorter trips that are driven still produce carbon. These are the easiest to switch modes immediately as they do not require the adoption of emerging and often expensive technologies, such as increased vehicle battery capacities for cars and HGVs, or wholescale electrification of rail lines. Given the complexities of reducing carbon for other trips such as freight, removing these emissions is a vital short-term goal.

Shifting these shorter trips also has an indirect carbon reduction effect. By reducing the need for car ownership overall, shifting these trips is likely to reduce the number of longer distance trips that are driven, if reasonable alternatives exist.

There are other key benefits to shifting shorter trips to active modes. Shifting the 39% of car trips that are under 5km from car to walking and cycling will reduce pressure on the NHS by improving health, improve air quality in town centres and remove severance in neighbourhoods meaning more sociable, prosperous places to live and work.

However, to successfully tackle the decarbonisation challenge in the South East it will be necessary to address long distance car trips.

Land use planning

Land use planning policies are determined by Central Government and typically Local Planning Authorities at a local level. They can be used to influence what is built where. This has a major impact on carbon emissions. By locating amenities and jobs close to residential areas, its possible to create the conditions for:

- **Fewer trips**. If amenities are easily accessible from residential areas, the number of trips that people take is reduced. For example, someone can combine a shopping trip with visiting a relative, rather than making two separate trips.
- **Shorter trips**. By locating people, amenities and residents closer together, the distance of trips is reduced. The shorter the distance, the fewer the emissions.
- **Trips by active and public modes**. Distance is a key factor in how people choose to travel. The shorter the distance, the more likely they are to choose zero emission modes such as walking and cycling.
- Public transport mode share is influenced by how dense developments are. The more people live in an area, the more demand there is for public transport that justifies a higher level of service. This relationship works in both directions: improving the public transport to a site can unlock land for housing development in a sustainable manner.

Baseline – key findings

- Shopping, leisure and personal trips account for more emissions than business and commuting trips combined
- Trips over 20km account for 82% of tailpipe emissions from surface transport
- Freight vehicles account for approximately half current emissions

3. Setting the decarbonisation challenge for the South East

Introduction

The first two phases of work were aimed at understanding the scale of the decarbonisation challenge that the South East faces. They answered a series of questions:

- How much carbon is transport in the TfSE area likely to emit between now and 2050?
- What types of journey drive these emissions?
- How effective are current policies likely to be in reducing those emissions?
- If current policies are insufficient, what future policy objectives need to be achieved in order to reach net zero?

Identifying which policies can be introduced in order to achieve those policy objectives is the focus of Stage 3; the impact of those policies on areas other than decarbonisation is the focus of Stage 4.

To answer the Stage 1 and Stage 2 questions, we formulated four trajectories (or groups of trajectories) which assume different policy objectives are achieved.

The remainder of this chapter describes the data sources used, before presenting the results for each trajectory, with key findings and commentary.

Trajectory 1: “Do Nothing” Trajctory: This trajectory assumes that no policies were enacted to reach net zero - no government ban on the sale of internal combustion engines for cars and vans from 2030; no material attempt to reduce the number of trips people take; and no major shift to more sustainable transport. This gives us a baseline to understand the impact of interventions.

- **Trajectory 2: National Policy Trajectories** model forecasts of travel demand using SERTM and DfT statistics of vehicle kilometres, and then applies the most recent Emissions Factor Toolkit v11 (2021) and the impact of Society of Motor Manufacturers and Traders (SMMT) forecast fleet mix changes. These facilitate an understanding of the importance of fleet mix changes in reducing emissions, whilst illustrating the role of local authorities in supporting this transition, for example through ensuring adequate provision of electric vehicle charging infrastructure.
- **Trajectory 3: 2050 Budget Based Trajectories:** These trajectories typically assume a series of policy outcomes are achieved relating to reducing the overall number of trips, fleet mix changes, and modal shift. This includes trajectories of national forecasts from the Committee on Climate Change (CCC), DfT’s *Decarbonising Transport* report figures, SCATTER Tool outputs by Local Transport Authority, and the Tyndall Centre’s multi-sectoral reporting at the TfSE areas.
- **Trajectory 4: 2040 Budget Based Trajectory:** This trajectory uses the same emissions budget as Trajectory 3 but shifts the date of achieving net zero to 2040. This has two benefits. First, it shows what policy objectives must be achieved to meet net zero earlier than 2050, as some local authorities in the TfSE area have set this as their target. Second, it allows for the fact that our emissions have not declined as precipitously between 2020 and 2022 as the SCATTER modelling suggested they needed to.
- These approaches all take budget-based approaches, identifying a fixed amount or “budget” of greenhouse gas emissions remaining to keep in line with targets for limiting global temperature rises.

Trajectory 1: "Do Nothing" Trajectory

Trajectory 1: Do nothing

Trajectory purpose and description

Trajectory 1 gives us a baseline to understand emissions.

It assumes:

- no government ban on the sale of internal combustion engines;
- no attempt to reduce the number of trips people take; and
- no major shift to public transport.

Method

The trajectory is generated by combining vehicle kilometres by vehicle type from the DfT's Road Traffic Statistics with the Emissions Factor Toolkit's forecast fleet mix and emissions factors.

We have assumed that vehicle kilometres by vehicle type stays constant to a 2018 baseline, only changing the emissions factors and fleet mix in line with the emissions factor toolkit.

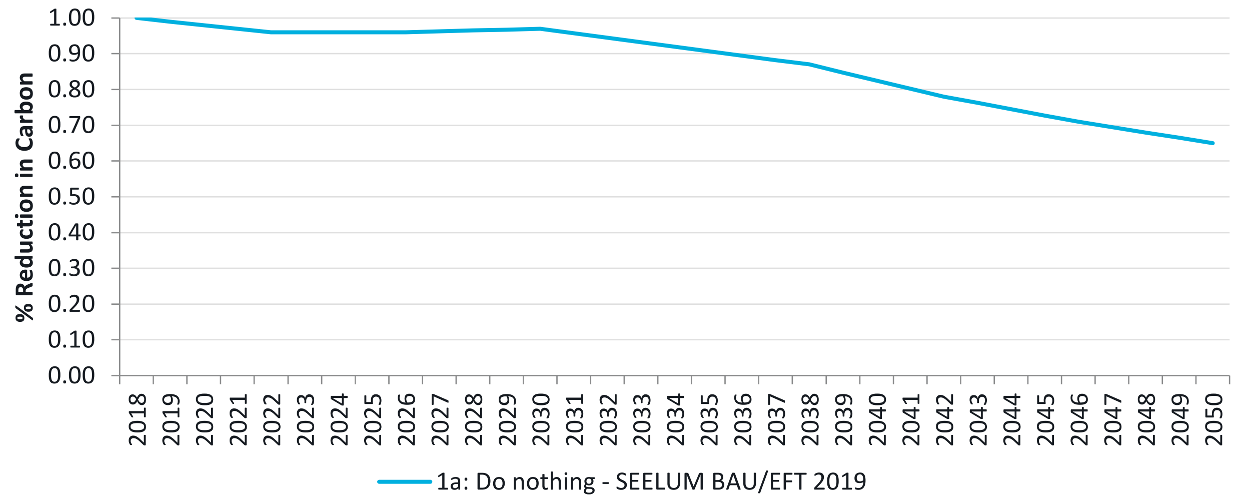
For trip length, we have used the National Highway's SERTM. This dataset includes future years, so we have included these for vehicle kilometres as well as accounting for the emissions factors and fleet mix changes in the Emissions Factor Toolkit.

Fleet mix assumptions

There are three sources that we have used to estimate how the fleet mix will change in the future:

- Trajectory 1a uses the Emissions Factor Toolkit fleet mix from 2019. This prediction only stretched as far as 2035 and was released before the announcement of the ban of the sale of internal combustion engine vehicles. In this Trajectory, we extrapolated the percentage change in electric vehicles predicted between 2034 to 2035 for each and every year between 2035 and 2050 to understand the fleet mix changes.

Figure 3.1: Trajectory 1 Total Annual Carbon Emissions between now and 2050



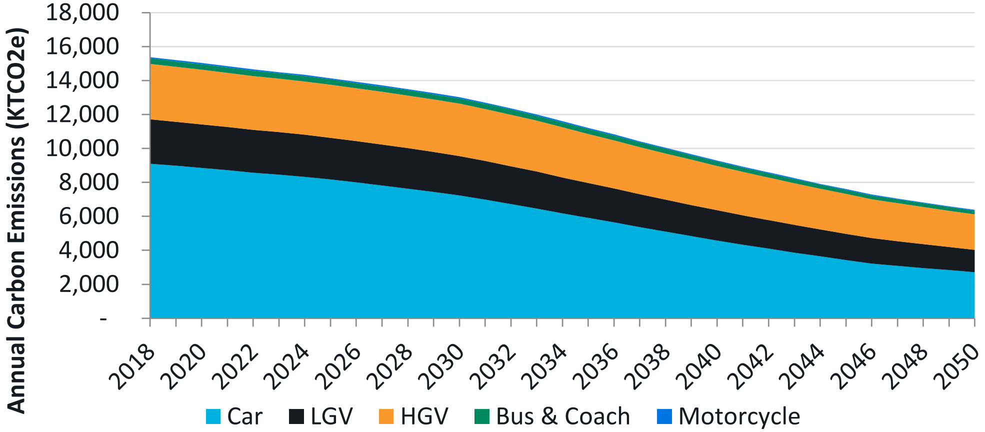
Source: South East Economic & Land Use Model (2019)

Do Nothing Trajectory

Figure 3.1 shows the difference in the rate of emissions reduction caused by the changing fleet mix resulting from Trajectory 1a. This is based on transport demand forecast from TfSE's SEELUM with emissions conversion using the assumptions underpinning DEFRA's EFT v9 (2019). This version of the EFT was issued before Central Government's regulatory announcements to ban the sale of internal combustion engine cars and vans from 2030. As such, it is only increased efficiency of engines and increased role out of hybrid and zero emissions vehicles driving reductions in overall emissions.

Trajectory 1: Do nothing

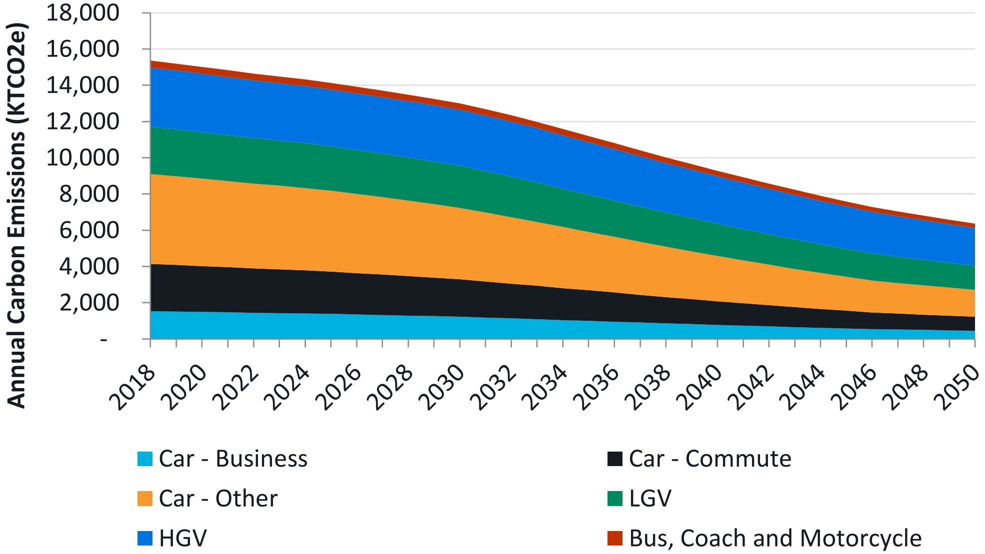
Figure 3.2 Trajectory 1 2019 EFT Fleet Mix Disaggregated by vehicle type (kTCO$_2$e)



Source: DEFRA EFT v9 (2019)

Figure 3.2 shows 2019 EFT total emissions split by vehicle types. This determines a proportional decrease in emissions across all vehicle types. Demonstrated is that under this trajectory the larger proportion of emissions are derived from freight vehicles rather than cars, illustrating the challenging of decarbonising freight vehicles.

Figure 3.3 Trajectory 1 Journey purpose



Source: DfT Statistics Table TRA0206 (2019 Base Year) / DEFRA EFT v11 (2021)

Figure 3.3 shows the proportion of car emissions by journey purpose. This information is taken from SERTM. It shows that most car emissions are caused by "Car – other", which means personal business, leisure and shopping trips. This points to the need for a shift in emphasis away form the traditional transport planning focus of considering the impacts of commuter trips.

Alternative Fuels for Heavy Goods Vehicles

It is much more difficult to convert Heavy Goods Vehicles to zero tailpipe emissions than cars or vans because they require significantly more power to move their heavy loads.

The National Infrastructure Commission's 2019 report, "Better Delivery", identified the need for significant central government financial support for research into alternative fuels for Heavy Goods Vehicles.

Shifting freight to rail can be electrified much more easily through electric overhead lines or rails, though this can be expensive. "Better Delivery" recommended that government:

"should undertake detailed cross-modal analysis, using a corridor-based approach, of the long term options for rail freight's transition to zero emissions, including low carbon rail services and the scope for road based alternatives. It should then publish, by the end of 2021, a full strategy for rail freight to reach zero emissions by 2050, specifying the investments and/or subsidies that it will provide to get there".

This recommendation is yet to be implemented.

Trajectory 1: Do nothing

Commentary and key findings

The current trajectory is insufficient to get to net zero and results in too much cumulative carbon being emitted during the period to 2050

With no major policy interventions, transport in the TfSE area is still expected to emit between 53% and 63% of its 2018 emissions in 2050.

In addition, rather than the curves being concave, with initial sharp reductions followed by slower reductions in latter years, they show reasonably steady emissions until approximately 2030. This means far more carbon is emitted over the period to 2050, as the area under the curve is greater and carbon budgets would be exceeded.

Technology alone will not get us there

The halving of emissions by 2050 does still include a significant shift to electric vehicles from petrol and diesel vehicles. 44% of all cars are projected to be electric by 2050, with a further 15% being hybrid vehicles. However, this will likely only be possible with significant expansion of charging infrastructure.

The reduction in emissions modelled in Trajectory 1 is mostly due to a result of the changing fleet mix.

December 2021 UK vehicle registration data appears to confirm this trend. 18% fewer cars were sold in December 2021 compared to December 2020. Of those that were sold, 27,705 battery electric vehicles were registered in December 2021, representing over 25% of all registrations and 125% of the number of battery electric vehicles registered in December 2020.

This is driven primarily by the premium market: the Tesla Model 3, which retails for approximately £45,000, sold more than double any other model of car using any fuel.[2]

Diesel vehicles, which produce less CO_2e per kilometre than their petrol equivalents, are expected to decline from approximately 44% of the car fleet today to 18% by 2050. This is good for air quality, as diesel vehicles produce far more poisonous gases than petrol, but not for carbon emissions: diesel vehicles produce less carbon dioxide per kilometre than petrol vehicles.

Freight vehicles account for a large proportion emissions in the South East

Although the key change between 2020 and 2050 is the small shift to electric vehicles away from petrol and diesel, it is not car trips that are responsible for the majority of emissions between now and 2050. Instead, by 2050, approximately half of emissions are produced by Heavy Goods Vehicles.

This is a result of:

- Heavy Goods Vehicles driving further. The average length of a Heavy Goods Vehicle trip being much longer than the average car trip.
- Heavy Goods Vehicles requiring more fuel per km driven. The emissions per kilometre driven is much higher for Heavy Goods Vehicles than cars using the same fuel, because they are much heavier. Our analysis gives a ratio of approximately 1:7 between cars and HGVs. That means that every kilometre driven by a car in the TfSE are emits seven times less CO_2e than an HGV in 2018. This ratio increases over time: although HGV engines are expected to become more efficient, this is outweighed by the car efficiency improvements, including the shift to electric.
- Heavy Goods Vehicles being more difficult to power with clean fuels. Whereas 44% of cars are expected to be powered fully by battery in 2050, only 21% of LGVs are expected to be powered by battery and there is currently no commercially viable fuel for HGVs to use.

2 Source: SMMT Car Registrations data

Trajectory 1 key findings

- Even without a ban of the sale of internal combustion engines, there is still a significant shift to zero emission vehicles due to market incentives and continued investment in charging infrastructures
- However, significantly off net zero carbon by 2050
- Estimated <ten years of current emission rates before the entire carbon budget (to 2050) is depleted
- Road freight (HGVs) form a increasing proportion of emissions over time as cars decarbonise much more rapidly

Group Trajectory 2: National Policy Trajectories

Group Trajectory 2: National policies

Trajectory purpose and description

Trajectory 2 tests the impact of committed national policies.

The Transport Decarbonisation Plan has been used as the source for Government commitments. There is one commitment that it is possible to model: the ban of sale of ICE cars and vans by 2030 (and hybrids by 2035).

Other policy commitments in the Transport Decarbonisation Plan enable local authorities to take action but are not measurable policy goals themselves: we have called these *enabling factors*. The Transport Decarbonisation Plan does not, for example, commit to Road User Charging, which would change the attractiveness of driving. Nor does it commit to phase out dates for buses, coaches or Heavy Goods Vehicles, although in November 2021 the government committed to 2035 and 2040 phase out dates for HGVs <26 tonnes and > 26 tonnes respectively. These phase out dates are not included in this trajectory, but they are included in Trajectory 5.

Examples of enabling factors set out in the Transport Decarbonisation Plan include:

- investing more than £12 billion in local transport systems over the current Parliament.
- £2 billion of funding over five years with the aim that half of all journeys in towns and cities will be cycled or walked by 2030.

These therefore provide useful context as to what TfSE and its constituent authorities are likely to be able to do in regard to intervention options, as discussed in Stages 3 and 4, but are not commitments to be modelled in Stage 2 of this work.

Method

This trajectory has been modelled using fleet mix assumptions built on forecasts from the Society for Motor Manufacturers and Traders which consider the car fleet make up to 2035 should ICE sales be banned by 2030.

Trajectory 2 is predicated on the government's main policy commitment in the Transport Decarbonisation Plan: the ban of sale of ICE cars and vans from 2030 (and hybrids from 2035). This policy will have a significant impact on the fleet mix, and therefore on the total emissions.

To predict how the fleet mix is likely to change as a result of the ban of ICE vehicles, we have fed data produced by the Society for Motor Manufacturers and Traders into SEELUM due to a need for extrapolation.

Extrapolating the Society for Motor Manufacturers and Traders forecast suggests that 98% of all cars and vans will be fully electric by 2050, compared to 44% in Trajectory 2a. This is predicated on a large expansion in the South East's electric charging infrastructure network.

DEFRA Emissions Factor Toolkit (EFT)

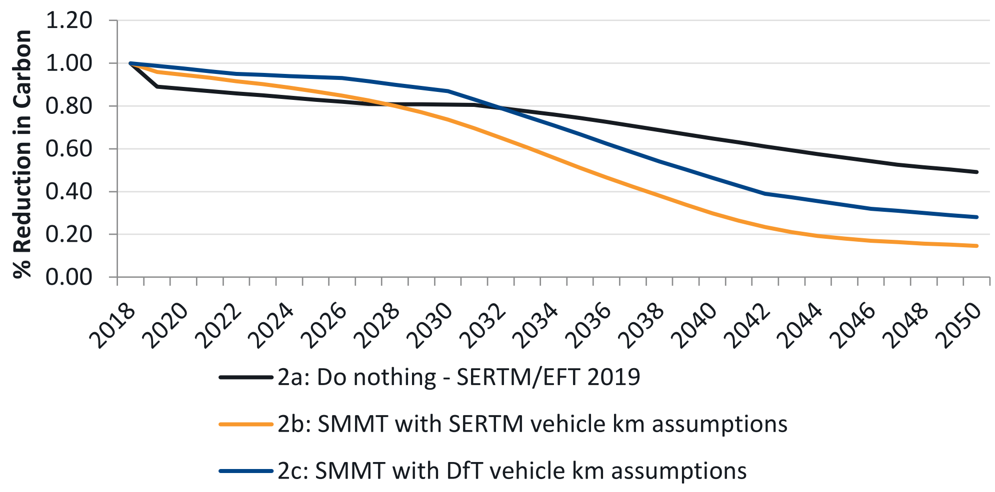
Within the earlier description of data sources available for this work, the Department for the Environment, Food and Rural Affairs published a multi-sectoral emissions database and toolkit to model carbon, other greenhouse gases and air pollutants.

Data is presented through "tailpipe" emissions based on a number of trips per link, link length, speed, and mode/vehicle/engine type.

The EFT requires a significant scale of inputs, such as from a transport/LUTI model like TfSE's SEELUM model.

Group Trajectory 2: National policies

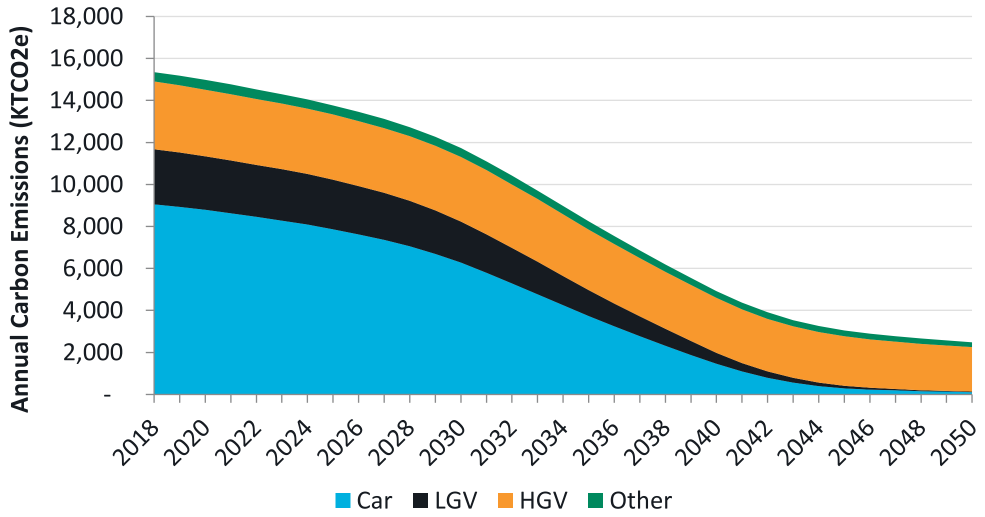
Figure 3.4 Trajectory 2 total annual emissions



Source: DEFRA EFT v9 (2019) / SMNT/DfT (2021)

Figure 3.4 illustrates the resulting three separate sub-trajectories resulting from national policies. 2a presents the Do nothing approach utilising SERTM/EFT 2019 fuel mixes whilst 2b and 2c present SMMT fuel mix forecasts against the differing SERTM/DfT vehicle km assumptions. Overall, they demonstrate the difference in the rate of emissions reduction caused by the changing fleet mix assumptions from the Emissions Factor Toolkit in 2019 (as modelled in Trajectory 1), to the SMMT Central forecast Fleet Mix (reflecting a ban of sales of all Internal Combustion Engines for cars and vans by 2030). We have been informed by the DfT that the 2021 Emissions Factor Toolkit does include the effect of the ban of the sale of internal combustion engine vehicles in 2030. However, the data predicts that only 44% of vehicles are fully electric by 2050, with a further 15% hybrids. This is surprisingly low if the sale of internal combustion engines was banned 20 years previously, implying that 40% of the fleet is older than 20 years old in 2050.

Figure 3.5 Trajectory 2 SMMT Central Forecast Fleet Mix Disaggregated by vehicle type (KTCO2e)



Source: SMNT/DfT (2021)

Figure 3.5 left illustrates the shift in annual carbon emissions through time, by vehicle type. It shows no material change to HGV emissions over time. This is because the vehicle kilometres are constant, and the Emissions Factor Toolkit only incorporates HGVs engine efficiency improvements (not alternative fuels), despite the government's pledges outlined previously. This orange tranche would reduce to less than is shown as alternative fuels are increasingly used: we have not illustrated that on the graph due to the complexities and inaccuracies involved in introducing our own assumptions on future phase rates of HGVs. It should be recognised that this will however reduce.

Group Trajectory 2: National policies

Commentary and key findings

Shift to electric cars and vans has a significant impact but still insufficient to get to net zero

The ban of sale of internal combustion engine cars and vans will result in lower emissions from transport. The SMMT forecast predicts that 98% of cars and vans on the road in 2050 are electric, increasing from 20% in 2030 and 75% in 2040.

This means that 2% of vehicles are still expected to be powered by fossil fuels, producing a very small amount of emissions.

Enabling a shift of this scale will involve the extension of the UK's charging network, needing TfSE's constituent bodies to engage with the public and private sector to ensure sufficient charging provision. It will also have knock-on impacts for taxation: vehicle excise duty is currently zero for electric vehicles. A mooted replacement, road user charging, could also work to constrain demand.

To maximise the decarbonisation benefit, it is also vital that the electricity supply comes from renewable sources.

Emissions reductions are not made fast enough, represented in a convex form

Like Trajectory 1, the trajectory as defined in Figure 3.4 transitions from a convex to a concave form. This is a different shape to the Tyndall curve and would mean overspending the South East's transport carbon budget.

Freight grows as a proportion of total emissions

Reducing car emissions through banning the sale of internal combustion engines means that the total transport emissions are reduced by 65%. However, a greater proportion of this is now expected to be caused by freight.

This highlights the necessity of addressing longer distance freight trips. This can be addressed through:

- Reduce demand for unnecessary / lower need or value freight trips.
- Shift to rail because easier to electrify, but costs more for freight operators.
- Improve efficiency of engines and find zero carbon technology. The process of finding zero emissions goods vehicles will be accelerated by the government's announced ban on sale of diesel goods vehicles in 2035 and 2040 (varying by size)

Trajectory 2 key findings

- Based on technology / regulatory assumptions primarily based on the sale of internal combustion engine cars and van in 2030
- Shift to electric cars is significant but still insufficient in its own right to get to net zero
- Emissions reductions are not made fast enough, represented by a convex curve
- Freight continues to grow and with an almost fully electrified car fleet, now makes up a significant proportion of total emissions. This effect should be mitigated by the government's announced ban on sale of diesel goods vehicles in 2035 and 2040 (varying by size)

Group Trajectory 3: 2050 Budget Based Trajectories

Group Trajectory 3a to 3c: CCC & DfT

The Committee on Climate Change's Balanced pathway to net zero and Department for Transport's national surface trajectories

Figure 3.6 illustrates the resulting three separate budget-based trajectories from the CCC's and DfT's national surface transport trajectories, both being national-level policies.

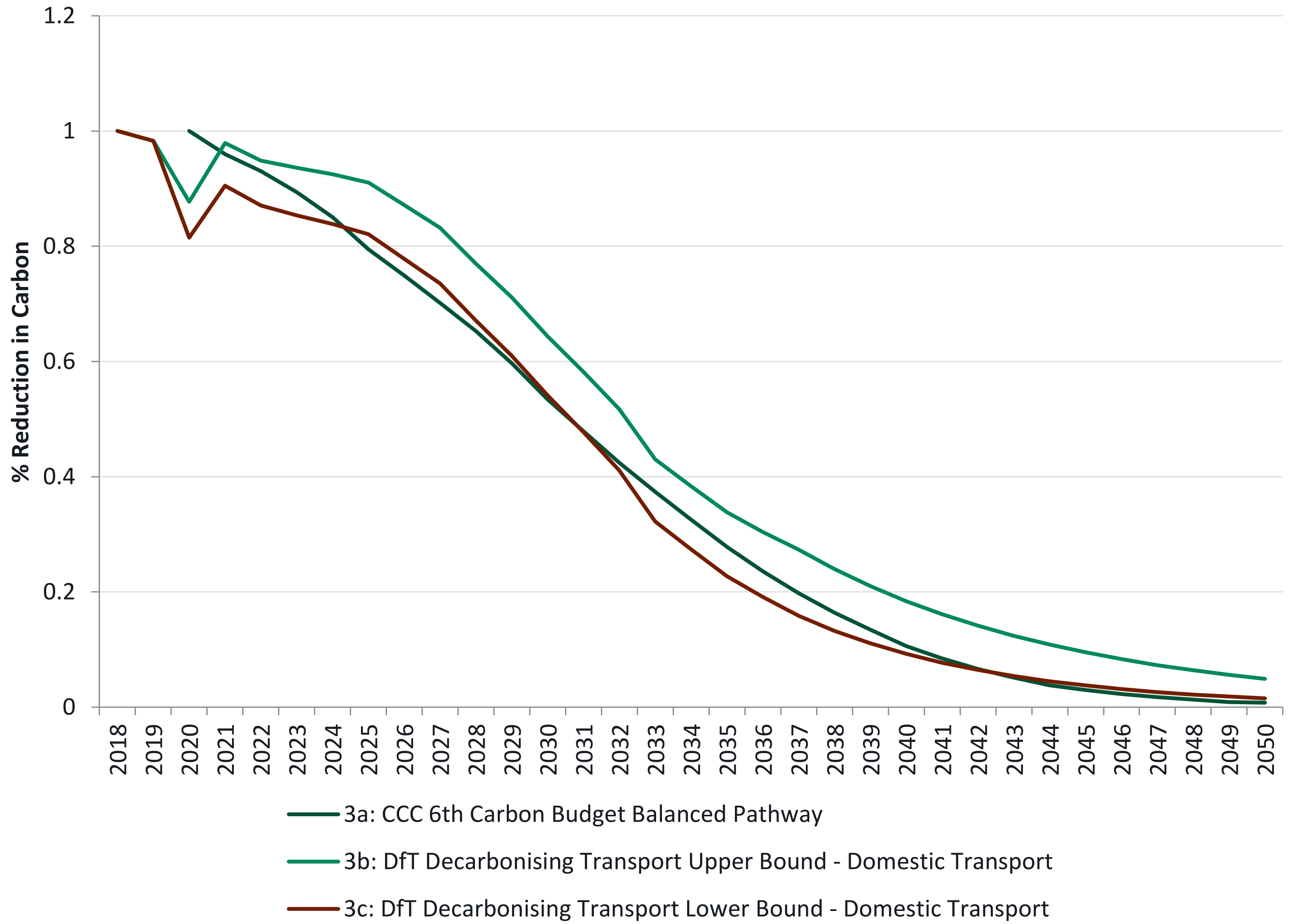
CCC 6th Carbon Budget Balanced Pathway (Trajectory 3a) has the highest baseline for 2020 and is the closest to reach net zero at 1% by 2050.

DfT Decarbonising Transport trajectories both start at the same 2018 baseline and follow a similar trajectory, including a recorded strong dip for 2020 but followed by a return to near-normal in 2021.

DfT Decarbonising Transport Upper Bound (Trajectory 3b) is the furthest from reaching net zero at 6% by 2050.

DfT Decarbonising Transport Lower Bound (Trajectory 3c) is the furthest from reaching net zero at 2% by 2050.

Figure 3.6 Trajectories 3a to 3c - CCC and DfT



Source: CCC (2021) / DfT (2021)

Group Trajectory 3d & 3e: SCATTER Tool

Trajectory purpose and description

SCATTER identifies decarbonisation-relevant policy levers and estimates the impact of pushing them to very ambitious targets. We have used these estimates to form a trajectory.

Method

As outputs, the tool gives both a trajectory and the policy outcomes required to achieve it.

The table on the right explains the emissions sources that SCATTER uses to calculate the trajectories. Only the emissions category in bold relate to surface transport tailpipe emissions, which is the scope of this study.

This trajectory was derived by aggregating the emissions by Local Authority to generate a trajectory for the TfSE Area. However, data was not gathered for every local authority in the TfSE area. The table on the right shows the proxies we used; these were deemed the most appropriate in discussions with stakeholders. We then factored the proxy data by the population ratio.

For example, East Sussex was identified as being the most similar to the Isle of Wight in terms of its general characteristics. In 2019, 142,000 people lived on the Isle of Wight, compared to 559,000 in East Sussex. East Sussex's emissions were therefore multiplied by 3.94 (559,000/142,000).

Table 3.1: Trajectory 3: SCATTER emissions categories

Emissions category	Subcategory	Description
Stationary energy	Off-road transportation	Petroleum – Agriculture2
Transportation	**On-road**	**Petroleum products (2)Road transport**
Transportation	**On-road**	**Onroad SC petroleum**
Transportation	**On-road**	**Coal (2) Rail**
Transportation	**Rail**	**Petroleum products (2)Rail**
Transportation	Waterborne navigation	004:Petroleum products_internal
Transportation	Waterborne navigation	004:Petroleum products_coastal
Transportation	Aviation	Aviation_fuel_Sc1
Transportation	Aviation	Aviation_fuel_Sc3
Stationary Energy	Off-road transportation	Offroad petroleum

Table 3.2 Local Authority SCATTER proxies

Authority	Proxy
Isle of Wight	East Sussex
Slough	Reading
West Berkshire	East Sussex
Windsor & Maidenhead	Bracknell Forest
Wokingham	Bracknell Forest

Group Trajectory 3d & 3e: SCATTER Tool

The SCATTER tool gives local authorities the ability to change the settings of the policy outcomes, choosing between 1 (mild intervention) and 4 (stringent intervention).

Trajectory 3d SCATTER Mild presents results for the South East when all transport interventions are "set to their lowest" and Trajectory 3e SCATTER Stringent presents results for the South East when all transport interventions are "set to their highest".

Importantly, even those mild policy objectives shown in Table 3.3 are more ambitious than either Trajectory 1a or 2a. As demonstrated in the previous trajectories, being a policy objective of 100% cars, buses and rail being electric by 2050 will take significantly more than just banning the sale of internal combustion engine cars and vans from 2030; increasing vehicle occupancies and reducing the distance travelled per person will require change in vehicle ownership and access arrangements and changes to land use planning.

Achieving the stringent policy objectives shown in Table 3.3 will require a radically different set of policies to those that are currently proposed nationally, regionally or locally.

Note: There is some doubt remaining over the meaning of the descriptions of emissions sources used in SCATTER.

- "Petroleum products (2)Road transport" is by far the largest category, and decreases by the largest proportion. This is assumed to be tailpipe emissions from vehicles driving on the road. "Domestic passenger transport – technology" reduces these emissions to 8% of the total; "mode shift", "demand management" and "freight" all reduce it to between 25%-27% of its 2020 total.
- "Petroleum products (2)Rail" varies widely between regions. In all trajectories except the modal shift trajectory, it remains constant in all authorities. In the modal shift Trajectory, it increases over time. This is strange, as the "technology" intervention specifies that all rail travel is electric by 2030.
- "Onroad SC petroleum" is zero in Brighton & Hove, East Sussex and West Sussex, but as much as 17% of all emissions in Kent. This reduces at exactly the same rate as the "Petroleum products (2)Road transport" in each Trajectory.
- "Coal (2) rail" only applies in Kent and Hampshire, and is a very small proportion of total emissions. It does not change in either trajectory.

The organisations behind SCATTER contacted did not reply to our requests for information.

Table 3.3 Trajectory 3d and 3e - SCATTER policy outcomes

Intervention category	Mild policy outcomes	Stringent policy outcomes
Domestic freight	By 2050, 47% increase in distance travelled by road freight; 40% increase in efficiency.	By 2050, 22% decrease in distance travelled by road freight; 75% increase in efficiency
Domestic passenger transport - demand	No change to total travel demand per person	25% reduction in total distance travelled per individual per year by 2030
Domestic passenger transport – modal shift	No change to current national average modal split by total miles: 74% transportation by cars, vans and motorcycles	Average modal share of cars, vans and motorbikes decreases from current national average 74% total miles to 38% in 2050
Domestic passenger transport – technology	Cars, buses and rail are 100% electric by 2050. Slight increase in average train occupancy	Cars and buses are 100% electric by 2035 Rail is 100% electric by 2030 Average occupancies increase to 18 people per bus km (from 12), 1.65 people per car km (from 1.56) and 0.42 people per rail km (from 0.32)

Group Trajectory 3d & 3e: SCATTER Tool

Figure 3.7 shows the impact of applying the stringent policy outcomes shown in Table 3.3 to the following intervention categories:

- Domestic freight
- Domestic passenger transport - demand
- Domestic passenger transport – modal shift
- Domestic passenger transport – technology

Trajectory 3d SCATTER Mild represents the combined impact of applying the mild policy initiatives in each of the four areas.

The policy specific trajectories represent the proportional reduction in carbon that could be achieved by applying the stringent policy initiative. For example, the difference between the Do Minimum trajectory and the "Domestic Freight trajectory shows the extent to which the stringent freight policies will contribute towards achieving net zero.

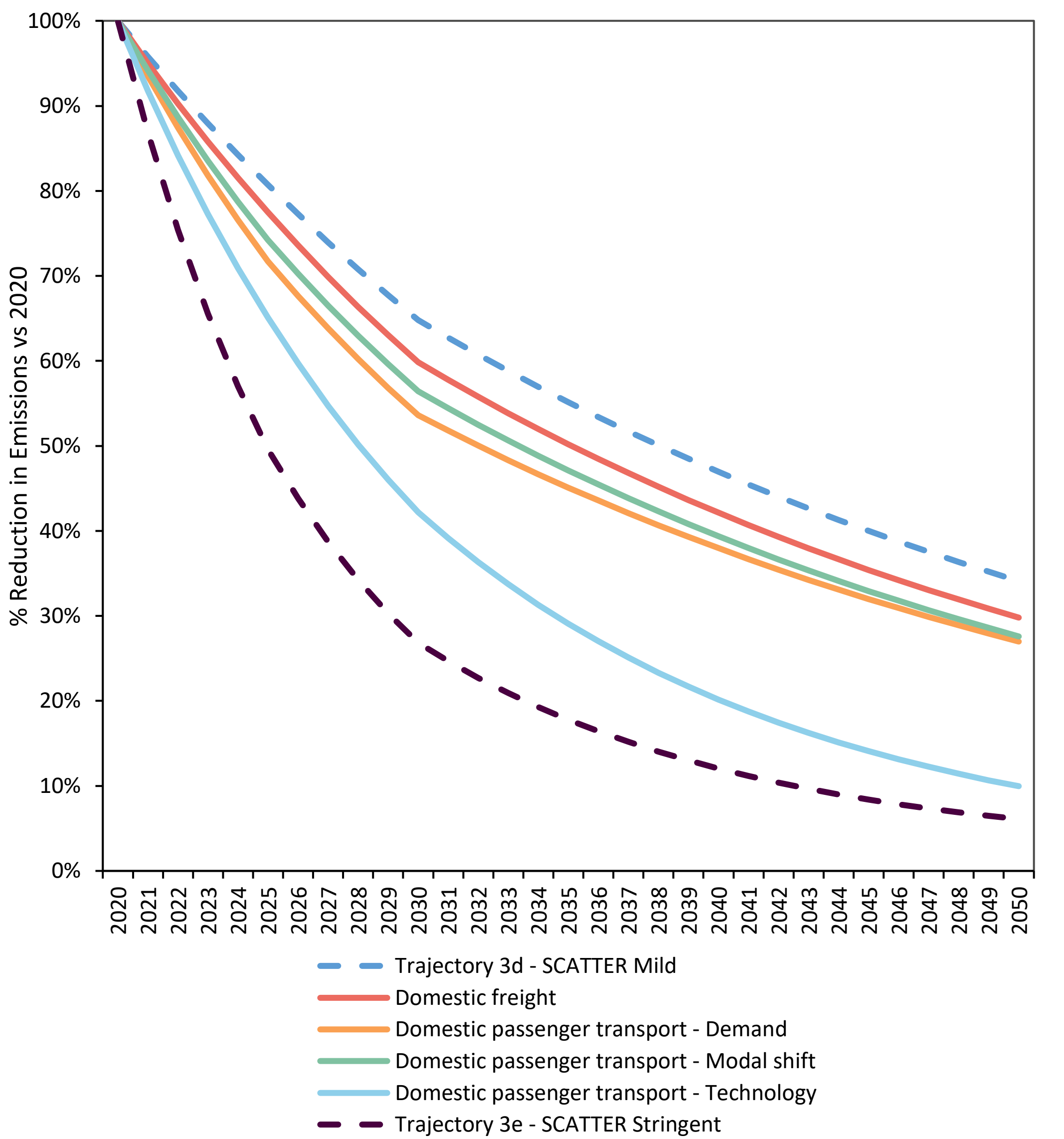
The SCATTER Stringent trajectory represents the combined impact of applying stringent policy initiatives in each of the four areas.

The lines represent the total aggregate emissions in all categories and in all local transport authorities.

Of the interventions, the change in domestic passenger transport technology has by far the biggest impact on total emissions. This is surprising given our earlier finding on the contribution made by heavy goods vehicles to total emissions: there is no mention of changes to freight fleet in the technology Trajectory; seemingly it is covered in the Domestic Freight Trajectory, which describes a 75% increase in efficiency of freight vehicles. The Domestic Freight intervention is shown as the least effective.

Changing the fleet mix, as SCATTER implies is the most important, can be facilitated by the South East local authorities, but achieving the policy outcomes outlined in this Trajectory – cars and buses being 100% electric by 2035, rail by 2030 and average vehicle occupancies increasing on all modes – will require very stringent measures from central government. Combining all four interventions reduces the total emissions by less than the sum of each intervention individually. This is logical: reducing the number of trips has less effect on total emissions if those trips are already made by electric vehicle than it does if the trips are still made in petrol cars.

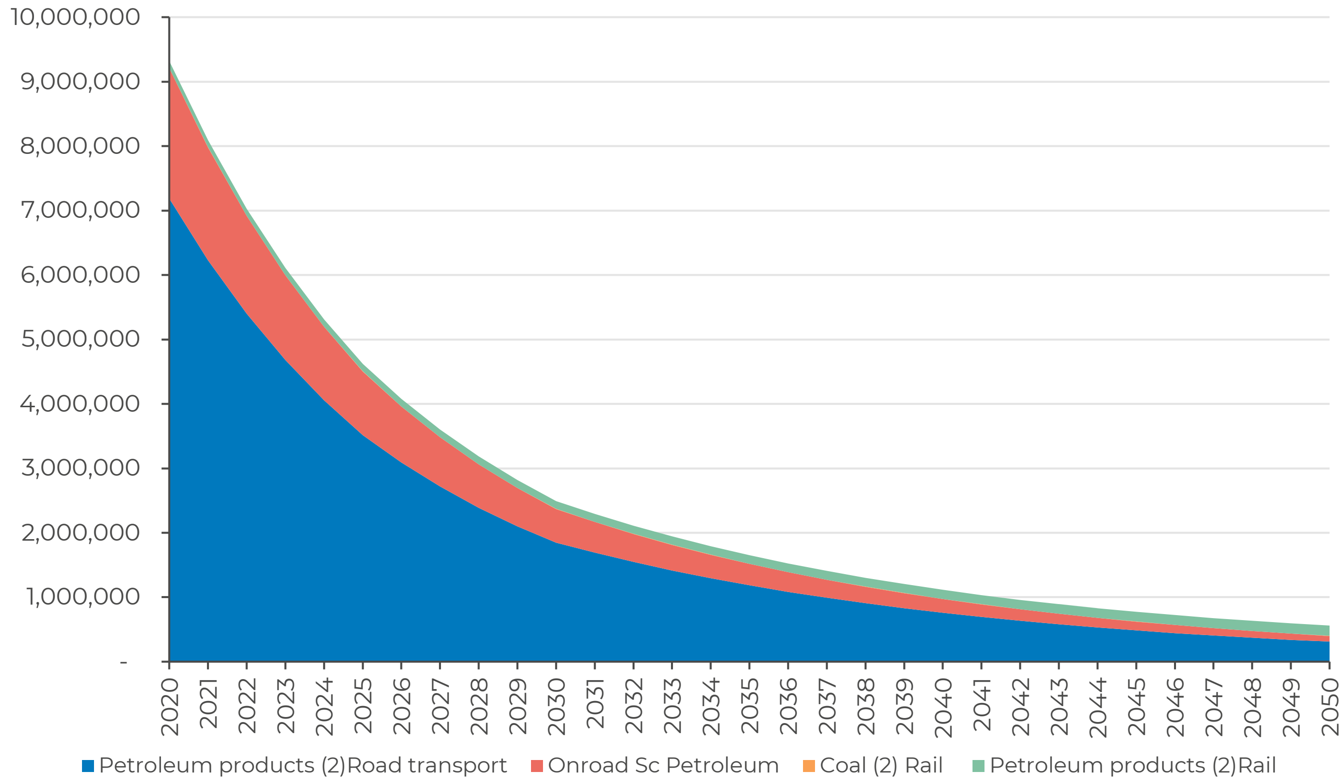
Figure 3.7 SCATTER Tool impacts of different policy outcomes



Source: SCATTER (2019)

Group Trajectory 3d & 3e: SCATTER Tool

Figure 3.8 Trajectory 3b Emissions disaggregated by emissions category



Source: CCC (2021) / DfT (2021)

Figures 3.8 illustrates the resulting levels of emissions by emissions category by applying SCATTER Tool's "Stringent" policy outcomes ("set to 4") across all four policy areas, "Petroleum products (2)Road transport" and "Onroad Sc Petroleum" cause by far the largest proportion of emissions. This does not change significantly over time, though the proportion does slightly decrease as electrification occurs and "Petroleum products (2)Rail" stays constant.

However, we must bear in mind the earlier query about why "Petroleum products (2)Rail" does not decarbonise, despite "Domestic passenger transport – technology" promising 100% electric rail by 2030.

Group Trajectory 3f: Tyndall Centre

Tyndall Centre Carbon Budget Tool

The Tyndall Centre has produced decarbonisation trajectories that reflect total carbon budgets for local authorities which, if all were achieved, would enable the UK to meet its climate obligations under the Paris agreement.

These carbon budgets are not disaggregated: they account for all emissions, not just transport.

Figure 3.9 illustrates that If transport was to follow the average reductions required to stay within an identified carbon budget as forecast by the Tyndall Centre, compared to a 2020 baseline, transport would need to reduce annual emissions by:

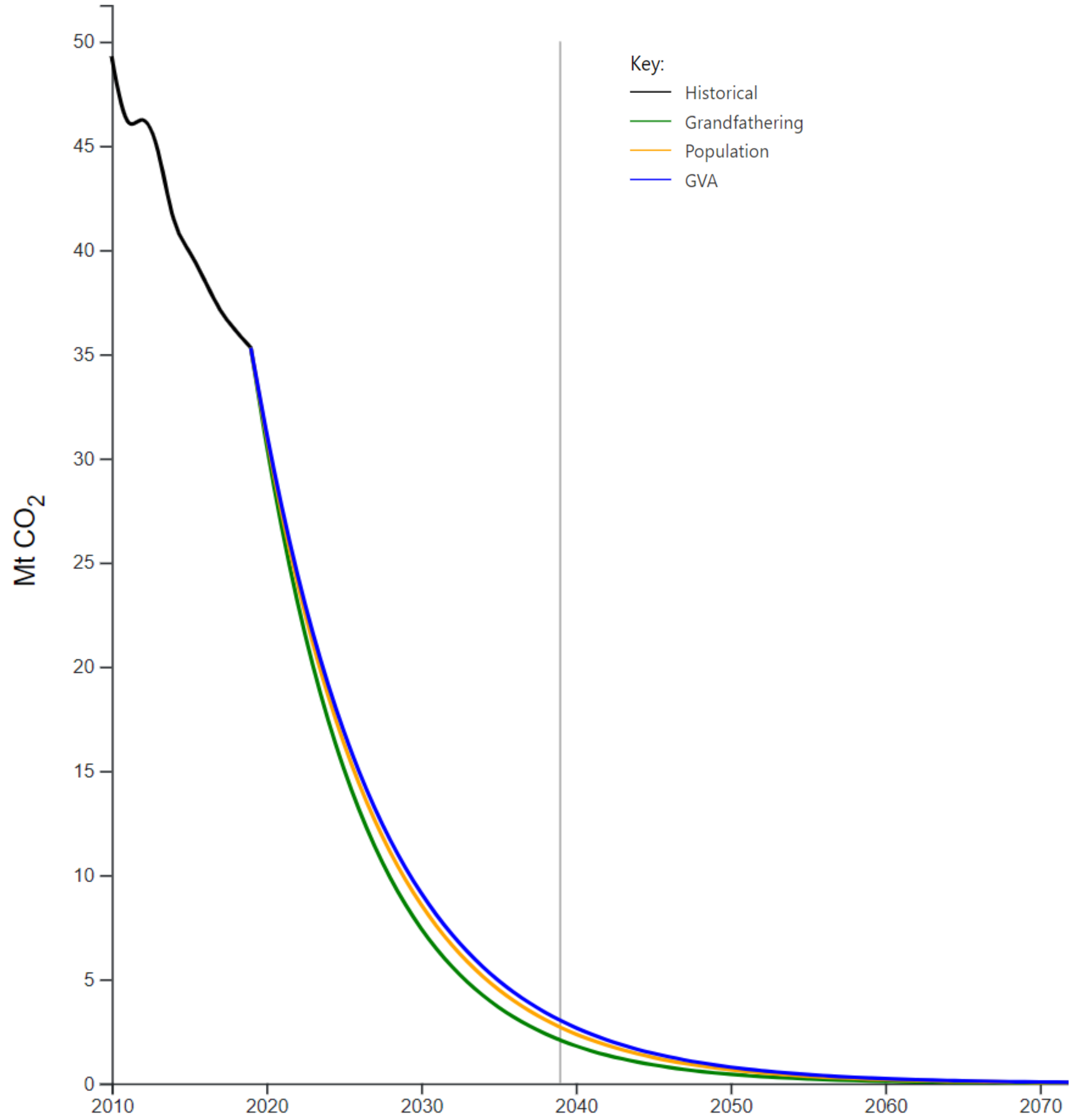
- 63% by 2025
- 82% by 2030
- 91% by 2035
- 95% by 2040
- 96% by 2045
- 98% by 2050

Emissions from transport have changed little in the past 20 years, whereas other sectors such as energy have already decarbonised heavily. Therefore, to meet the Tyndall Centre trajectory, transport may in fact need to reduce emissions faster than this.

The historical curve shows how overall carbon emissions from all sectors have reduced in the past decade. The three forecast curves represent slight differences in calculation. Each take total UK reductions required, then assign these reductions to areas of the UK taking into account:

- "Grandfathering"3: meaning as a proportion of emissions used to date - this means if your baseline is higher, you are required to reduce emissions less so that change is less drastic.
- Population: The number of people living in the region.
- GVA: The size of the economy.

Figure 3.9 Trajectory 3f Tyndall Centre for the TfSE area



Source: Tyndall Centre (2020)

3 Source: *Grandfathering: Environmental Uses and Impacts* (Damon. M; Cole, D H; Ostrom, E; and Sterner, T, 2020)

Group Trajectory 3f: Tyndall Centre

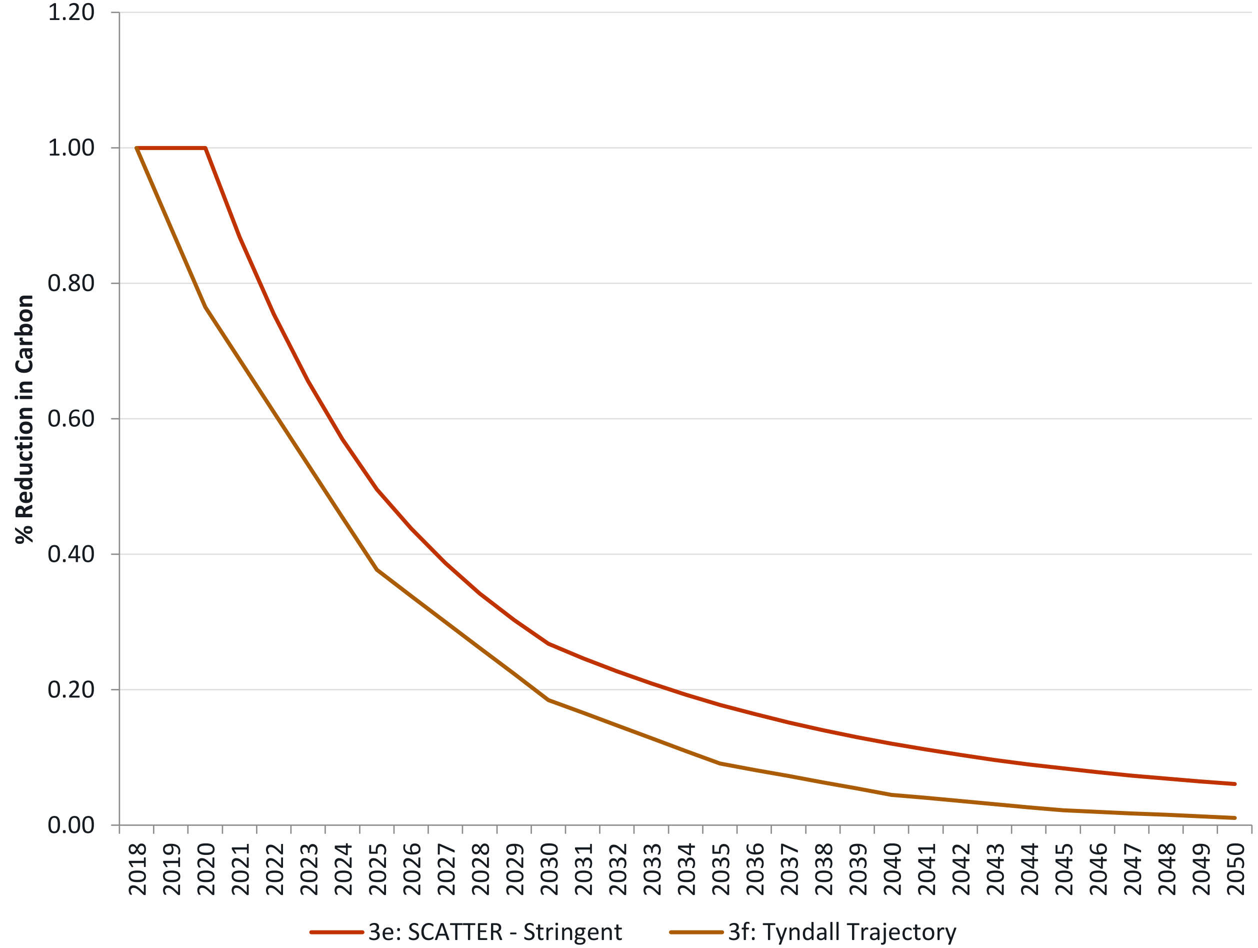
Tyndall Centre Carbon Budget Tool

Figure 3.10 illustrates a comparison between the resulting 3e SCATTER stringent and 3f Tyndall centre trajectories. Both trajectories start at different baseline years and illustrate a steep curve.

SCATTER Stringent Policy Outcomes (Trajectory 3e) runs close to net zero at 6% of total emissions by 2050.

Tyndall Centre (Trajectory 3f) runs much closer to absolute zero carbon at 2% of total emissions by 2050.

Figure 3.10 Scatter Stringent and Tyndall Centre Trajectories



Source: SCATTER (2019) / Tyndall Centre (2021)

Group Trajectory 3: Use of SCATTER tool

Commentary and key findings

SCATTER's stringent pathway is not enough to reach net zero

Even the most stringent intervention, which would require much more action than is currently being discussed, would not enable TfSE to achieve its goal of zero carbon by 2050.

TfSE's Transport Strategy "Sustainable Route to Growth" Trajectory should aim to replicate this trajectory where possible, but going slightly further to ensure net zero and minimal carbon budget spend.

More reductions sooner means total carbon budget spend is lower

Unlike Trajectories 1 and 2, the curves generated by the SCATTER tool imply steep reductions in the short term, followed by continuing reductions at a lower rate as we get closer to net zero.

These concave curves have less area underneath them than the convex curves of Trajectories 1 and 2. This represents far less total carbon being emitted over time, in line with the shape of Tyndall Centre curves.

Electrification of fleet has by far the biggest impact of all SCATTER policy objectives

Electrification of road transport has by far the biggest impact of all SCATTER's modelled interventions. Whereas modal shift and demand reduction have similar impacts of achieving approximately 70% reductions in annual emissions by 2050, electrifying the fleet means 85% reductions. The electrification curve is also much steeper at the beginning, meaning in terms of carbon budget the electrification scenario is even further ahead.

The cumulative impact of pulling all four buttons is less than the sum of each on their own. This is because reducing the number of trips is not as effective at reducing carbon if those trips are already zero tailpipe emission – this can be seen by the gap between the "technology" curve and the "All set to 4" curve being greatest until 2030, when the ban of sale of internal combustion engine cars and vans comes into force.

Trajectory 3 key findings

- The Scatter and Tyndall Centre curves are steeper in the early years than the government/CCC, with 20% reductions in emission in the first two to three years
- SCATTER Tool "stringent" pathway is not enough to reach net zero
- The switch to zero emission vehicles has the greatest impact
- The Tyndall Centre sees the steepest reduction of all, bus is not sector disaggregated - as a result transport will need to reduce faster

Trajectory 4: 2040 Budget Based Trajectory

Trajectory 4: Target 2040

Trajectory purpose and description

Several local authorities in the TfSE area have set more ambitious carbon reduction targets than the Governments 2050 net zero date, with some aiming for net zero as early as 2030.

Trajectory 4 has been developed to test the rate of carbon reduction required to reach the same volume of emissions between 2020 and 2050, modelled in Trajectory 3e SCATTER stringent a decade earlier, in 2040. Trajectory 4 is based on the Tyndall Centre budgets – this same budget has been applied across the whole period to 2040.

Method

Trajectory 4 takes the total emissions budget that the Tyndall Centre applies to 2050, and shrinks the time period during which carbon can be expended to 2040.

Trajectory 4 also accounts for the fact that little progress has been made to decarbonise between 2018 and 2022. According to Trajectories 3e/3f, the TfSE area should have reduced emissions by 20% between 2020 and 2022. If this has happened, it is a result of the COVID-19 pandemic and may not be sustained. Trajectory 4 therefore accounts for this slow start by allocating the last ten years' worth of carbon budget to the first two years, as shown in Figure 3.4.

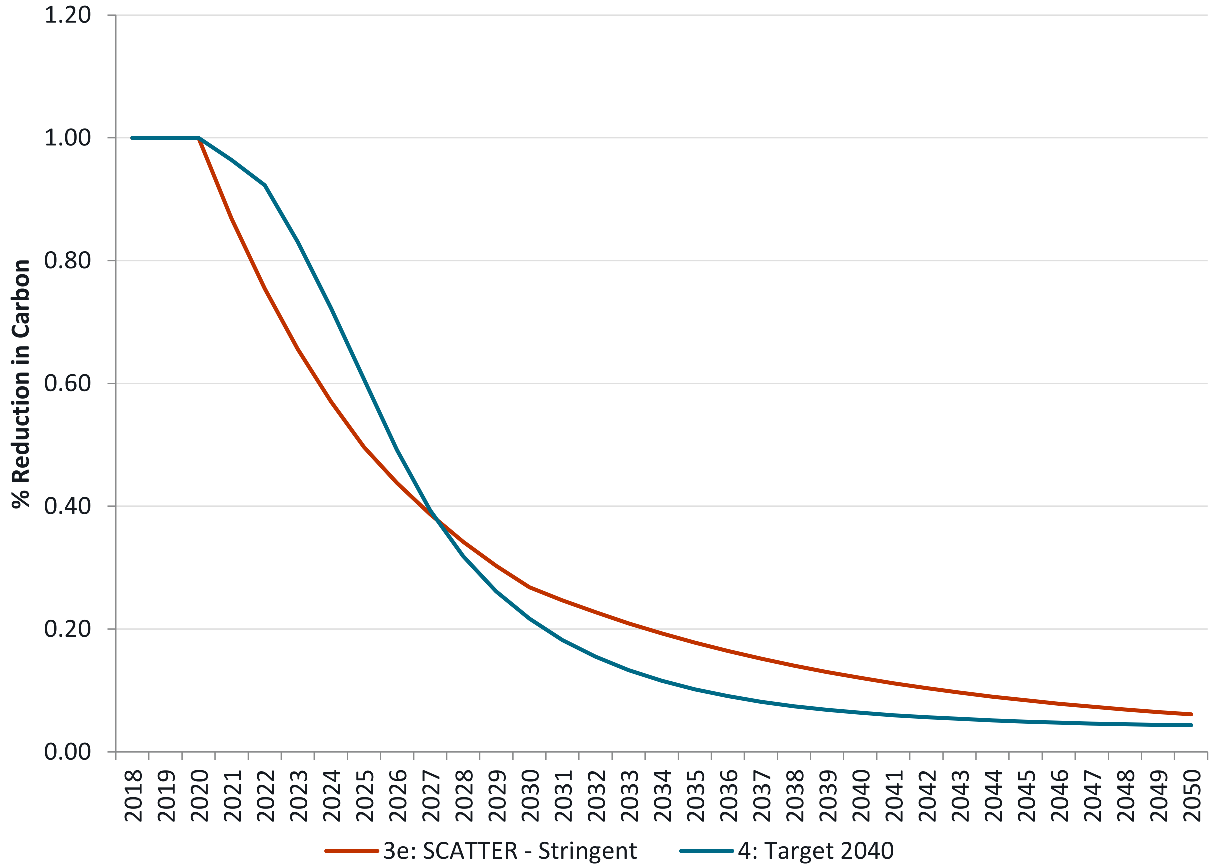
Target 2040

Figure 3.11 illustrates a comparison between the resulting 3e SCATTER stringent and 4 Target 2040 trajectories. Both trajectories start at different baseline years and follow a steep curve.

Trajectory 3e SCATTER Stringent runs close to net zero at 6% of total emissions by 2050.

Trajectory 4 Target 2040 runs close to net zero at 6% of total emissions by 2040 and is comprised of a much steeper drop in comparison. A rapid acceleration in decarbonisation would need to take place from now for the following 10 years in order to reach net zero

Figure 3.11 2040 and 2050 Tyndall Centres Trajectories



Source: Tyndall Centre (2021)

Trajectory 4: Target 2040

Commentary and key findings

Inaction now requires drastic action in mid-2020s

Trajectory 4 adapts the curve taken from SCATTER reductions modelled in Trajectory 3d/e and aims to reach net zero in 2040. This trajectory allows for more emissions in the 2020s than Trajectory 3b, which may be realistic given the challenges associated with meeting the fleet mix changes identified in Trajectory 3b. However, the two curves intersect in 2030. That means that emissions are expected to be the same in 2030, at 30% of current levels.

In effect, this Trajectory sees the 2040s and some of the 2030s carbon budget allocated in Trajectory 3b to be used in advance, in the 2020s, with the pay-off being that emissions must be reduced much more rapidly year on year from the mid 2020s and until 2036.

These sharp reductions must begin next year (2023), with a 10% reduction compared to 2022. This year on year reduction increases to 20% between 2026 and 2027.

Given how stringent the assumptions behind the Trajectory 3b curve are – including a totally electrified car and van fleet by 2035 – it is difficult to see how this curve can be achieved without major change of policy and funding from central government.

In conclusion, a slow start mean more drastic action will have to taken in the medium term.

Trajectory 4 key findings

- Still based on limiting global temperature rises by no +2 degrees Celsius
- Allows for more emissions in the 2020s compared to 2050 target based on budgeting techniques
- Might be more realistic given current "progress"
- Requires more concerted effort overall (i.e. more to do in a shorter period of time)

Summary of findings from analysis of trajectories

Comparison of Trajectories

None of the trajectories enable net zero to be achieved in the TfSE area

- 56% of baseline emissions remain in 2050 in a "Do Nothing" Trajectory.
- The ban on the sale of internal combustion engines cars and vans will reduce this to between 30% and 40%, subject to accelerated roll out of hybrid and zero emission vehicles.
- The most stringent interventions modelled in SCATTER suggest 6% of baseline emissions will remain in 2050.
- The nature of these extremely stringent interventions makes them challenging economically and politically.

Freight is likely to generate the majority of transport emissions in latter years

- Freight vehicles account for between a third and a half of emissions today in the TfSE area – a higher proportion than the national average due to the presence of key international gateways and strategic routes.
- This proportion is likely to rise as cars and vans are electrified.
- There is currently no commercially viable technology to power HGVs without fossil fuels.

The longer it takes to start reducing emissions, the more drastic the reductions will have to be to meet legal targets

- Short term wins of shifting local trips vital to save carbon budget immediately
- If reductions only start in earnest in 2023, reductions of up to 20% will need to be made year-on-year through the 2020s
- Net zero by a date earlier than 2050 will require very drastic measures to be introduced almost immediately

Figure 3.12 overleaf shows all trajectories profiled over time. **None of the trajectories reach the carbon budget assigned by the Tyndall projections and none reach absolute zero for surface or domestic transport tailpipe emissions.**

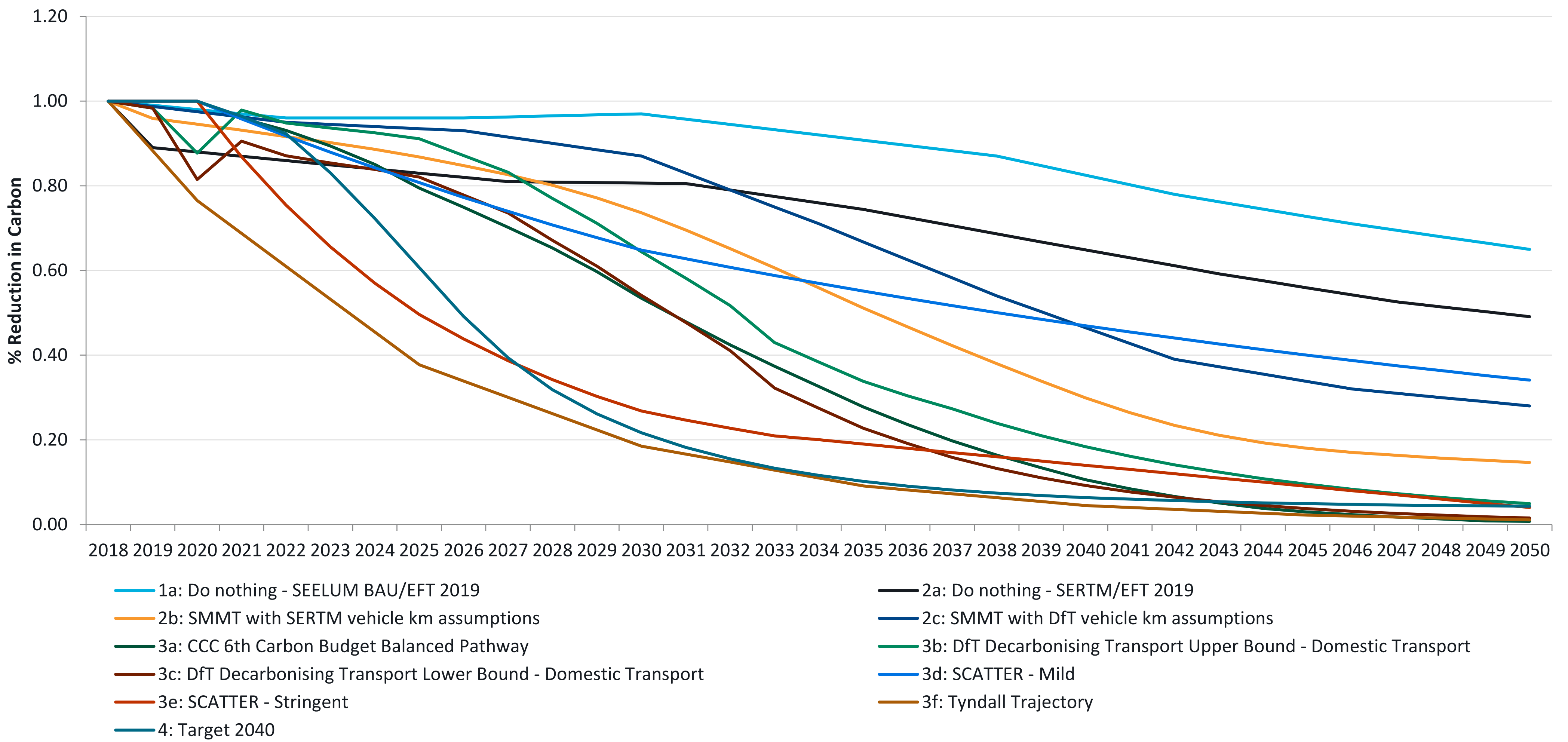
Table 3.4 Summary of emissions reductions of different trajectories

Trajectory	Methodology	2018 emissions (ktCO²)	2050 emissions (ktCO²)	% reduction	Total emissions 2018-2050 (ktCO²)	Av. Emissions per year (ktCO²)
1: Do nothing	*SEELUM BAU/EFT 2021*	10,539	5,940	-44%	246,637	7,707
2: National policies	*SEELUM BAU/EFT 2019*	15,368	6,365	-59%	370,522	11,579
	Society of Motor Manufacturers and Traders (SMMT)	10,476	3,318	-68%	195,965	6,124
3: Committee on Climate Change & DfT Decarbonising Trajectories	*CCC 6th Carbon Budget Balanced Pathway*	N/A	N/A	-99%	N/A	N/A
	DfT Decarbonising Transport Upper Bound - Domestic Transport	N/A	N/A	-95%	N/A	N/A
	DfT Decarbonising Transport Lower Bound - Domestic Transport	N/A	N/A	-98%	N/A	N/A
3: SCATTER/Tyndall	*Scatter Mild Policy Objectives*	9,751	3,325	-66%	188,731	5,898
	Scatter Stringent Policy Objectives	9,751	594	-94%	94,354	2,949
	Tyndall Centre for Climate Change Research	N/A	N/A	-97%	N/A	N/A
4: Target 2040	*Through adjusting Scatter Stringent Trajectory and bringing forward to 2040*	9,751	423	-96%	90,607	2,831

TRANSPORT FOR THE South East

Trajectory conclusions

Figure 3.12 All trajectories (indexed)



TRANSPORT FOR THE South East

Trajectory conclusions

Base Year

- Shopping, leisure and personal trips account for more emissions than business and commuting trips combined
- Trips over 20km account for 82% of tailpipe emissions from surface transport
- Freight accounts for approximately half current emissions

Do Nothing

- Even without a ban of the sale of internal combustion engines, there is still a significant shift to zero emission vehicles
- However, significantly misses net zero carbon by 2050
- Estimates of less than ten years of current emission rates before we use entire budget to 2050

National Policy

- Based on technology / regulatory assumptions and particularly the ending of the sale of internal combustion engine cars and van in 2030
- Shift to electric cars is significant but still insufficient in its own right to get to net zero
- Emissions reductions are not made fast enough, represented by a convex curve

2050 Budget

- The Scatter and Tyndall Centre curves are steeper in the early years than the CCC, with 20% reductions in emission in the first two to three years
- SCATTER Tool "stringent" pathway is not enough to reach net zero
- The switch to zero emission vehicles has the greatest impact
- The Tyndall Centre sees the steepest reduction of all, bus is not sector disaggregated - as a result transport will need to reduce faster

2040 Target

- Still based on limiting global temperature rises by no more than +2 degrees Celsius
- Allows for more emissions in the 2020s compared to 2050 target based on budgeting techniques
- Might be more realistic given current "progress"
- Requires more concerted effort overall (i.e. more to do in a shorter period of time)

4. Identifying policies to meet the challenge

Overview

If previous chapters identified that current policies and trajectories that follow them are insufficient, this third chapter identifies what future areas of policy and intervention are needed in order we reach net zero. Not only net zero by a fixed date, but to align with the carbon budget-based trajectories that account for the volume of emissions emitted between now and 2050 or 2040 – principally the Committee on Climate Change's 6th Budget Balanced Pathway for UK Surface Transport and the "stringent" trajectory derived form the SCATTER Tool for the TfSE area.

In this chapter, options – areas of policy and intervention – and their contribution to net zero have been identified. However, consensus is building that no one area of policy or intervention will be enough for transport to reach net zero. As such the use of scenarios – approaches to transport and wider planning bundling multiple options together – has been used.

In this chapter, the following is detailed:

- methodology for option generation and scenario development and assessment;
- identification of options and scenarios;
- scenario carbon impact modelling and assessment;
- additional scenario carbon impact modelling and assessment – considering scaling and phasing of options to optimise alignment with desired net zero trajectories.

Methodology

The methodology developed and followed for option and scenario development and assessment is detailed below and summarised in Figure 4.1 to the right.

Option Generation and Scenario Development Workshop

To develop an understanding of how to prioritise different areas of policy and intervention, a workshop was held with members of the Transport Strategy Working Group on Tuesday 1st March 2022.

This was framed through the application of 26 options (see pages 55 to 58) to three scenarios (see below). Options were prioritized by importance/ precedence and timescale (see page 59 for an example in Figure 4.3).

The three scenarios were first defined as part of TfSE's Transport Strategy in 2020, as part of a set of five scenarios. Only the three that were deemed to align to a material reduction in carbon emissions were selected as part of this workshop exercise:

- Sustainable Future
- Digital Growth
- A Sustainable Route to Growth

These are summarised in terms of their key attributes on page 60 and page 62.

Policy ambitions, outputs and intervention types

The 26 options were grouped into 12 option areas, from which each scenario was given a level of policy ambition across the 12 option areas (see Figure 4.4 on page 61).

As an example, for the rail-specific option area (see Figure 4.6 on page 63), each level of policy ambition was given a corresponding level of policy output, and intervention types we identified commensurate with the desired level of policy ambition. These were based on benchmarking and drawing on technical modelling and benchmarking work as part of the Area Studies programmed. All option area summaries with levels of policy output and interventions types corresponding with different levels of ambition are provided in Appendix D).

Initial carbon impact assessment - modelling of scenarios

Scenarios and their prioritised options and corresponding level of policy ambition were converted into a series of model inputs (see Appendix C for the detail of model inputs by scenario and option area).

SEELUM was used to model the scenarios and understand the transport impacts, with model outputs converted into "tailpipe" carbon emissions using DEFRA's Emissions Factors Toolkit (v11), where appropriate.

Based on the level of identified policy ambition these were converted into absolute or percentage reductions in generalised journey times by mode or trip rates, with consequential changes in travel demand and carbon emissions.

Key findings from scenario development and the workshops and carbon profiles from modelling of each scenario are provided on page 64 and in Figure 4.7 on page 65 respectively.

Figure 4.1 Method diagram for option generation, scenario development and carbon assessment

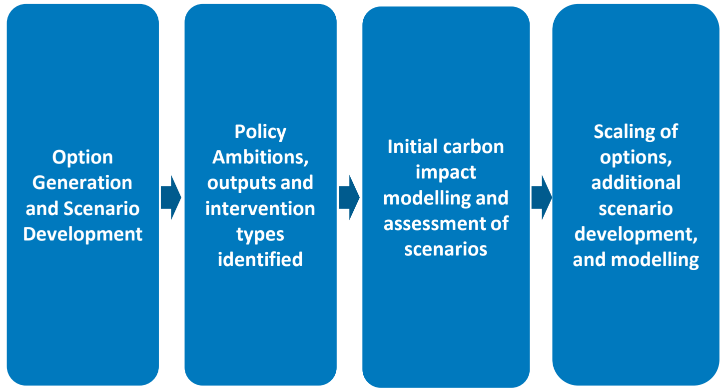


Figure 4.2: Three scenarios for decarbonisation – summary of scenario characteristics

Scenario 1 Sustainable Future

- **Principle:** Demand management
- **Characteristics:** environmentally focused with strong 'green' credentials with a strong focus on reducing car usage altogether
- **Supported by:** Road pricing, encouragement of active and public transport, road space reallocation, public transport fare subsidies and improved bus services

Scenario 2 Digital Growth

- **Principle:** Connected and Autonomous Vehicle network
- **Characteristics:** technology-focused facilitating the uptake of electric and autonomous vehicles alongside demand-responsive public transport modes, whilst concurrently promoting home working and reducing trips
- **Supported by:** technological deregulation, no policy constraints on CAVs/MaaS, pedestrianised urban centres

Scenario 3 Sustainable Route to Growth

- **Principle:** modal shift
- **Characteristics:** the most effective policy elements of digital growth and sustainable futures, improving connectivity and technological change whilst driving modal shift
- **Supported by:** Road pricing, public transport subsidies, no policy constraints on CAV/MaaS, encouragement of active and public transport, road space reallocation, improved bus/urban transport, pedestrianised urban centres

Sustainable Travel Options

Sustainable travel options relate largely to the capacity and connectivity of these infrastructure and services, alongside elements of behavioral change and accessibility improvements.

The general principles of these options include the following:

- Investment in rail operations and specifically rolling stock and staffing, by increasing the number of services running with longer, higher capacity trains.
- Investment in station buildings, platforms and other assets, predominantly relating to design, accessibility and amenability.
- Improved integration of rail services with ports and airports such as increasing the availability of accessible rail sidings and facilitating rail freight operators to invest in rolling stock and operations.
- Enhancements to urban bus journeys, including investment in bus shelters and stations, and bus-priority measures such as full segregation (such as guided bus ways), general bus lanes and junction priority.
- Enhancements to interurban bus journeys, increasing service frequencies and integration with general bus journey enhancements.
- Providing subsidies to reduce the cost of rail and bus journeys, whilst facilitating Mobility as a Service principles and technologies.
- Facilitating more journeys by active travel by road space reallocation and other cycle-friendly measures such as full segregation and junction priority.

Sustainable Travel Options
1. Improved rail capacity/connectivity on radial routes into London
2. Improved rail capacity/connectivity on inner orbital rail corridors
3. Improved rail capacity/connectivity on south coast and Marsh Link
4. Improved freight and passenger rail connectivity to major ports
5. Improved freight and passenger rail connectivity to major airports
6. Sustainable urban transport packages for large towns and cities – bus
6a: Improved interurban bus services
6b: Subsidised and integrated bus and rail fares
7. Sustainable urban transport packages for large towns and cities – active travel / micro-mobility / public realm

Highway Options

Highway options relate largely to the capacity and connectivity of roads and junction, which aim to reduce journey times for road-based private and freight vehicles, as well as providing capacity to support new development.

The general principles of these options include the following:

- Enhancing the capacity of the Major (Motorways and Dual Carriageways), Strategic (Faster A-roads) and local (other A, B and C-roads) road networks
- Improved collaboration between partners such as Highways England, local and regional authorities and port/airport operators
- Policy facilitation and investment in smart road technology, including intelligent traffic management on the strategic road network and at junctions (signals)

Highway Options
8. Improved capacity/connectivity on radial roads into London
9. Improved capacity/connectivity on inner orbital strategic highway routes
10. Improved capacity/connectivity on outer orbital strategic highway routes
11. Improved road connectivity to major ports
12. Improved road connectivity to major airports

Digital Connectivity Options

Digital connectivity options relate largely to the provision of electric vehicle charging infrastructure, subsidisation and incentivisation of electric vehicles, investment in broadband connectivity and policy facilitating technological innovation.

The general principles of these options include the following:

- Emissions-based road user charging incentivising the shift to zero-emission vehicles
- Improved integration of online ticketing and route-finding systems across public transport, car-clubs and micromobility
- Investment in super-fast broadband services to both residential and commercial properties, with strong policy requirements for new developments
- Subsidisation of electric LGVs and HGVs to operators to shift existing ICE freight vehicle fleets
- Policy facilitation and investment in smart road technology, including intelligent traffic management on the strategic road network and at junctions (signals)

Digital Connectivity Options
13. Accelerate uptake of zero emission vehicles – car
14. Accelerate uptake of zero emission vehicles – bus, coach and shared mobility
15. Accelerate uptake of zero emission vehicles – freight
16. Accelerate delivery of Mobility as a Service
17. Increase digital connectivity - connected and autonomous vehicles
18. Increase digital connectivity – broadband and wifi

Demand Management Options

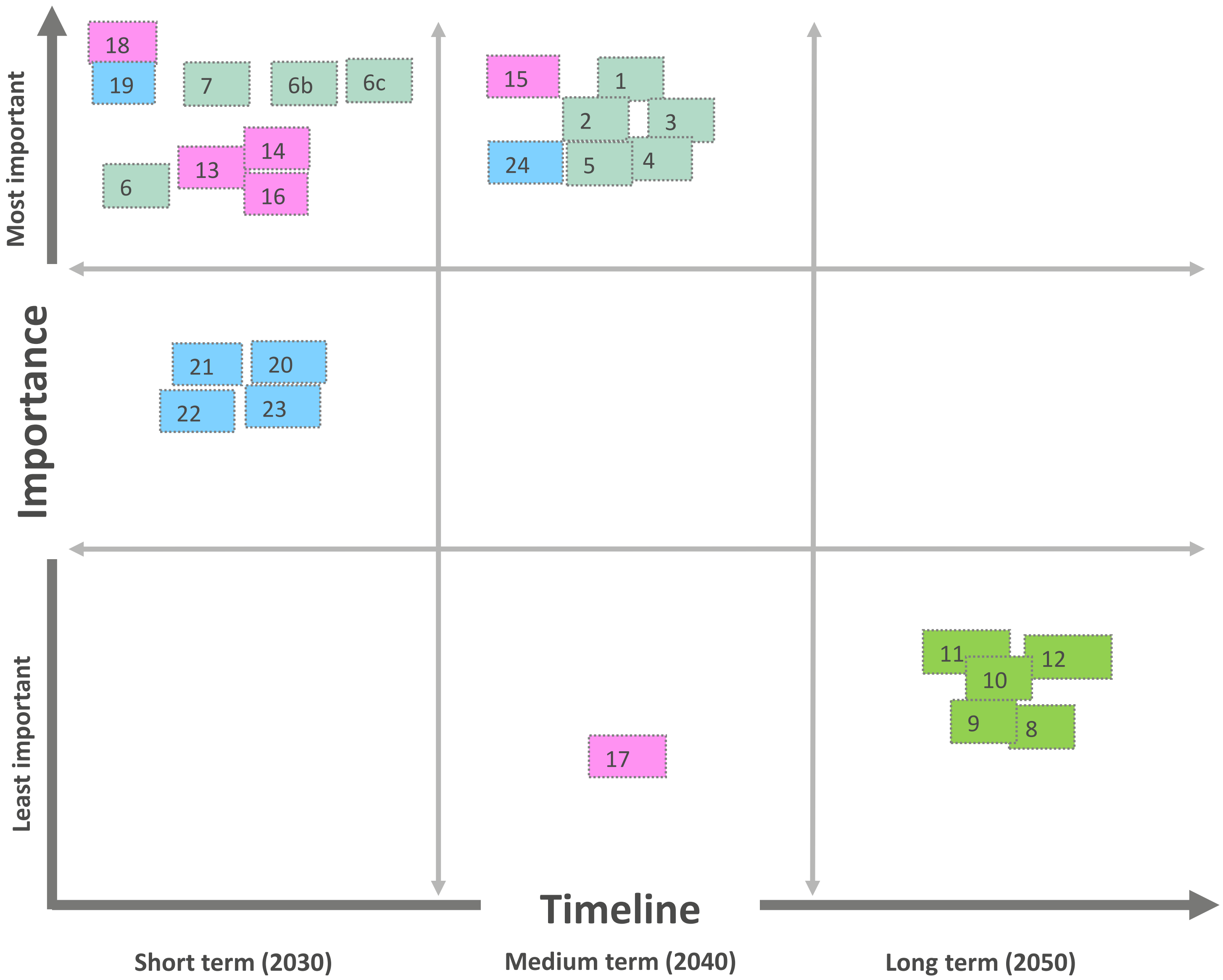
Demand Management options relate primarily to reducing the number of trips on the highway network.

The general principles of these options include the following:

- Investment in super-fast broadband services to both residential and commercial properties, with strong policy requirements for new developments
- Emissions-based road user charging incentivising the shift to zero-emission vehicles at both national and local levels
- Impeding parking availability and accessibility in urban centres through increased charges and introduction of workplace parking levies
- Planning and urban design policies prioritizing high density and compact, equitable mixed-use developments particularly in areas with good public transport accessibility
- Improved integration of online ticketing and route-finding systems across public transport, car-clubs and micromobility

Demand Management Options
19. Local behaviour change packages (e.g. marketing campaigns, PTP)
20. Urban demand management (e.g. ULEZ, WPL)
21. National demand management (e.g. road user charging, fuel tax)
22. Alternative bus operating models (e.g. enhanced partnership, franchising)
23. Focussing investment in our deprived communities
24. Integration of land use and transport planning (e.g. transit-oriented development)

Figure 4.3: Example matrix of prioritized interventions for Scenario 3 Sustainable Route to Growth



Option Prioritisation by scenario

An example prioritisation grid is shown in Figure 4.3 for Scenario 3 – Sustainable Routes to Growth.

The principles of Scenario 3, for example, has a focus of modal shift to sustainable modes of travel, alongside balancing the opportunities of facilitating technological innovation. As a result, specific bus and shared mobility, rail, and active travel and micromobility options were determined to be of greatest importance or having the most 'transformational' improvement. This is complimented with the uptake of zero emission freight and public transport vehicles, alongside MaaS principles and technologies.

This scenario also included a high usage of options discouraging private vehicle trips, and as such correspond to a moderate or significant discouragement of private vehicles for both passenger and freight movement.

Many of the options were identified as being of high importance and required within the short-term, which was a trend replicated across the other two scenarios.

Grids for Scenario 1 – Sustainable Futures and Scenario 2 – Digital Growth (grids provided in Appendix B), with summaries for all three provided on pages 61 to 63.

Identification of Options and Scenarios

Scenario 1 – Sustainable Futures

- Majority of bus & rail, digital connectivity and demand management interventions were identified as the most important short term priorities.
- This is additionally supported by strong demand management measures increasing the cost of vehicle journeys.
- These seek to avoid vehicle trips by vehicles by improving digital connectivity, whilst shifting trips to bus and active travel modes.
- Recognition that rail-based interventions will take a longer time for delivery but are still vital for enabling modal shift.
- Interventions enabling the uptake of Connected and Autonomous vehicles sees lower priority.
- All highway-based interventions (bar improved connections to ports) see exclusion from this scenario as highway construction will go against the grain of facilitating modal shift and sustainable travel.

Scenario 2 – Digital Growth

- Digital connectivity and demand management interventions remain the top focus for digital growth, particularly avoiding longer trips and prioritising localisation.
- These seek to avoid vehicle trips by vehicles by improving digital connectivity, whilst shifting trips to bus and active travel modes.
- This is additionally supported by strong demand management measures increasing the cost of vehicle journeys.
- Lower priority for urban-based public transport interventions, as CAVs and electric vehicles provide an appropriate alternative.
- Recognition that rail-based interventions will take a longer time for delivery and a lower priority given a reduced need to travel but are still important for enabling modal shift.
- Interventions enabling the uptake of Connected and Autonomous vehicles sees lower priority.
- Highway based interventions see a low priority and in the longer term but recognises that highway investment may be required to accommodate CAVs alongside electric vehicle charging infrastructures. Unlikely this will relate to capacity-building with generally lower demands.

Scenario 3 – Sustainable Route to Growth

- Digital connectivity, bus and active travel-related interventions were identified as top priorities under this scenario shifting urban car journeys. Additional recognition that public transport vehicles should be zero-emission and journeys seamless as possible for passengers.
- Urban demand management interventions are recognised to have a higher deliverability in the short term but of a lower importance.
- Recognition that rail-based interventions will take a longer time for delivery and a lower priority given a reduced need to travel but are still important for enabling modal shift.
- Interventions enabling the uptake of Connected and Autonomous vehicles sees lower priority.
- Highway based interventions see a low priority and in the longer term but recognising that highway investment may be required to accommodate public and active transport, whilst facilitating further development increasing demand.

Figure 4.4 Filtering of options into policy outcomes and modelled policy outputs

Rail	Bus	Walk	Cycle & Micro-Mobility	Shared Mobility – Passenger	Highway – Car	Freight (Highway and Railway)	Demand Mgmt – Local	Demand Mgmt – National	Local-isation	Digital Connect-ivity	ZE Vehicle uptake
1, 2 ,3, 4, 5	6, 22	7, 19	7, 19	16, 19	8, 9, 10, 12, 17	4, 8, 9, 10, 11, 12	20	21	19	16, 17, 18	13, 14, 15
23, 24											

Scenario development by desired outcomes by typology	Rail	Bus	Walk	Cycle & Micro-Moblity	Shared Mobility – Passenger	Highway – Car	Highway – Freight	Demand Mgmt – Local	Demand Mgmt - National	Local-isation	Digital Connect-ivity	ZE Vehicle uptake
1. Sustainable Futures	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓	×	✓	✓	✓	✓	✓	✓✓
2. Digital Growth	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓	✓	✓	✓✓	✓✓	✓✓
3. Sustainable Route to Growth	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	×	✓	✓	✓	✓✓	✓✓	✓✓

Policy Score	Level of Policy Ambition
✓	Moderate improvement
✓✓	Significant improvement
✓✓✓	Transformational improvement
×	Moderate discouragement
××	Significant discouragement

Identification of Options and Scenarios

Figure 4.5 Workshopped Scenario Principles

Scenario 1 - Sustainable Futures

- **High focus on making sustainable modes more attractive from the short term through investment in services and reducing fares**
- Small increase in vehicle operating costs
- Trip rate reduction in travel to work trips
- Align fleet decarbonisation with SMMT central forecast

Scenario 2 - Digital Growth

- Medium focus on making sustainable modes more attractive from the short term
- **Autonomous vehicles and car sharing initiatives increase attractiveness of highway in the longer term**
- **Higher trip rate reduction in travel to work trips and other trips from the short term**
- Align fleet decarbonisation with SMMT central forecast

Scenario 3 - Sustainable Route to Growth

- A combination of initiatives from the sustainable futures and digital growth scenarios.

Figure 4.6 Policy development scores and outcomes – demonstrating rail-specific policy outcomes

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate increase in rail patronage from new journeys and modal shift from highway journeys	• Moderate increase in the frequency of rail services provided across all routes • Moderate reduction in rail journey times and interchange wait times • Moderate increase in the reliability and comfort of rail services	• Signalling and timetable optimisation initiatives enabling more services to be operated more reliably • Investment in improving the passenger experience including the rolling stock, station assets • Investment in initiatives such as integrated ticketing, wayfinding and passenger information
✓✓	• Significant increase in rail patronage from new journeys and modal shift from highway journeys	• Significant increase in the frequency of rail services provided across all routes • Significant reduction in rail journey times and interchange wait times • Significant increase in the reliability and comfort of rail services	• *Increased investment in the above +* • Targeted infrastructure investment to overcome known bottlenecks to unlock greater capacity on heavily utilised railway lines • Ensuring railway fares are competitive vs other modes
✓✓✓	• Transformational increase in rail patronage from new journeys and modal shift from highway journeys	• Transformational increase in the frequency of rail services and reduction in journey times provided across all routes • The introduction of new routes which increases the catchment of users who have access to a direct, competitive useful rail service • Transformational increase in the reliability and comfort of rail services	• *Increased investment in the above +* • Transformational infrastructure investment to upgrade existing railway lines and open new routes which ensure rail is a competitive option vs other modes for all medium and longer-distance journeys

Key findings – scenario development

The prioritisation of interventions across all three scenarios saw minor differences

It was recognised that the principles of each scenario were different both in scope and response to the contemporary transport context, but prioritisation of the underlying options were largely similar. This illustrates the challenge of selecting specific options and scenarios to focus on.

All the scenarios prioritised a mixture of sustainable transport, digital connectivity and demand management-related policy interventions

During scenario development, workshop attendees concluded that each scenario would require the adoption of a range of focused, wide-impacting strong options as soon as possible.

Some interventions exhibit long-term planning and implementation phases, delaying their impact in facilitating decarbonisation of the South East

Given the complexities and stakeholders involved, it was recognised that some options, such as those relating to rail and urban planning principles will take much longer to develop, deliver and see impact. However, these options were deemed to have a positive, measurable impact on decarbonisation so were given a high priority.

Most transport strategy-led interventions see great applicability to the decarbonisation of the South East

Transport and wider planning options that help facilitate a reduction in private vehicle kilometers whilst shifting those remaining to clean fuels were viewed as having an integral and material contribution to decarbonising surface transport ion the South East.

Decarbonising freight vehicle fleets remains a momentous challenge

Electric and other zero-emission freight vehicles remain in the early stages of adoption. Only larger fleet operators have began implementing zero emission HGVs into their fleets for specific use cases. Shifting HGV mileage to rail freight is challenging with highway interventions facilitating road freight also encouraging private vehicle usage. It was determined that a balance should be met, with some prioritisation of freight from major ports and other international gateways.

Many interventions rely on the progression of the market which is also reliant on the national and international economies

Sustainable development in the built environment is heavily reliant on high-levels of private investment and the facilitation of a skilled workforce in the construction and engineering industries. The planning and construction of larger developments and masterplans is time consuming.

Key findings – carbon impact modelling and assessment

Each of the three scenarios resulted in a material reduction in carbon emission on the baseline "Business as Usual" trajectory

Carbon impacts of each scenario were very similar (see Figure 4.7 overleaf):

- a further 26 to 28 percentage point reduction in carbon emissions in the year 2050 on the "Business as Usual" scenario to a 71% to 73% reduction in 2022 emission levels; and
- a 31% to 33% in overall emissions between 2022 and 2050 than the "Business as Usual Scenario.

However, no scenario reached net zero or had an aligned pathway to meet either the CCC's 6th Budget Moderate Pathway – Surface Transport or SCATTER Tool – "Stringent" trajectories

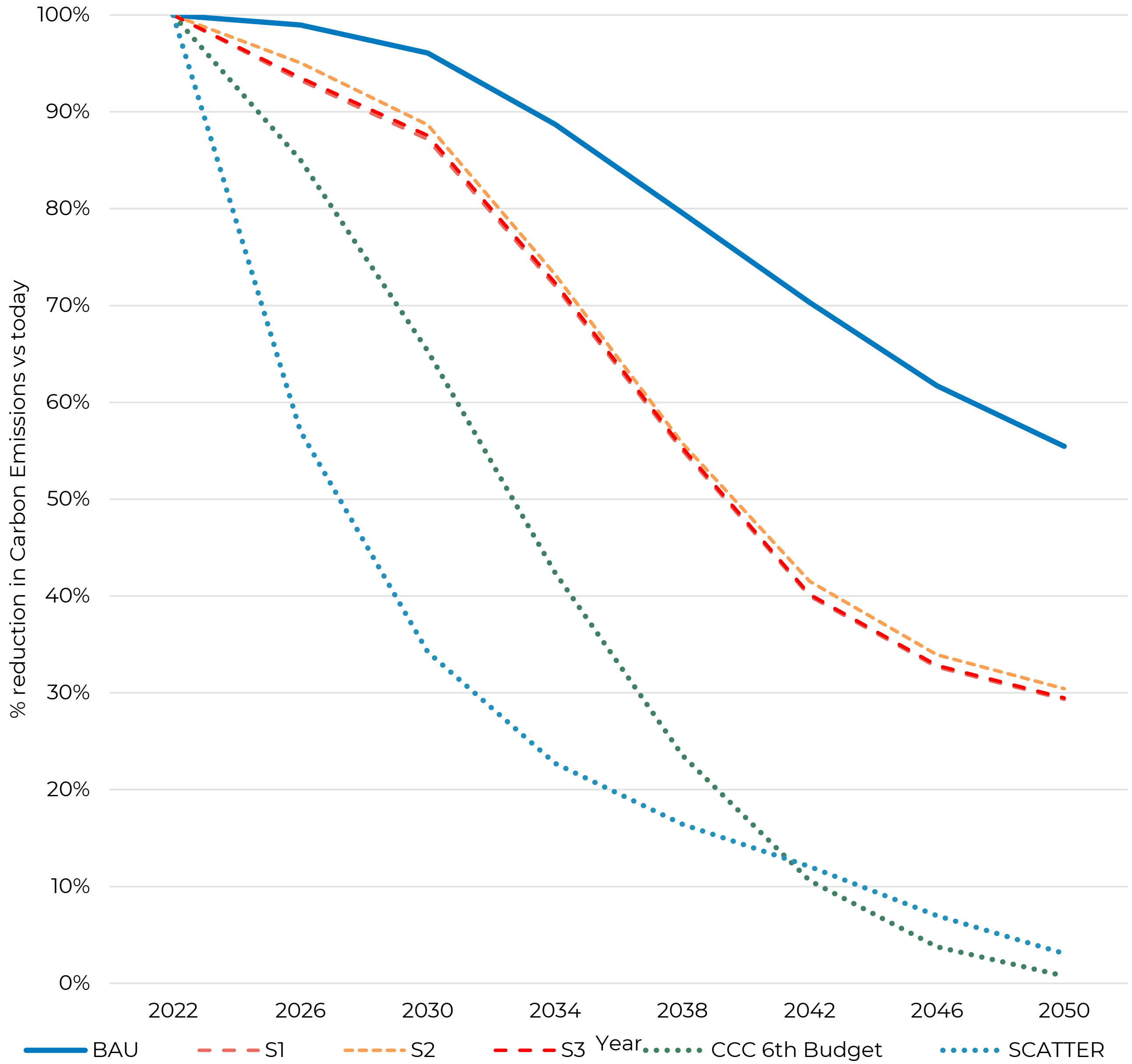
In effect, each scenario was a minor variation on the other two. This emphasises the need for transformational scales of intervention required to make a more material impact.

As such, a further round of option and scenario development took place – the methodology and results for which are presented on pages 67 and 68, and pages 69 to 71 respectively.

Figure 4.7 Workshopped scenarios model outputs – demonstrating % reduction in carbon emissions vs. today

Scenario	Carbon emitted in 2050 (vs 2022)	Carbon Budget Spend vs BAU (2022-2050)
BAU	-45%	-
1. Sustainable Futures	-73%	-33%
2. Digital Growth	-71%	-31%
3. Sustainable Route to Growth	-72%	-32%
CCC 6th Carbon Budget Balanced Pathway	-99%	-59%
SCATTER – Stringent Pathway	-96%	-70%

Each of the workshopped scenarios results in a considerable reduction in total emissions in 2050 in comparison to 2022. They all exhibit a considerably lack of effectiveness in reducing emissions to enable the UK's carbon budgeting commitments, producing a high level of strain and demand on other sectors in reducing emissions.



Methodology

The methodology developed and followed for the additional scenario development and assessment is detailed below and summarized below.

Additional Scenario Development

As demonstrated in the methodology for the option generation and scenario development on page 54, the modelling results of the three workshopped scenarios were very similar, with each a minor variation on the other two – and none reaching net zero or a sufficient reduction in overall carbon emissions. This has illustrated the need to develop and assess additional scenarios.

Figure 4.8 and Figure 4.9 summarises the additional scenarios in terms of description and levels of policy ambition. The additional scenarios are all incremental on each other.

Scenario 4 builds on Scenario 3 - Sustainable Route to Growth – with faster adoption of zero-emission technologies and vehicle, leading to emissions from road vehicles being zero emission by 2050. This is in line with ambition and assumptions within the CCC's 6th Carbon Budget – Moderate Pathway for surface transport.

Scenario 5 builds on Scenario 4 with faster realisation of integrated spatial planning policies reducing the need for as many medium- to long-distance trips and promoting a greater number of shorter-distance trip – trips that are more likely to be accommodated by sustainable models, particularly walk, cycles, micromobility modes, and bus and shared mobility modes. In addition, faster roll out and utilisation of digital connectivity akin to ultrafast gigabit and 5G connectivity as ubiquitous. Reducing the need to travel for some trip purposes by facilitating further levels of home working and online / remote access to key services.

Scenario 6 builds on Scenario 5 with materially greater levels of local urban demand management. This would be through implementation of multiple schemes such as:

- road space reallocation to give priority to active and shared / higher occupancy modes (e.g. buses) and to effectively increase the time and costs of operating private vehicles;
- greater use of parking restraint and pricing, including car-free town and city centres and Workplace Parking Levies;
- Clean Air Zones / (Ultra) Low Emission Zones;
- area-based Congestion Charges; and
- tolling of assets such as bridges, tunnels, and/or parts of road network.

Further consideration is being given to the planning and deliverability of such schemes as part of parallel work. The exploration of these options is considering carbon impacts and-economic, environmental, transport, and deliverability considerations, as well as the capital and operating costs and revenues over time.

There is potential for lower trip rates and mode shift to more sustainable modes be incentivised as a result of such options being implemented. Furthermore, any revenues generated could be hypothecated to invest in sustainable transport and complementary areas.

Scenario 7 builds on Scenario 6 with the introduction of national road user charging as a demand management tool. This scenario comes after Scenario 6 on the premise that local areas have the potential to implement such schemes quicker than the roll out of national systems. Ideally, there would be interoperability of systems between national and local levels.

Given the scale of intervention across all options, this scenario is the "last turn of the dial" to provide not only a net zero outcome, but also align to carbon budget trajectories provided by CCC's 6th Carbon Budget – Moderate Pathway for surface transport nationally and the SCATTER Tool – "Stringent" pathway for the TfSE area.

Scenario 8 builds on Scenario 7 and seeks to define a pathway to net zero carbon by 2040 for surface transport. This sets the ambition for vehicle emissions to be zero by 2040.

For all scenarios which have an ambition for zero vehicle emissions by 2050 or 2040, it is apparent that significant changes in national regulation are required, as well as significant advances in technology, its roll out, and affordability.

Additional Scenario Modelling

The additional scenarios were subsequently modelled utilising the same methodology to model the three initial workshopped scenarios.

In Figure 4.10 on page 71 these have been plotted against the CCC's 6th Carbon Budget – "Moderate Pathway" for surface transport and SCATTER Tool – "Stringent" trajectories from Chapter 3, and the three initial workshopped scenarios. These are followed by Figure 4.11 on page 72 which illustrates the carbon budgets and their corresponding percentage reductions.

Modelling detail of each of the additional scenarios is illustrated in Appendix C.

Figure 4.8 Additional scenario sequential development process

Scenario 1 - Sustainable Futures

Scenario 2 - Digital Growth

Scenario 3 - Sustainable Route to Growth

Scenario 4 – Above + faster adoption of zero-emission vehicles

- Committee on Climate Change 6th Carbon Budget Profile which aims to decarbonise full vehicle fleet including HGVs by 2050

Scenario 5 – Above + Spatial Planning / Digital Policies

- Spatial planning and digital policies which encourage shorter distance, non-motorised trips and reduced need to travel longer distances

Scenario 6 – Above + Urban Demand Management Policies

- Introducing further urban demand management policies which discourage driving

Scenario 7 – Above + National Road User Charging Policies

- Introducing national road user charging as a demand management tool

Scenario 8 – Above + Acceleration of adoption of net zero vehicles

- Policies which accelerate the roll out of zero-emission vehicles including HGVs by 2040

Figure 4.9 Additional scenario characteristics

Scenario development by desired outcomes by typology	Rail	Bus	Walk	Cycle & Micro-Moblity	Shared Mobility – Passenger	Highway – Car	Highway – Freight	Demand Mgmt – Local	Demand Mgmt - National	Local-isation	Digital Connect-ivity	ZE Vehicle uptake
4. Above + faster adoption of zero-emission vehicles	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	×	✓✓	✓	✓	✓✓✓	✓✓✓	✓✓✓
5. Above + Spatial Planning Policies	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	×	✓✓	✓	✓	✓✓✓	✓✓✓	✓✓✓
6. Above + Urban Demand Management Policies	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	××	✓✓	✓✓✓	✓	✓✓✓	✓✓✓	✓✓✓
7. Above + National Road User Charging Policies	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	××	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
8. Above + Acceleration of adoption of net zero vehicles	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	××	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓✓

Efficacy Score	Level of Anticipated Efficacy
✓	Minor
✓✓	Moderate
✓✓✓	Major
✓✓✓✓	Extensive
×	Negative Minor
××	Negative Major

Key findings – additional scenario carbon impact modelling and assessment

- The additional scenarios – Scenario 4 to Scenario 8 – when modelled all see further reductions in carbon emissions (see Figure 4.10 on page 71 overleaf) .
- All reach net zero through the assumption and policy ambition introduced in Scenario 4 and throughout, that all vehicle emissions are zero from 2050 at the latest.
- Only the most ambitious scenarios of Scenarios 7 and 8 present pathways close to the budgeted trajectories of the CCC's 6th Carbon Budget Moderate Pathway for surface transport and SCATTER Tool – "Stringent" trajectory for surface transport (see Figure 4.11 on page 72).
- Scenarios 7 and 8 represent a 56% and 68% reduction in overall emissions between 2022, close to or withing the CCC and SCATTER Tool trajectories of 59% and 70% respectively. However, it is only the addition of the ambition of all vehicles being zero emission by 2040 – in Scenario 8 – which brings any of the scenario pathways within these tolerances.

Figure 4.10 Additional scenario model outputs

Scenario	Carbon emitted in 2050 (vs 2022)	Carbon Budget Spend vs BAU (2022-2050)
BAU	-45%	-
1. Sustainable Futures	-73%	-33%
2. Digital Growth	-71%	-31%
3. Sustainable Route to Growth	-72%	-32%
4. Above + faster adoption of zero-emission vehicles	-97%	-45%
5. Above + Spatial Planning Policies	-97%	-49%
6. Above + Urban Demand Mgmt Policies	-98%	-52%
7. Above + National Road User Charging Policies	-98%	-56%
8. Above + Acceleration of net zero vehicles by 2040	-98%	-68%
CCC 6th Carbon Budget Balanced Pathway	-99%	-59%
SCATTER – Stringent Pathway	-96%	-70%

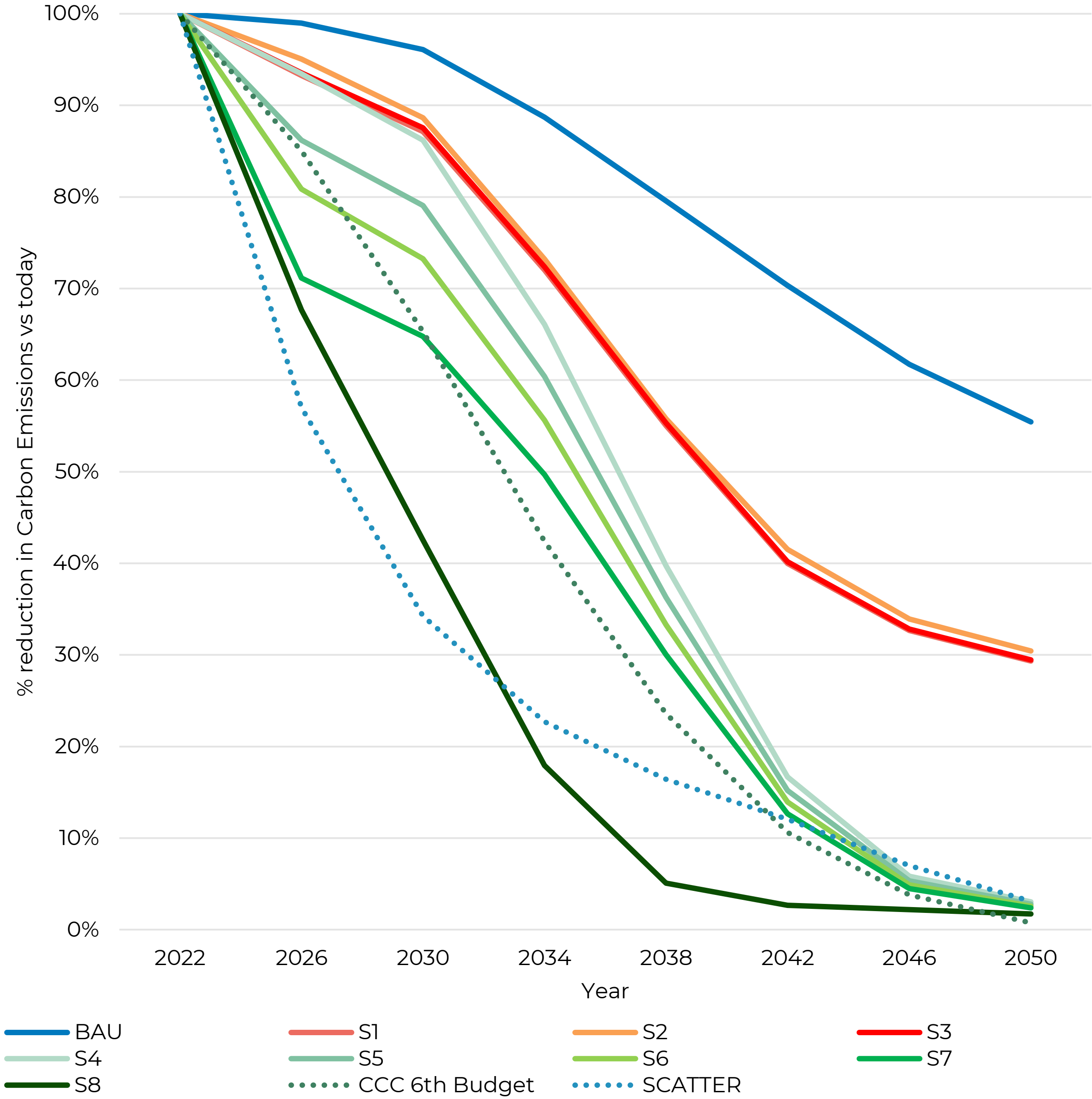
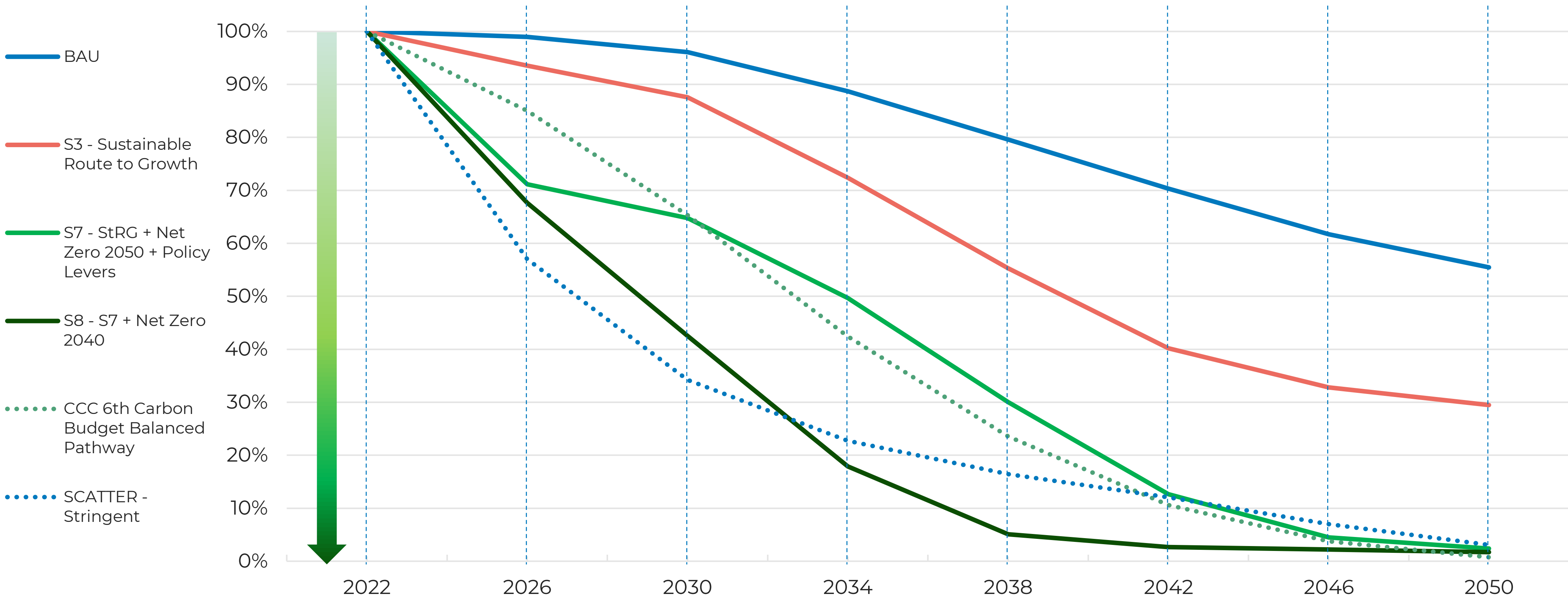


Figure 4.11 Additional scenario carbon budgeting



Scenario	Carbon Budget Spend vs BAU						
	2022-2026	2027-2030	2031-2034	2035-2038	2039-2042	2043-2046	2047-2050
S3. Sustainable Route to Growth	-7%	-13%	-14%	-26%	-42%	-49%	-50%
S7. SRtG + Net Zero 2050 + Additional Policies	-21%	-36%	-38%	-54%	-76%	-89%	-95%
S8. Above + Net Zero 2040	-23%	-51%	-59%	-79%	-96%	-97%	-97%
CCC 6th Carbon Budget Balanced Pathway	-9%	-27%	-49%	-69%	-85%	-94%	-98%
SCATTER – Stringent Pathway	-29%	-58%	-74%	-81%	-86%	-90%	-93%

5. Application to people, place, movement

Overview

The fifth and final phase of work identifies that the TfSE area is diverse in terms of its population demographics, places, and movement types. The objective of this phase is to determine how effective policy interventions are likely to be on each of these diverse factors.

Method

The methodology involved the use of people personas, place and journey types sourced from the TfSE Transport Strategy and Future Mobility Strategy respectively.

It then utilised a scoring system against each of the intervention types for their constituent efficacies to enable decarbonisation. This was developed based on a professional judgement approach. As such this reflects the degree to which each people, place or movement type will subsequently respond to decarbonisation-related interventions.

Interpretation

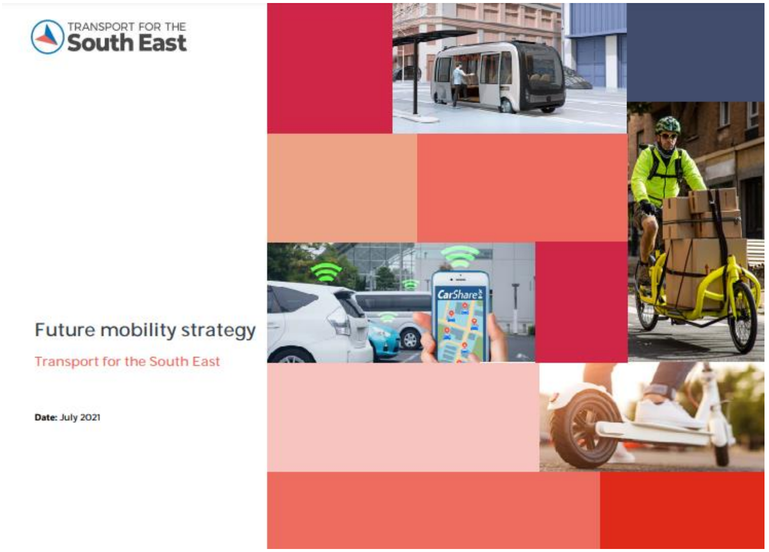
This final phase is vital as each of the constituent local authorities will exhibit a wide range of people, place and movement types, and likely possess an ambition to increase the diversity of their communities. Interventions facilitating decarbonisation differs considerably across these types.

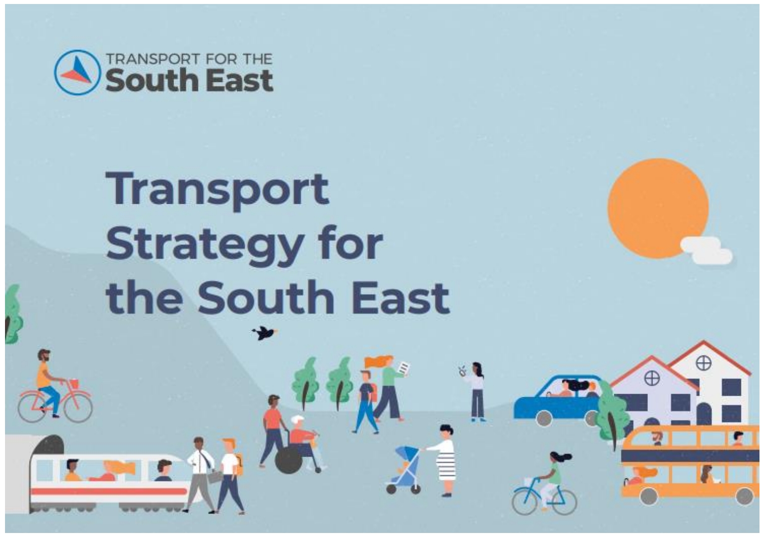
Interpretation of the people, place and movement types tables on the next pages can be led either by intervention groups (columns) or the people, place and movement types (rows).

To serve as an example, highways-based interventions increasing capacity, and as such facilitating travel by car, are likely to negatively impact the decarbonisation potential of most sociodemographic groups.

Scoring System

Score
Major positive efficacy
Moderate positive efficacy
Minor positive efficacy
No efficacy
Moderate negative efficacy
Major negative efficacy





People Typologies

Sociodemographic Group	Headline Description
Village life	The population of this segment live in areas that are less densely populated, typically in a village or small town. They tend to be older and well educated and to live in detached properties which they own, though an above average proportion live in retirement homes. Each household is likely to have multiple motor vehicles, and these will be the most common method of transport to their places of work.
Central connectivity	The majority of people in the Central Connectivity segment live in relatively densely populated urban areas. They include an above average proportion of young adults without children, including full time students.
Family terraces	This segment typically live on the edge of a town centre, in the transitional areas between the core and the suburbs, There is an above average proportion of families with pre-school or school age children. Typically they will have one car between two adults, with one driving to work and the other walking or using public transport.
Service sector workers	The Service Sector Workers segment tend to live in urban areas and work in the information and communication, financial, public administration and education related sectors. There is an above average likelihood of being young children in the household and a below average likelihood of older age adults.
Comfortable 'self-sufficiency'	Those in the Comfortable Self-sufficiency segment are typically approaching retirement age or already retired. They tend to live in a detached property or flat and are quite likely to have paid off their mortgage and have no dependent children, so while they may have a modest income are still quite likely to have both time and money.
Semi-detached suburbia	People living in areas of Semi Detached Suburbia will typically have school age children and own at least one car. The will mostly work in information and communication, finance, public administration and education sectors. It also includes some recently retired people living in semi-detached or detached housing.
Traditional towns	Households in this segment are more likely than average to have older non-dependent children and to live in semi-detached or terraced property. Their level of qualifications tend to be lower than average with jobs typically in the wholesale and retail, energy and transport related industries.
Sparsely populated	Locations with very few people living there (less than 50 people per 1km2).
Pre-school families	A significant increase in younger people, living in urban areas, who are more concerned over the environmental issues focusing on minimising consumption including home-working and sustainable modes of transport.
Semi-retired flexibility	A gradual increase in older people at the latter end of their working lives, in better paid roles, who can take a more flexible approach to working hours and the days they work.
School-run suburbia	A growing segment of suburban families who, within their means, try to take action to reduce their environmental impact including reducing the impact of their travel choices.

People Results

Sociodemographic Group	Rail	Bus	Walk	Cycle & Micromoblity	Shared Mobility – Passenger	Highway – Car	Demand Management – Local	Demand Management – National	Localisation	Digital Connectivity	ZE Vehicle uptake
Village life											
Central connectivity											
Family terraces											
Service sector workers											
Comfortable 'self-sufficiency'											
Semi-detached suburbia											
Traditional towns											
Sparsely populated											
Pre-school families											
Semi-retired flexibility											
School-run suburbia											

People Results

Key findings

- Each intervention area exhibits a wide range of impacts on sociodemographic groups, from those living within the centre of major cities and towns to those in very rural and sparsely populated areas.
- Demand management, digital connectivity and uptake of zero-emission vehicles exhibit the greatest levels of efficacy against many of the sociodemographic groups.
- Highway-based interventions (those which reduce vehicle journey times) are likely to exhibit a greater benefit to those who are likely to drive more, such as those within villages or dispersed suburban areas.
- Modal-specific interventions generally exhibit lower levels of efficacy against all the people types.

Sociodemographic Groups

- Those living in suburban areas and villages are also likely to respond positively to measures improving digital connectivity, facilitating both home working and entertainment and reducing the need to take trips in the first place.
- Those with younger children (not yet in school), and semi-retired are likely to have a need to travel less frequently, and as a result exhibit lower levels of responses to all interventions.

Place Typologies

Place typologies across the South East follow that of their corresponding economic hub, and are typified by the following:

- Coastal and estuarine
- Well-connected larger rural hinterlands further from London
- Large urban centres
- Local and regional administrative centres further from London
- London commuter towns
- London orbital business hubs

For the purposes of this assessment, the place types have been split largely by their corresponding movement patterns, determining their ability to decarbonise. This also illustrates the proportion of populations residing within these place typologies.

Place Types	Headline Description
Major Economic Hubs (MEH)	Economic drivers of the South East's economy and the focus by which other, smaller settlements are concentrated, comprising the ~60% of the SE's population.
Urban areas	Other urban areas exhibiting strongest connections to and reflect conditions within MEHs and the rest of the SE, comprising ~24% of its population. These urban areas vary significantly in size from a population of ~5,000 – 133,000.
Rural	Larger rural settlements ranging in size ~150 – 5,000, comprising ~9% of the population of the SE.
Remote rural	The remaining population of the SE of ~300,000 resides within small villages, hamlets and dispersed dwellings in places with less than 140 residents.

Place Results

Place Types	Rail	Bus	Walk	Cycle & Micro-mobility	Shared Mobility – Passenger	Highways	Demand Management - Local	Demand Management - National	Localisation	Digital Connectivity	ZE Vehicle uptake
Major Economic Hubs (MEH)											
Urban Areas											
Rural											
Remote rural											

Key findings

- Localisation and digital connectivity-led policy interventions have the greatest levels of efficacy across each of the place types due to their ability to reduce the need for medium and longer-length journeys which are unlikely to be walked or cycled.
- As highway-based policy interventions are likely to enable driving and are unlikely to facilitate decarbonisation, they see negative efficacies against all place types.

Place Types

- Major economic hubs and other urban areas exhibit the greatest opportunities for demand management and localization-based interventions and as such are likely to respond the best – those living within them would be more likely to walk, cycle or take public transport for shorter journeys.
- Rural place types generally respond less well to modal-specific interventions (whereby lower densities reduces accessibility and amenability) but are more likely to respond well to digital connectivity reducing the need for a trip in the first place.

Movement Typologies

Movement typologies across the South East have a stronger relationship to journey types across the UK. However, the South East's proximity to London and coastal location both results in a great number of international and freight-related journeys.

Movement Types	Headline Description
Radial	Longer distance passenger journeys which typically use either the Strategic Road Network (radiating from the M25) or main line railways that terminate in central London.
Orbital and Coastal	Longer distance passenger journeys which use corridors running perpendicular to the radial corridors described previously. Generally these roads and railways are sparser with lower capacity and speeds than most radial corridors. These provide important links between economic hubs across the South East but have lacked investment in recent years.
Inter-urban	Medium distance passenger journeys between economic hubs and the Strategic Road Network. These journeys are predominantly served by the South East area's Major Road Network and any railways that mirror these corridors.
Local	Short distance journeys to destinations within the same community, village, town or city. They also include the first or last part of longer distance journeys (first/last mile movements) that form the other journey types.
International gateways and freight	Passenger and freight international gateways comprising airport, rail and port infrastructures. They are critically important for businesses particularly outside the TfSE area, including London, Midlands and North of England.

Movement Types	Rail	Bus	Walk	Cycle & Micromobility	Shared mobility	Highway - Car	Highway - Van	Highway - HGV	Demand Management - Local	Demand Management - National	Localisation	Digital Connectivity	ZE Vehicle uptake
Radial													
Orbital and Coastal													
Inter-urban													
Local													
International gateways and freight													

Movement Results

Key findings

- Uptake of Zero Emission Vehicles has the greatest efficacy across all movement types, as they facilitate the shift to decarbonise existing vehicle trips.
- Demand management-led interventions additionally exhibit high levels of efficacy against most movement types due to their ability in shifting vehicle trips to alternative modes.
- Further consideration is being given to the planning, deliverability, and potential impacts of demand management interventions, particularly pricing mechanisms as part of parallel work.

Movement Types

- All movement types respond particularly well to demand management and zero emission vehicle policy interventions.
- Some movement types respond slightly better to various modal-specific interventions, which is based largely on the length of journey. Longer journeys typically respond well to rail-based interventions whilst local journeys respond well to all other modal-specific interventions.

6. Findings and Recommendations

Scale of the challenge

Analysis and supporting work presented within this report has identified:

- the extent of transport-originated carbon emissions historically, currently, and in the future under a "business as usual" scenario;
- net zero carbon decarbonisation trajectories published by various national and academic / research bodies; and
- the packages of intervention required to achieve net zero carbon along with meeting a budget-based approach to help limit global temperature increases this century below +2˚C in line with the Paris Agreement.

Scenario development confirmed that in order to accelerate the pathway to net zero, the extent of intervention is vast and require immediate action to its fullest extent across most areas of intervention.

This requires collective intervention between all levels of the public sector, working with the private sector, academia and research institutions, and the third sector.

Finally, it quantified the carbon reduction impact of different areas of intervention for carbon reduction policy packages for different people, place and movement types.

Trajectories

Trajectories are presented as both future forecasts of surface transport emissions under a "business as usual" scenario as well as different trajectories to reach net zero carbon.

The trajectories based on a carbon budgeting approach demonstrate the significant reductions in the levels of emissions that will be required to meet the Paris Agreement, particularly during the 2020s, where a further 9% to 29% reduction is required by 2026, and a 27% to 58% is required by 2030.

Defining a pathway aligning with suitable net zero trajectories

The main factor in defining a pathway to net zero carbon is identifying the interventions required to reduce the number of trips we make, shift the mode of travel used to zero emission modes, and to reduce vehicle emissions to zero. However, there are several other factors required to define and achieve a pathway:

- In addition to transport interventions, the wider spatial planning, energy, and digital network investment, as well as the co-ordination of public service delivery and sustained behaviour change required, along with necessary financial and regulatory incentives.
- For all involved in the planning and delivery of interventions, this includes doing so with great urgency and to a significant or full extent – perhaps the likes of which we have never seen before.
- Appreciation of demographic, spatial / place, and movement contexts and variation in efficacy of different interventions and their impact across these contexts.

There's present uncertainty in the definition, alignment and quality of constituent data sets

The development of the trajectories and scenarios has required the application of various datasets from different sources and has included the use of complex strategic transport demand models. The challenge of aligning data sources as result contributes to some uncertainty.

It can be challenging to compare or align the different trajectories given the different data sources, analytical approaches and tools, and policy assumptions used to inform them.

Planning and delivery

The need for multi-modal and multi-sector intervention

In order to facilitate an effective pathway to net zero it is paramount to plan to optimize the role of public transport, active travel, and zero emission vehicle interventions, along with demand management and behaviour change interventions. This includes both capital and resource investment.

There is a requirement for significant intervention in ancillary policy areas which influence the demand for travel and the way we travel, principally spatial panning, energy, digital technology, and the delivery of public services.

An effective budgeting approach is required

It is unsound to plan simply for the end date of net zero given the scale of change required. A carbon budgeting approach requires effective planning and management by yielding effective and measurable targets to plan a workable strategy as well as managing the total volume of emissions in line with the Paris Agreement.

Scale of intervention required

The policy options and packages modelled within the scenarios enabling an effective curve to both meet the UK's carbon budgeting commitments, and consequentially reach net zero by 2050, are of an unprecedented scale. To compound this, these packages need to be defined, planned, financed and implemented as soon as possible.

Political ambition for net zero and the scale of changed and urgency required to get there is imperative in order to bring residents and businesses along with the change required, but to also make the decisions required and to promote change.

Wider policy context

Policy will need to be far-reaching and integrated, with a strong alignment with funding and decision-making factors. This could well require alignment of all policy and funding decisions to government's Transport Decarbonisation Plan and Net Zero Carbon Plan.

This also extends to operations and delivery of public services, along with necessary financial and regulatory incentives.

Funding opportunities

There are many options available to raise revenue at the local level, both in lieu of and in combination with central government funding.

The most significant opportunities being local road pricing mechanisms and amended parking charges, both of which, in turn have the potential to lead to significant reductions in carbon emissions.

Additional elements regarding the decarbonisation of transport need to be considered

This piece of work has focused on and considered only the tailpipe emissions of vehicular transport. There are other elements which in due course should be considered:

- embodied emissions comprising the manufacturing and supply chain of vehicles and infrastructure;
- the sources of energy fueling zero emission vehicles; and
- domestic and international aviation and maritime transport.

Parallel work and next steps

Development of a decarbonisation plan

To integrate this technical work with TfSE's Area Studies programme and Strategic Investment Plan, a Transport Decarbonisation Thematic Plan has been developed, including identification of the impact of 'global' and place-based packages of interventions contained within the Area Studies and Strategic Investment Plan, along with the scale of gap between these and net zero carbon, and the scale of intervention required to address the gap.

Segregating trajectory data packs and scenario pathways for each Local Transport Authority area

Each Local Transport Authority exhibits varying levels of baseline emissions alongside a variety of people, place and movement types within them. In order to effectively communicate the challenge and opportunities, it is proposed to disaggregate the TfSE into constituent local authority areas. This work is set to commence in August 2022.

Analytical Framework Development

As TfSE moves forward with the development of its analytical framework it will be important to incorporate mechanisms that will enable the impacts of individual interventions to be assessed on carbon and then trade-offs with other socio-economic and transport impacts .

APPENDIX A TRAJECTORY 2 FLEET MIX ASSUMPTIONS

Fleet Mix Assumptions – Trajectory 2a Emissions Factor Toolkit v11 (2021)

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
1Petrol car	Car	40.0%	39.8%	39.7%	39.4%	39.2%	39.0%	38.7%	38.4%	37.9%	37.4%	36.7%	36.0%	35.1%	34.3%	33.4%	32.5%	31.6%	30.8%	29.7%	28.7%	27.7%	26.7%	25.7%	24.6%	23.6%	22.6%	21.6%	20.6%	19.5%	19.0%	18.5%	18.1%	17.6%
2Diesel car	Car	36.0%	35.6%	35.0%	34.3%	33.5%	32.6%	31.7%	30.6%	29.4%	28.1%	26.9%	25.7%	24.5%	23.5%	22.5%	21.7%	20.9%	20.2%	19.7%	19.2%	18.7%	18.2%	17.7%	17.2%	16.7%	16.2%	15.7%	15.2%	14.7%	14.4%	14.1%	13.9%	13.6%
3Taxi (black cab)	Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4Petrol LGV	LGV	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.3%	0.4%	0.4%	0.5%	0.5%	0.6%	0.6%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%
5Diesel LGV	LGV	15.3%	15.4%	15.5%	15.5%	15.5%	15.5%	15.5%	15.4%	15.3%	15.3%	15.2%	15.1%	14.9%	14.9%	14.8%	14.7%	14.6%	14.5%	14.3%	14.2%	14.1%	14.0%	13.9%	13.7%	13.6%	13.5%	13.4%	13.2%	13.1%	13.0%	12.9%	12.8%	12.7%
6Rigid	HGV	2.1%	2.1%	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
7Artic	HGV	3.1%	3.1%	3.1%	3.0%	3.0%	3.0%	2.9%	2.9%	2.9%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%
8Bus and coach	Other	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
9Motorcycle	Other	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
10HybridCar Petrol	Car	1.1%	1.5%	1.8%	2.2%	2.5%	2.7%	3.0%	3.2%	3.4%	3.5%	3.7%	3.8%	3.8%	3.8%	3.8%	3.8%	3.7%	3.7%	3.5%	3.4%	3.3%	3.2%	3.0%	2.9%	2.8%	2.7%	2.6%	2.4%	2.3%	2.3%	2.2%	2.1%	2.1%
11PlugInHybridCarPetrol	Car	0.3%	0.4%	0.6%	0.9%	1.3%	1.8%	2.3%	2.9%	3.4%	4.0%	4.6%	5.2%	5.8%	6.4%	6.9%	7.4%	7.8%	8.1%	8.2%	8.2%	8.2%	8.3%	8.3%	8.3%	8.4%	8.4%	8.4%	8.5%	8.5%	8.6%	8.6%	8.7%	8.7%
12HybridCar Diesel	Car	0.1%	0.2%	0.4%	0.5%	0.7%	0.8%	1.0%	1.1%	1.2%	1.3%	1.4%	1.5%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.5%	1.4%	1.4%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%
13ElectricCar	Car	0.2%	0.4%	0.5%	0.6%	0.8%	1.1%	1.4%	2.0%	2.8%	3.7%	4.8%	5.9%	7.2%	8.5%	9.8%	11.1%	12.4%	13.6%	15.2%	16.8%	18.4%	20.0%	21.6%	23.2%	24.8%	26.4%	28.0%	29.6%	31.2%	32.0%	32.8%	33.5%	34.2%
14ElectricLGV	LGV	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.8%	0.9%	1.1%	1.3%	1.4%	1.6%	1.8%	1.9%	2.0%	2.1%	2.2%	2.3%	2.5%	2.6%	2.7%	2.8%	2.9%	3.0%	3.2%	3.3%	3.4%	3.6%
	Car	77.9%	77.9%	77.9%	78.0%	78.0%	78.0%	78.1%	78.1%	78.1%	78.1%	78.1%	78.1%	78.1%	78.1%	78.0%	78.0%	78.0%	77.9%	77.9%	77.8%	77.8%	77.8%	77.7%	77.7%	77.6%	77.6%	77.5%	77.5%	77.4%	77.4%	77.3%	77.3%	77.3%
	LGV	15.6%	15.7%	15.7%	15.8%	15.8%	15.8%	15.8%	15.8%	15.9%	15.9%	15.9%	16.0%	16.0%	16.1%	16.2%	16.2%	16.3%	16.4%	16.4%	16.5%	16.5%	16.6%	16.6%	16.7%	16.7%	16.8%	16.8%	16.8%	16.9%	16.9%	17.0%	17.0%	17.1%
	HGV	5.2%	5.1%	5.1%	5.0%	5.0%	4.9%	4.9%	4.8%	4.8%	4.8%	4.7%	4.7%	4.7%	4.6%	4.6%	4.6%	4.6%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
	Other	1.4%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%

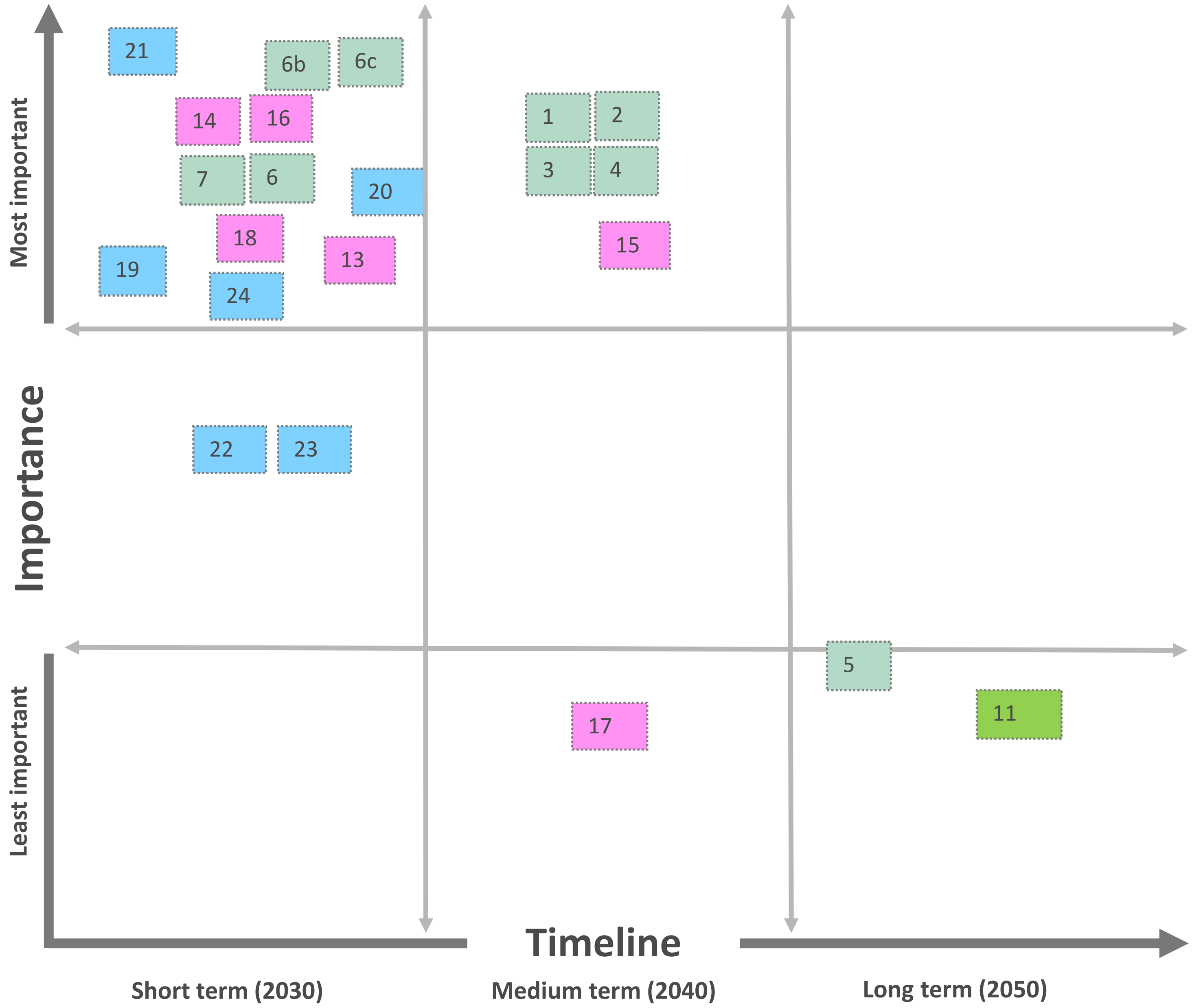
Fleet Mix Assumptions – Trajectory 2b SMMT Central forecast Fleet Mix

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
1Petrol car	Car	35.2%	34.1%	33.3%	32.5%	31.7%	30.9%	30.2%	29.4%	28.6%	27.7%	26.6%	25.2%	23.6%	21.9%	20.1%	18.3%	16.5%
2Diesel car	Car	40.5%	40.8%	40.7%	40.4%	39.8%	39.0%	37.9%	36.6%	35.1%	33.4%	31.6%	29.6%	27.4%	25.1%	22.9%	20.6%	18.5%
3Taxi (black cab)	Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4Petrol LGV	LGV	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
5Diesel LGV	LGV	15.0%	15.1%	15.1%	15.2%	15.3%	15.3%	15.2%	15.1%	14.9%	14.7%	14.4%	13.9%	13.3%	12.7%	11.9%	11.1%	10.3%
6Rigid	HGV	2.3%	2.3%	2.3%	2.2%	2.2%	2.2%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%	2.0%	2.0%
7Artic	HGV	3.0%	3.0%	3.0%	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
8Bus and coach	Other	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
9Motorcycle	Other	0.9%	0.9%	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
10HybridCarPetrol	Car	1.4%	1.6%	2.0%	2.2%	2.5%	2.7%	2.9%	3.0%	3.1%	3.2%	3.2%	3.2%	3.1%	2.9%	2.7%	2.5%	2.3%
11PlugInHybridCarPetrol	Car	0.5%	0.7%	0.5%	0.8%	1.1%	1.5%	1.9%	2.4%	2.9%	3.4%	3.9%	4.6%	5.3%	6.0%	6.6%	7.0%	7.2%
12HybridCarDiesel	Car	0.2%	0.4%	0.6%	0.8%	1.0%	1.2%	1.4%	1.5%	1.7%	1.8%	1.8%	1.9%	1.8%	1.8%	1.7%	1.6%	1.4%
13ElectricCar	Car	0.1%	0.1%	0.4%	0.8%	1.4%	2.1%	3.1%	4.4%	5.8%	7.6%	9.7%	12.3%	15.4%	18.9%	22.5%	26.3%	30.4%
14ElectricLGV	LGV	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.6%	0.9%	1.2%	1.6%	2.1%	2.7%	3.5%	4.3%	5.2%	6.1%	7.1%
	Car	77.8%	77.7%	77.6%	77.6%	77.5%	77.5%	77.4%	77.3%	77.2%	77.1%	76.9%	76.8%	76.6%	76.5%	76.4%	76.3%	76.2%
	LGV	15.4%	15.5%	15.6%	15.8%	15.9%	16.0%	16.1%	16.2%	16.4%	16.6%	16.7%	16.9%	17.0%	17.1%	17.3%	17.4%	17.5%
	HGV	5.2%	5.2%	5.2%	5.2%	5.1%	5.1%	5.1%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
	Other	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%

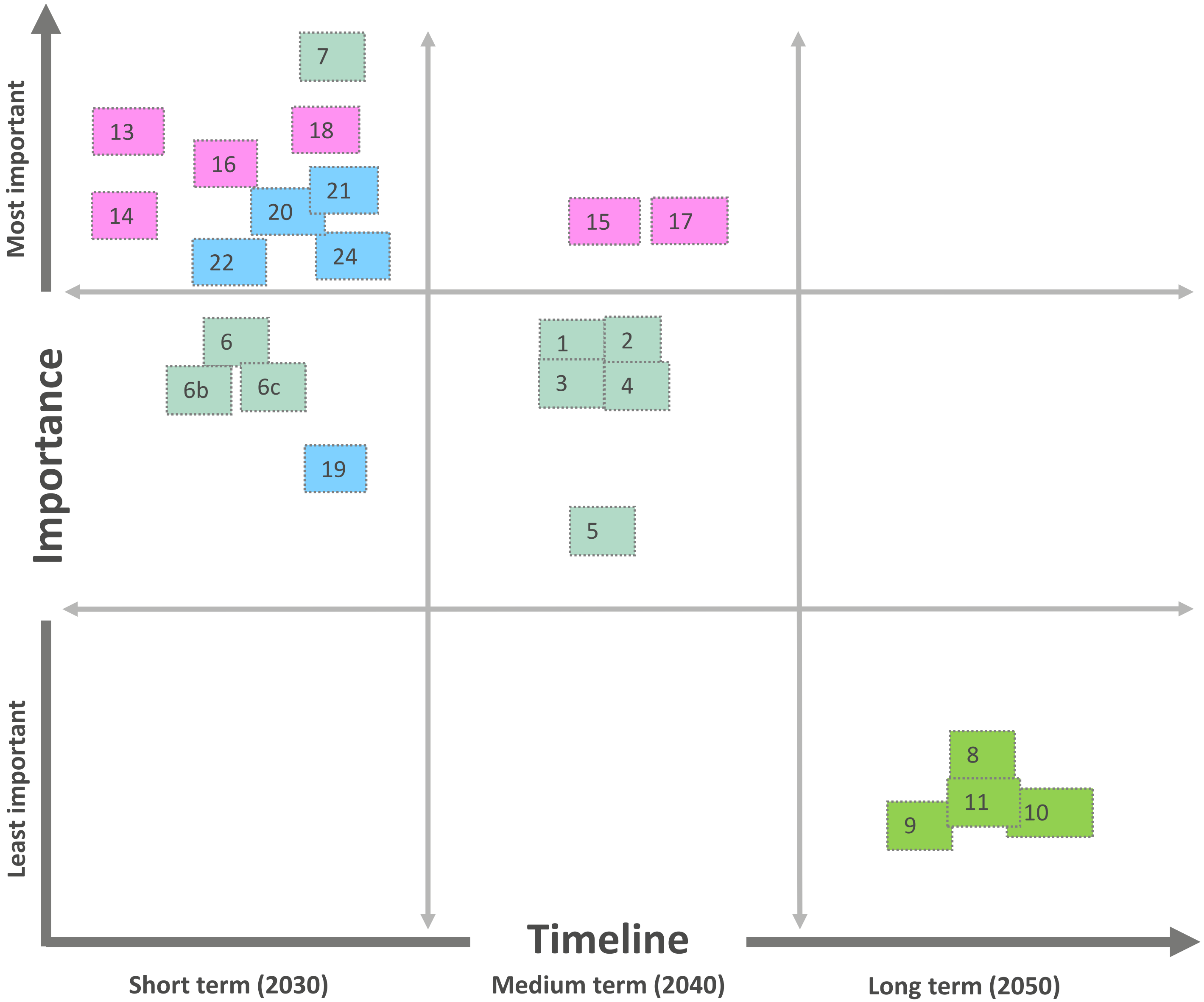
		2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
1Petrol car	Car	14.7%	12.9%	11.2%	9.5%	7.8%	6.1%	4.6%	3.3%	2.4%	1.7%	1.3%	1.1%	1.0%	0.8%	0.7%	0.6%
2Diesel car	Car	16.4%	14.4%	12.5%	10.5%	8.6%	6.7%	5.0%	3.6%	2.6%	1.9%	1.4%	1.1%	1.0%	0.9%	0.8%	0.6%
3Taxi (black cab)	Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4Petrol LGV	LGV	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5Diesel LGV	LGV	9.4%	8.4%	7.5%	6.6%	5.6%	4.6%	3.6%	2.8%	2.1%	1.6%	1.2%	0.9%	0.7%	0.5%	0.4%	0.4%
6Rigid	HGV	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.8%
7Artic	HGV	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.1%	3.1%	3.1%	3.1%	3.1%
8Bus and coach	Other	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
9Motorcycle	Other	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
10HybridCarPetrol	Car	2.0%	1.8%	1.6%	1.3%	1.1%	0.9%	0.7%	0.5%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%
11PlugInHybridCarPetrol	Car	7.0%	6.7%	6.3%	5.9%	5.4%	4.9%	4.3%	3.7%	3.1%	2.4%	1.7%	1.1%	0.6%	0.0%	0.0%	0.0%
12HybridCarDiesel	Car	1.3%	1.1%	1.0%	0.9%	0.7%	0.6%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
13ElectricCar	Car	34.7%	39.1%	43.3%	47.7%	52.1%	56.4%	60.5%	63.9%	66.7%	68.9%	70.4%	71.5%	72.2%	72.9%	73.1%	73.3%
14ElectricLGV	LGV	8.1%	9.2%	10.3%	11.3%	12.4%	13.6%	14.6%	15.6%	16.4%	17.0%	17.6%	18.0%	18.3%	18.6%	18.8%	18.9%
	Car	76.1%	76.0%	75.9%	75.8%	75.7%	75.6%	75.5%	75.5%	75.4%	75.3%	75.2%	75.1%	75.0%	74.9%	74.8%	74.7%
	LGV	17.6%	17.7%	17.8%	17.9%	18.1%	18.2%	18.3%	18.4%	18.5%	18.6%	18.7%	18.8%	19.0%	19.1%	19.2%	19.3%
	HGV	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
	Other	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%

APPENDIX B WORKSHOP RESULTS

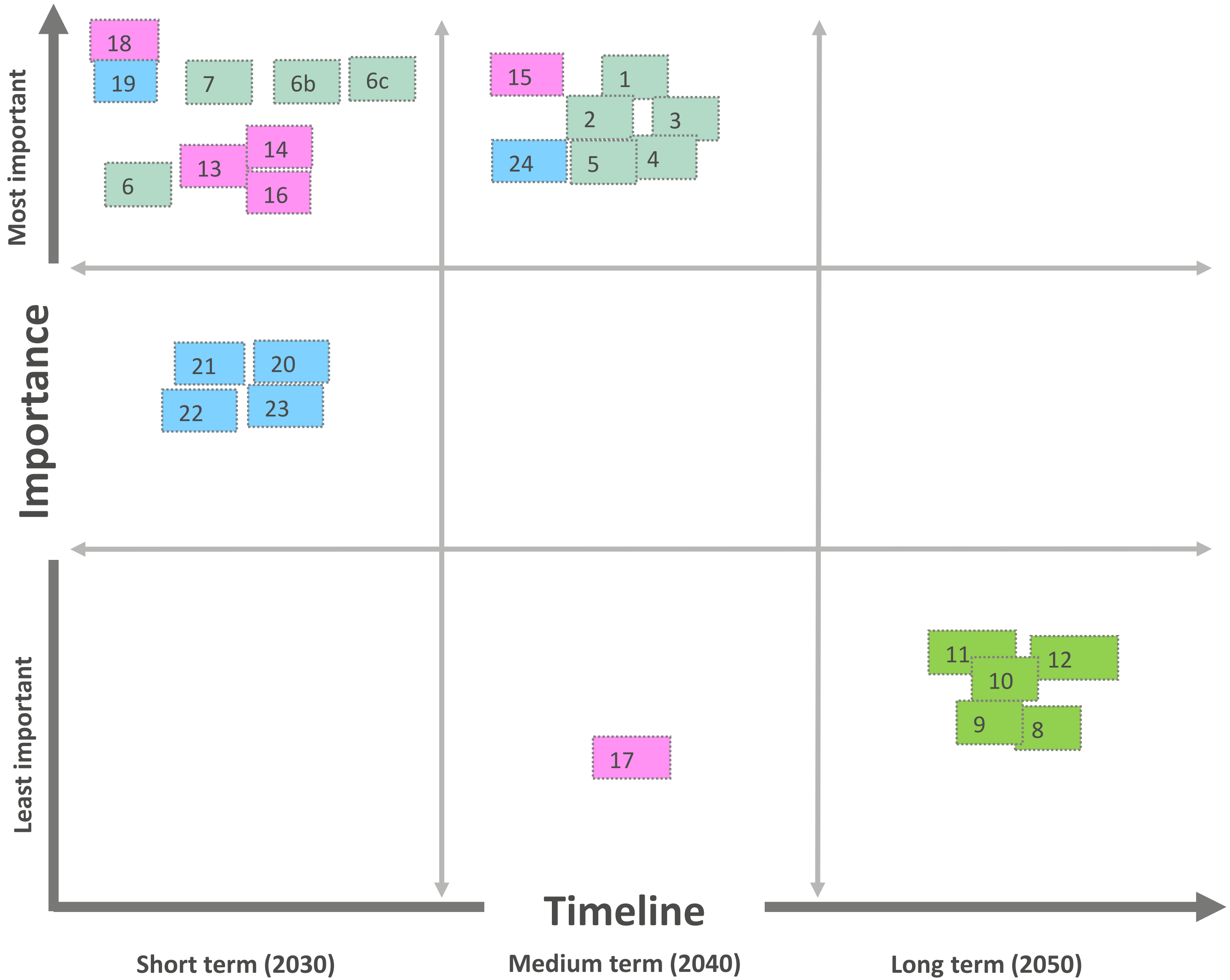
Scenario 1 – Sustainable Futures



Scenario 2 – Digital Growth



Scenario 1 – Sustainable Route to Growth



APPENDIX C SCENARIO MODELLING INPUTS

Scenario 1 – Sustainable Future Modelling Assumptions

Key:
Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	Scenario 1 – Sustainable Futures
Rail	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 10% greater capacity and 10% faster journeys on key railway lines in the Medium Term, rising to 20% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 35% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services which utilise bus priority measures and segregated infrastructure where appropriate, such as on key corridors into urban centres – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • 45% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	• 50% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, general improvements to the public realm (Policy 7), behavioral changes, spatial/transport planning changes (Policy 21) and better Public Transport and first/last mile integration
Highway – Car and Shared Mobility	• 2.5% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, the introduction of smart motorways, and to reflect targeted highways improvements for freight traffic on corridors connecting ports.
Highway – Freight and other vehicles	• SMMT Central forecast with no additional adjustment for HGVs or other vehicle types.
Demand Management	• 10% increase in vehicle operating costs to reflect national road user charging and other initiatives
Localisation and Digital Connectivity	• 20% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, no change in other trips
ZE Vehicle Uptake	• SMMT Central forecast ensures nearly 100% of cars and LGVs are electric by 2050, with remaining carbon emissions predominantly from HGVs

Scenario 2 – Digital Growth Modelling Assumptions

Key:
Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	Scenario 2 – Digital Growth
Rail	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 5% greater capacity and 5% faster journeys on key railway lines in the Medium Term, rising to 10% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 17.5% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services and improvements in Mobility as a Service initiatives and demand responsive transport – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • 22.5% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	• 30% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, including e-bikes and Mobility as a Service initiatives improving Public Transport and first/last mile integration
Highway – Car and Shared Mobility	• 10% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, greater benefit from smart motorways and from autonomous vehicle technology roll out
Highway – Freight and other vehicles	• SMMT Central forecast with no additional adjustment for HGVs or other vehicle types.
Demand Management	• No changes applied.
Localisation and Digital Connectivity	• 20% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, 20% reduction in other trips from digital innovation reducing the need to travel far for non-work purposes
ZE Vehicle Uptake	• SMMT Central forecast ensures nearly 100% of cars and LGVs are electric by 2050, with remaining carbon emissions predominantly from HGVs

Scenario 3 – Sustainable Route to Growth Modelling Assumptions

Key: Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	From previous scenario	Scenario 3 – Sustainable Route to Growth
Rail	From 1 & 2	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 10% greater capacity and 10% faster journeys on key railway lines in the Medium Term, rising to 20% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 35% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	From 1 & 2	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services which utilise bus priority measures and segregated infrastructure where appropriate, such as on key corridors into urban centres, and improvements in Mobility as a Service initiatives and demand responsive transport – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • 45% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	From 1 & 2	• 50% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, general improvements to the public realm (Policy 7), behavioral changes, spatial/transport planning changes (Policy 21), faster roll-out of new technology including e-bikes and Mobility as a Service initiatives improving Public Transport and first/last mile integration
Highway – Car and Shared Mobility	From 1	• 2.5% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, the introduction of smart motorways, and to reflect targeted highways improvements for freight traffic on corridors connecting ports.
Highway – Freight and other vehicles	From 1 & 2	• SMMT Central forecast with no additional adjustment for HGVs or other vehicle types.
Demand Management	From 1	• 10% increase in vehicle operating costs to reflect national road user charging and other initiatives
Localisation and Digital Connectivity	From 2	• 20% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, 20% reduction in other trips from digital innovation reducing the need to travel far for non-work purposes
ZE Vehicle Uptake	From 1 & 2	• SMMT Central forecast ensures nearly 100% of cars and LGVs are electric by 2050, with remaining carbon emissions predominantly from HGVs

Scenario 4 – Sustainable Route to Growth Modelling Assumptions

Key: Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	From previous scenario	Scenario 4 – Sustainable Route to Growth + faster adoption of zero-emission vehicles
Rail	From 3	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 10% greater capacity and 10% faster journeys on key railway lines in the Medium Term, rising to 20% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 35% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	From 3	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services which utilise bus priority measures and segregated infrastructure where appropriate, such as on key corridors into urban centres, and improvements in Mobility as a Service initiatives and demand responsive transport – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • 45% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	From 3	• 50% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, general improvements to the public realm (Policy 7), behavioral changes, spatial/transport planning changes (Policy 21), faster roll-out of new technology including e-bikes and Mobility as a Service initiatives improving Public Transport and first/last mile integration
Highway – Car and Shared Mobility	From 3	• 2.5% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, the introduction of smart motorways, and to reflect targeted highways improvements for freight traffic on corridors connecting ports.
Highway – Freight and other vehicles		• **Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050. This assumption is based on technology push in making HGV vehicles electric and a shift to rail freight which results in a lower carbon emission per km.**
Demand Management	From 3	• 10% increase in vehicle operating costs to reflect national road user charging and other initiatives
Localisation and Digital Connectivity	From 3	• 20% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, 20% reduction in other trips from digital innovation reducing the need to travel far for non-work purposes
ZE Vehicle Uptake		• **Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050.**

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Scenario 5 – 4 + Spatial Planning Policies Modelling Assumptions

Key: Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	From previous scenario	Scenario 5 – Scenario 4 + Spatial Planning Policies
Rail	From 4	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 10% greater capacity and 10% faster journeys on key railway lines in the Medium Term, rising to 20% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 35% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	From 4	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services which utilise bus priority measures and segregated infrastructure where appropriate, such as on key corridors into urban centres, and improvements in Mobility as a Service initiatives and demand responsive transport – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • *Further 30% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"* • 45% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	From 4	• 50% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, general improvements to the public realm (Policy 7), behavioral changes, spatial/transport planning changes (Policy 21), faster roll-out of new technology including e-bikes and Mobility as a Service initiatives improving Public Transport and first/last mile integration • *Further 20% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"*
Highway – Car and Shared Mobility	From 4	• 2.5% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, the introduction of smart motorways, and to reflect targeted highways improvements for freight traffic on corridors connecting ports. • *Perceived 10% increase in car journey times for longer-distance trips to discourage longer trips and promote local trips - concept of a "15-minute city"*
Highway – Freight and other vehicles	From 4	• Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050. This assumption is based on technology push in making HGV vehicles electric and a shift to rail freight which results in a lower carbon emission per km.
Demand Management	From 4	• 10% increase in vehicle operating costs to reflect national road user charging and other initiatives
Localisation and Digital Connectivity		• **30% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, 30% reduction in other trips from digital innovation reducing the need to travel far for non-work purposes**
ZE Vehicle Uptake	From 4	• Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050.

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Scenario 6 – 5 + Urban Demand Management Policies Modelling Assumptions

Key:
Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	From previous scenario	Scenario 6 – Scenario 5 + Urban Demand Management Policies
Rail	From 5	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 10% greater capacity and 10% faster journeys on key railway lines in the Medium Term, rising to 20% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 35% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	From 5	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services which utilise bus priority measures and segregated infrastructure where appropriate, such as on key corridors into urban centres, and improvements in Mobility as a Service initiatives and demand responsive transport – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • *Further 30% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"* • 45% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	From 5	• 50% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, general improvements to the public realm (Policy 7), behavioral changes, spatial/transport planning changes (Policy 21), faster roll-out of new technology including e-bikes and Mobility as a Service initiatives improving Public Transport and first/last mile integration • *Further 20% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"*
Highway – Car and Shared Mobility	From 5	• 2.5% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, the introduction of smart motorways, and to reflect targeted highways improvements for freight traffic on corridors connecting ports. • *Perceived 10% increase in car journey times for longer-distance trips to discourage longer trips and promote local trips - concept of a "15-minute city"*
Highway – Freight and other vehicles	From 5	• Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050. This assumption is based on technology push in making HGV vehicles electric and a shift to rail freight which results in a lower carbon emission per km.
Demand Management		• 10% increase in vehicle operating costs to reflect national road user charging and other initiatives • **Introduce a local area charge equivalent to increasing car journey times by 15 mins for entering urban areas – this could reflect ULEZ, car parking charging levies and other charges.**
Localisation and Digital Connectivity	From 5	• 30% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, 30% reduction in other trips from digital innovation reducing the need to travel far for non-work purposes
ZE Vehicle Uptake	From 5	• Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050.

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Scenario 7 – 6 + National Demand Management Policies Modelling Assumptions

Key:
Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	From previous scenario	Scenario 7 – Scenario 6 + National Demand Management Policies
Rail	From 6	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 10% greater capacity and 10% faster journeys on key railway lines in the Medium Term, rising to 20% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 35% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	From 6	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services which utilise bus priority measures and segregated infrastructure where appropriate, such as on key corridors into urban centres, and improvements in Mobility as a Service initiatives and demand responsive transport – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • *Further 30% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"* • 45% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	From 6	• 50% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, general improvements to the public realm (Policy 7), behavioral changes, spatial/transport planning changes (Policy 21), faster roll-out of new technology including e-bikes and Mobility as a Service initiatives improving Public Transport and first/last mile integration • *Further 20% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"*
Highway – Car and Shared Mobility	From 6	• 2.5% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, the introduction of smart motorways, and to reflect targeted highways improvements for freight traffic on corridors connecting ports. • *Perceived 10% increase in car journey times for longer-distance trips to discourage longer trips and promote local trips - concept of a "15-minute city"*
Highway – Freight and other vehicles	From 6	• Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050. This assumption is based on technology push in making HGV vehicles electric and a shift to rail freight which results in a lower carbon emission per km.
Demand Management		• 10% increase in vehicle operating costs to reflect national road user charging and other initiatives • Introduce a local area charge equivalent to increasing car journey times by 15 mins for entering urban areas – this could reflect ULEZ, car parking charging levies and other charges. • **Introduce a national charge equivalent to increasing vehicle operating costs by 50%.**
Localisation and Digital Connectivity	From 6	• 30% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, 30% reduction in other trips from digital innovation reducing the need to travel far for non-work purposes
ZE Vehicle Uptake	From 6	• Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050.

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Scenario 8 – 7 + Net Zero by 2040 Modelling Assumptions

Key:
Policy area given greater focus under this scenario

Assumptions by desired outcomes by typology:	From previous scenario	Scenario 8 – Scenario 7 + Net Zero by 2040
Rail	From 6	• 10% perceived reduction in journey time for all rail journeys from the Short Term to reflect short term perceived wins and the first/last benefits of improving bus/active travel, connectivity, integrated policy etc. • 10% greater capacity and 10% faster journeys on key railway lines in the Medium Term, rising to 20% in the Long Term, to reflect targeted heavy rail infrastructure interventions on key corridors • 35% reduction in rail fares – This is in line with global policy interventions in the Area Studies Work
Bus	From 6	• 20% perceived journey time reduction from the Short term to reflect better, more frequent, interconnected bus services which utilise bus priority measures and segregated infrastructure where appropriate, such as on key corridors into urban centres, and improvements in Mobility as a Service initiatives and demand responsive transport – This is in line with area studies interventions (and higher than assumptions in our BSIP work. • *Further 30% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"* • 45% reduction in bus fares – This is in line with global policy interventions in the Area Studies Work
Walk, Cycle and Micro-mobility	From 6	• 50% perceived journey time reduction to reflect a host of interventions to support Active Travel, micro-mobility, general improvements to the public realm (Policy 7), behavioral changes, spatial/transport planning changes (Policy 21), faster roll-out of new technology including e-bikes and Mobility as a Service initiatives improving Public Transport and first/last mile integration • *Further 20% journey time reduction for local bus trips to reflect perceived concept of a "15-minute city"*
Highway – Car and Shared Mobility	From 6	• 2.5% increase in capacity in LT to reflect identified Area Study interventions and to reflect some gain from reduced traffic on roads, the introduction of smart motorways, and to reflect targeted highways improvements for freight traffic on corridors connecting ports. • *Perceived 10% increase in car journey times for longer-distance trips to discourage longer trips and promote local trips - concept of a "15-minute city"*
Highway – Freight and other vehicles	From 6	• Carbon 6th budget profile scenario which includes 80% of HGV trips being electric by 2050. This assumption is based on technology push in making HGV vehicles electric and a shift to rail freight which results in a lower carbon emission per km.
Demand Management		• 10% increase in vehicle operating costs to reflect national road user charging and other initiatives • Introduce a local area charge equivalent to increasing car journey times by 15 mins for entering urban areas – this could reflect ULEZ, car parking charging levies and other charges. • **Introduce a national charge equivalent to increasing vehicle operating costs by 50%.**
Localisation and Digital Connectivity	From 6	• 30% reduction in commuting trips from increased digital connectivity and changes resulting in more home working modelled, 30% reduction in other trips from digital innovation reducing the need to travel far for non-work purposes
ZE Vehicle Uptake	From 6	• **Increase rollout of Zero Emission Vehicles with a goal of 100% electric Car and LGVs and 80% electric HGV by 2040.**

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APPENDIX D POLICY DEVELOPMENT TABLES

Policy Development – Bus and Mass Rapid Transit*

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate increase in bus/MRT patronage from new journeys and modal shift from highway journeys	• Moderate increase in the coverage and frequency of bus/MRT services provided facilitating a turn-up and go service on major corridors • Moderate reduction in journey times and interchange wait times • Moderate increase in the reliability and comfort of services	• Investment in expanding the bus fleet and improving the comfort and reliability of the bus fleet • Investment in bus infrastructure, including interchanges. • Investment in initiatives such as integrated ticketing, wayfinding and passenger information
✓✓	• Significant increase in bus/MRT patronage from new journeys and modal shift from highway journeys	• Significant increase in the coverage and frequency of bus/MRT services provided facilitating a turn-up and go service on most corridors • Significant reduction in journey times and interchange wait times • Significant increase in the reliability and comfort of services	• *Increased investment in the above +* • Targeted bus priority infrastructure investment on busy corridors to reduce journey times and increase the reliability of bus services. • Ensuring bus fares are competitive vs other modes
✓✓✓	• Transformational increase in bus/MRT patronage from new journeys and modal shift from highway journeys	• Transformational increase in the coverage and frequency of bus/MRT services provided across all corridors • Transformational reduction in journey times and interchange wait times • Transformational increase in the reliability and comfort of services	• *Increased investment in the above +* • Transformational infrastructure investment in Mass Rapid Transit in major economic hubs across the area, including the creation of fully segregated tram and bus rapid transit where appropriate • Transformational increase in rural services to ensure the whole population are in catchment of a frequent and reliable bus service

* Mass Rapid Transit being a proxy for BRT, Tram and Domestic Ferry

Policy Development – Walk, Cycle and Micro-mobility

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate increase in the proportion of trips which are undertaken by sustainable modes and subsequent modal shift of short distance highway journeys	• Moderate investment in increasing the coverage of urban and inter-urban mobility corridors which effectively accommodate sustainable modes	• Investment in upgrading corridors with significant demand generators and attractors (including strategic mobility hubs) to ensure seamless first-last mile connectivity for users • Investment in local placemaking initiatives and the public realm which make sustainable modes more attractive and intuitive for new users
✓✓	• Significant increase in the proportion of trips which are undertaken by sustainable modes and subsequent modal shift of short distance highway journeys	• Significant investment in increasing the coverage of urban and inter-urban mobility corridors which effectively accommodate sustainable modes	• *Increased investment in the above +* • Significant investment in increasing the coverage of fully segregated, mobility corridors across urban areas and ensuring an almost complete network whereby micro-mobility users have a dedicated right of way and do not need to cross paths with highway traffic
✓✓✓	• Transformational increase in the proportion of trips which are undertaken by sustainable modes and subsequent modal shift of short distance highway journeys	• Transformational investment in increasing the coverage of urban and inter-urban mobility corridors which effectively accommodate sustainable modes	• *Increased investment in the above +* • Transformational infrastructure investment and policy changes (including road space reallocation) to ensure priority is always given to micro-mobility modes

Policy Development – Shared Passenger Mobility

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate increase in the proportion of trips which are undertaken by shared transport modes and subsequent modal shift of short distance highway journeys	• Moderate increase in the number of services offering shared passenger mobility solutions such as car-sharing, ride-sharing and bike-sharing, offering users a flexible way to travel and less reliant on private vehicles	• Ensure policies are in place which overcome known barriers and help support the roll out of shared passenger mobility initiatives include car-sharing, ride-sharing and bike-sharing
✓✓	• Significant increase in the proportion of trips which are undertaken by shared transport modes and subsequent modal shift of short distance highway journeys	• Significant increase in the number of services offering shared passenger mobility solutions such as car-sharing, ride-sharing and bike-sharing, offering users a flexible way to travel and less reliant on private vehicles	• *Increased investment in the above +* • Policies which ensure shared passenger mobility modes are accessible and affordable to all

Policy Development – Highway (Car trips)

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate increase in car trips by 2050.	• Moderate increase in road capacity, moderate reduction in congestion resulting in faster journey times and improved journey time reliability • Successful rollout of connected and autonomous vehicles (CAVs) in the long term	• Investment in a moderate number of highway schemes to be delivered in the longer term which unlock greater road capacity and reduce congestion • Policy facilitation and investment in connected and autonomous vehicles (CAVs) technology
×	• Moderate decrease in car trips by 2050.	• Small increase in the perceived and/or actual journey times relative to other modes. • Small increase in perceived and/or actual cost of car trips relative to other modes.	• Moderate road space reallocation to support other modes and local placemaking initiatives • Moderate Road user charging and Urban demand management policies
××	• Significant decrease in car trips by 2050.	• Significant increase in perceived and/or actual journey times relative to other modes. • Significant increase in perceived and/or actual cost of car trips relative to other modes.	• Significant road space reallocation to support other modes and local placemaking initiatives • Significant Road user charging and Urban demand management policies

Policy Development – Freight (Highway and Railway)

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate increase in highway freight trips by 2050. • Moderate increase in rail freight trips by 2050. • Moderate growth of key ports facilitated by an increase in capacity and reliability of highway and railway freight network in accommodating onward freight movements	• Moderate increase in road capacity on key corridors connecting ports, supporting a moderate reduction in congestion resulting in faster journey times and improved journey time reliability. • Moderate increase in rail capacity on key corridors connecting ports, facilitating the growth of ports in the area and ensuring a moderate shift of freight to rail.	• Investment in a moderate number of highway schemes on key freight corridors such as the A34 to be delivered in the longer term which unlock greater road capacity for HGVs and reduce congestion. • Initiatives which foster innovation and seek the effective roll out of low-emission HGV vehicles. • Investment in rail schemes which look to maximise paths for rail freight on key corridors such as the South West Main Line.
✓✓	• Moderate increase in highway freight trips by 2050. • Significant increase in rail freight trips by 2050. • Significant growth of key ports facilitated by an increase in capacity and reliability of highway and railway freight network in accommodating onward freight movements	• Moderate increase in road capacity on key corridors connecting ports, supporting a moderate reduction in congestion resulting in faster journey times and improved journey time reliability. • Significant increase in rail capacity on key corridors connecting ports, facilitating the growth of ports in the area and ensuring a moderate shift of freight to rail.	• *Increased investment in the above +* • Increasing railway gauges to accommodate higher loadings and longer freight trains. • Investment in electrifying rail lines to ensure decarbonised freight movements in 2050. • National investment in strategic rail freight hubs across the country for onward rail freight connectivity. • Digital innovation, embracing just in time logistics to maximise freight carried by the transport network using sustainable modes.

Policy Development – Local Demand Management

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate reduction in highway demand in urban centres	• Moderate increase in the cost of private vehicle use in urban centres. Desired outputs from other policy areas: • *Moderate decrease in road capacity, making private vehicle use less attractive in urban centres.* • *Complementary increase in the provision of sustainable modes to ensure a net-gain in connectivity options for users.*	• Moderate decrease in the availability of car parking and subsequent increase in the cost of car parking including workplace parking levy's in urban centres. • Increased roll out of low-emission zones in urban centres. • Investigating the potential introduction of urban demand management charges in other urban areas.
✓✓✓	• Transformational reduction in highway demand in urban centres	• Significant increase in the cost of private vehicle use in urban centres. Desired outputs from other policy areas: • *Significant decrease in road capacity, making private vehicle use less attractive in urban centres.* • *Complementary increase in the provision of sustainable modes to ensure a net-gain in connectivity options for users.*	• Significant decrease in the availability of car parking and subsequent increase in the cost of car parking including workplace parking levy's in urban centres. • Significant roll out of low-emission zones in urban centres. • Strong consideration of the potential introduction of urban demand management charges in largest urban centres.

Policy Development – National Demand Management

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate reduction in highway demand across the country	• Moderate increase in the cost of private vehicle use across the country. Desired outputs from other policy areas: • *Moderate decrease in road capacity, making private vehicle use less attractive in urban centres.* • *Complementary increase in the provision of sustainable modes to ensure a net-gain in connectivity options for users.*	• Introduction of a national road user charging mechanism which increases the variable cost of driving in light of a shift away from fossil-fuel based cars, counteracting current revenue from fuel taxes and replacing existing road tax mechanisms. • Policies which ensure equity consequences are considered to ensure those who need to drive are allocated discounts and exemptions where appropriate.
✓✓✓	• Transformational reduction in highway demand across the country	• Significant increase in the cost of private vehicle use across the country. Desired outputs from other policy areas: • *Significant decrease in road capacity, making private vehicle use less attractive in urban centres.* • *Complementary increase in the provision of sustainable modes to ensure a net-gain in connectivity options for users.*	• Introduction of a progressive, national road user charging mechanism which increases the variable cost of driving to where driving is much-less attractive than alternative modes for short, medium and longer-distance journeys. • Policies which ensure equity consequences are considered to ensure those who need to drive are allocated discounts and exemptions where appropriate.

Policy Development – Localisation

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate change in our approach to spatial and transport planning policy which looks to facilitate complete neighbourhoods where residents have access to services.	• Moderate change in spatial and transport planning which meets desired outcomes. Desired outputs from other policy areas: • *Complementary increase in the provision of sustainable modes to ensure short-distance trips are accessible and attractive for all.*	• Spatial planning policy initiatives encouraging mixed-use developments • Urban design policy initiatives which promote higher-density developments
✓✓	• Significant change in our approach to spatial and transport planning policy which looks to facilitate complete neighbourhoods where residents have access to services.	• Significant change in spatial and transport planning which meets desired outcomes. Desired outputs from other policy areas: • *Complementary increase in the provision of sustainable modes to ensure short-distance trips are accessible and attractive for all.*	• *Increased focus in the above +* • Digitalisation and other initiatives which support home working • Designing an attractive public realm with local leisure facilities to encourage more local trips are made by sustainable modes
✓✓✓	• Transformational change in our approach to spatial and transport planning policy which delivers the concept of a "15-minute city" which ensures residents meet most of their daily needs within a short distance from home through delivering a decentralized urban environment which revitalizes local centres.	• Transformational change in spatial and transport planning which meets desired outcomes. Desired outputs from other policy areas: • *Complementary increase in the provision of sustainable modes to ensure short-distance trips are accessible and attractive for all.*	• *Increased focus in the above +* • Urban design principles which minimize walk and cycle journey times whilst increasing vehicle journey times • Spatial planning policy initiatives require to adhere to 15-minute city principles

Policy Development – Digital Connectivity

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Moderate reduction in the need to travel for working purposes.	• More residents are working from home	• Small-scale increase in digital connectivity, such as reliable broadband connectivity for all
✓✓	• Moderate reduction in the need to travel for working purposes. • Moderate reduction in the need to travel for other purposes, such as leisure.	• More residents are working from home • More residents are conducting leisure activities at home and/or locally • When residents do travel, they are embracing Mobility as a service applications which when coupled with a reduction in the need to travel, supports a shift away from personally-owned modes of transportation and towards mobility provided as a service.	• Significant investment in high-speed broadband connectivity for all • Significant innovation and investment in Mobility as a service initiatives
✓✓✓	• Significant reduction in the need to travel for working purposes. • Significant reduction in the need to travel for other purposes, such as leisure.	• Significantly more residents are working from home • Significantly more residents are conducting leisure activities at home and/or locally • When residents do travel, they are embracing Mobility as a service applications which when coupled with a reduction in the need to travel, supports a shift away from personally-owned modes of transportation and towards mobility provided as a service.	• Transformational investment in high-speed broadband connectivity for all • Opportunities and support for workers to work from home if possible • Transformational innovation and investment in Mobility as a service initiatives

Policy Development – Zero Emission Vehicle Uptake

Policy Score	Desired outcomes	Desired outputs	Interventions to achieve desired outcomes
✓	• Significant reduction in emissions from transport vehicles in 2050.	• Mostly decarbonised car and vehicle fleet by 2050 (in line with EFT 2021 assumptions). • Small reduction in emissions from HGV through more efficient vehicles by 2050.	• Moderate technology investment to ensure successful rollout of electric vehicles that are accessible to the population. • Ban of ICEs by 2035.
✓✓	• Near net zero emissions from transport vehicles in 2050.	• Fully decarbonised car and LGV fleet by 2050 (in line with SMMT Central Scenario fleet assumptions). • Significant reduction in emissions from HGV through technology development	• Significant technology investment to ensure successful rollout of electric vehicles that are accessible to the population. • Significant technology investment to ensure successful rollout of electric HGVs. • Ban of ICEs by 2035.
✓✓✓	• net zero emissions from all transport vehicles in 2050.	• Fully decarbonised vehicle fleet in 2050 (including cars, LGVs, HGVs, buses and other vehicle types) in line with Carbon Sixth Budget Trajectory.	• Transformational technology investment to ensure successful rollout of electric vehicles that are fully accessible to the population. • Ban of ICEs by 2035. • Significant technology investment to ensure successful rollout of electric HGVs from 2035.
✓✓✓✓	• net zero emissions from transport vehicles in 2040.	• Fully decarbonised vehicle fleet in 2040 (including cars, LGVs, HGVs, buses and other vehicle types).	• Transformational technology investment to enable a fast rollout of electric vehicles, and particularly that of electric HGVs (from 2030). • Ban of ICEs by 2030.

For further information please contact

Mark Valleley
TfSE Client Project Manager
Mark.Vallely@eastsussex.gov.uk

Steven Bishop
Technical Advisor Programme Director
Steven.Bishop@steergroup.com

James Draper
Workstream Project Manager
James.Draper@steergroup.com

Tamsin MacMillan
Workstream Peer Review
Tamsin.Macmillan@atkinsglobal.com

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